

TI-RTOS 2.00 for Sitara

Getting Started Guide



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Read This First

About This Manual

This manual describes TI-RTOS for Sitara. The version number as of the publication of this manual is v2.00.

Notational Conventions

This document uses the following conventions:

- Program listings, program examples, and interactive displays are shown in a special typeface. Examples use a bold version of the special typeface for emphasis.

Here is a sample program listing:

```
#include <xdc/runtime/System.h>
int main(void)
{
    System_printf("Hello World!\n");
    return (0);
}
```

- 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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April 11, 2014

About TI-RTOS

This chapter provides an overview of TI-RTOS for Sitara.

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1.1 What is TI-RTOS?

TI-RTOS is a scalable embedded tools ecosystem for TI devices. It scales from a real-time multitasking kernel (SYS/BIOS) to a complete RTOS solution including additional middleware components. By providing essential system software components that are pre-tested and pre-integrated, TI-RTOS enables you to focus on differentiating your application.



TI-RTOS is *not* installed automatically as part of the Code Composer Studio v6.0 installation. You can install TI-RTOS from the CCS App Center (choose **View > CCS App Center** in CCS). Choose the version of TI-RTOS for your device family. If you use devices in multiple families, you can install multiple TI-RTOS versions. See [Section 2.3](#) for details.

If you do not use CCS, you can [download and install TI-RTOS as a standalone product](#) (see [Section 2.4](#)).

TI-RTOS is provided with full source code and requires no up-front or runtime license fees.

1.2 What are the TI-RTOS Components?

TI-RTOS contains its own source files, pre-compiled libraries (both instrumented and non-instrumented), and examples. Additionally, TI-RTOS contains a number of components within its "products" subdirectory. The components of TI-RTOS for Sitara are as follows.

Table 1–1. TI-RTOS Components

TI-RTOS Component	Name	PDF Documentation Location
TI-RTOS Kernel	SYS/BIOS	<i>SYS/BIOS (TI-RTOS Kernel) User's Guide</i> -- SPRUJEX3
TI-RTOS Instrumentation	UIA	<i>System Analyzer User's Guide</i> -- SPRUH43
TI-RTOS Networking	NDK	<i>TI Network Developer's Kit (NDK) Guide</i> -- SPRU523 <i>TI Network Developer's Kit (NDK) API Reference</i> -- SPRU524
TI-RTOS File System	FatFS	<i>TI-RTOS User's Guide</i> -- SPRUHD4

The components in the "products" subdirectory are:

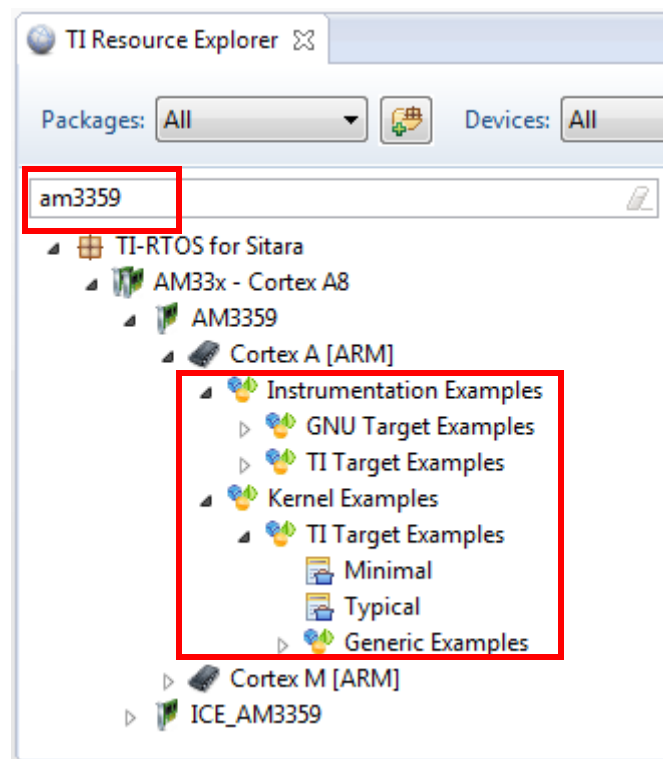
- **TI-RTOS Kernel — SYS/BIOS.** SYS/BIOS is a scalable real-time kernel. It is designed to be used by applications that require real-time scheduling and synchronization or real-time instrumentation. It provides preemptive multi-threading, hardware abstraction, real-time analysis, and configuration tools. SYS/BIOS is designed to minimize memory and CPU requirements on the target.
- **TI-RTOS Instrumentation — UIA.** The Unified Instrumentation Architecture (UIA) provides target content that aids in the creation and gathering of instrumentation data (for example, Log data).
- **TI-RTOS Networking — NDK.** The Network Developer's Kit (NDK) is a platform for development and demonstration of network enabled applications on TI embedded processors.
- **XDCtools.** This core component provides the underlying tooling for configuring and building TI-RTOS and its components. XDCtools is installed as part of CCSv6. If you install TI-RTOS outside CCS, a compatible version of XDCtools is installed automatically. XDCtools is installed in a directory at the same level as TI-RTOS, not in the "products" directory of the TI-RTOS installation.

1.3 How Can I Find Example Projects?

TI-RTOS and its components provide numerous examples that you can import using the **TI Resource Explorer** in Code Composer Studio (CCS). These examples use TI-RTOS and its components and have all the settings needed for your device. Expand the tree in the TI Resource Explorer to see the examples that are available for your device. TI Resource Explorer provides TI-RTOS examples for both the TI and GNU tool chains.

- **Instrumentation Examples** are UIA examples.
- **Kernel Examples** are the SYS/BIOS examples.

Follow the steps in [Section 3.1](#) to import, build, and run these examples.



1.4 What Compilers and Targets are Supported?

The following code generation tool (compilers and linkers) versions are supported. The versions listed are recommended because they were used to build the TI-RTOS libraries and to perform testing. More recent versions are expected to be compatible.

- **Texas Instruments:** ARM CodeGen Tools v5.1.5
- **GCC:** gcc-arm-none-eabi-4_7-2013q3

The configuration uses a "target" specification during the build. This specification is sometimes called the "RTSC target." The targets supported are:

- ti.targets.arm.elf.A8Fnv
- gnu.targets.arm.A8F
- gnu.targets.arm.A9F

1.5 For More Information

To see release notes for a component, go to the subdirectory for that component within the TI-RTOS products directory. For example, `C:\ti\tirtos_sitara_2_##_##_##\products\bios_6_40_##_##` contains release notes for SYS/BIOS.

To see user guide PDFs and other documentation for a component, go to the "docs" subdirectory within the directory that contains the release notes.

To learn more about TI-RTOS and its components, refer to the following documentation:

- **TI-RTOS**
 - [TI-RTOS User's Guide \(SPRUHD4\)](#)
 - [TI-RTOS on the Texas Instruments Wiki](#)
 - [TI-RTOS forum on TI's E2E Community](#)
 - [TI-RTOS Porting Guide](#)
 - [Embedded Software Download Page](#)
- **Code Composer Studio (CCS)**
 - [CCS online help](#)
 - [CCSv6 on the Texas Instruments Wiki](#)
 - [Code Composer forum on TI's E2E Community](#)
- **SYS/BIOS**
 - [SYS/BIOS User's Guide \(SPRUEX3\)](#)
 - [SYS/BIOS online reference \(also called "CDOC"\)](#). Choose **Help > Help Contents** and expand the **TI-RTOS** item for your device family. Choose the **Config API Reference (cdoc)** item and see help under the `ti.sysbios` and `xdc.runtime` modules.
 - [SYS/BIOS on the Texas Instruments Wiki](#)
 - [TI-RTOS forum on TI's E2E Community](#)
 - [SYS/BIOS 6.x Product Folder](#)
- **XDCtools**
 - [XDCtools online reference](#). Open from CCS help or run `<xdc_install>/docs/xdctools.chm`.
 - [RTSC-Pedia Wiki](#)
 - [TI-RTOS forum on TI's E2E Community](#)
- **NDK**
 - [NDK User's Guide \(SPRU523\)](#)
 - [NDK Programmer's Reference Guide \(SPRU524\)](#)
 - [NDK online API reference](#). Run `<tirtos_install>/products/ndk_#_##_##_##/docs/doxygen/html/index.html`.
 - [NDK online configuration reference](#). Choose **Help > Help Contents** and expand the **TI-RTOS** item for your device family. Choose the **Config API Reference (cdoc)** item and see help under the `ti.ndk` module.

- [NDK on the Texas Instruments Wiki](#)
- [TI-RTOS forum on TI's E2E Community](#)
- **UIA**
 - [System Analyzer User's Guide \(SPRUH43\)](#)
 - UIA online reference. Choose **Help > Help Contents** and expand the **TI-RTOS** item for your device family. Choose the **Config API Reference (cdoc)** item and see help under the ti.uia module.
 - [System Analyzer on the Texas Instruments Wiki](#)
- **FatFS API**
 - [Open source documentation](#)
 - [FatFS for SYS/BIOS wiki page](#)
 - SYS/BIOS online reference (also called "CDOC").
Open from CCS help or run `<tirtos_install>/products/bios_#_##_##_###/docs/cdoc/index.html`.
Navigate to the ti.sysbios.fatfs.FatFS module topic in the SYS/BIOS API reference documentation.
- **General microcontroller information**
 - [Microcontrollers forum on TI's E2E Community](#)

Installing TI-RTOS

This chapter covers the steps to install TI-RTOS within Code Composer Studio or as a standalone software product.

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2.1 System Requirements

The Microsoft Windows version of TI-RTOS can be installed on systems running Windows 7, Windows Vista, or Windows XP (SP2 or SP3).

The Linux version of TI-RTOS can be installed on systems that are running Linux RedHat v4 and higher or Ubuntu v10.04 and higher.

Separate versions of TI-RTOS are available for various Texas Instruments device families.

In order to install TI-RTOS, you must have at least 1 GB of free disk space. (If you have not yet installed Code Composer Studio, you will also need at least 4 GB of disk space for that installation.)

2.2 Installing Code Composer Studio

TI-RTOS 2.0 is used in conjunction with Code Composer Studio 6.0 or higher. CCS is available for Microsoft Windows and Linux.

For Windows installations, we recommend that you install CCS in the default installation directory of `c:\ti`. If you install in `c:\Program Files` (or `c:\Program Files (x86)` with Windows 7), you are likely to run into problems related to Windows security permissions.

Note: Do not install CCS in a location that contains any spaces in the full path. For example, CCS should not be installed in `c:\Program Files`. Makefiles may not function correctly with directory paths that include spaces.

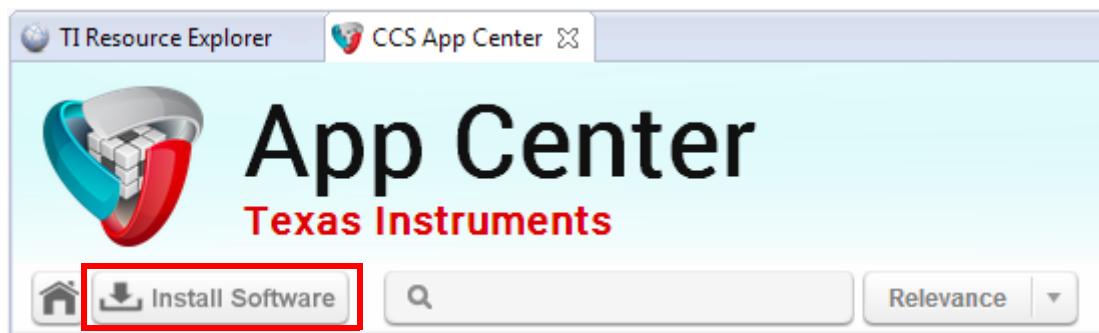
To install CCS 6.0, go to the ["Download CCS" page on the Texas Instruments wiki](#) and follow a link to download the software for your license type. For multi-user licenses, see the [CCS product page](#).

Run the installer, and answer the prompts as appropriate.

2.3 Installing TI-RTOS in Code Composer Studio

TI-RTOS is *not* installed automatically as part of the Code Composer Studio v6.0 installation. Instead, you install it through the CCS App Center. Follow these steps to install TI-RTOS:

1. Run CCS v6.0 or higher.
2. Choose **View > CCS App Center** in CCS.
3. Select the version of TI-RTOS for your device family. If you use devices from multiple families, you can select multiple TI-RTOS versions.
4. Click the **Install Software** button near the top of the App Center view.



5. Answer the prompts as necessary to complete the TI-RTOS installation.
6. Restart CCS in order for TI-RTOS and its components to be available.

2.4 Installing TI-RTOS as a Standalone Product

If you do not use Code Composer Studio, you can install TI-RTOS as a standalone product.

1. [Download the Windows or Linux installer](#) for TI-RTOS for the device family you use. For example, `tirtos_setupwin32_sitara_2_##_##_##.exe` or `tirtos_setuplinux_sitara_2_##_##_##.bin`.
2. Run the downloaded file to install TI-RTOS. You can install TI-RTOS in a standalone directory. Installing in a directory path that contains spaces, such as `C:\Program Files (x86)`, is not recommended.

Note: TI-RTOS installs the core functionality of the XDCtools component if you have not already installed the necessary version as part of a CCS installation. TI-RTOS places XDCtools in a separate directory at the same level where you install TI-RTOS. For example, if the TI-RTOS installation directory is located in `C:\ti\tirtos_sitara_2_##_##_##`, the XDCtools directory will be in `C:\ti\xdctools_3_30_##_##_core`.

Examples for TI-RTOS

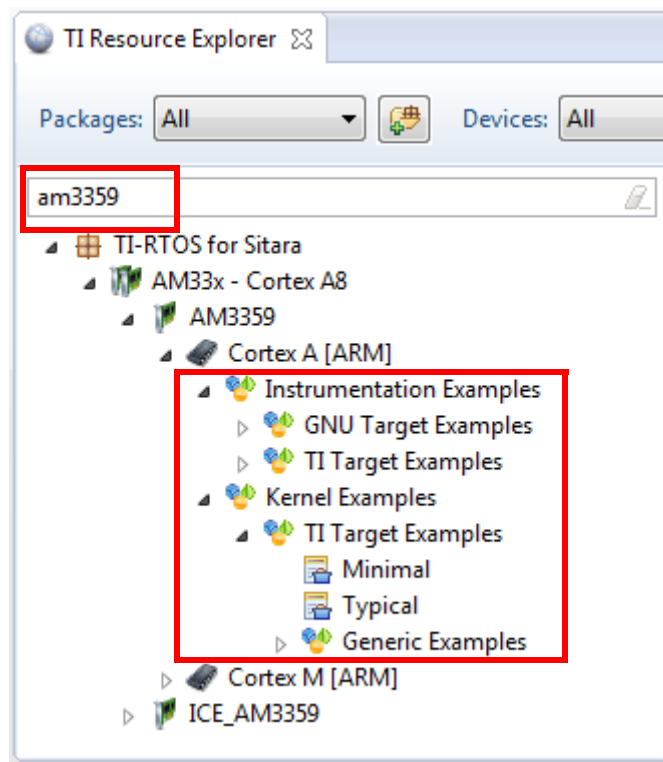
TI-RTOS comes with a number of examples that illustrate on how to use the individual components. This chapter explains how to create and use these examples.

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3.1 Creating Example Projects Using the TI Resource Explorer

You can use the **TI Resource Explorer** in Code Composer Studio (CCS) to create example projects that use TI-RTOS and its components and have all the settings needed for your device. Follow these steps:

1. Open CCS. If you do not see the TI Resource Explorer, make sure you are in the **CCS Edit** perspective and choose **View > Resource Explorer (Examples)** from the menus.
2. Type the name or part of the name of your device in the **enter search keyword** field to hide all the examples that don't apply to your device.
3. Expand the tree until you see the examples for your device. Any **Driver Examples** listed are TI-RTOS driver examples. Any **Instrumentation Examples** listed are UIA examples. The **Kernel Examples** are the SYS/BIOS examples. TI Resource Explorer provides TI-RTOS examples for both the TI and GNU tool chains.



4. Select the example you want to create. A description of the selected example is shown to the right of the example list.
5. Click the **Step 1** link in the right pane of the TI Resource Explorer to **Import the example project into CCS**. This adds a new project to your Project Explorer view. Once you have completed a step for a particular example and device, a green checkmark will be shown next to that step.

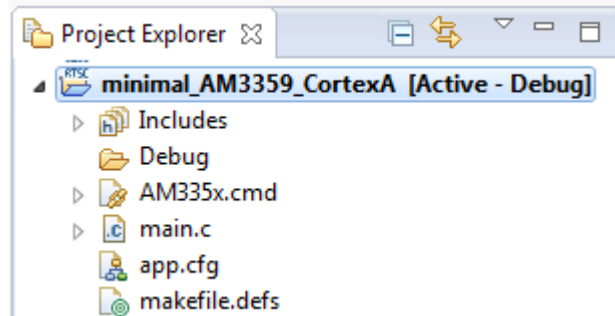
Step 1:  [Import the example project into CCS](#)





*Click on the link above to import the project. The imported project is available in the **Project Explorer** view, expand the project node to browse the imported source files. To modify source code, double clicks on the source file within the project to open the source file editor.*

Note: CCS will not allow two projects with the same name in a workspace. If you want to import both TI and GNU projects for the same board and example in the same workspace, you would need to rename the first project you import before importing the second version.

- The project created will have a name with the format `<example_name>_<board>`. You can expand the project to view or change the source code and configuration file.





- The page shown when you select an example in the TI Resource Explorer provides additional links to perform common actions with that example.
- Use the **Step 2** link when you are ready to build the project. If you want to change any build options, right click on the project and select **Properties** from the context menu. For example, you can change compiler, linker, and RTSC (XDCtools) options.

Step 2:  [Build the imported project](#) 

*To change build options, right click on the project and select **Properties** from the context menu. To build the project, select the link above, or select the **Build** toolbar button, or select the **Project | Build Project** menu item.*


- Use the **Step 3** link to change the connection used to communicate with the board. The current setting is shown in the TI Resource Explorer page for the selected example. (If you want to use a simulator instead of a hardware connection, double-click the *.ccxml file in the targetConfigs folder of the project to open the Target Configuration File editor. Change the **Connection** as needed, and click **Save**.)

Step 3:  [Debugger Configuration](#) 

*Connection: **Spectrum Digital XDSPRO USB Emulator**
Click on the link above to change the device connection. Additionally, this option is also available in the project properties.*

- You will see the Debugger Configuration dialog. Choose an emulator from the list.

11. Use the **Step 4** link to launch a debug session for the project and switch to the **CCS Debug Perspective**.

Step 4:  [Debug the imported project](#)



*Click on the link above to launch a debug session for the **UART Echo** project and switch to the **CCS Debug Perspective**. Additionally, these are other methods to start a project debug session. Select the project in the **Project Explorer** view and click on the bug toolbar button. To relaunch a previous debug session, click on the small arrow beside the bug toolbar button and select one of the debug session from the history.*

Configuring TI-RTOS

This chapter describes how to configure TI-RTOS and its components for use by your application.

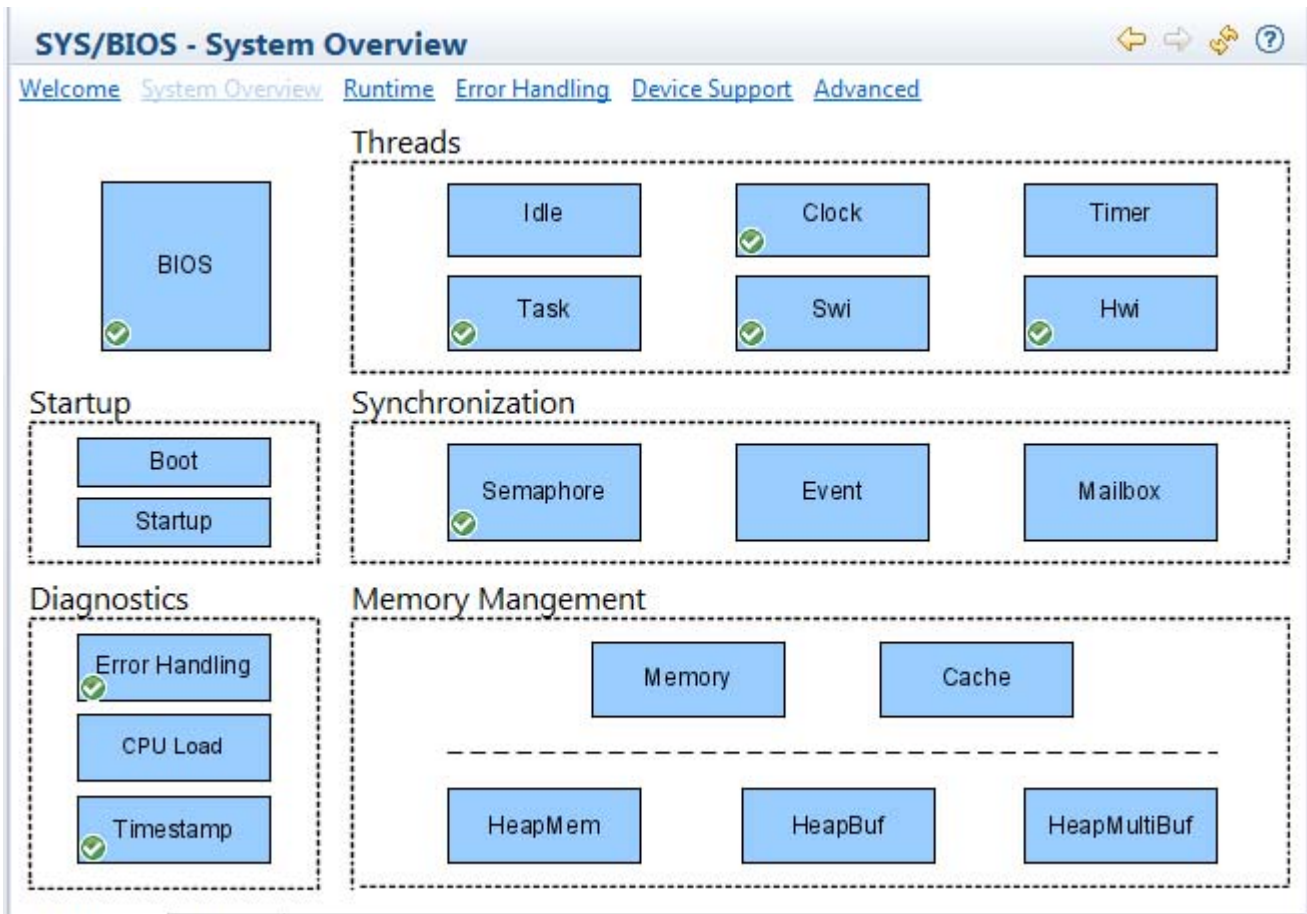
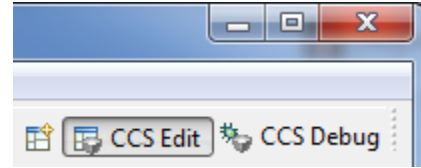
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4.1 Starting the Configuration Tool

This section shows how to open XGCONF and view the System Overview. For details about how to use XGCONF, see Chapter 2 of the [SYS/BIOS User's Guide \(SPRUEX3\)](#).

To use CCS to open the graphical tool for editing configuration files (XGCONF), follow these steps:

1. Make sure you are in the **C/C++** perspective of CCS. If you are not in that perspective, click the C/C++ icon to switch back.
2. Double-click on the *.cfg configuration file for a TI-RTOS example project in the **Project Explorer** tree. (See [Section 3.1](#) if you need to create an example project.) While XGCONF is opening, the CCS status bar shows that the configuration is being processed and validated.
3. When XGCONF opens, you see the **Welcome** sheet for SYS/BIOS. The Welcome sheet provides links to documentation resources.
4. Click the **System Overview** link to see a diagram of the modules available through SYS/BIOS. A green check mark indicates which modules are being used by the application.



5. Click a blue box in the System Overview to go to the configuration page for a module.

Note: If the configuration is shown in a text editor instead of XGCONF, close the text editor window. Then, right-click on the .cfg file and choose **Open With > XGCONF**. If you are comfortable editing configuration scripts with a text editor, you can do that. However, you should not have the file open in both types of editor at the same time.

4.2 Configuring TI-RTOS

When you open a configuration file in XGCONF, you see a list of Available Products.

The SysCallback module lets you configure the functions that handle System output—for example, System_printf() and System_abort(). This module handles transmissions to System output only; it does not handle responses received. See the chapter on "TI-RTOS Utilities" in the *TI-RTOS User's Guide* (SPRUHD4) for more about the SysCallback module.

Other SystemSupport implementations are provided with XDCtools.

- **SysMin** stores System_printf() strings in an internal buffer in RAM. SysMin requires RAM, so it not ideal for devices with minimal RAM.
- **SysStd** writes System_printf() strings to STDOUT (the CCS Console window). By default, SysStd allows System_printf() to be called from Tasks only (not Swis or hardware interrupts); it can be modified to allow calls from Swis and Hwis, but this impacts real-time performance.

4.3 Configuring Components of TI-RTOS

For information about configuring individual sub-components of TI-RTOS, see the documentation for that component. Chapter 2 of the [SYS/BIOS User's Guide \(SPRUJEX3\)](#) provides information about using XGCONF.

Within XGCONF, you can see the full file path to the version of the component being used by hovering your mouse cursor over a component in the "Other Products" list in the **Available Products** area.

The CCS online help lets you access the CDOC reference help for various components. For information about properties you can configure and instances you can create, scroll down in CDOC to see the sections with gray outlines. (You can use the "Configuration settings" link at the top of each page to skip to the configuration information.)

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Products

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DLP® Products www.dlp.com
DSP dsp.ti.com
Clocks and Timers www.ti.com/clocks
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Logic logic.ti.com
Power Mgmt power.ti.com
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OMAP Mobile Processors www.ti.com/omap
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