TMS320DM6437 DVDP Getting Started Guide

Literature Number: SPRUEV6
July 2007

Texas Instruments

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FCC Warning

Preface

About This Guide

The TMS320DM6437 DVDP (Digital Video Development Platform) is an evaluation platform that showcases the DM643x architecture and lets users evaluate the power and performance of the DM643x as a Multimedia engine. The intended audience is the user who is developing software on the DM643x.

This guide gives you overview information about the setup and use of the board and the SVSDK software provided with the board. It is intended to be used as the initial "getting to know you" document for the DVDP. Other documents provide more in-depth information. See the DVDP documentation index for a complete list of documents that have been included with the product.

Additional Documents and Resources

You can use the following sources to supplement this user's guide:

- TMS320DM6437 Digital Video Development Platform (DVDP): http://www.ti.com/dm6437dvdp
- DM6437 EVM at Spectrum Digital: http://c6000.spectrumdigital.com/evmdm6437
- *Codec Engine Application Developer's Guide* (SPRUE67)
- Other PDF documents on the CDs included with the DVDP
- The release notes and manual index HTML pages installed with the software.

Notational Conventions

This document uses the following conventions:

- Program listings, program examples, and interactive displays are shown in a `mono-spaced font`. Examples use **`bold`** for emphasis, and interactive displays use **`bold`** to distinguish commands that you enter from items that the system displays (such as prompts, command output, error messages, etc.).
- Square brackets ([and]) identify an optional parameter. If you use an optional parameter, you specify the information within the brackets. Unless the square brackets are in a **bold** typeface, do not enter the brackets themselves.

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Chapter 1

TMS320DM6437 DVDP Overview

This chapter introduces the TMS320DM6437 DVDP (Digital Video Development Platform).

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1.1 Welcome!

Your new DVDP (Digital Video Development Platform) will allow you to evaluate TI's DaVinci^{TM} Technology and the TMS320DM643x architecture.

The board included in this kit is the DaVinci DM6437 EVM board from Spectrum Digital.

The TMS320DM6437 processor takes full advantage of the DaVinci software and development infrastructure by allowing designers to focus on the application functionality. Developers can implement video, audio, voice, and speech technology through simple calls to the DaVinci application programming interface (API) that manages the implementation of codec engines and matching screen resolutions.

The DM6437 EVM board looks like this:

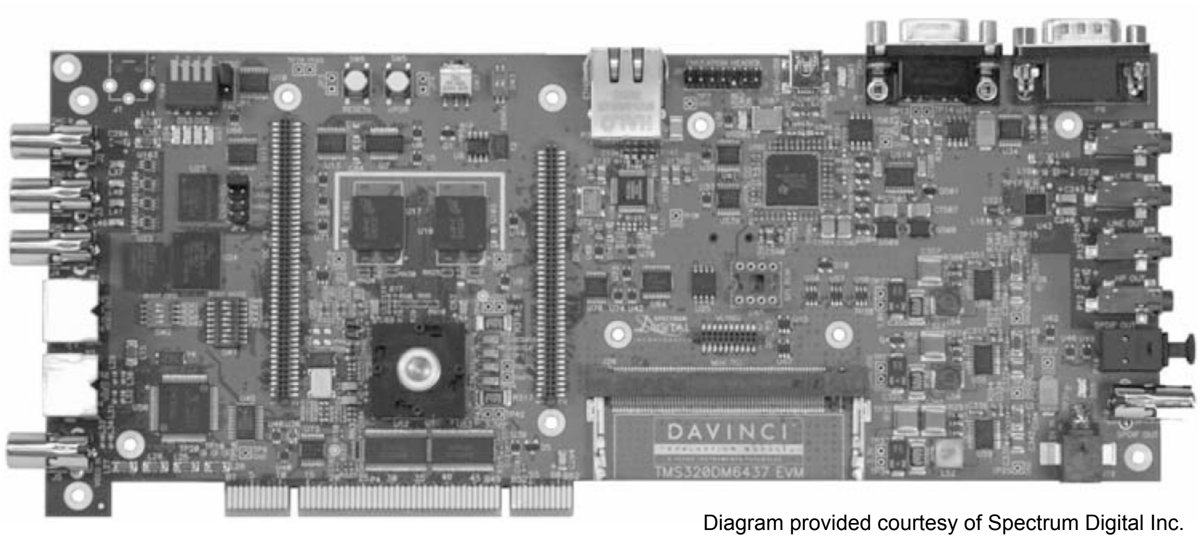

Diagram provided courtesy of Spectrum Digital Inc.

The intended audience is a developer of DSP software on the DM643x DSP.

1.2 What’s in this Kit?

Your DVDP kit contains the following hardware items. Section 2.1, *Setting Up the Hardware* tells how to connect these components.

- ☐ **DM6437 EVM Board**. This board contains a DaVinci TMS320DM6437 DSP device.
- ☐ **USB cable.** This connects the EVM board to your PC workstation to enable emulation debugging via Code Composer Studio.
- ☐ **Universal power supply.** Use this to power the board.
- ☐ **Ethernet cable.** This connects the EVM board to a PC workstation to enable the host side of the demo application.

The DVDP kit also comes with the following software CDs. Information about how to use the software components is provided in Chapter 4.

- ☐ **Digital Video Software Development Kit (DVSDK) case** (from Texas Instruments)
  - ■ **CD 1 of 2.** Contains Microsoft Windows installer for Codec Engine software and demos and an evaluation version of codecs (H.264 encoder/decoder, MPEG4 decoder, and G.711 encoder/decoder). Also contains documentation, drivers, Chip Support Library (CSL), Digital Video Test Bench, and an evaluation version of Network Developer’s Kit (NDK).
  - ■ **CD 2 of 2.** Contains sample AV files.
- ☐ **DM643x SoC Analyzer case**
  - ■ **CD 1 of 1.** Contains Windows installer for SoC Analyzer.
- ☐ **VirtualLogix™ VLX for Digital Media** (22 CD-ROMs)
  - ■ The VirtualLogix DVD case contains royalty-free VirtualLogix Linux, VirtualLogix VLX Real-Time Virtualization™ software, and the TI ’C6000 Linux compiler evaluation software. This software set allows you to develop low-cost products that require the real-time response, codecs, and applications of TI's real-time DSP/BIOS™ kernel, combined with the advanced protocol stacks, device drivers, GUI, and rich features of the Linux™ operating system, all running on a DM643x or ’C642x DSP.
- ☐ **Spectrum Digital case**
  - ■ **CD 1 of 1.** Contains Spectrum Digital Board Support Package (BSP), drivers and diagnostics, Sheldon Instruments PCI host driver, and DM6437 EVM-specific installer for Code Composer Studio. This CCStudio install package includes DSP/BIOS, the Fast FlashBurn utility, the Chip Scale Package (CSP), and more.

1.3 What's on the Board?

The following block diagram shows the major hardware components on the DM6437 EVM.

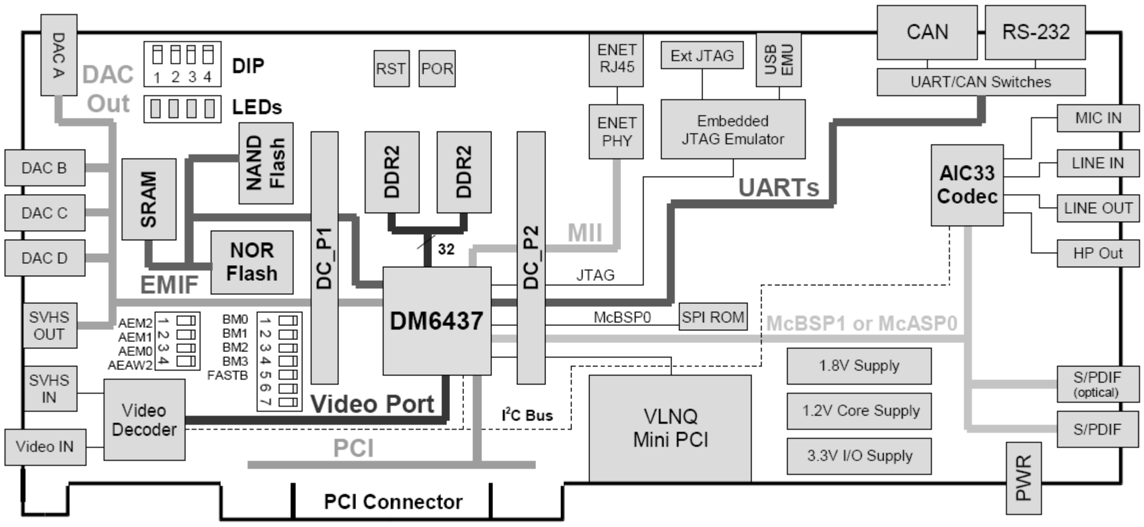

Diagram provided courtesy of Spectrum Digital Inc.

Figure 1–1 DM6437 EVM Hardware Block Diagram

For more information about the DM6437 EVM hardware, see the website at http://c6000.spectrumdigital.com/evmdm6437.

1.4 What's Next?

To get started evaluating the DVDP and developing applications for the DM643x, begin by using this Getting Started guide. It will step you through connecting the hardware, testing the software, and beginning to develop applications.

When you are ready for more information about DaVinci Technology and the DM643x architecture, see the following:

- TMS320DM6437 Digital Video Development Platform (DVDP): http://www.ti.com/dm6437dvdp
- DM6437 EVM at Spectrum Digital: http://c6000.spectrumdigital.com/evmdm6437
- *Codec Engine Application Developer's Guide* (SPRUE67)
- Other PDF documents on the CDs included with the DVDP

Chapter 2

DVDP Hardware and Software Setup

This chapter tells you how to set up the DVDP hardware and software.

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2.1 Setting Up the Hardware

To set up the hardware, use the steps that follow:

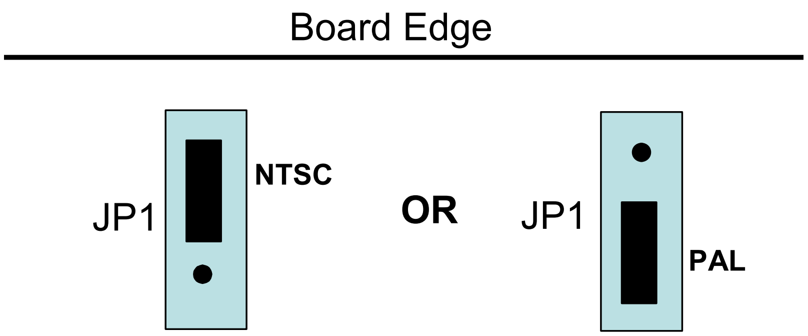
1) The DVDP is sensitive to static discharges. Use a grounding strap or other device to prevent damaging the board.

   Be sure to connect communication cables before applying power to any equipment.

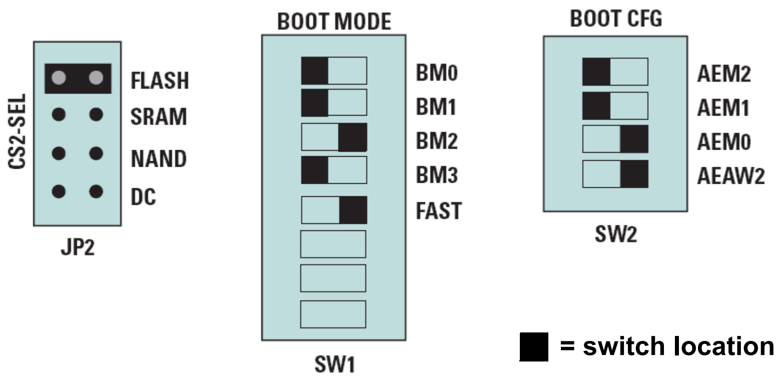
   To be ESD safe, do not plug in the power cord of peripheral devices such as audio and video input and output devices until the later step that instructs you to do so.

ATTENTION
OBSERVE PRECAUTIONS FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICES

2) Verify that the board jumper JP1 is set to the correct display format—either NTSC or PAL—as shown in the following diagram.

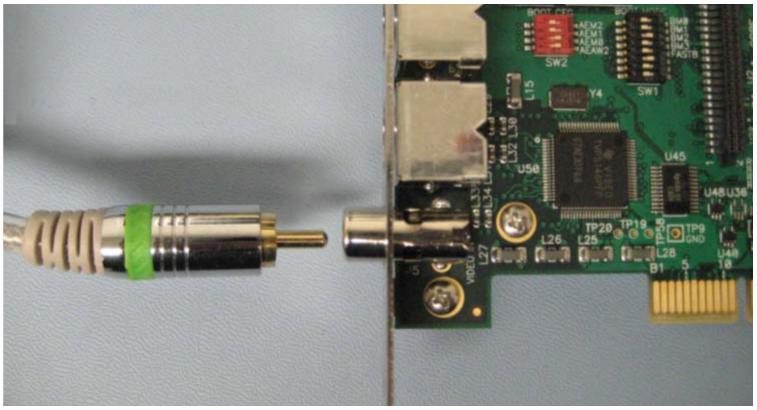


3) Verify that the board jumpers and switches are set as shown in the following diagram so that the boot mode is EMIF boot (out of Flash). Switches are "on" when switched to the right.

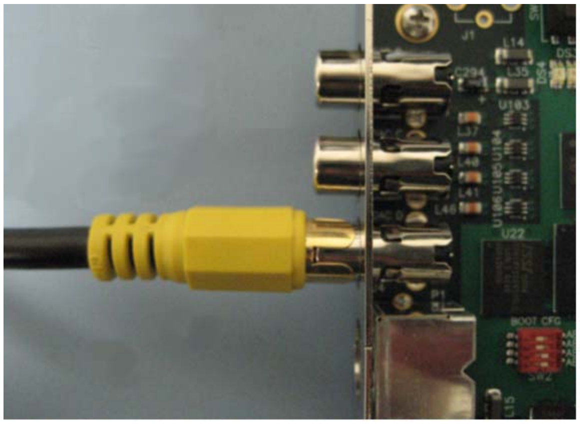


4) Install the following software using the CDs included with the kit. See Section 2.2, *Installing the Software* for more details.

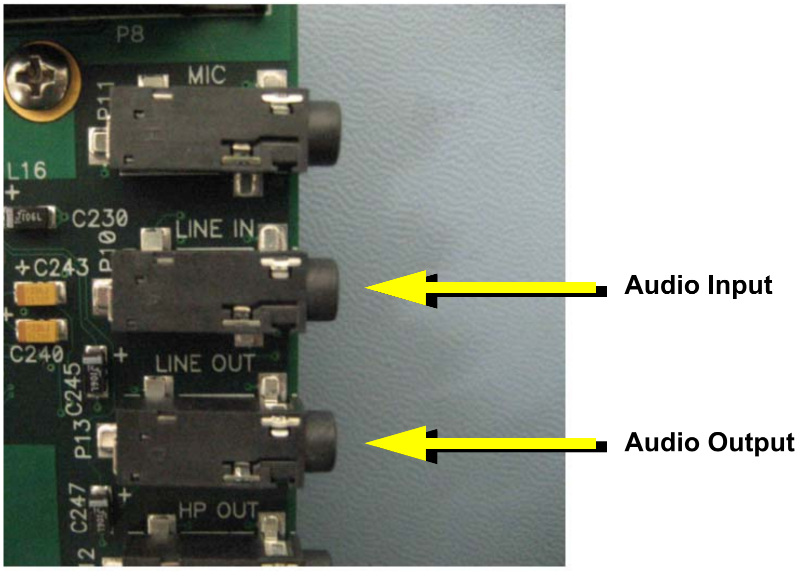
5) Connect a composite video cable from an NTSC or PAL video camera or some other video input device to the EVM board's Video In RCA jack J5 as shown below.



6) Connect a composite video cable from a video display to the EVM board's DAC D Video Out RCA jack J4.

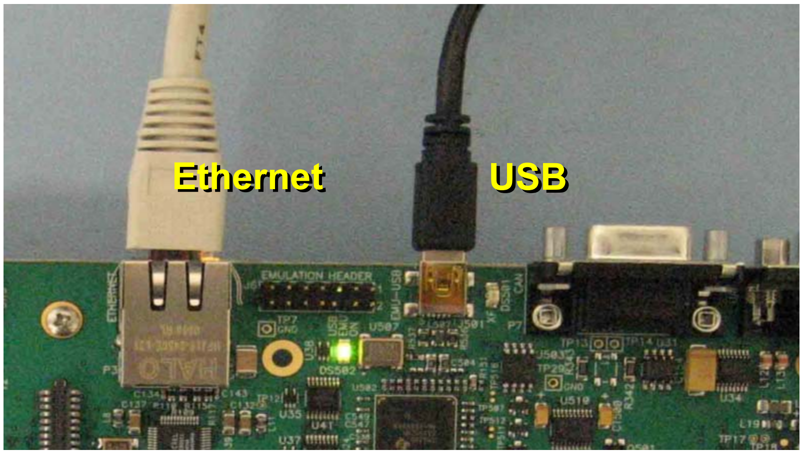


7) Connect an audio cable from a CD player, microphone, or other audio device to the EVM board’s Audio Line In Connector 3.5 mm stereo jack P10.



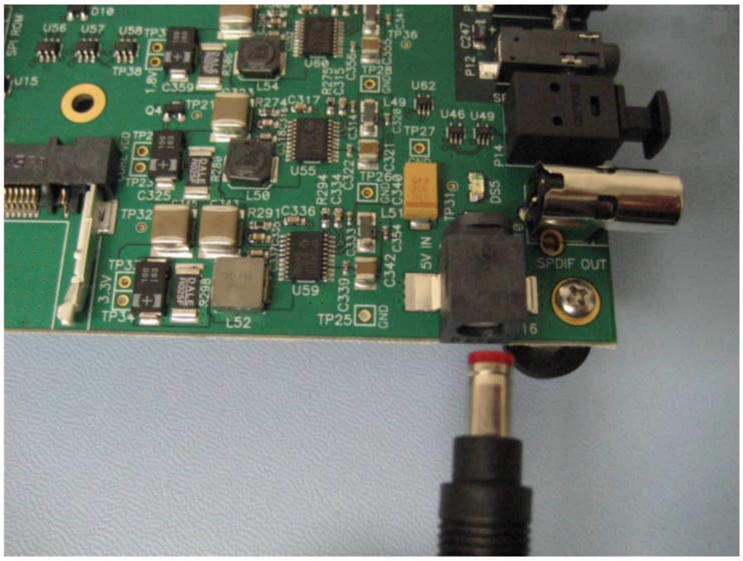
8) Connect an audio cable from a speaker to the EVM board’s Audio Line Out Connector 3.5 mm stereo jack P13.

9) Use the provided USB cable to connect the EVM's USB connector to a PC. You may want to connect through a USB hub for safety. The USB connection enables debugging via Code Composer Studio.



10) Use the provided Ethernet cable to connect the EVM's Ethernet connector to the same PC workstation to enable the host-side part of the demo application.

11) Plug in the video camera, video display, audio input device, and speaker (if necessary).
12) Connect the provided +5V power supply to an AC power source.
13) Connect the provided +5V power supply to the EVM board’s power connector as shown below.



14) You should see the following actions:
    - The EVM board should boot up and start executing the demo application in standalone mode (from flash).
    - Live video from the video source should display on the video output device. Live audio should be played if SW4-3 is set to the down position.
    - You can switch the demo mode using the Video Mode Switch (SW7). See Section 3.2, *Running the Demos in Standalone Mode*.
15) If you have used the USB cable to connect the board to your PC, you will see the Windows "Add New Hardware Wizard". If you are using Windows XP, the USB driver files should be found automatically. If the driver files are not found automatically, they are located on the Spectrum Digital CD with the filenames targ645x.inf and sdusb2em.sys. See the *TMS320DM6437 EVM Quick Start Installation Guide* for USB debugging and troubleshooting hints.

2.2 Installing the Software

To install the software needed to use the DVDP, follow these steps:

1) Use the Spectrum Digital CDs to install Code Composer Studio 3.3.
2) Also use the same Spectrum Digital CDs to install the DM6437 EVM Drivers and Target Content.
3) Optionally use the SoC Analyzer CD to install the SoC Analyzer software. See the SoC Analyzer documentation for details.
4) Install the DVSDK software for your board by following these steps:
    a) Insert the Digital Video Software Development Kit (DVSDK) CD #1 of 2 and allow the installer to autostart or alternatively run the DM6437_DVSDK_setupwin32_1_xx_xx_xx.exe file, where "xx" indicates the version and build numbers.
    b) When you are prompted for an installation directory, we strongly recommend that you use the default location. If the DVSDK is installed in a nonstandard location, you will need to edit the xdcpaths_evmDM6437.dat file located in the top-level directory to modify the path set for dvsdkInstallDir so that it points to the actual installation location.
    c) The DVSDK installer automatically launches the DSP/BIOS installer, dsp_bios_setupwin32_5_xx_xx_xx.exe, to update your Code Composer Studio directory with a newer release of DSP/BIOS (where "xx" indicates the version and build numbers). You will also need to:
        - ❖ Make sure the BIOS_INSTALL_DIR environment variable is changed to point to this new version of DSP/BIOS: BIOS_INSTALL_DIR = C:/CCStudio_v3.3/bios_5_xx_xx
        - ❖ Launch the CCStudio Component Manager and modify the Target Content (DSP/BIOS)->TMS32067xx setting to use the updated version of DSP/BIOS.
    d) A minimal set of A/V clips is installed automatically from CD #1. If you want to install the full complement of A/V clips, insert DVSDK CD #2 of 2 and run the dvsdk-avinstaller.exe installer.
5) See the release_notes_biosdvsdk_1_xx.html file installed with the DVSDK for the latest information about the software in the DVSDK and the index_manuals.html file for links to other documents in the DVSDK.

The DVSDK installation creates the following key directories in the default directory, which is C:\dvsdk_1_xx_xx_xx.

- biosutils_1_xx_xx. DSP/BIOS Log Server for NDK programs.
- codec_combos. Codec combinations that use the Codec Engine.
- codec_engine_1_xx_xx. The Codec Engine framework.
- codecs_1_xx. A/V codecs packaged for Codec Engine.
- data. Audio and video sample data files.
- dm6437_demo_1_xx_xx. Demonstration software.
- docs. Various documentation.
- dvtb_1_xx. Digital Video Test Bench.
- examples. CCStudio project-based examples.
- flashburn_files. Files for use with the FlashBurn utility.
- framework_components_1_20. Components for use with xDAIS.
- ndk_1_92_xx_xx_eval. Network Developer's Kit evaluation.
- PSP_1_xx_xx_xx. Product Support Package.
- xdais_5_20. The xDAIS interface standard and xDM extensions.
- xdc_2_xx_xx. Packaging and configuration tools.

6) Some components require extra configuration to be able to build and run the examples. For details, you should see the release notes of individual components. Some highlights are included here:

- For the NDK examples, create the following Windows environment variables. Substitute the appropriate version numbers where these commands use "x":

```
  NDK_INSTALL_DIR = C:\dvsdk_1_xx_xx\ndk_1_92_xx_xx_eval
BSL_EVMDM6437_INSTALLDIR = C:\CCStudio_v3.3\boards\evmdm6437_v2
```

- For the Codec Engine examples, follow the instructions in codec_engine_1_xx_xx\examples\build_instructions.html.

Chapter 3

Running the Demonstration Software

This chapter explains how to run the software demos provided with the DVDP.

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3.1 Overview of the Demo Software

The demo software provided with the DVDP allows you to run examples that encode and/or decode a signal. The examples can be run either entirely on the target (standalone) or via a PC host application. Four example modes are provided:

- Preview mode. (Also called Capture / Display mode.)
- Encode mode.
- Decode mode.
- Encode / Decode mode. (Also called Loopback mode.)

The algorithms used are H.264 or MPEG4 for video and G.711 for audio.

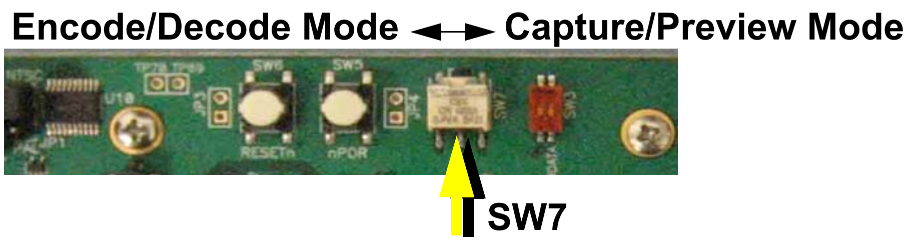
3.2 Running the Demos in Standalone Mode

When you power up the board, the pre-loaded demo application runs automatically from Flash memory. You should see the following actions:

- The EVM board boots up and starts executing the demo application in standalone mode (from flash).
- Live video from the input video device (for example, a camera) displays on the video output device.

By default, the standalone demo runs in Preview (Capture/Display) mode. In this mode, audio and video are captured by the input devices and sent directly to the output devices. No encoding and decoding is performed.

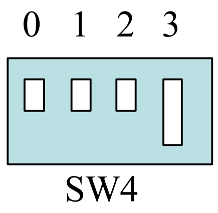
If the demo is running standalone, you can switch the demo mode using the Video Mode Switch (SW7). The Encode/Decode Loopback mode also captures audio and video from the input devices and send it to the output devices. However, the signals are encoded and decoded using are H.264 or MPEG4 for video and G.711 for audio.



The Capture/Display mode uses D1 format for video display. D1 has a resolution of 720 × 480 pixels if you are using NTSC and 720 × 576 pixels if you are using PAL.

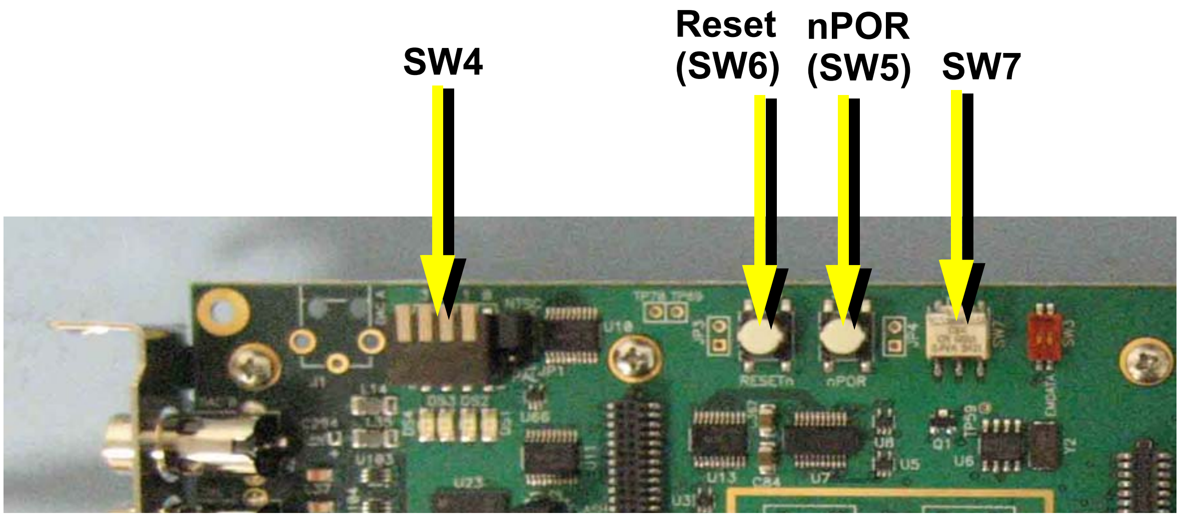
The Encode/Decode Loopback mode uses CIF format for video display. CIF (Common Intermediate Format) video format, when using NTSC, has a resolution of 352 x 240 pixels and a frame rate of about 30 frames per second. If you are using PAL, CIF has a resolution of 352 x 288 pixels and a frame rate of about 25 frames per second.

The demo also reads the SW4-3 switch (the rightmost switch when looking at the board edge-on) at startup and enables audio output if the switch is in the DOWN position.



Edge-On View
SW4-3 Up = Audio Disabled (default)
SW4-3 Down = Audio Enabled

To restart the demo, you can press the Reset button (SW6), which resets the DSP chip.



Note: Avoid using SW5. In contrast to SW6, the nPOR (power-on reset) button (SW5) resets everything on the board, including the on-board emulator—resulting in a need to restart Code Composer Studio if you were using it.

3.3 Running the Demos with the PC Host Application

The target-side demo application is stored in Flash memory and runs automatically when you power up the board.

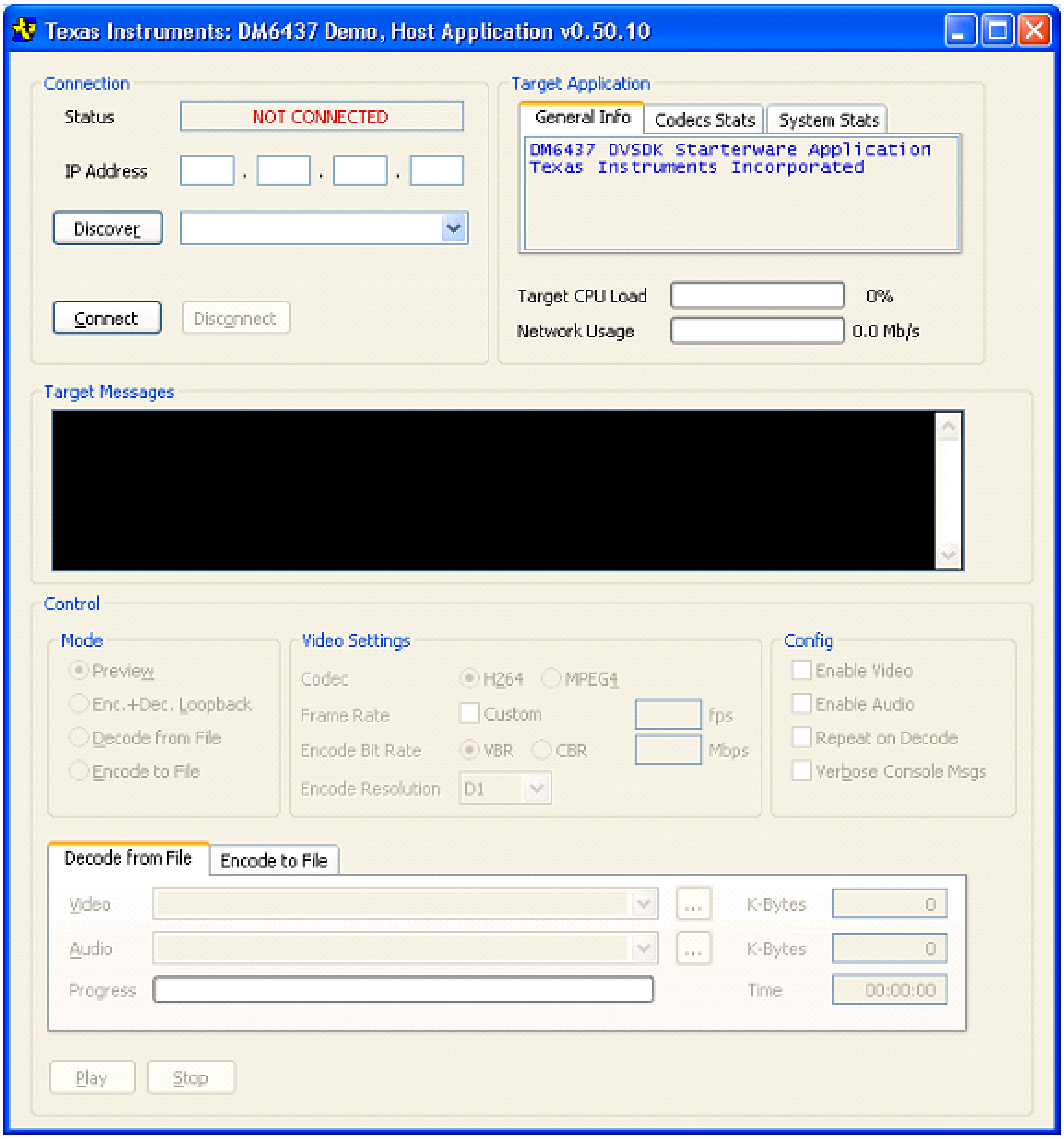
Alternately, you can run the target-side demo application manually by following these steps:

1) If you have not already done so, use CCStudio Setup to select the DM643x platform.
2) Connect to the DM6437 by choosing **Debug->Connect** (Alt+C).
3) Reset the CPU by choosing **Debug->Reset CPU** (Ctrl+R).
4) Within CCStudio, choose **File->Load Program** and select the dm643x_demo.out file in the Debug subdirectory. This loads the target program onto the DM6437 EVM.
5) Use CCStudio to run the program on the target. If you like, you can run the target program on more than one DM6437 EVM if they are connected to your network.

The PC host-side application lets you control the target-side demo application. The host-side and target-side applications exchange data only through the IP network (not through JTAG).

To run the host-side component of the demo application, follow these steps:

1) To start the host-side demo application, run the run.bat file in the C:\dvsdk_1_xx_xx_xx\dm6437_demo_x_xx_xx\hostapp directory. You can run this file from a DOS prompt or double-click on the file in Windows Explorer. You will see a window that looks like this:



Status: NOT CONNECTED

DM6437 DVSDK Starterware Application
Texas Instruments Incorporated

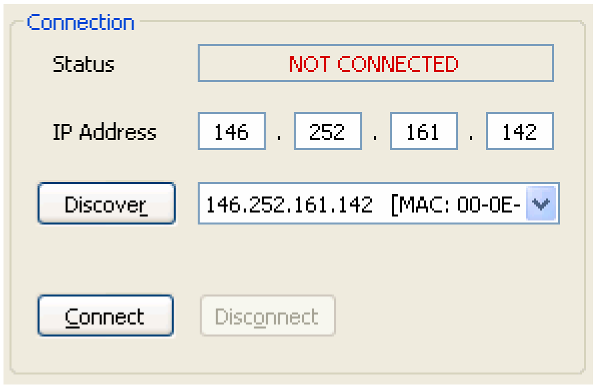
Target CPU Load: 0%
Network Usage: 0.0 Mb/s

Mode: [✓ Preview]
Codec: [✓ H264]
Encode Bit Rate: [✓ VBR]
Encode Resolution: D1

Video K-Bytes: 0
Audio K-Bytes: 0
Time: 00:00:00

2) Click the **Discover** button to find the IP address of the EVM board. (If more than one board is found, the IP and MAC addresses of all boards running the target application are listed in the drop-down, and you can select the one you want. The MAC address is also shown on the physical board.)

3) Click the **Connect** button.

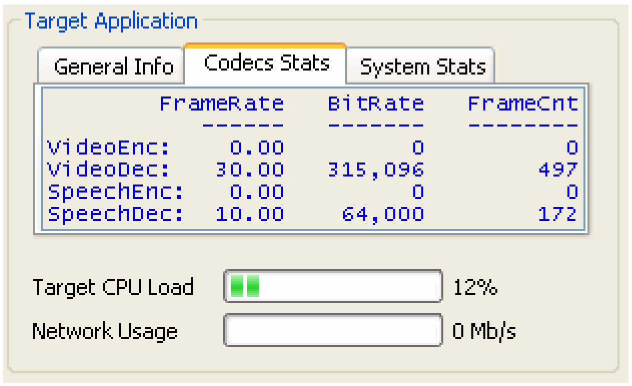

Connection

Status: NOT CONNECTED

IP Address: 146 . 252 . 161 . 142

The Status display should change to "Connected". The application is probably already running in its automatic startup mode.

4) You can see dynamically-updated information about the application's status in the Target Application area. Tabs provide General Info (application and component versions), Codec Stats (frame rates, bit rates, and frame counts for encoders and decoders in use), and System Stats (used and free memory and buffer information) are provided. In addition, the CPU load on the target DSP and the network data transfer rate (from the host's perspective) are shown in this area. The CPU load includes the load consumed by communication between the host and target.

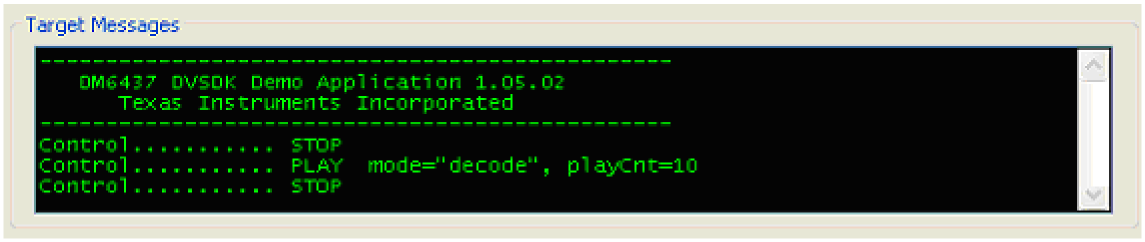


```
            FrameRate    BitRate    FrameCnt
            ---------    -------    --------
VideoEnc:     0.00           0           0
VideoDec:    30.00     315,096         497
SpeechEnc:    0.00           0           0
SpeechDec:   10.00      64,000         172
```

Target CPU Load 12%

Network Usage 0 Mb/s

5) You can read log messages from the target-side application in the Target Messages area:

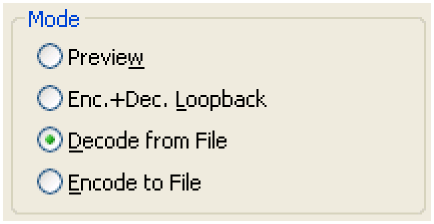


Target Messages

```
--------------------------------------------------
   DM6437 DVSDK Demo Application 1.05.02
      Texas Instruments Incorporated
--------------------------------------------------
Control........... STOP
Control........... PLAY  mode="decode", playCnt=10
Control........... STOP
```

6) To configure the application, you must first click **Stop** at the bottom of the window. This makes the Control area active.

7) In the Mode area, select the mode in which you want to run the demo. Then, go to the section indicated in this book for information on choosing files for the mode you selected and running the demo.



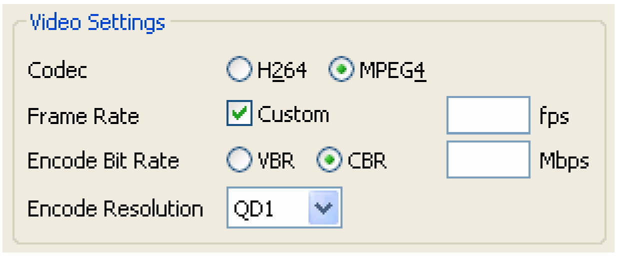
Mode

Preview [✓ Decode from File] Enc.+Dec. Loopback Encode to File

- **Preview** (also called Capture/Display mode). See Section 3.3.1.
- **Enc.+ Dec. Loopback** (also called Encode / Decode mode). See Section 3.3.2.
- **Decode from File.** See Step 9 and Section 3.3.3.
- **Encode to File.** See Step 10 and Section 3.3.4.

8) In the Video Settings area, choose the video codec and its properties for the current demo mode. You can select H.264 or MPEG4 encoding and decoding. Optionally, you can set a custom frame rate and/or encoding bit rate (either a variable or constant bit rate). For the encoding resolution, you can select full image or quarter image for NTSC and PAL.

When you select a file for decoding or encoding, the codec selection changes automatically based on the file extension. Verify that the selection is correct before running a decode or encode operation.



Video Settings

Codec: H264 [✓ MPEG4]

Frame Rate: [✓ Custom] fps

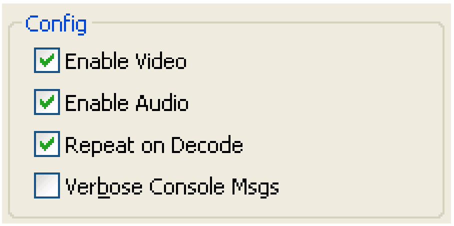
Encode Bit Rate: VBR [✓ CBR] Mbps

Encode Resolution: QD1

Note: It is possible to choose settings that result in sub-optimal video quality or that overrun the available MHz of the processor. There are no automatic checks against non-optimal parameter settings, so you should carefully choose settings and examine the resulting video output quality and DSP performance load against the design requirements. For example, it is not recommended to set the bit rate lower than 2 Mbps if you are using the H.264 encoder at D1 resolution.

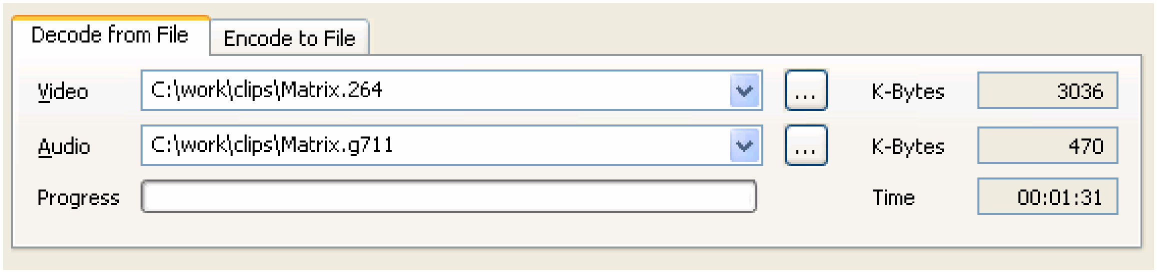
The host application provides these controls for experimental purposes. They allow you to experiment with the limits of performance and quality. If you experiment with them, keep in mind that some settings will necessarily degrade performance and quality.

9) In the Config area, choose various options for how the application should run:


Config
- [✓] Enable Video
- [✓] Enable Audio
- [✓] Repeat on Decode
- [ ] Verbose Console Msgs

- **Enable Video.** On by default. Off disables video preview and encode/decode.
- **Enable Audio.** On by default. Off disables audio preview and encode/decode.
- **Repeat on Decode.** Tells the target to repeat the file when decoding from a file. That is, to play it indefinitely.
- **Verbose Console Msgs.** Tells the target to send more detailed messages about its operation.

10) If you select "Decode from File" mode, you can select a file to decode in the Decode from File tab.



Video: C:\work\clips\Matrix.264 — K-Bytes: 3036
Audio: C:\work\clips\Matrix.g711 — K-Bytes: 470
Progress — Time: 00:01:31

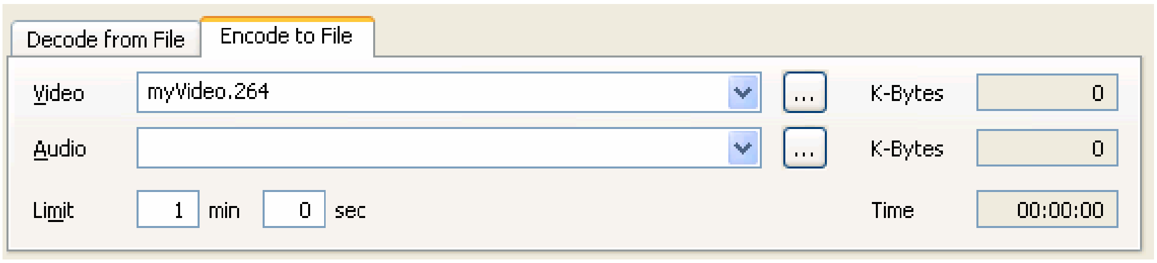
To select a video input file, click the "..." button next to the Video field. Browse to a H.264 or MPEG4 file and click **Open**. For sample data files, browse to the C:\dvsdk_1_xx_xx_xx\data\video folder.

To select an audio file, click the "..." button next to the Audio field. Browse to a G.711 file and click **Open**. For sample data files, browse to the C:\dvsdk_1_xx_xx_xx\data\sounds folder.

Note that the input video and audio files need to be "raw" files. These do not contain header information, just raw H.264, MPEG4, and G.711 data. You can download the free VLC Media Player utility, which can convert standard media files to "raw" files.

After you click **Play**, the Progress bar shows the percentage of the video file that has been consumed by the target's video decoder. The K-Bytes fields show the number KB of video and audio processed thus far. The Time field shows how long the application has been running in Decode from File mode.

11) If you select "Encode to File" mode, you can select a file location to store the encoded output from the target-side application.



Video: myVideo.264 — K-Bytes: 0
Audio: — K-Bytes: 0
Limit: 1 min 0 sec — Time: 00:00:00

To select a video output file, click the "..." button next to the Video field. Browse to the location where you want the file stored. The C:\dvsdk_1_xx_xx_xx\data\video folder is the default. Type a filename and click **Save**. No file extension is added automatically. You might want to use .h264 or .mpeg.

To select an audio output file, click the "..." button next to the Audio field. Browse to the location where you want the file stored. The C:\dvsdk_1_xx_xx_xx\data\sounds folder is the default. Type a filename and click **Save**. No file extension is added automatically. You might want to use .g711.

Note that the output video and audio files generated are "raw" files. These do not contain header information, just raw H.264, MPEG4, and G.711 data. You can download the free VLC Media Player utility, which can convert "raw" file to standard media files.

You can set a time limit for encoding in the File Output area. This prevents your disk from filling up if you leave the application running. The default is one minute. Be aware that the files generated are quite large, especially if you extend the time limit.

The K-Bytes fields show the number KB of video and audio processed thus far. The Time field shows how long the application has been running in Encode to File mode.

12) Click **Play** to begin the demo and **Stop** to halt the demo.

3.3.1 Preview Mode (Capture / Display)

This mode does not use an input file or an output file. It simply captures video from the input video device (for example, a camera) and sends it to the display. If audio is enabled, it captures audio from the audio input (for example, a microphone) and sends it to the speaker.

The signals are sent directly without any encoding and decoding.

3.3.2 Enc.+ Dec. Loopback Mode

This mode does not use an input file or an output file. It captures video from the input video device (for example, a camera) and sends it to the display. If audio is enabled, it captures audio from the audio input (for example, a microphone) and sends it to the speaker.

The H.264 algorithm is used internally to encode and decode the video. The G.711 algorithm is used internally to encode and decode the audio.

3.3.3 Decode from File Mode

Decode from File mode requires a video input file. If audio is enabled, it also requires an audio input file. It decodes the input files and sends the output signals to the display (and to the speaker if audio is enabled).

The video input file must have been encoded using H.264 or MPEG4. The audio input file must have been encoded using G.711.

3.3.4 Encode to File Mode

Encode to File mode requires a video output file. If audio is enabled, it also requires an audio output file. It encodes video from the input video device (for example, a camera) and audio from the audio input and sends the encoded signals to the files you select.

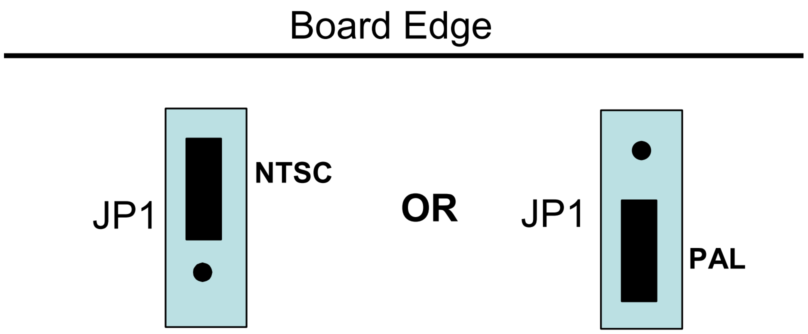
The video input file will be encoded using H.264. The audio input file will be encoded using G.711.

3.4 About Buttons and Switches

The subsections that follow describe some useful buttons and switches on the board.

3.4.1 PAL/NTSC Switch

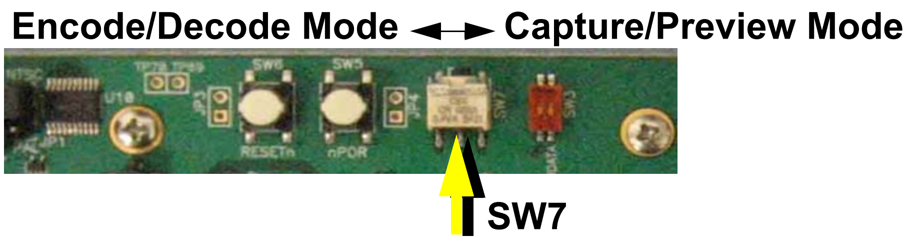
The board jumper JP1 determines whether NTSC or PAL is used. The jumper controls this setting as shown in the following diagram.



3.4.2 Demo Mode Switches

By default, the standalone demo runs in Capture/Display mode. In this mode, audio and video are captured by the input devices and sent directly to the output devices. No encoding and decoding is performed.

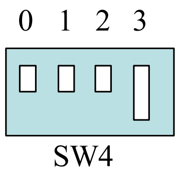
You can switch the demo mode using the Video Mode Switch (SW7).



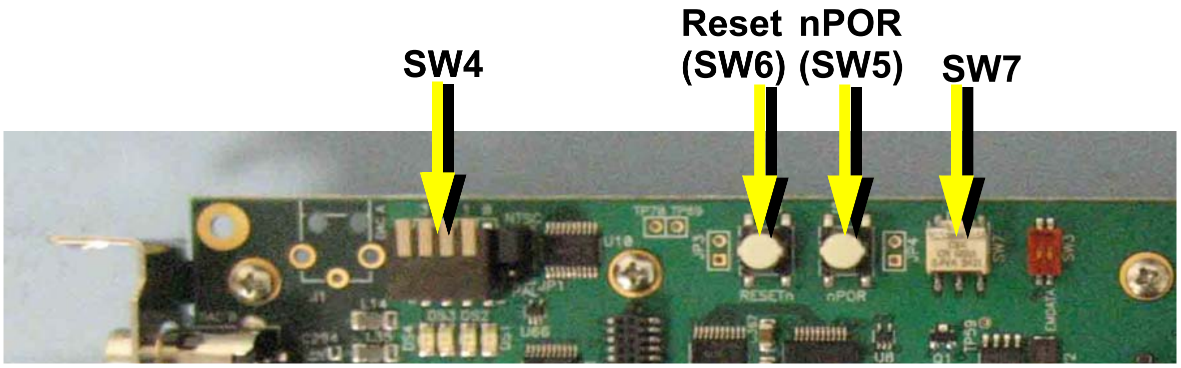
The Capture/Display mode uses D1 format for video display. D1 has a resolution of 720 × 486 pixels if you are using NTSC and 720 × 576 pixels if you are using PAL.

The Encode/Decode Loopback mode also captures audio and video from the input devices and send it to the output devices. The signals are encoded and decoded using H.264 for video and G.711 for audio. The Encode/Decode Loopback mode uses CIF format for video display. CIF (Common Intermediate Format) video format, when using NTSC, has a resolution of 352 x 240 pixels and a frame rate of about 30 frames per second. If you are using PAL, CIF has a resolution of 352 x 288 pixels and a frame rate of about 25 frames per second.

The demo also reads the SW4-3 switch (the rightmost switch when looking at the board edge-on) at startup and enables audio output if the switch is in the DOWN position.



Edge-On View
SW4-3 Up = Audio Disabled (default)
SW4-3 Down = Audio Enabled



3.4.3 Reset Buttons

To restart the demo, you can press the Reset button (SW6), which resets the DSP chip.

Note: Avoid using SW5. In contrast to SW6, the nPOR (power-on reset) button (SW5) resets everything on the board, including the on-board emulator—resulting in a need to restart Code Composer Studio if you were using it.

Chapter 4

Rebuilding DVDP Software

This chapter explains how to rebuild the software provided with the DVDP.

Topic **Page**

4.1 Software Overview

The DaVinci software approach provides interoperable, optimized, production-ready video and audio codecs that leverage DSP and integrated accelerators. These codecs are built into configurable frameworks, and are presented via published APIs within popular operating systems (such as Linux) for rapid software implementation.

4.1.1 Software Components

The software included with the TMS320DM6437 DVDP is the Digital Video Software Development Kit (DVSDK).

The heart of this software is the Codec Engine programming model. Related components include the DSP/BIOS target operating system, drivers, a networking stack (evaluation version). Customers can use the provided Codec Engine or choose individual components for their own video application development.

For the TMS320DM6437 DVDP, which is a DSP-only kit, the DVSDK includes Microsoft Windows host software.

For more information about the software components used in these applications see www.ti.com and the PDF files included with the installation.

4.2 Rebuilding the Demo Target Software

As a way to prepare to develop your own applications, you may modify the target demo applications provided with the DVDP. This document does not discuss in detail how to modify these applications.

4.2.1 Rebuilding the Examples

To rebuild the examples, follow these steps:

1) Make sure that xdcpaths.mak has the correct path for DAVINCI64LC_INSTALL_DIR and BIOS_INSTALL_DIR. These should normally be set to the following:

```
DAVINCI64LC_INSTALL_DIR := C:/dvsdk_1_xx_xx_xx
BIOS_INSTALL_DIR  := c:/CCStudio_v3.3/bios_5_31_xx
```

2) If you want to build from within the CCStudio IDE, follow these substeps:

   - Choose **Project->Open** and browse to the directory for the example you want to rebuild. (For example, C:\dvsdk_1_xx_xx_xx\examples\<*example_name*>.)
   - Select the <*example_name*>.pjt file.
   - Then choose **Project-> Rebuild All**.

3) Alternately, to build from the command line, follow these substeps:

   - Change directory to the location of the example to rebuild (for example, C:\dvsdk_1_xx_xx_xx\examples\<*example_name*>).
   - Type the following command. Note that you much use forward slashes in the path to timake.

```
C:/<path_to_CCS>/cc/bin/timake.exe <example_name>.pjt Debug
```

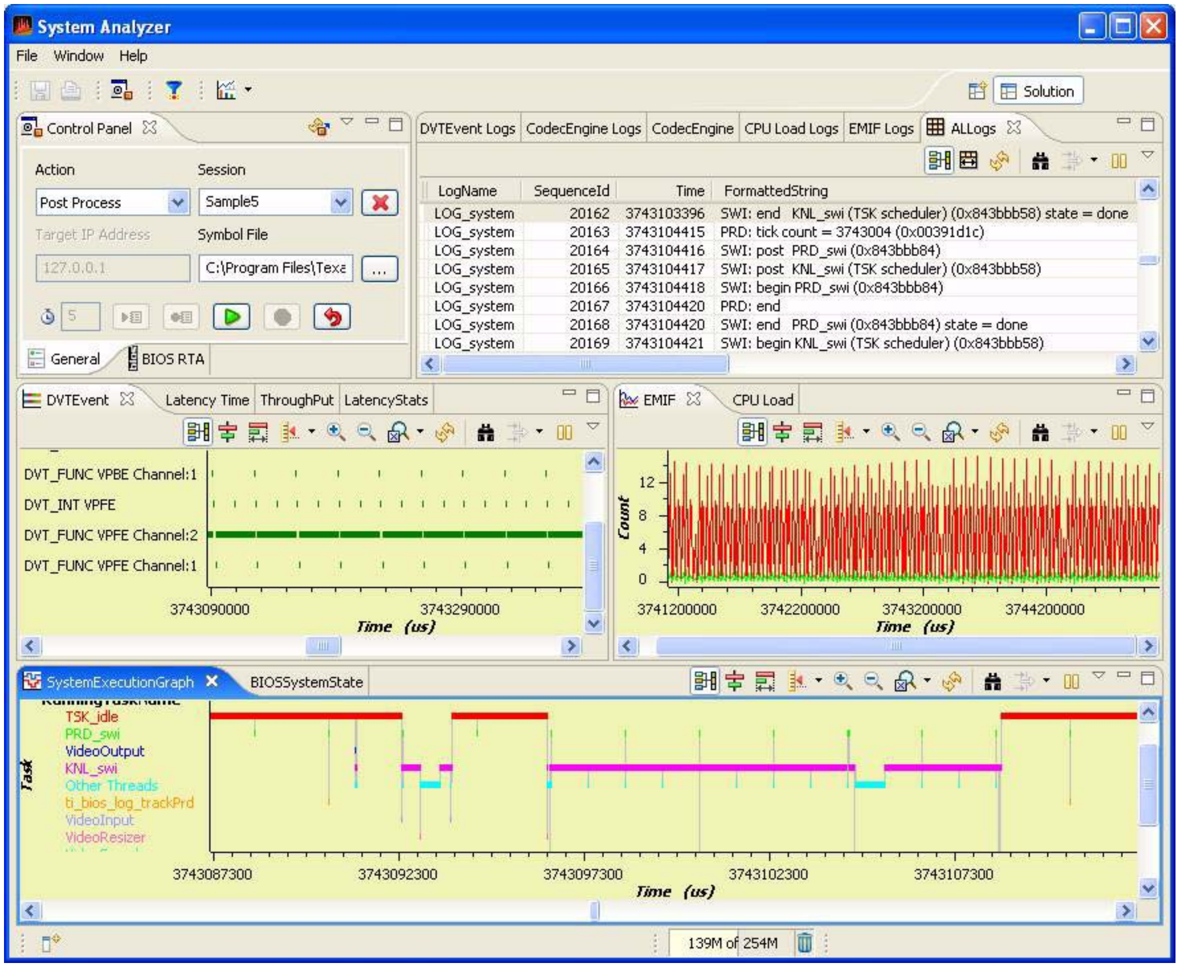
4.2.2 Viewing SoC Analyzer Logs

The SoC Analyzer is a powerful analysis tool that provides visibility into a running application for debugging and optimizing its performance.

You can view graphical representations of running tasks, SWIs, and drivers to easily identify unexpected behavior. Peripheral, CPU, and EMIF load analysis help you quickly isolate bottlenecks. Inclusive and exclusive execution-time analysis of codecs, drivers, and tasks shows whether algorithms are performing up to specifications and the impact of preemption on their performance.

Data for the SoC Analyzer is collected in real-time from framework instrumentation and is transported over TCP/IP for analysis and visualization. Using a TCPI/IP transport has the advantage of enabling local or remote data collection.

The SoC Analyzer provides advanced user interface features to allow easy correlation of system activities, isolation of unexpected behavior, and measurement of performance. For details, please see the SoC Analyzer online help, which is available from the Analyzer Help menu.



Action: Post Process
Session: Sample5
Target IP Address: 127.0.0.1
Symbol File: C:\Program Files\Texa

```
LogName      SequenceId  Time        FormattedString
LOG_system   20162       3743103396  SWI: end  KNL_swi (TSK scheduler) (0x843bbb58) state = done
LOG_system   20163       3743104415  PRD: tick count = 3743004 (0x00391d1c)
LOG_system   20164       3743104416  SWI: post  PRD_swi (0x843bbb84)
LOG_system   20165       3743104417  SWI: post  KNL_swi (TSK scheduler) (0x843bbb58)
LOG_system   20166       3743104418  SWI: begin PRD_swi (0x843bbb84)
LOG_system   20167       3743104420  PRD: end
LOG_system   20168       3743104420  SWI: end  PRD_swi (0x843bbb84) state = done
LOG_system   20169       3743104421  SWI: begin KNL_swi (TSK scheduler) (0x843bbb58)
```

The dm6437_demo.out file was built with device driver instrumentation turned off. However, pre-built instrumented versions of the driver libraries have been provided with the DVSDK product. To use these instrumented drivers, simply follow these steps:

1) Right-click on the demo project in CCStudio, and select the Instrumented option.
2) Rebuild the demo application.
3) Use CCStudio to load and run the dm6437_demo_x_xx_xx\Debug\dm6437_demo.out file.
4) Launch the SoC Analyzer by selecting Start->All Programs->Texas Instruments->SoC Analyzer 1.0->SoC Analyzer.
5) In the SoC Analyzer Control Panel, enter the IP address that was displayed in the CCStudio stdout window.
6) In the SoC Analyzer Control Panel, enter the path to the .out file.
7) You can then user the SoC Analyzer to start capturing log data and analyzing the results. See the SoC Analyzer's online help for more information.

Appendix A

Additional Procedures

This appendix describes optional procedures you may use depending on your setup and specific needs.

Topic **Page**

A.1 Using the Bootloader

You can select one of the following boot modes using the boot device pins. When the board is reset, it captures the status of these pins and branches to the appropriate code to implement the selected boot method.

- No Boot (non-secure)
- ROM Boot (non-secure)
- HPI
- PCI (DSP as slave)
- AEMIF/NOR FLASH
- AEMIF/NOR FLASH
- I2C (DSP as master)
- SPI (DSP as master)
- UART (DSP as slave)

For information about which pins to use and details about the various boot modes, see the *Using the TMS320DM643x Bootloader* (SPRAAG0) application note.

A.2 Replacing the Demo Codec Combinations

The codecs used by the demo application are packaged as combinations in C:\dvsdk_1_xx_xx_xx\codec_combos_1_00\ti\sdo\apps.

For information about combining other codecs to create your own Codec Engine configuration, see *Codec Engine Application Developer User's Guide* (SPRUE67). In particular, see Chapter 5 of that book.

A.3 Using the FlashBurn Utility

If you want to place an update to the demo software or your own application in Flash memory, you can use the FlashBurn plug-in utility.

Note: For the latest version of the FlashBurn utility and more information about it, see the www.softwaredesignsolutions.com website.

Before you can use the FlashBurn utility, you must follow these installation steps:

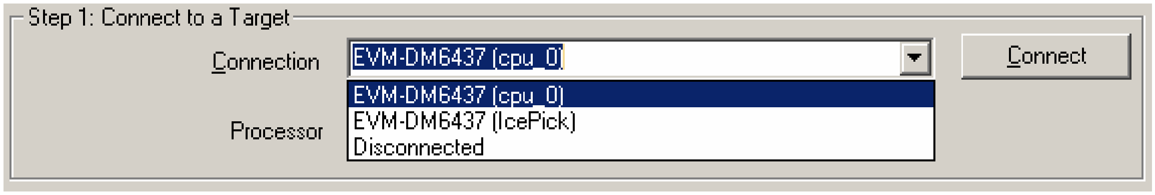
1) Install CCStudio 3.3.38.2 from the Spectrum Digital CD included in the DVDP.
2) Install the EVM Target and Drivers Content from the Spectrum Digital CD included in the DVDP.
3) **Do NOT** install the FlashBurn utility from the Spectrum Digital CD. Go to http://www.softwaredesignsolutions.com/flashburn.aspx and download the free FlashBurn DSK utility (registration required). Install the FlashBurn DSK.
4) Install the DVDP's DVSDK software, provided by TI. Within the main install directory, there is a directory called "flashburn_files", which contains all the needed files referenced in these instructions.

To flash the DM6437 EVM for booting in NOR FastBoot AIS mode, follow these steps:

1) Connect the EVM to the PC via the supplied USB cable to use the board’s embedded emulation support. Then, plug in the EVM.
2) Start DM6437 EVM CCStudio v3.3. Use the desktop icon to start CCStudio, since this sets up the proper board connection and loads the correct GEL file.

   DM6437 EVM CCStudio v3.3
3) Make sure that the JP2 jumper is set to "Flash." If it is not, shut down CCStudio, power off the board, and start over at step 1 of these instructions.
4) Connect to the target EVM by pressing Alt+C in CCStudio.
5) Reset the CPU in CCStudio. (If you skip this step, FlashBurn has trouble connecting to the EVM and loading its program successfully.)
6) Start the FlashBurn DSK Utility using the Windows Start menu to choose **All Programs->Software Design Solution->FlashBurn DSK**.
7) If you are ask to create a configuration, choose "Create a New FlashBurn configuration". Otherwise, within the FlashBurn Utility, choose **File->New** to start a new configuration file (.cdd).

8) In the Step 1 area of the FlashBurn DSK dialog box, connect to the target by choosing the "EVM-DM6437 (cpu_0)" Connection option and clicking the **Connect** button. The dialog box shows the resulting connection status.


Step 1: Connect to a Target

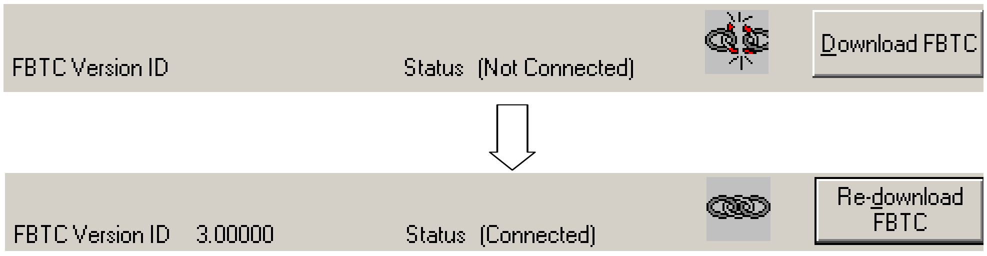
Connection: EVM-DM6437 (cpu_0)

Processor

EVM-DM6437 (cpu_0)
EVM-DM6437 (IcePick)
Disconnected

9) In the Step 2 area, click the Browse (...) button next to the "FBTC Program File" field. Locate and select the provided FlashBurn Target Component (FBTC) file, FBTCEVMDM6437.out, which is located in the flashburn_files directory of the DVSDK installation.

10) Click the "Download FBTC" button. The dialog box shows the resulting connection status.


FBTC Version ID   Status (Not Connected)

FBTC Version ID 3.00000   Status (Connected)

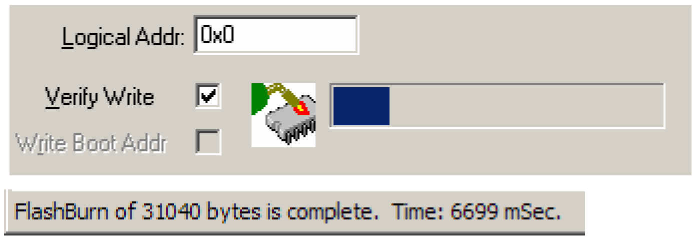
11) You may optionally click Erase Flash (in the Step 3 area of the dialog) to perform a global erase of the NOR flash to prepare for writing.

12) Prepare the application to be flashed to the EVM. The file should be in hexadecimal format (Motorola S-record or ASCII hex). You can convert a CCStudio COFF file (a .out file) to a proper hex format using the provided hexAIS tool, which is located in the <*DM6437_install_dir*>\flashburn_files\hexAIS directory. For example the "`hexAIS a.out`" command produces the file a.hex, which can be flashed to the NOR flash of the DM643x. This procedure uses the included file, DM643x.ini, to provide information on basic initialization of the system PLLs, DDR interface, and EMIFA interface. (The hexAIS tool is a .NET application and requires that the Microsoft .NET Framework v2.0 or higher to be installed. See the readme.txt file for more details.)

13) In the Step 3 area, browse for the File to burn to the NOR flash. The file should be in hexadecimal format as described previously. Leave all other settings at their defaults.

14) Click the Burn icon or choose **Program->Program Flash**.

    The status bar next to the Burn icon shows the progress of the operation. The status bar of the window shows the result of the operation when it is complete.



Logical Addr: 0x0

Verify Write [✓]

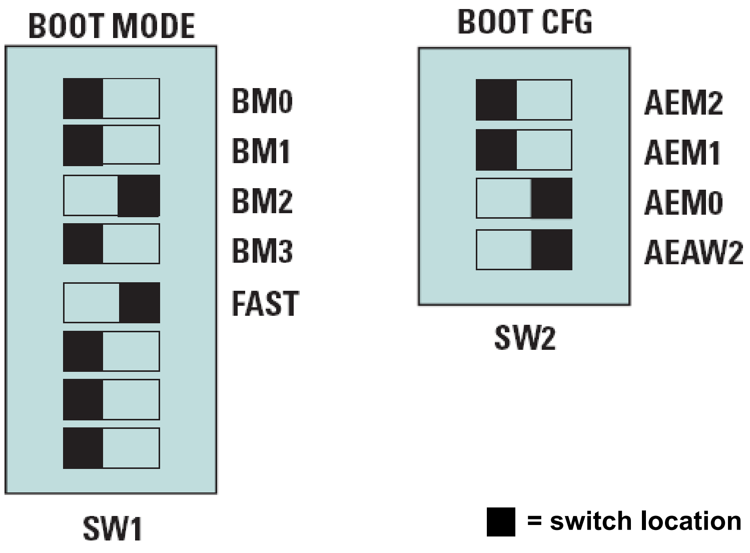
Write Boot Addr [ ]

FlashBurn of 31040 bytes is complete. Time: 6699 mSec.

15) If the burn fails, do a complete erase of the NOR region, and then try again.

16) When you are finished, close FlashBurn, press Alt+C to disconnect CCStudio from the board, and power off the board. (You may save the FlashBurn configuration file if you wish.)

17) Set the SW1 and SW2 switches as follows:



18) Turn the board on. Your application should start. Note that the AIS image format can only initialize the DDR memory (and the associated PLL2), the system PLL (PLL1), the AEMIF interface, and the PINMUX registers. Other required initialization steps (such as turning on power domains) must take place in the user application.

A.4 Rebuilding the Demo Host Software

If you want to modify the host-side demo application, you likely only need to add or remove some buttons and drop-down lists and read and write different target state parameters used by your target application. This can be done by changing the GUI script in Main.js.

The demo host-side application runs on a host machine (typically a PC running Windows or Linux) and connects over the network to a TMS320DM6437 EVM board that is running the target-side demo application. The host-side application lets users control the target's behavior and stream audio and video files to and from the target.

The host-side program is written in ECMAScript—popularly known as JavaScript—and requires no development tools other than a text editor. You run the program by running the .bat file located in the same directory as the host-side application. (To run the program in a graphical debugger, edit the .bat file itself and comment out the appropriate line.)

A.4.1 JavaScript Misconceptions

There are some common misconceptions about JavaScript. The core JavaScript language, which is used for this program, has nothing to do with Web pages; it is a general-purpose scripting language like Perl or Python.

Also, JavaScript is not Java. However, it does let developers use existing Java libraries without requiring the developer to be a Java programmer. Three such libraries are used by the host-side application script:

- Networking library
- File I/O library
- GUI library

These Java libraries are part of the XDC toolset, which is used primarily for development of target software, and are included in the DM6437EVM tools installation.

(Perl, an alternative scripting language, while more widely used, is considered less coder-friendly and would require a separate installation of Perl tools. Another alternative, executables developed with Microsoft Visual C++, is less suitable for rapid development of applications like this one and would require the installation of licensed Microsoft tools.)

JavaScript's syntax allows C programmers to understand and (to a degree) modify programs written in this language even if they have never seen this language before. To learn how to make nontrivial modifications or to write new JavaScript programs, please refer to this Web page:

`http://developer.mozilla.org/en/docs/Core_JavaScript_1.5_Guide`

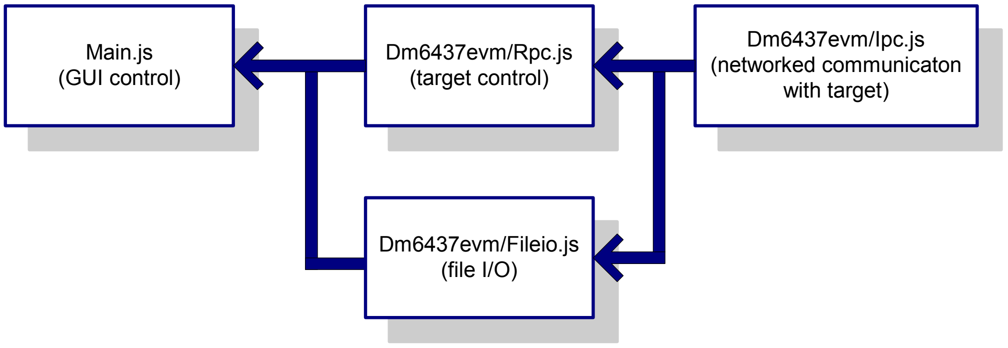
Most C programmers will not need to refer to the JavaScript guide in order to understand the scripts in this section. C programmers typically "get" patterns of JavaScript scripts quickly and can replicate them without formally learning the language.

Note that the host-side JavaScript scripts use Java library classes. Modifying these statements requires knowing the APIs of the libraries in question. However, using Java classes from JavaScript is much easier than writing Java programs in Java.

A.4.2 Structure of the Host-Side Application

The host-side application is split into four modules:

☐ **GUI control:**	`Main.js`
☐ **Target control (RPC):**	`Dm6437evm/Rpc.js`
☐ **File I/O:**	`Dm6437evm/Fileio.js`
☐ **Networking (communicates with target):**	`Dm6437evm/Ipc.js`



The main script, Main.js, is in charge of the GUI only. It draws buttons and input fields and listens for user actions to send an appropriate command to the target (for example, start playing, stop playing, and switch mode). It also starts a separate thread to run fileio functions and thus serve the target with input and output audio/video files.

The Rpc.js script (Remote Procedure Call) provides the GUI script with several functions, of which the important ones are:

- **rpc.connect(ipAddr):** Connects to the target at ipAddr.
- **rpc.paramGet(paramName):** Gets the state of a target parameter, such as "mode".
- **rpc.paramSet(paramName):** Changes the state of a target parameter. For example, sets "mode" to "decode".
- **rpc.controlPlay/Stop():** Starts and stops the target's audio/video processing.

The paramGet() and paramSet() functions read and write state variables on the target—such as I/O registers. These state variables are defined by the target application. The demo application accesses several such variables. For example:

- "runFlag" indicates whether the demo running or stopped.
- "audioEnableFlag" indicates whether audio is enabled.
- "mode" indicates the current running mode.

The Fileio.js script has an even simpler API:

- **fileio.connect(ipAddr, port):** Connects to the target's fileio port.
- **fileio.recvCmd():** Receives File I/O commands from the target.
- **fileio.dispatchCmd():** Runs received File server commands, such as "read".

The target sends commands like "open file xyz" or "read N bytes from the file" to the host. The GUI script does not care what the commands are; its only duty is to run the commands from a separate thread.

The Ipc.js script (Inter-Process Communication) takes data structures from Rpc and Fileio, serializes them, and sends or receives them to or from the target over the network. The API, which is not directly used by the GUI script, provides the following functions:

- **ipc.connect(ipAddr, port):** Connects to the port at the given address.
- **ipc.writeWord(word):** Writes a 32-bit word to the target.
- **ipc.readWord():** Reads a 32-bit word from the target.
- **ipc.writeString(string):** Passes a text string to the target.
- **ipc.readString():** Reads a text string from the target.

For details about how the Rpc, Fileio, and Ipc modules work, see their scripts directly. They follow certain rules for exchanging information between the host and the target. It is unlikely you will have to change any of those modules. If you want to modify the host and the target demo application for your own needs, on the host side you most likely need to change only the GUI script by adding or removing some buttons and drop-down lists and reading and writing target state parameters used by your target application.

A.4.3 The Main Application Script, Main.js

The flow of the main script is as follows:

- ☐ Initialize target communication modules.
- ☐ Draw buttons and other widgets on the screen.
- ☐ Assign a function to each button.
- ☐ Loop, waiting for the user to close the window.
  - ■ Whenever the user clicks a button, the function assigned to the button runs. Typically this sends some message to the target, such as "connect" or "start playback".

In more detail (and you may also want to refer to the code), Main.js flows like this:

1) First Main.js loads the two scripts, Rpc.js and Fileio.js, that implement communication with the target by sending messages to it over the network. They let us create target communication objects later on in main().
2) Then, Main.js defines global variables used in the Main.js script. Some of these variables are references to library objects, others we define as null and initialize later on.
   - ■ We create aliases for the GUI Java libraries ("classes") used. We do not use the standard Java GUI library but something called "SWT" (Standard Windowing Toolkit), which is made by IBM for its development environment, Eclipse. SWT works faster than the standard Java GUI and looks like a "normal" Windows application.
   - ■ The "debugFxn" variable turns debugging on or off. This variable is really a function (in JavaScript a variable can be of any type, including a function). If a later script line executes the command "`debugFxn( "Debug: File I/O thread started" );`", the result depends on "debugFxn" is defined. If "var debugFxn =

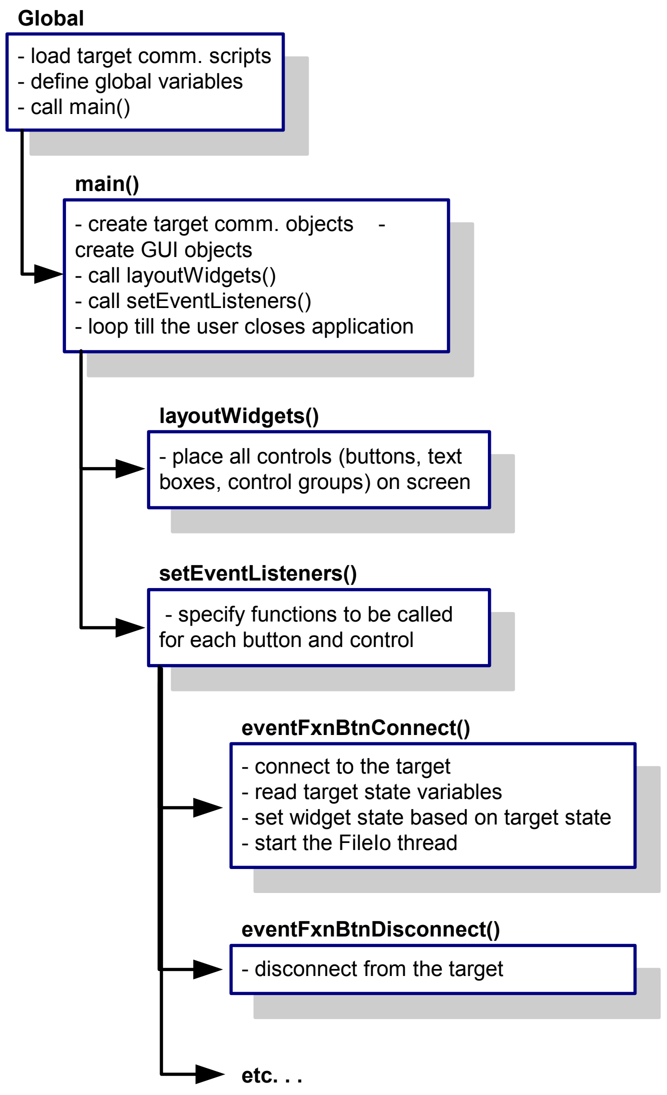
print;" and print() is a built-in function, the message appears. If "var debugFxn = function() {}", all calls to debugFxn() are silent.

- The global variables "rpc" and "fileio" are for target communication. The global variables "display" and "shell" refer to the system screen and the application's window. These are set to null and will be initialized in main().
- The variable "myWidgets" is a hash-table—an array whose elements are accessed by name instead of by index—that is initially empty. It is later filled with references to various screen controls. For example, we will read what the user types in the "txtIP1" box—the box with the first part of the target IP address—by calling "myWidgets["txtIP1"].getText();". Or, we can find out whether the user selected the "Encode" video mode with "if (myWidgets["radioEncode"].getSelection() == true)".

3) The final outside-any-function statement executed by the Main.js script is main(), which calls the function main() defined below. In JavaScript, a variable or function is in scope if it is defined anywhere in the scope; it does not have to be defined before it is referenced.

- The main() function first creates an Rpc object from the Rpc.js module. After the "rpc" variable is initialized, any function in the script can connect or send a message to the target, like "rpc.connect("168.123.012.99")" or "rpc.controlPlay()".
- The main() function creates a similar "fileio" variable for a fileio object from the Fileio.js module. For details about the Rpc and Fileio APIs, refer to their scripts.
- The main() function next creates a "display" and a "shell", initializing these global variables. The "display" is the whole screen; the "shell" is where buttons and other widgets are drawn.
- The main() function then calls the layoutWidgets() function to draws the widgets.
- The main() function then calls the setEventListeners() function to assign "event listener" functions to be called when a button is pressed.
- The main() function calls a function to gray out everything except the "connect" button's area, because the application has just started and is not yet connected.
- The main() function then runs a standard loop for SWT GUI programs that refreshes the screen and calls event functions when a button click (or some other widget event) occurs, leaving the loop only when the user closes the main window.

Here is a diagram of the functions in Main.js and their actions:


Global
- load target comm. scripts
- define global variables
- call main()
main()
- create target comm. objects -
create GUI objects
- call layoutWidgets()
- call setEventListeners()
- loop till the user closes application
layoutWidgets()
- place all controls (buttons, text boxes, control groups) on screen
setEventListeners()
- specify functions to be called for each button and control
eventFxnBtnConnect()
- connect to the target
- read target state variables
- set widget state based on target state
- start the FileIo thread
eventFxnBtnDisconnect()
- disconnect from the target
etc. . .

A.4.4 Drawing Screen Controls (Widgets)

Since we don't use a graphical editor to draw the host-side application widgets, we lay them out within the script in a recipe-like fashion. For our application window (the "shell"), the script says which groups of widgets are drawn next to, below, or within others.

A "widget" is a common name for a single element like a button, text field, label, drop-down box, or a container for other widgets.

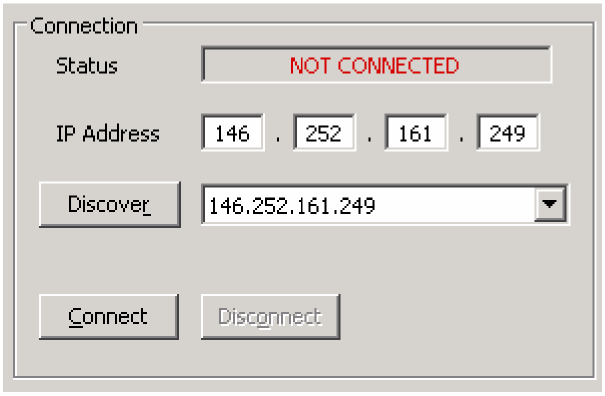
Containers are special because they can contain other widgets—both simple elements and other containers. This application uses two kinds of containers: "Groups" and "Composites". The difference between these is that Groups have visible frames around the widgets they contain, while Composites have no visible frames.

Another thing to know about containers is that a "grid" layout specify how widgets inside them are laid out. Grids are matrices (including matrices with only one row or column) in which each grid cell contains a widget (including container widgets).

Each grid cell can be aligned left, right, or centered. A cell's width or height can also be controlled, but we usually don't have to. If we set the width of a widget in pixels, the grid's column width adapts automatically to match the widest element in the column. Also, if the widget size isn't specified, it adapts to the size needed to display its text.

A number of other properties of containers (for example, "margin width", "vertical spacing", and "make all columns equal width") are available to create professional-looking applications.

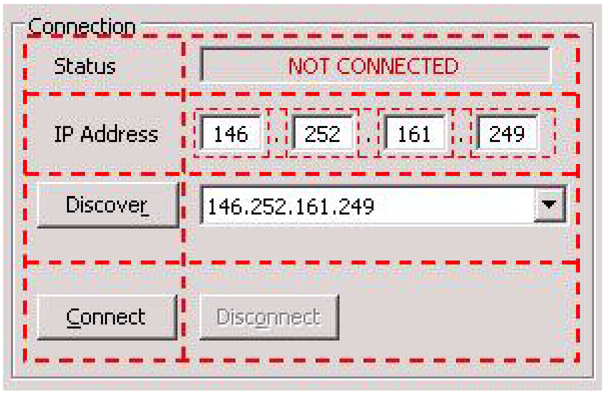
Here is an example. If you run the host-side application, the "Connection" frame contains several buttons and text fields, one drop-down list (called a "combo box"), and a few labels:



The "Connection" frame is a cell in a larger grid, but it could be the only thing on the screen—we'd script it the same way. This needs to be a "Group" container, because we want a visible frame with "Connection" as the text. We give this container a grid with 2 columns in each row.

One challenge is that we have two widgets per row in all rows except the second—the IP address takes 7 widgets: four text fields and three labels (each containing just "." as its text). So, we treat the IP address set of fields differently. We lump all of its widgets into an invisible "Composite" container and put that composite in the second cell of the second row. Then, as far as the "Connection" group is concerned, it sees only two elements in each row.

The following figure shows how the widgets in the Connection frame are grouped into containers and cells.



Let's look at the script code that does this layout. We define two handy functions, WID() and END() (almost like macros) that make the code look more readable. WID(<new widget>) adds the new widget to the current widget, referenced with variable $w, and makes the new widget current until a matching END() is called. WID() also returns the reference to the newly created widget object, so that we can store it in the myWidgets[] hash table. We only need to keep references to the widgets we may later want to somehow control.

The following code creates the "Connection" frame inside the current widget, and adds the first two elements—the text and field in the first row. Some formatting statements have been omitted to simplify this example.

```
                          WID( widgets.Group( $w, SWT.NONE ) );
                              $w.setText( "Connection" );  // $w = current widget
                              var gl = layout.GridLayout( 2, false );
                              $w.setLayout( gl );

                               WID( widgets.Label( $w, SWT.NONE ) );
                                   $w.setText( "   Status" );
                               END();

w["txtStatus"] =               WID( widgets.Text( $w, SWT.BORDER | SWT.CENTER |
                                   SWT.READ_ONLY ) );
                                   $w.setLayoutData( GD( 164, SWT.DEFAULT ) );
                               END();
```

This code creates the "Connection" group, sets its label text appropriately, and gives it a grid layout of 2 columns per row. The function that creates a new layout is GridLayout(<#columns>, <make cols equal width>).

All widgets, when created, as a first argument take the reference of the containing widget. With our macro-like functions, it is always "$w". The second argument to a widget usually defines some attribute(s), such as whether it has a border or how is its text justified.

We then add a label, "Status", and create a text box to contain the connection status. The connection status text could be placed in another label like "Status", because we can change the text of any widget dynamically, but we use a text box for an aesthetic effect. We make the textbox have a border, have its text center-aligned, and be read only; we also record its reference in myWidgets["txtStatus"], where "w" is a short alias for "myWidgets". In the next line, we say that the grid cell where the text box is should be 164 pixels wide and have the default height (determined by the textbox's font and font size).

To learn which widgets are available and which properties they have, see the following web page. This site has a picture of each widget, its API syntax, and an example code snippet.

```
http://www.eclipse.org/swt/widgets
```

The rest of the layout code for the "Connection" frame lays out the "IP address" label, the invisible 7-column "Composite" with its IP address fields and labels, the "Discover" button and combo box, and the "Connect" and "Disconnect" buttons. Note how the END() function closes the definition of a widget:

```
                          WID( widgets.Composite( $w, SWT.NONE ) );
                              var gl = new layout.GridLayout( 7, false );
                              gl.marginWidth = 0;
                              $w.setLayout( gl );
w["txtIP1"] =                 WID( widgets.Text($w,SWT.BORDER|SWT.CENTER ));
                                  $w.setLayoutData( GD( 20, SWT.DEFAULT ) );
                              END();
                              WID( widgets.Label( $w, SWT.NONE ) );
                                  $w.setText( "." );
                              END();
w["txtIP2"] =                 WID( widgets.Text($w,SWT.BORDER|SWT.CENTER));
                                  $w.setLayoutData( GD( 20, SWT.DEFAULT ) );
                              END();
                              WID( widgets.Label( $w, SWT.NONE ) );
                                  $w.setText( "." );
                              END();
                              ... etc, for IP3 and IP4
                          END();

w["btnDiscover"] =        WID( widgets.Button( $w, SWT.PUSH ) );
                              $w.setText( "   Discove&r   " );
                          END();

w["cmbDiscover"] =        WID( widgets.Combo( $w, SWT.READ_ONLY ) );
                              $w.setLayoutData( GD( 158, SWT.DEFAULT ) );
                          END();

w["btnConnect"] =         WID( widgets.Button( $w, SWT.PUSH ) );
                              $w.setText( "   &Connect   " );
                          END();

w["btnDisconnect"] =      WID( widgets.Button( $w, SWT.PUSH ) );
                              $w.setText( " Disc&onnect " );
                          END();
                      END();
```

The indentation before WID() and END() functions lets us better see which object contains which. It is not necessary to use WID() and END(), but we use them because they improve readability of the code. (If you place a widget in the wrong container, you'll often get drastically different results.)

A.4.5 Reacting to Button Clicks

The setEventListeners() function assigns a function to every widget the user can click. The first such assignment—remembering that "w" is an alias for the "myWidgets" hash table—is as follows:

```
w["btnDiscover"].addListener( SWT.Selection, eventFxnBtnDiscover );
```

That means, when the user clicks the "Discover" button, our eventFxnBtnDiscover() function is to be called. If you look at the body of that function further below, you'll see the expected—it calls the rpc.discover() function, which returns zero or more IP addresses of targets running the demo (determined by their response to a specific broadcast message, see Rpc.js for details), and then fills in the w["cmbDiscover"] drop-down list with those addresses and copies the first in the list into the "IP address" input fields.

However, setEventListeners() defines shorter functions for events with simpler actions right on the spot. Take this one for example:

```
w["btnInVideoBrowse"].addListener( SWT.Selection, function( event ) {
     var dialog = new widgets.FileDialog( shell );
     var fileName = dialog.open();
     if (fileName != null) {
         w["cmbInVideo"].add( fileName, 0 );
         w["cmbInVideo"].select( 0 );
        w["txtInVideoSizeKB"].setText( Math.floor( new java.io.File(
             fileName ).length() / 1024 ) );
     }
 } );
```

This is a function for the "Browse for Input Video file" button. It opens a new file dialog, and, if the user has selected a file, it adds the file to the top of the "input video file" drop-down list and makes it the first choice. Then, it reads the file's size and shows it in the "txtInVideoSizeKB" read-only textbox. (The function call java.io.File(fileName).length() returns the file size in bytes or 0 if the file doesn't exist.) Such versatile Java library functions make the scripts short.

A.4.6 Exceptions

(C++ and OOP developers can skip this section, since they will be familiar with the type of exception handling used by JavaScript.)

The APIs provided by the Rpc.js, Fileio.js, and Ipc.js scripts have functions that do not return success or failure. Instead, if en error occurs, an "exception" is thrown, either by a system module that the function uses or by the function itself if it detects some irregularity. That exception travels up the call stack until it is caught. If no function catches it, the application exits in an error with its call stack listed.

This behavior frees us from having to check the return status frequently. Instead, we catch exceptions by enclosing function(s) whose execution can result in an exception in a "try-catch" block like the following:

```
try {
    function(s) called here
} catch (e) {
    // we're here only if an error occurred
    print ("error occurred, reason: " + e)
}
```

In the demo application, the Main.js script contains examples of "try-catch" blocks.

A.4.7 Threading

The host-side application is multi-threaded.

- The **main thread** runs the main() function, looping to see if the display should be refreshed, dispatching any events, and exiting when the window is closed. Each of our widget event functions, called by the SWT GUI system, runs in the context of that main thread. So the main application thread is in charge of the GUI.
- Another thread is the **FileIO thread**. When the main thread connects to the target, it soon starts a separate thread that connects to the target on a different port. This new thread becomes the target's file server. The new thread reads input files from the disk and sends audio/video data to the target, and receives data from the target and writes output files.
- The application also uses an occasional **timer thread** to update a counter or periodically check for target status.

Creating a new thread in JavaScript is simple. For example, in code like this, the main thread prints "Hello", then creates a secondary thread that prints "cruel" when it runs, and finally the main thread prints "world".

```
print( "Hello" );
new java.lang.Thread( new java.lang.Runnable() {
    run: function() {
        print( "cruel" );
    }
} ).start();
print( "world" );
```

The new thread may print its message between the two main thread's messages or after. The new thread also could run a loop, perhaps sleeping occasionally by calling java.lang.Thread.sleep(<milliseconds>) or yielding the CPU with java.lang.Thread.yield(). This is all standard for any threading system; the difference is only the ease of thread creation.

All threads can read and write the script's global variables. For example, the fileio thread loops while the "stopFileIoThreadFlag" global variable is false. This variable is set to true by the main() function when it exits.

Threads whose "run" functions are defined inline—as in the "Hello world" example above—have access to all the variables in the scope of the function that defined them. That lets us define quick, short thread functions without having to define separate functions and pass on piles of variables.

The only exception to this idyllic picture comes when different threads need to access GUI objects: "shell" and "myWidgets[]" in our case. They cannot be accessed directly from a thread other than the main thread. For example, this would fail:

```
// main thread
w["myText"].setText( "lovely" );
new java.lang.Thread( new java.lang.Runnable() {
    run: function() {
        // new thread
       print( "Hello " + w["myText"].getText() + " world" );
    }
} ).start();
```

The main thread sets the text of the "myText" text widget and creates the new thread. But the new thread is not allowed to call the "getText()" method of the w["myText"] object. It can get around this limitation by calling a method "display.syncExec()" or "display.asyncExec()" and specify a thread-like code within it to access the widget:

```
w["myText"].setText( "lovely" );
new java.lang.Thread( new java.lang.Runnable() {
    run: function() {
        var myTextContents;
        display.syncExec(
            new java.lang.Runnable() {
                run: function() {
                    myTextContents = w["myText"].getText();
                }
             }
        );
        print( "Hello " + myTextContents + " world" );
    }
} ).start();
```

The new thread now makes a blocking call to the display.syncExec() method that creates yet another thread, but now one that is allowed to read the widget. The newest thread reads the contents of the text widget, stores it in the second thread's local variable, "myTextContents", and exits. Then the second thread continues and goes on to print the contents of its local variable, "myTextContents", knowing that it has been set to reflect the contents of the widgets that it couldn't access directly.

We use display.asyncExec() a couple places in Main.js. One such example is the fileio thread. The main thread in Main.js spawns a new thread to be a fileio server upon connection to the target. The new thread calls fileio.recvCmd() and fileio.dispatchCmd(cmd) methods in a loop. The later one can be (and often is) a write request from the target—the target wants to write data to a file or text on the console. If you look at Fileio.js, you will see that the function that implements write also calls a method "showWriteInfo(filename, newFileSize)". This method is by default a dummy function, but the fileio thread in Main.js sets this method to update the file size textboxes on the screen. And this is where display.asyncExec() comes to play:

Fileio's showWriteInfo is effectively a callback, called from another thread, and is set to update some widgets on the screen. We know that is not allowed, so in Main.js' fileio thread we set the callback not to be a simple update of the text, but we wrap it around display.asyncExec() and it all works.

Why didn't we use display.syncExec() (that is, the blocking version)? The answer is, we don't want the fileio thread to be blocked on what is a less important task—updating the widgets—and be less responsive to the data the target sends. This problem would be compounded if the main thread happened to be doing a blocking call itself, like rpc.controlStop(), which exchanges some messages with the target. Then the fileio thread would unnecessarily wait for that blocking call to complete just so it can finish updating some not-so-important widget. This is why display.asyncExec() is the right method to use.

A.4.8 Final Note on JavaScript

One of the strengths of JavaScript is that functions can be defined and even generated on the fly. Any syntactically valid text can be turned into a function.

Another strength is that variables can be of any type, and fields in a structure like hash-table can be added on the fly and be of any type.

These features both carry dangers. Incorrect functions can be constructed and you won't know until you run them. Also, typos can set a wrong field or value in a hash-table without any error. Traditional languages have compilers to prevent some of these errors.

A third powerful feature is the integration of Java classes and ability to use them easily. Since Java classes could be made to access native code like driver DLLs, it would not be difficult to create wrapper Java classes that would call low-level driver functions from a JavaScript script.

A.4.9 Information Resources for ECMAScript (JavaScript) and Libraries

JavaScript programs can readily use Java libraries just by knowing their APIs. Here are the resources for the libraries used in this application:

- **JavaScript:** http://developer.mozilla.org/en/docs/Core_JavaScript_1.5_Guide
- **Java Networking overview:** http://java.sun.com/docs/books/tutorial/networking/index.html
- **Java Networking sockets:** http://java.sun.com/j2se/1.4.2/docs/api/java/net/Socket.html
- **Java File I/O:** http://java.sun.com/docs/books/tutorial/essential/io/
- **GUI widgets and APIs:** http://www.eclipse.org/swt/widgets/
- **Programming with SWT:** http://www.developer.com/java/other/article.php/3330861

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