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Dallas, Texas 75265

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Preface

Read This First

About This Manual

DSP/BIOS gives developers of mainstream applications on Texas Instruments TMS320C6000™ DSP devices the ability to develop embedded real-time software. DSP/BIOS provides a small firmware real-time library and easy-to-use tools for real-time tracing and analysis.

You should read and become familiar with the TMS320 DSP/BIOS User’s Guide, a companion volume to this API reference guide.

Before you read this manual, you may use the Code Composer Studio online tutorial and the DSP/BIOS section of the online help to get an overview of DSP/BIOS. This manual discusses various aspects of DSP/BIOS in depth and assumes that you have at least a basic understanding of DSP/BIOS.

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; interactive displays use a bold version of the special typeface to distinguish commands that you enter from items that the system displays (such as prompts, command output, error messages, etc.).

Here is a sample program listing:

```c
Void copy(HST_Obj *input, HST_Obj *output)
{
    PIP_Obj     *in, *out;
    Uns         *src, *dst;
    Uns         size;
}
```
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.

Throughout this manual, 62 represents the two-digit numeric appropriate to your specific DSP platform. For example, DSP/BIOS assembly language API header files for the C6000 platform are described as having a suffix of .h62. For the C64x or C67x DSP platform, substitute either 64 or 67 for each occurrence of 62.

Information specific to a particular device is designated with one of the following icons:

---

**Related Documentation From Texas Instruments**

The following books describe TMS320 devices and related support tools. To obtain a copy of any of these TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924. When ordering, please identify the book by its title and literature number.

**TMS320C6000 Assembly Language Tools User’s Guide** (literature number SPRU186) describes the assembly language tools (assembler, linker, and other tools used to develop assembly language code), assembler directives, macros, common object file format, and symbolic debugging directives for the c5000 generation of devices.

**TMS320C6000 Optimizing C Compiler User’s Guide** (literature number SPRU187) describes the c6000 C/C++ compiler and the assembly optimizer. This C/C++ compiler accepts ANSI standard C/C++ source code and produces assembly language source code for the c6000 generation of devices. The assembly optimizer helps you optimize your assembly code.

**TMS320C6000 Programmer’s Guide** (literature number SPRU189) describes the c6000 CPU architecture, instruction set, pipeline, and interrupts for these digital signal processors.

**TMS320c6000 Peripherals Reference Guide** (literature number SPRU190) describes common peripherals available on the TMS320C6000 family of digital signal processors. This book includes information on the internal data and program memories, the external memory interface (EMIF), the host port, multichannel buffered serial ports, direct memory access (DMA), clocking and phase-locked loop (PLL), and the power-down modes.


**Related Documentation**

You can use the following books to supplement this reference guide:


*Programming in C*, Kochan, Steve G., Hayden Book Company


*American National Standard for Information Systems-Programming Language C* X3.159-1989, American National Standards Institute (ANSI standard for C); (out of print)

---

**TMS320C6000 Code Composer Studio Tutorial Online Help** (literature number SPRH125) introduces the Code Composer Studio integrated development environment and software tools. Of special interest to DSP/BIOS users are the Using DSP/BIOS lessons.

**Code Composer Studio Application Program Interface (API) Reference Guide** (literature number SPRU321) describes the Code Composer Studio application programming interface, which allows you to program custom analysis tools for Code Composer Studio.

**TMS320C6000 Chip Support Library API Reference Guide** (literature number SPRU401) contains a reference for the Chip Support Library (CSL) application programming interfaces (APIs). The CSL is a set of APIs used to configure and control all on-chip peripherals.
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All other brand or product names are trademarks or registered trademarks of their respective companies or organizations.
## Contents

1 API Functional Overview ................................................................. 1-1
   Provides an overview to the TMS320C6000 DSP/BIOS API functions.
   1.1 DSP/BIOS Modules ..................................................................... 1-2
   1.2 Naming Conventions .................................................................. 1-3
   1.3 List of Operations ..................................................................... 1-4

2 Application Program Interface ................................................................. 2-1
   Describes the TMS320C6000 DSP/BIOS API functions and the overall capabilities of each module.
   2.1 Assembly Language Interface Overview ...................................... 2-2
   2.2 ATM Module ........................................................................... 2-4
   2.3 C62 and C64 Modules ................................................................. 2-17
   2.4 CLK Module ............................................................................ 2-26
      2.4.1 Clock Manager Properties .................................................. 2-27
      2.4.2 CLK Object Properties ....................................................... 2-28
      2.4.3 CLK - Code Composer Studio Interface ............................... 2-29
   2.5 DEV Module ............................................................................ 2-36
      2.5.1 DEV Manager Properties .................................................. 2-37
      2.5.2 DEV Object Properties ....................................................... 2-38
   2.6 Global Settings ....................................................................... 2-72
      2.6.1 Global Settings Properties ................................................ 2-72
   2.7 HOOK Module ......................................................................... 2-75
      2.7.1 HOOK Manager Properties ................................................ 2-76
      2.7.2 HOOK Object Properties ................................................... 2-76
   2.8 HST Module ............................................................................ 2-80
      2.8.1 HST Manager Properties .................................................... 2-80
      2.8.2 HST Object Properties ....................................................... 2-81
      2.8.3 HST - Host Channel Control Interface ............................... 2-82
   2.9 HWI Module ............................................................................ 2-85
      2.9.1 HWI Manager Properties .................................................. 2-87
      2.9.2 HWI Object Properties ....................................................... 2-88
      2.9.3 HWI - Execution Graph Interface ...................................... 2-90
2.10 IDL Module ................................................................. 2-103
   2.10.1 IDL Manager Properties ....................................... 2-103
   2.10.2 IDL Object Properties ......................................... 2-104
   2.10.3 IDL- Execution Graph Interface ............................ 2-105
2.11 LCK Module ........................................................... 2-107
   2.11.1 LCK Manager Properties ...................................... 2-107
   2.11.2 LCK Object Properties ....................................... 2-107
2.12 LOG Module ............................................................ 2-112
   2.12.1 LOG Manager Properties ...................................... 2-113
   2.12.2 LOG Object Properties ....................................... 2-113
2.13 MBX Module ............................................................ 2-127
   2.13.1 MBX Manager Properties ...................................... 2-127
   2.13.2 MBX Object Properties ....................................... 2-128
   2.13.3 MBX Code Composer Studio Interface ....................... 2-128
2.14 MEM Module ........................................................... 2-133
   2.14.1 MEM Manager Properties ...................................... 2-134
   2.14.2 MEM Object Properties ....................................... 2-138
   2.14.3 MEM Code Composer Studio Interface ....................... 2-140
2.15 PIP Module ............................................................. 2-148
   2.15.1 PIP Manager Properties ...................................... 2-150
   2.15.2 PIP Object Properties ....................................... 2-150
   2.15.3 PIP - Code Composer Studio Interface ...................... 2-151
2.16 PRD Module ............................................................ 2-170
   2.16.1 PRD Manager Properties ...................................... 2-171
   2.16.2 PRD Object Properties ....................................... 2-171
   2.16.3 PRD - Code Composer Studio Interface ...................... 2-172
2.17 QUE Module ............................................................. 2-178
   2.17.1 QUE Manager Properties ...................................... 2-179
   2.17.2 QUE Object Properties ....................................... 2-179
2.18 RTDX Module ........................................................... 2-195
   2.18.1 RTDX Manager Properties .................................... 2-195
   2.18.2 RTDX Object Properties ..................................... 2-196
2.19 SEM Module ............................................................. 2-211
   2.19.1 SEM Manager Properties ...................................... 2-212
   2.19.2 SEM Object Properties ....................................... 2-212
   2.19.3 SEM - Code Composer Studio Interface ...................... 2-212
2.20 SIO Module ............................................................. 2-221
   2.20.1 SIO Manager Properties ...................................... 2-222
   2.20.2 SIO Object Properties ....................................... 2-222
2.21 STS Module ............................................................. 2-241
   2.21.1 STS Manager Properties ...................................... 2-244
   2.21.2 STS Object Properties ....................................... 2-244
   2.21.3 STS - Statistics View Interface ............................ 2-245
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.22</td>
<td>SWI Module</td>
<td>2-253</td>
</tr>
<tr>
<td>2.22.1</td>
<td>SWI Manager Properties</td>
<td>2-255</td>
</tr>
<tr>
<td>2.22.2</td>
<td>SWI Object Properties</td>
<td>2-256</td>
</tr>
<tr>
<td>2.22.3</td>
<td>SWI - Code Composer Studio Interface</td>
<td>2-256</td>
</tr>
<tr>
<td>2.23</td>
<td>SYS Module</td>
<td>2-287</td>
</tr>
<tr>
<td>2.23.1</td>
<td>SYS Manager Properties</td>
<td>2-288</td>
</tr>
<tr>
<td>2.23.2</td>
<td>SYS Object Properties</td>
<td>2-288</td>
</tr>
<tr>
<td>2.24</td>
<td>TRC Module</td>
<td>2-302</td>
</tr>
<tr>
<td>2.24.1</td>
<td>TRC - Code Composer Studio Interface</td>
<td>2-303</td>
</tr>
<tr>
<td>2.25</td>
<td>TSK Module</td>
<td>2-309</td>
</tr>
<tr>
<td>2.25.1</td>
<td>TSK Manager Properties</td>
<td>2-313</td>
</tr>
<tr>
<td>2.25.2</td>
<td>TSK Object Properties</td>
<td>2-314</td>
</tr>
<tr>
<td>2.25.3</td>
<td>TSK - DSP/BIOS Analysis Tool Interface</td>
<td>2-315</td>
</tr>
<tr>
<td>2.26</td>
<td>std.h and stdlib.h Functions</td>
<td>2-344</td>
</tr>
</tbody>
</table>

### 3 Utility Programs

Provides documentation for TMS320C6000 utilities that can be used to examine various files from the MS-DOS command line.

<table>
<thead>
<tr>
<th>Section</th>
<th>Program Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>cdbprint</td>
<td>3-2</td>
</tr>
<tr>
<td>3.2</td>
<td>gconfgen</td>
<td>3-3</td>
</tr>
<tr>
<td>3.3</td>
<td>nmti</td>
<td>3-6</td>
</tr>
<tr>
<td>3.4</td>
<td>sectti</td>
<td>3-7</td>
</tr>
<tr>
<td>3.5</td>
<td>sizeti</td>
<td>3-8</td>
</tr>
<tr>
<td>3.6</td>
<td>vers</td>
<td>3-9</td>
</tr>
</tbody>
</table>

### A Function Callability and Error Tables

Provides tables describing TMS320C6000 errors and function callability.

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1</td>
<td>Function Callability by Thread Type</td>
<td>A-2</td>
</tr>
<tr>
<td>A.2</td>
<td>DSP/BIOS Error Codes</td>
<td>A-8</td>
</tr>
</tbody>
</table>
# Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>RTA Control Panel Properties Page</td>
<td>2-114</td>
</tr>
<tr>
<td>2-2</td>
<td>Pipe Schematic</td>
<td>2-149</td>
</tr>
<tr>
<td>2-3</td>
<td>PRD Tick Cycles</td>
<td>2-175</td>
</tr>
<tr>
<td>2-4</td>
<td>Statistics Accumulation on the Host</td>
<td>2-244</td>
</tr>
<tr>
<td>2-5</td>
<td>RTA Control Panel Properties Page</td>
<td>2-246</td>
</tr>
<tr>
<td>2-6</td>
<td>RTA Control Panel Properties Page</td>
<td>2-304</td>
</tr>
</tbody>
</table>
# Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>DSP/BIOS Modules</td>
<td>1-2</td>
</tr>
<tr>
<td>1-2</td>
<td>The DSP/BIOS Operations</td>
<td>1-4</td>
</tr>
<tr>
<td>2-1</td>
<td>HWI Interrupts for the TMS320C6000</td>
<td>2-90</td>
</tr>
<tr>
<td>2-2</td>
<td>Conversion Characters for LOG_printf</td>
<td>2-124</td>
</tr>
<tr>
<td>2-3</td>
<td>Typical Memory Segments for c6x EVM Boards</td>
<td>2-140</td>
</tr>
<tr>
<td>2-4</td>
<td>Typical Memory Segment for c6711 DSK Boards</td>
<td>2-140</td>
</tr>
<tr>
<td>2-5</td>
<td>Statistics Units for HWI, PIP, PRD, and SWI Modules</td>
<td>2-242</td>
</tr>
<tr>
<td>2-6</td>
<td>Conversion Characters Recognized by SYS_printf</td>
<td>2-293</td>
</tr>
<tr>
<td>2-7</td>
<td>Conversion Characters Recognized by SYS_sprintf</td>
<td>2-295</td>
</tr>
<tr>
<td>2-8</td>
<td>Conversion Characters Recognized by SYS_vprintf</td>
<td>2-297</td>
</tr>
<tr>
<td>2-9</td>
<td>Conversion Characters Recognized by SYS_vsprintf</td>
<td>2-299</td>
</tr>
<tr>
<td>2-10</td>
<td>Events and Statistics Traced by TRC</td>
<td>2-302</td>
</tr>
<tr>
<td>A-1</td>
<td>Function Callability by Thread Type</td>
<td>A-2</td>
</tr>
<tr>
<td>A-2</td>
<td>DSP/BIOS Error Codes</td>
<td>A-8</td>
</tr>
</tbody>
</table>
Chapter 1

API Functional Overview

This chapter provides an overview to the TMS320C6000 DSP/BIOS API functions.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 DSP/BIOS Modules</td>
<td>1-2</td>
</tr>
<tr>
<td>1.2 Naming Conventions</td>
<td>1-3</td>
</tr>
<tr>
<td>1.3 List of Operations</td>
<td>1-4</td>
</tr>
</tbody>
</table>
## 1.1 DSP/BIOS Modules

### Table 1-1. DSP/BIOS Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM</td>
<td>Atomic functions written in assembly language</td>
</tr>
<tr>
<td>C62</td>
<td>Target-specific functions</td>
</tr>
<tr>
<td>C64</td>
<td>Target-specific functions</td>
</tr>
<tr>
<td>CLK</td>
<td>System clock manager</td>
</tr>
<tr>
<td>DEV</td>
<td>Device driver interface</td>
</tr>
<tr>
<td>GBL</td>
<td>Global setting manager</td>
</tr>
<tr>
<td>HOOK</td>
<td>Hook function manager</td>
</tr>
<tr>
<td>HST</td>
<td>Host channel manager</td>
</tr>
<tr>
<td>HWI</td>
<td>Hardware interrupt manager</td>
</tr>
<tr>
<td>IDL</td>
<td>Idle function and processing loop manager</td>
</tr>
<tr>
<td>LCK</td>
<td>Resource lock manager</td>
</tr>
<tr>
<td>LOG</td>
<td>Event Log manager</td>
</tr>
<tr>
<td>MBX</td>
<td>Mailboxes manager</td>
</tr>
<tr>
<td>MEM</td>
<td>Memory manager</td>
</tr>
<tr>
<td>PIP</td>
<td>Buffered pipe manager</td>
</tr>
<tr>
<td>PRD</td>
<td>Periodic function manager</td>
</tr>
<tr>
<td>QUE</td>
<td>Queue manager</td>
</tr>
<tr>
<td>RTDX</td>
<td>Real-time data exchange manager</td>
</tr>
<tr>
<td>SEM</td>
<td>Semaphores manager</td>
</tr>
<tr>
<td>SIO</td>
<td>Stream I/O manager</td>
</tr>
<tr>
<td>STS</td>
<td>Statistics object manager</td>
</tr>
<tr>
<td>SWI</td>
<td>Software interrupt manager</td>
</tr>
<tr>
<td>SYS</td>
<td>System services manager</td>
</tr>
<tr>
<td>TRC</td>
<td>Trace manager</td>
</tr>
<tr>
<td>TSK</td>
<td>Multitasking manager</td>
</tr>
<tr>
<td>C library stdlib.h</td>
<td>Standard C library I/O functions</td>
</tr>
</tbody>
</table>
1.2 Naming Conventions

The format for a DSP/BIOS operation name is a 3- or 4-letter prefix for the module that contains the operation, an underscore, and the action.

In the Assembly Interface section for each macro, Preconditions lists registers that must be set before using the macro. Postconditions lists the registers set by the macro that you may want to use. Modifies lists all individual registers modified by the macro, including registers in the Postconditions list.
1.3 List of Operations

Table 1-2. The DSP/BIOS Operations

a. ATM module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM_andi, ATM_andu</td>
<td>Atomically AND two memory locations and return previous value of the second</td>
</tr>
<tr>
<td>ATM_cleari, ATM_clearu</td>
<td>Atomically clear memory location and return previous value</td>
</tr>
<tr>
<td>ATM_deci, ATM_decu</td>
<td>Atomically decrement memory and return new value</td>
</tr>
<tr>
<td>ATM_inci, ATM_incu</td>
<td>Atomically increment memory and return new value</td>
</tr>
<tr>
<td>ATM_ori, ATM_oru</td>
<td>Atomically OR memory location and return previous value</td>
</tr>
<tr>
<td>ATM_seti, ATM_setu</td>
<td>Atomically set memory and return previous value</td>
</tr>
</tbody>
</table>

b. C62 operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C62_disableIER</td>
<td>Disable certain maskable interrupts</td>
</tr>
<tr>
<td>C62_enableIER</td>
<td>Enable certain maskable interrupts</td>
</tr>
<tr>
<td>C64_disableIER</td>
<td>Disable certain maskable interrupts</td>
</tr>
<tr>
<td>C64_enableIER</td>
<td>Enable certain maskable interrupts</td>
</tr>
<tr>
<td>C64_plug</td>
<td>C function to plug an interrupt vector</td>
</tr>
<tr>
<td>C62_plug</td>
<td>C function to plug an interrupt vector</td>
</tr>
</tbody>
</table>

c. CLK module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLK_countspms</td>
<td>Number of hardware timer counts per millisecond</td>
</tr>
<tr>
<td>CLK_gethtime</td>
<td>Get high-resolution time</td>
</tr>
<tr>
<td>CLK_getltime</td>
<td>Get low-resolution time</td>
</tr>
<tr>
<td>CLK_getprd</td>
<td>Get period register value</td>
</tr>
</tbody>
</table>
### List of Operations

**d. DEV module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEV_match</td>
<td>Match a device name with a driver</td>
</tr>
<tr>
<td>Dxx_close</td>
<td>Close device</td>
</tr>
<tr>
<td>Dxx_ctrl</td>
<td>Device control operation</td>
</tr>
<tr>
<td>Dxx_idle</td>
<td>Idle device</td>
</tr>
<tr>
<td>Dxx_init</td>
<td>Initialize device</td>
</tr>
<tr>
<td>Dxx_issue</td>
<td>Send a buffer to the device</td>
</tr>
<tr>
<td>Dxx_open</td>
<td>Open device</td>
</tr>
<tr>
<td>Dxx_ready</td>
<td>Check if device is ready for I/O</td>
</tr>
<tr>
<td>Dxx_reclaim</td>
<td>Retrieve a buffer from a device</td>
</tr>
</tbody>
</table>

**e. HOOK module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOOK_getenv</td>
<td>Get environment pointer for a given HOOK and TSK combination</td>
</tr>
<tr>
<td>HOOK_setenv</td>
<td>Set environment pointer for a given HOOK and TSK combination</td>
</tr>
</tbody>
</table>

**f. HST module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HST_getpipe</td>
<td>Get corresponding pipe object</td>
</tr>
</tbody>
</table>

**g. HWI module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWI_disable</td>
<td>Globally disable hardware interrupts</td>
</tr>
<tr>
<td>HWI_enable</td>
<td>Globally enable hardware interrupts</td>
</tr>
<tr>
<td>HWI_enter</td>
<td>Hardware interrupt service routine prolog</td>
</tr>
<tr>
<td>HWI_exit</td>
<td>Hardware interrupt service routine epilog</td>
</tr>
<tr>
<td>HWI_restore</td>
<td>Restore global interrupt enable state</td>
</tr>
</tbody>
</table>
**List of Operations**

**h. IDL module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDL_run</td>
<td>Make one pass through idle functions</td>
</tr>
</tbody>
</table>

**i. LCK module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCK_create</td>
<td>Create a resource lock</td>
</tr>
<tr>
<td>LCK_delete</td>
<td>Delete a resource lock</td>
</tr>
<tr>
<td>LCK_pend</td>
<td>Acquire ownership of a resource lock</td>
</tr>
<tr>
<td>LCK_post</td>
<td>Relinquish ownership of a resource lock</td>
</tr>
</tbody>
</table>

**j. LOG module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG_disable</td>
<td>Disable a log</td>
</tr>
<tr>
<td>LOG_enable</td>
<td>Enable a log</td>
</tr>
<tr>
<td>LOG_error/LOG_message</td>
<td>Write a message to the system log</td>
</tr>
<tr>
<td>LOG_event</td>
<td>Append an unformatted message to a log</td>
</tr>
<tr>
<td>LOG_printf</td>
<td>Append a formatted message to a message log</td>
</tr>
<tr>
<td>LOG_reset</td>
<td>Reset a log</td>
</tr>
</tbody>
</table>

**k. MBX module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBX_create</td>
<td>Create a mailbox</td>
</tr>
<tr>
<td>MBX_delete</td>
<td>Delete a mailbox</td>
</tr>
<tr>
<td>MBX_pend</td>
<td>Wait for a message from mailbox</td>
</tr>
<tr>
<td>MBX_post</td>
<td>Post a message to mailbox</td>
</tr>
</tbody>
</table>
### List of Operations

1. **MEM module operations**:

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEM_alloc, MEM_valloc,</td>
<td>Allocate from a memory heap</td>
</tr>
<tr>
<td>MEMcalloc</td>
<td></td>
</tr>
<tr>
<td>MEM_define</td>
<td>Define a new memory heap</td>
</tr>
<tr>
<td>MEM_free</td>
<td>Free a block of memory</td>
</tr>
<tr>
<td>MEM_redefine</td>
<td>Redefine an existing memory heap</td>
</tr>
<tr>
<td>MEM_stat</td>
<td>Return the status of a memory heap</td>
</tr>
</tbody>
</table>

2. **PIP module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIP_alloc</td>
<td>Get an empty frame from a pipe</td>
</tr>
<tr>
<td>PIP_free</td>
<td>Recycle a frame that has been read back into a pipe</td>
</tr>
<tr>
<td>PIP_get</td>
<td>Get a full frame from a pipe</td>
</tr>
<tr>
<td>PIP_getReaderAddr</td>
<td>Get the value of the readerAddr pointer of the pipe</td>
</tr>
<tr>
<td>PIP_getReaderNumFrames</td>
<td>Get the number of pipe frames available for reading</td>
</tr>
<tr>
<td>PIP_getReaderSize</td>
<td>Get the number of words of data in a pipe frame</td>
</tr>
<tr>
<td>PIP_getWriterAddr</td>
<td>Get the value of the writerAddr pointer of the pipe</td>
</tr>
<tr>
<td>PIP_getWriterNumFrames</td>
<td>Get the number of pipe frames available to be written to</td>
</tr>
<tr>
<td>PIP_getWriterSize</td>
<td>Get the number of words that can be written to a pipe frame</td>
</tr>
<tr>
<td>PIP_peek</td>
<td>Get the pipe frame size and address without actually claiming the pipe frame</td>
</tr>
<tr>
<td>PIP_put</td>
<td>Put a full frame into a pipe</td>
</tr>
<tr>
<td>PIP_reset</td>
<td>Reset all fields of a pipe object to their original values</td>
</tr>
<tr>
<td>PIP_setWriterSize</td>
<td>Set the number of valid words written to a pipe frame</td>
</tr>
</tbody>
</table>

3. **PRD module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRD_getticks</td>
<td>Get the current tick counter</td>
</tr>
<tr>
<td>PRD_start</td>
<td>Arm a periodic function for one-time execution</td>
</tr>
<tr>
<td>PRD_stop</td>
<td>Stop a periodic function from execution</td>
</tr>
<tr>
<td>PRD_tick</td>
<td>Advance tick counter, dispatch periodic functions</td>
</tr>
</tbody>
</table>
### List of Operations

#### a. QUE module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUE_create</td>
<td>Create an empty queue</td>
</tr>
<tr>
<td>QUE_delete</td>
<td>Delete an empty queue</td>
</tr>
<tr>
<td>QUE_dequeue</td>
<td>Remove from front of queue (non-atomically)</td>
</tr>
<tr>
<td>QUE_empty</td>
<td>Test for an empty queue</td>
</tr>
<tr>
<td>QUE_enqueue</td>
<td>Insert at end of queue (non-atomically)</td>
</tr>
<tr>
<td>QUE_get</td>
<td>Get element from front of queue (atomically)</td>
</tr>
<tr>
<td>QUE_head</td>
<td>Return element at front of queue</td>
</tr>
<tr>
<td>QUE_insert</td>
<td>Insert in middle of queue (non-atomically)</td>
</tr>
<tr>
<td>QUE_new</td>
<td>Set a queue to be empty</td>
</tr>
<tr>
<td>QUE_next</td>
<td>Return next element in queue (non-atomically)</td>
</tr>
<tr>
<td>QUE_prev</td>
<td>Return previous element in queue (non-atomically)</td>
</tr>
<tr>
<td>QUE_put</td>
<td>Put element at end of queue (atomically)</td>
</tr>
<tr>
<td>QUE_remove</td>
<td>Remove from middle of queue (non-atomically)</td>
</tr>
</tbody>
</table>

#### p. RTDX module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTDX_channelBusy</td>
<td>Return status indicating whether a channel is busy</td>
</tr>
<tr>
<td>RTDX_CreateInputChannel</td>
<td>Declare input channel structure</td>
</tr>
<tr>
<td>RTDX_CreateOutputChannel</td>
<td>Declare output channel structure</td>
</tr>
<tr>
<td>RTDX_disableInput</td>
<td>Disable an input channel</td>
</tr>
<tr>
<td>RTDX_disableOutput</td>
<td>Disable an output channel</td>
</tr>
<tr>
<td>RTDX_enableInput</td>
<td>Enable an input channel</td>
</tr>
<tr>
<td>RTDX_enableOutput</td>
<td>Enable an output channel</td>
</tr>
<tr>
<td>RTDX_isInputEnabled</td>
<td>Return status of the input data channel</td>
</tr>
<tr>
<td>RTDX_isOutputEnabled</td>
<td>Return status of the output data channel</td>
</tr>
<tr>
<td>RTDX_read</td>
<td>Read from an input channel</td>
</tr>
</tbody>
</table>
### List of Operations

#### API Functional Overview

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTDX_readNB</td>
<td>Read from an input channel without blocking</td>
</tr>
<tr>
<td>RTDX_sizeofInput</td>
<td>Return the number of bytes read from an input channel</td>
</tr>
<tr>
<td>RTDX_write</td>
<td>Write to an output channel</td>
</tr>
</tbody>
</table>

#### q. SEM module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEM_count</td>
<td>Get current semaphore count</td>
</tr>
<tr>
<td>SEM_create</td>
<td>Create a semaphore</td>
</tr>
<tr>
<td>SEM_delete</td>
<td>Delete a semaphore</td>
</tr>
<tr>
<td>SEM_ipost</td>
<td>Signal a semaphore (interrupt only)</td>
</tr>
<tr>
<td>SEM_new</td>
<td>Initialize a semaphore</td>
</tr>
<tr>
<td>SEM_pend</td>
<td>Wait for a semaphore</td>
</tr>
<tr>
<td>SEM_post</td>
<td>Signal a semaphore</td>
</tr>
<tr>
<td>SEM_reset</td>
<td>Reset semaphore</td>
</tr>
</tbody>
</table>

#### r. SIO module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIO_bufsize</td>
<td>Size of the buffers used by a stream</td>
</tr>
<tr>
<td>SIO_create</td>
<td>Create stream</td>
</tr>
<tr>
<td>SIO_ctrl</td>
<td>Perform a device-dependent control operation</td>
</tr>
<tr>
<td>SIO_delete</td>
<td>Delete stream</td>
</tr>
<tr>
<td>SIO_flush</td>
<td>Idle a stream by flushing buffers</td>
</tr>
<tr>
<td>SIO_get</td>
<td>Get buffer from stream</td>
</tr>
<tr>
<td>SIO_idle</td>
<td>Idle a stream</td>
</tr>
<tr>
<td>SIO_issue</td>
<td>Send a buffer to a stream</td>
</tr>
<tr>
<td>SIO_put</td>
<td>Put buffer to a stream</td>
</tr>
<tr>
<td>SIO_reclaim</td>
<td>Request a buffer back from a stream</td>
</tr>
</tbody>
</table>
### List of Operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIO_segid</td>
<td>Memory section used by a stream</td>
</tr>
<tr>
<td>SIO_select</td>
<td>Select a ready device</td>
</tr>
<tr>
<td>SIO_staticbuf</td>
<td>Acquire static buffer from stream</td>
</tr>
</tbody>
</table>

#### s. STS module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS_add</td>
<td>Add a value to a statistics object</td>
</tr>
<tr>
<td>STS_delta</td>
<td>Add computed value of an interval to object</td>
</tr>
<tr>
<td>STS_reset</td>
<td>Reset the values stored in an STS object</td>
</tr>
<tr>
<td>STS_set</td>
<td>Store initial value of an interval to object</td>
</tr>
</tbody>
</table>

#### t. SWI module operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWI_andn</td>
<td>Clear bits from SWI’s mailbox and post if becomes 0</td>
</tr>
<tr>
<td>SWI_andnHook</td>
<td>Specialized version of SWI_andn</td>
</tr>
<tr>
<td>SWI_create</td>
<td>Create a software interrupt</td>
</tr>
<tr>
<td>SWI_dec</td>
<td>Decrement SWI’s mailbox and post if becomes 0</td>
</tr>
<tr>
<td>SWI_delete</td>
<td>Delete a software interrupt</td>
</tr>
<tr>
<td>SWI_disable</td>
<td>Disable software interrupts</td>
</tr>
<tr>
<td>SWI_enable</td>
<td>Enable software interrupts</td>
</tr>
<tr>
<td>SWI_getattrs</td>
<td>Get attributes of a software interrupt</td>
</tr>
<tr>
<td>SWI_getmbox</td>
<td>Return SWI’s mailbox value</td>
</tr>
<tr>
<td>SWI_getpri</td>
<td>Return an SWI’s priority mask</td>
</tr>
<tr>
<td>SWI_inc</td>
<td>Increment SWI’s mailbox and post</td>
</tr>
<tr>
<td>SWI_or</td>
<td>Set or mask in an SWI’s mailbox and post</td>
</tr>
<tr>
<td>SWI_oHook</td>
<td>Specialized version of SWI_or</td>
</tr>
<tr>
<td>SWI_post</td>
<td>Post a software interrupt</td>
</tr>
<tr>
<td>SWI_raisepri</td>
<td>Raise an SWI’s priority</td>
</tr>
<tr>
<td>SWI_restorepri</td>
<td>Restore an SWI’s priority</td>
</tr>
</tbody>
</table>
### List of Operations

#### API Functional Overview

1. **u. SYS module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWI_self</td>
<td>Return address of currently executing SWI object</td>
</tr>
<tr>
<td>SWI_setattrs</td>
<td>Set attributes of a software interrupt</td>
</tr>
</tbody>
</table>

2. **SYS module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS_abort</td>
<td>Abort program execution</td>
</tr>
<tr>
<td>SYS_atexit</td>
<td>Stack an exit handler</td>
</tr>
<tr>
<td>SYS_error</td>
<td>Flag error condition</td>
</tr>
<tr>
<td>SYS_exit</td>
<td>Terminate program execution</td>
</tr>
<tr>
<td>SYS_printf, SYS_sprintf, SYS_vprintf, SYS_vsprintf</td>
<td>Formatted output</td>
</tr>
<tr>
<td>SYS_putchar</td>
<td>Output a single character</td>
</tr>
</tbody>
</table>

3. **TRC module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRC_disable</td>
<td>Disable a set of trace controls</td>
</tr>
<tr>
<td>TRC_enable</td>
<td>Enable a set of trace controls</td>
</tr>
<tr>
<td>TRC_query</td>
<td>Test whether a set of trace controls is enabled</td>
</tr>
</tbody>
</table>

4. **TSK module operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSK_checkstacks</td>
<td>Check for stack overflow</td>
</tr>
<tr>
<td>TSK_create</td>
<td>Create a task ready for execution</td>
</tr>
<tr>
<td>TSK_delete</td>
<td>Delete a task</td>
</tr>
<tr>
<td>TSK_deltatime</td>
<td>Update task STS with time difference</td>
</tr>
<tr>
<td>TSK_disable</td>
<td>Disable DSP/BIOS task scheduler</td>
</tr>
<tr>
<td>TSK_enable</td>
<td>Enable DSP/BIOS task scheduler</td>
</tr>
<tr>
<td>TSK_exit</td>
<td>Terminate execution of the current task</td>
</tr>
<tr>
<td>TSK_getenv</td>
<td>Get task environment</td>
</tr>
<tr>
<td>TSK_geterr</td>
<td>Get task error number</td>
</tr>
<tr>
<td>TSK_getname</td>
<td>Get task name</td>
</tr>
</tbody>
</table>
**List of Operations**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSK_getpri</td>
<td>Get task priority</td>
</tr>
<tr>
<td>TSK_getsts</td>
<td>Get task STS object</td>
</tr>
<tr>
<td>TSK_itick</td>
<td>Advance system alarm clock (interrupt only)</td>
</tr>
<tr>
<td>TSK_self</td>
<td>Returns a handle to the current task</td>
</tr>
<tr>
<td>TSK_setenv</td>
<td>Set task environment</td>
</tr>
<tr>
<td>TSK_seterr</td>
<td>Set task error number</td>
</tr>
<tr>
<td>TSK_setpri</td>
<td>Set a task execution priority</td>
</tr>
<tr>
<td>TSK_settime</td>
<td>Set task STS previous time</td>
</tr>
<tr>
<td>TSK_sleep</td>
<td>Delay execution of the current task</td>
</tr>
<tr>
<td>TSK_stat</td>
<td>Retrieve the status of a task</td>
</tr>
<tr>
<td>TSK_tick</td>
<td>Advance system alarm clock</td>
</tr>
<tr>
<td>TSK_tick</td>
<td>Return current value of system clock</td>
</tr>
<tr>
<td>TSK_tick</td>
<td>Yield processor to equal priority task</td>
</tr>
</tbody>
</table>

**x. C library stdlib.h**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>atexit</td>
<td>Registers one or more exit functions used by exit</td>
</tr>
<tr>
<td>calloc</td>
<td>Allocates memory block initialized with zeros</td>
</tr>
<tr>
<td>exit</td>
<td>Calls the exit functions registered in atexit</td>
</tr>
<tr>
<td>free</td>
<td>Frees memory block</td>
</tr>
<tr>
<td>getenv</td>
<td>Searches for a matching environment string</td>
</tr>
<tr>
<td>malloc</td>
<td>Allocates memory block</td>
</tr>
<tr>
<td>realloc</td>
<td>Resizes previously allocated memory block</td>
</tr>
</tbody>
</table>

**y.) DSP/BIOS std.h special utility C macros**

<table>
<thead>
<tr>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArgToInt(arg)</td>
<td>Casting to treat Arg type parameter as integer (Int) type on the given target</td>
</tr>
<tr>
<td>ArgToPtr(arg)</td>
<td>Casting to treat Arg type parameter as pointer (Ptr) type on the given target</td>
</tr>
</tbody>
</table>
Chapter 2

Application Program Interface

This chapter describes the TMS320C6000 DSP/BIOS API functions, which are alphabetized by name. In addition, there are reference sections that describe the overall capabilities of each module.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Assembly Language Interface Overview</td>
<td>2-2</td>
</tr>
<tr>
<td>2.2 ATM Module</td>
<td>2-4</td>
</tr>
<tr>
<td>2.3 C62 and C64 Modules</td>
<td>2-17</td>
</tr>
<tr>
<td>2.4 CLK Module</td>
<td>2-26</td>
</tr>
<tr>
<td>2.5 DEV Module</td>
<td>2-36</td>
</tr>
<tr>
<td>2.6 Global Settings</td>
<td>2-72</td>
</tr>
<tr>
<td>2.7 HOOK Module</td>
<td>2-75</td>
</tr>
<tr>
<td>2.8 HST Module</td>
<td>2-80</td>
</tr>
<tr>
<td>2.9 HWI Module</td>
<td>2-85</td>
</tr>
<tr>
<td>2.10 IDL Module</td>
<td>2-103</td>
</tr>
<tr>
<td>2.11 LCK Module</td>
<td>2-107</td>
</tr>
<tr>
<td>2.12 LOG Module</td>
<td>2-112</td>
</tr>
<tr>
<td>2.13 MBX Module</td>
<td>2-127</td>
</tr>
<tr>
<td>2.14 MEM Module</td>
<td>2-133</td>
</tr>
<tr>
<td>2.15 PIP Module</td>
<td>2-148</td>
</tr>
<tr>
<td>2.16 PRD Module</td>
<td>2-170</td>
</tr>
<tr>
<td>2.17 QUE Module</td>
<td>2-178</td>
</tr>
<tr>
<td>2.18 RTDX Module</td>
<td>2-195</td>
</tr>
<tr>
<td>2.19 SEM Module</td>
<td>2-211</td>
</tr>
<tr>
<td>2.20 SIO Module</td>
<td>2-221</td>
</tr>
<tr>
<td>2.21 STS Module</td>
<td>2-241</td>
</tr>
<tr>
<td>2.22 SWI Module</td>
<td>2-253</td>
</tr>
<tr>
<td>2.23 SYS Module</td>
<td>2-287</td>
</tr>
<tr>
<td>2.24 TRC Module</td>
<td>2-302</td>
</tr>
<tr>
<td>2.25 TSK Module</td>
<td>2-309</td>
</tr>
<tr>
<td>2.26 std.h and stdlib.h functions</td>
<td>2-344</td>
</tr>
</tbody>
</table>
2.1 Assembly Language Interface Overview

When calling DSP/BIOS APIs from assembly source code, you should include the module.h62 or module.h64 header file for any API modules used. This modular approach reduces the assembly time of programs that do not use all the modules.

Where possible, you should use the DSP/BIOS API macros instead of using assembly instructions directly. The DSP/BIOS API macros provide a portable, optimized way to accomplish the same task. For example, use HWI_disable instead of the equivalent instruction to temporarily disable interrupts. On some devices, disabling interrupts in a threaded interface is more complex than it appears. Some of the DSP/BIOS API functions have assembly macros and some do not.

Most of the DSP/BIOS API macros do not have parameters. Instead they expect parameter values to be stored in specific registers when the API macro is called. This makes your program more efficient. A few API macros accept constant values as parameters. For example, HWI_enter and HWI_exit accept constants defined as bitmasks identifying the registers to save or restore.

The Preconditions section for each DSP/BIOS API macro in this chapter lists registers that must be set before using the macro.

The Postconditions section lists registers set by the macro.

Modifies lists all individual registers modified by the macro, including registers in the Postconditions list.

Example

Assembly Interface

**Syntax**

SWI_getpri

**Preconditions**

a4 = address of the SWI object
b14 = address of start of .bss

**Postconditions**

a4 = SWI object’s priority mask

**Modifies**

a4

Assembly functions can call C functions. Remember that the C compiler adds an underscore prefix to function names, so when calling a C function from assembly, add an underscore to the beginning of the C function name. For example, call _myfunction instead of myfunction. See the TMS320C6000 Optimizing Compiler User’s Guide for more details.
The Configuration Tool creates two names for each object: one beginning with an underscore, and one without. This allows you to use the name without the underscore in both C and assembly language functions.

All BIOS APIs are preconditioned per standard C conventions. Individual APIs in this document only indicate additional conditions, if any.

BIOS APIs save/restore context for each task during the context switch that comprises all the registers listed as *Save by Child* in the C compiler manual appropriate for your platform. You must save/restore all additional register context you chose to manipulate directly in assembly or otherwise.
2.2 ATM Module

The ATM module includes assembly language functions.

**Functions**
- ATM_andi, ATM_andu. AND memory and return previous value
- ATM_cleari, ATM_clearu. Clear memory and return previous value
- ATM_deci, ATM_decu. Decrement memory and return new value
- ATM_inci, ATM_incu. Increment memory and return new value
- ATM_ori, ATM_oru. OR memory and return previous value
- ATM_seti, ATM_setu. Set memory and return previous value

**Description**
ATM provides a set of assembly language functions that are used to manipulate variables with interrupts disabled. These functions can therefore be used on data shared between tasks, and on data shared between tasks and interrupt routines.
**ATM_andi**

*Atomically AND Int memory location and return previous value*

**C Interface**

**Syntax**

```
ival = ATM_andi(idst, isrc);
```

**Parameters**

- volatile Int *idst; /* pointer to integer */
- Int isrc; /* integer mask */

**Return Value**

- Int ival; /* previous value of *idst */

**Assembly Interface**

none

**Description**

ATM_andi atomically ANDs the mask contained in isrc with a destination memory location and overwrites the destination value *idst with the result as follows:

```plaintext
'interrupt disable'
ival = *idst;
*idst = ival & isrc;
'interrupt enable'
return(ival);
```

ATM_andi is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

- ATM_andu
- ATM_ori
ATM_andu

Atomically AND Uns memory location and return previous value

C Interface

Syntax

```c
uval = ATM_andu(udst, usrc);
```

Parameters

- `volatile Uns *udst; /* pointer to unsigned */`
- `Uns usrc; /* unsigned mask */`

Return Value

- `Uns uval; /* previous value of *udst */`

Assembly Interface

none

Description

ATM_andu atomically ANDs the mask contained in `usrc` with a destination memory location and overwrites the destination value `*udst` with the result as follows:

```c
'interrupt disable'
  uval = *udst;
  *udst = uval & usrc;
'interrupt enable'
  return(uval);
```

ATM_andu is written in assembly language, efficiently disabling interrupts on the target processor during the call.

See Also

- ATM_andi
- ATM_oru
### ATM_cleari

**Atomically clear Int memory location and return previous value**

**C Interface**

<table>
<thead>
<tr>
<th>Syntax</th>
<th>ival = ATM_cleari(idst);</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>volatile Int <em>idst; /</em> pointer to integer */</td>
</tr>
<tr>
<td>Return Value</td>
<td>Int ival; /* previous value of *idst */</td>
</tr>
</tbody>
</table>

**Assembly Interface**

- none

**Description**

ATM_cleari atomically clears an Int memory location and returns its previous value as follows:

- `interrupt disable`
  
  ival = *idst;
  
  *dst = 0;

- `interrupt enable`

  return (ival);

ATM_cleari is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

- ATM_clearu
- ATM_seti
**ATM_clearu**  

*Atomically clear Uns memory location and return previous value*

**C Interface**

**Syntax**

\[
uval = \text{ATM\_clearu}(\text{udst});
\]

**Parameters**

volatile Uns *udst; /* pointer to unsigned */

**Return Value**

Uns uval; /* previous value of *udst */

**Assembly Interface**

none

**Description**

ATM_clearu atomically clears an Uns memory location and returns its previous value as follows:

```c
'\text{interrupt disable}'
\text{uval} = *\text{udst};
*\text{udst} = 0;
'\text{interrupt enable}'
\text{return (uval)};
```

ATM_clearu is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

ATM_clearu  
ATM_setu
ATM_deci

 Atomically decrement Int memory and return new value

C Interface

Syntax
ival = ATM_deci(idst);

Parameters
volatile Int *idst; /* pointer to integer */

Return Value
Int ival; /* new value after decrement */

Assembly Interface
none

Description
ATM_deci atomically decrements an Int memory location and returns its new value as follows:

'interrupt disable'
ival = *idst - 1;
*idst = ival;
'interrupt enable'
return (ival);

ATM_deci is written in assembly language, efficiently disabling interrupts on the target processor during the call.

Decrementing a value equal to the minimum signed integer results in a value equal to the maximum signed integer.

See Also
ATM_decu
ATM_inci
ATM_decu

Atomically decrement Uns memory and return new value

C Interface

Syntax
uval = ATM_decu(udst);

Parameters
volatile Uns *udst; /* pointer to unsigned */

Return Value
Uns uval; /* new value after decrement */

Assembly Interface
none

Description
ATM_decu atomically decrements a Uns memory location and returns its new value as follows:

'interrupt disable'
uval = *udst - 1;
*udst = uval;
'interrupt enable'
return (uval);

ATM_decu is written in assembly language, efficiently disabling interrupts on the target processor during the call.

Decrementing a value equal to the minimum unsigned integer results in a value equal to the maximum unsigned integer.

See Also

ATM_deci
ATM_incu
ATM_inci

Atomically increment Int memory and return new value

C Interface

Syntax
ival = ATM_inci(idst);

Parameters
volatile Int *idst; /* pointer to integer */

Return Value
Int ival; /* new value after increment */

Assembly Interface
none

Description
ATM_inci atomically increments an Int memory location and returns its new value as follows:

`interrupt disable`
ival = *idst + 1;
*idst = ival;
`interrupt enable`
return (ival);

ATM_inci is written in assembly language, efficiently disabling interrupts on the target processor during the call.

Incrementing a value equal to the maximum signed integer results in a value equal to the minimum signed integer.

See Also
ATM_deci
ATM_incu
ATM_incu

Atomically increment Uns memory and return new value

C Interface

Syntax
uval = ATM_incu(udst);

Parameters
volatile Uns *udst; /* pointer to unsigned */

Return Value
Uns uval; /* new value after increment */

Assembly Interface
none

Description
ATM_incu atomically increments an Uns memory location and returns its new value as follows:

' interrupt disable'
üval = *udst + 1;
*udst = uval;
' interrupt enable'
return (uval);

ATM_incu is written in assembly language, efficiently disabling interrupts on the target processor during the call.

Incrementing a value equal to the maximum unsigned integer results in a value equal to the minimum unsigned integer.

See Also
ATM_decu
ATM_inci
**ATM_ori**

*Atomically OR Int memory location and return previous value*

**C Interface**

**Syntax**

```c
ival = ATM_ori(idst, isrc);
```

**Parameters**

- `volatile Int *idst; /* pointer to integer */`
- `Int isrc; /* integer mask */`

**Return Value**

- `Int ival; /* previous value of *idst */`

**Assembly Interface**

`none`

**Description**

ATM_ori atomically ORs the mask contained in isrc with a destination memory location and overwrites the destination value *idst with the result as follows:

```
'interrupt disable'
ival = *idst;
*idst = ival | isrc;
'interrupt enable'
return(ival);
```

ATM_ori is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

- ATM_andi
- ATM_oru
**ATM_oru**

**Atomically OR Uns memory location and return previous value**

**C Interface**

**Syntax**

```c
uval = ATM_oru(udst, usrc);
```

**Parameters**

- `volatile Uns *udst; /* pointer to unsigned */`
- `Uns usrc; /* unsigned mask */`

**Return Value**

- `Uns uva; /* previous value of *udst */`

**Assembly Interface**

`none`

**Description**

ATM_oru atomically ORs the mask contained in `usrc` with a destination memory location and overwrites the destination value `*udst` with the result as follows:

```c
'interrupt disable'
uval = *udst;
*udst = uval | usrc;
'Interrupt enable'
return(uval);
```

ATM_oru is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

- ATM_andu
- ATM_ori
**ATM_seti**

Atomically set Int memory and return previous value

**C Interface**

**Syntax**

```c
iold = ATM_seti(idst, inew);
```

**Parameters**

- `volatile Int *idst; /* pointer to integer */`
- `Int inew; /* new integer value */`

**Return Value**

- `Int iold; /* previous value of *idst */`

**Assembly Interface**

- `none`

**Description**

ATM_seti atomically sets an Int memory location to a new value and returns its previous value as follows:

```
'interrupt disable'
ival = *idst;
*idst = inew;
'interrupt enable'
return (ival);
```

ATM_seti is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

- ATM_setu
- ATM_cleari
**ATM_setu**

Atomically set Uns memory and return previous value

**C Interface**

**Syntax**

```
uold = ATM_setu(udst, unew);
```

**Parameters**

- `volatile Uns *udst;` /* pointer to unsigned */
- `Uns unew;` /* new unsigned value */

**Return Value**

- `Uns uold;` /* previous value of *udst */

**Assembly Interface**

- `none`

**Description**

ATM_setu atomically sets an Uns memory location to a new value and returns its previous value as follows:

```
'debug disable'
uval = *udst;
*udst = unew;
'debug enable'
return (uval);
```

ATM_setu is written in assembly language, efficiently disabling interrupts on the target processor during the call.

**See Also**

- ATM_clearu
- ATM_seti
2.3 C62 and C64 Modules

The C62 and C64 modules include target-specific functions for the TMS320C6000 family.

Functions

- C62_disableIER. ASM macro to disable selected interrupts in the IER
- C62_enableIER. ASM macro to enable selected interrupts in the IER
- C62_plug. Plug interrupt vector
- C64_disableIER. ASM macro to disable selected interrupts in the IER
- C64_enableIER. ASM macro to enable selected interrupts in the IER
- C64_plug. Plug interrupt vector

Description

The C62 and C64 modules provide certain target-specific functions and definitions for the TMS320C6000 family of processors.

See the c62.h or c64.h files for the complete list of definitions for hardware flags for C. The c62.h and c64.h files contain C language macros, #defines for various TMS320C6000 registers, and structure definitions. The c62.h62 and c64.h64 files also contain assembly language macros for saving and restoring registers in interrupt service routines.
C62_disableIER  

Disable certain maskable interrupts

C Interface

Syntax
oldmask = C62_disableIER(mask);

Parameters
Uns mask; /* disable mask */

Return Value
Uns oldmask; /* actual bits cleared by disable mask */

Assembly Interface

Syntax
C62_disableIER IEMASK, REG0, REG1

Preconditions
IEMASK ; interrupt disable mask
REG0 ; temporary register that can be modified
REG1 ; temporary register that can be modified

Postconditions
none

Description
C62_disableIER disables interrupts by clearing the bits specified by mask in the Interrupt Enable Register (IER).

The C version of C62_disableIER returns a mask of bits actually cleared. This return value should be passed to C62_enableIER to re-enable interrupts.

See C62_enableIER for a description and code examples for safely protecting a critical section of code from interrupts.

See Also
C62_enableIER
C64_disableIER

*Disable certain maskable interrupts*

**C Interface**

**Syntax**
oldmask = C64_disableIER(mask);

**Parameters**
Uns mask; /* disable mask */

**Return Value**
Uns oldmask; /* actual bits cleared by disable mask */

**Assembly Interface**

**Syntax**
C64_disableIER IEMASK, REG0, REG1

**Preconditions**
IEMASK ; interrupt disable mask
REG0 ; temporary register that can be modified
REG1 ; temporary register that can be modified

**Postconditions**
none

**Description**
C64_disableIER disables interrupts by clearing the bits specified by mask in the Interrupt Enable Register (IER).

The C version of C64_disableIER returns a mask of bits actually cleared. This return value should be passed to C64_enableIER to re-enable interrupts.

See C64_enableIER for a description and code examples for safely protecting a critical section of code from interrupts.

**See Also**
C64_enableIER
C62_enableIER

Enable certain maskable interrupts

C Interface

Syntax
C62_enableIER(oldmask);

Parameters
Uns oldmask; /* enable mask */

Return Value
Void

Assembly Interface

Syntax
C62_enableIER IEMASK, REG0, REG1

Preconditions
IEMASK ; interrupt enable mask
REG0 ; temporary register that can be modified
REG1 ; temporary register that can be modified

Postconditions
none

Description
C62_disableIER and C62_enableIER disable and enable specific internal interrupts by modifying the Interrupt Enable Register (IER). C62_disableIER clears the bits specified by the mask parameter in the IER and returns a mask of the bits it cleared. C62_enableIER sets the bits specified by the oldmask parameter in the IER.

C62_disableIER and C62_enableIER are usually used in tandem to protect a critical section of code from interrupts. The following code examples show a region protected from all interrupts:

; ASM example
.include c62.h62
...

; disable interrupts specified by IEMASK
C62_disableIER IEMASK, b0, b1

‘do some critical operation’

; enable interrupts specified by IEMASK
C62_enableIER IEMASK, b0, b1

/* C example */
Uns oldmask;

oldmask = C62_disableIER(~0);
‘do some critical operation;‘
‘do not call TSK_sleep, SEM_post, etc.‘
C62_enableIER(oldmask);
Note:

DSP/BIOS kernel calls that can cause a task switch (for example, SEM_post and TSK_sleep) should be avoided within a C62_disableIER / C62_enableIER block since the interrupts can be disabled for an indeterminate amount of time if a task switch occurs.

Alternatively, you can disable DSP/BIOS task scheduling for this block by enclosing it with TSK_disable / TSK_enable. You can also use C62_disableIER / C62_enableIER to disable selected interrupts, allowing other interrupts to occur. However, if another HWI does occur during this region, it could cause a task switch. You can prevent this by using TSK_disable / TSK_enable around the entire region:

```c
Uns oldmask;

TSK_disable();
oldmask = C62_disableIER(INTMASK);
    'do some critical operation,'
    'NOT OK to call TSK_sleep, SEM_post, etc.'
C62_enableIER(oldmask);
TSK_enable();
```

Note:

If you use C_disableIER / C62_enableIER to disable only some interrupts, you must surround this region with SWI_disable / SWI_enable, to prevent an intervening HWI from causing a SWI or TSK switch.

The second approach is preferable if it is important not to disable all interrupts in your system during the critical operation.

See Also

C62_disableIER
**C64_enableIER**

*Enable certain maskable interrupts*

**C Interface**

**Syntax**

`C64_enableIER(oldmask);`

**Parameters**

* Un职 oldmask; /* enable mask */

**Return Value**

* Void

**Assembly Interface**

**Syntax**

`C64_enableIER IEMASK, REG0, REG1`

**Preconditions**

* IEMASK ; interrupt enable mask
* REG0 ; temporary register that can be modified
* REG1 ; temporary register that can be modified

**Postconditions**

* none

**Description**

`C64_disableIER` and `C64_enableIER` are used to disable and enable specific internal interrupts by modifying the Interrupt Enable Register (IER). `C64_disableIER` clears the bits specified by the mask parameter in the Interrupt Mask Register and returns a mask of the bits it cleared. `C64_enableIER` sets the bits specified by the oldmask parameter in the Interrupt Mask Register.

`C64_disableIER` and `C64_enableIER` are usually used in tandem to protect a critical section of code from interrupts. The following code examples show a region protected from all maskable interrupts:

```
; ASM example
.include c64.h64
...

; disable interrupts specified by IEMASK
C64_disableIER IEMASK, b0, b1
' do some critical operation'

; enable interrupts specified by IEMASK
C64_enableIER IEMASK, b0, b1

/* C example */
Uns oldmask;

oldmask = C64_disableIMR(~0);
```
`do some critical operation;`
`do not call TSK_sleep, SEM_post, etc.`
C64_enableIMR(oldmask);

**Note:**

DSP/BIOS kernel calls that can cause a task switch (for example, SEM_post and TSK_sleep) should be avoided within a C64_disableIER and C64_enableIER block since the interrupts can be disabled for an indeterminate amount of time if a task switch occurs.

Alternatively, you can disable DSP/BIOS task scheduling for this block by enclosing it with TSK_disable / TSK_enable. You can also use C64_disableIER and C64_enableIER to disable selected interrupts, allowing other interrupts to occur. However, if another HWI does occur during this region, it could cause a task switch. You can prevent this by using TSK_disable / TSK_enable around the entire region:

```c
Uns oldmask;

TSK_disable();
oldmask = C64_disableIER(INTMASK);
`do some critical operation;`
`NOT OK to call TSK_sleep, SEM_post, etc.`
C64_enableIER(oldmask);
TSK_enable();
```

**Note:**

If you use C64_disableIER and C64_enableIER to disable only some interrupts, you must surround this region with SWI_disable / SWI_enable, to prevent an intervening HWI from causing a SWI or TSK switch.

The second approach is preferable if it is important not to disable all interrupts in your system during the critical operation.

**See Also**

C64_disableIER
**C62_plug**

* C function to plug an interrupt vector

**C Interface**

**Syntax**

```c
C62_plug(vecid, fxn, dmachan);
```

**Parameters**

- `Int vecid; /* interrupt id */`
- `Fxn fxn; /* pointer to HWI function */`
- `Int dmachan; /* DMA channel to use for performing plug */`

**Return Value**

Void

**Assembly Interface**

none

**Description**

C62_plug writes an Interrupt Service Fetch Packet (ISFP) into the Interrupt Service Table (IST), at the address corresponding to vecid. The op-codes written in the ISFP create a branch to the function entry point specified by fxn:

```Assembly
stw    b0, *SP--[1]
mvk    fxn, b0
mvkh   fxn, b0
b      b0
ldw    *+++SP[1],b0
nop    4
```

If the IST is stored in external RAM, a DMA channel is not necessary and the dmachan parameter can be set to -1 to cause a CPU copy instead. A DMA channel can still be used to plug a vector in external RAM. A DMA channel must be used to plug a vector in internal program RAM.

If a DMA channel is specified by the dmachan parameter, C62_plug assumes that the DMA channel is available for use, and stops the DMA channel before programming it. If the DMA channel is shared with other code, a semaphore or other DSP/BIOS signaling method should be used to provide mutual exclusion before calling C62_plug.

C62_plug does not enable the interrupt. Use C62_enableIER to enable specific interrupts.

**Constraints and Calling Context**

- vecid must be a valid interrupt ID in the range of 0-15.
- dmachan must be 0, 1, 2, or 3 if the IST is in internal program memory.

**See Also**

- C62_enableIER
- HWI_dispatchPlug
C64_plug  

C function to plug an interrupt vector

C Interface

Syntax

C64_plug(vecid, fxn);

Parameters

Int vecid; /* interrupt id */
Fxnx /* pointer to HWI function */

Return Value

Void

Assembly Interface

none

Description

C64_plug writes an Interrupt Service Fetch Packet (ISFP) into the Interrupt Service Table (IST), at the address corresponding to vecid. The op-codes written in the ISFP create a branch to the function entry point specified by fxn:

```
stw b0, *SP--[1]
mvkr fxn, b0
mvkh fxn, b0
b b0
ldwb *++,SP[1],b0
nop 4
```

If the IST is stored in external RAM, a DMA channel is not necessary and the dmachan parameter can be set to -1 to cause a CPU copy instead. A DMA channel can still be used to plug a vector in external RAM. A DMA channel must be used to plug a vector in internal program RAM.

If a DMA channel is specified by the dmachan parameter, C64_plug assumes that the DMA channel is available for use, and stops the DMA channel before programming it. If the DMA channel is shared with other code, a semaphore or other DSP/BIOS signaling method should be used to provide mutual exclusion before calling C64_plug.

C64_plug hooks up the specified function as the branch target or a hardware interrupt (fielded by the CPU) at the vector address specified in vecid. C64_plug does not enable the interrupt. Use or C64_enableIER to enable specific interrupts.

Constraints and Calling Context

- vecid must be a valid interrupt ID in the range of 0-15.
- dmachan must be 0, 1, 2, or 3 if the IST is in internal program memory.

See Also

C64_enableIER
2.4 CLK Module

The CLK module is the system clock manager.

**Functions**
- CLK_countspms. Timer counts per millisecond
- CLK_gethtime. Get high resolution time
- CLK_getltime. Get low resolution time
- CLK_getprd. Get period register value

**Description**
The CLK module provides a method for invoking functions periodically.

DSP/BIOS provides two separate timing methods: the high- and low-resolution times managed by the CLK module and the system clock. In the default configuration, the low-resolution time and the system clock are the same.

The CLK module provides a real-time clock with functions to access this clock at two resolutions. This clock can be used to measure the passage of time in conjunction with STS accumulator objects, as well as to add timestamp messages to event logs. Both the low-resolution and high-resolution times are stored as 32-bit values. The value restarts at 0 when the maximum value is reached.

If the Clock Manager is enabled in the Configuration Tool, the timer counter register is incremented every four CPU cycles.

When this register reaches the value set for the period register, the counter is reset to 0 and a timer interrupt occurs. When a timer interrupt occurs, the HWI object for the selected timer runs the CLK_F_isr function. This function causes these events to occur:
- The low-resolution time is incremented by 1
- All the functions specified by CLK objects are performed in sequence in the context of that HWI

**Note: Specifying On-device Timer**

The Configuration Tool allows you to specify which on-device timer you want to use. DSP/BIOS requires the default setting in the interrupt selector register for the selected timer. For example, interrupt 14 must be configured for timer 0, interrupt 15 must be configured for timer 1, and interrupt 11 must be configured for timer 2.

Therefore, the low-resolution clock ticks at the timer interrupt rate and the clock’s value is equal to the number of timer interrupts that have occurred.
You can use the CLK_gettime function to get the low-resolution time and the CLK_getprd function to get the value of the period register property.

The high-resolution time is the number of times the timer counter register has been incremented (number of instruction cycles divided by 4). The 32-bit high-resolution time is actually calculated by multiplying the low-resolution time by the value of the period register property and adding the current value of the timer counter register. You can use the CLK_gettime function to get the high-resolution time and the CLK_countspms function to get the number of hardware timer counter register ticks per millisecond.

The CLK functions performed when a timer interrupt occurs are performed in the context of the hardware interrupt that caused the system clock to tick. Therefore, the amount of processing performed within CLK functions should be minimized and these functions can only invoke DSP/BIOS calls that are allowable from within an HWI.

**Note:**

CLK functions should not call HWI_enter and HWI_exit as these are called internally by the HWI dispatcher when it runs CLK_F_isr. Additionally, CLK functions should not use the `interrupt` keyword or the `INTERRUPT pragma in C functions.

If you do not want the on-device timer to drive the system clock, you can disable the CLK Manager by clearing the Enable CLK Manager checkbox on the CLK Manager Properties dialog. If this box is gray, go to the PRD Manager Properties dialog and clear the Use CLK Manager to Drive PRD box. Then you can disable the CLK Manager.

The HWI object that runs the CLK_F_isr function is configured to use the HWI dispatcher. You can modify the dispatcher-specific properties of this HWI object. For example, you can change the interrupt mask value and the cache control value. See the HWI module, page 2-85, for a description of the HWI dispatcher and these HWI properties. You may not disable the use of the HWI dispatcher for the HWI object that runs the CLK_F_isr function.

### 2.4.1 Clock Manager Properties

The following global properties can be set for the CLK module on the CLK Manager Properties dialog in the Configuration Tool:

- **Object Memory.** The memory segment that contains the CLK objects created with the Configuration Tool.
CPU Interrupt. Shows which HWI interrupt is used to drive the timer services. The value is changed automatically when you change the Timer Selection. This is an informational field only.

Timer Selection. The on-device timer to use. Changing this setting also automatically changes the CPU Interrupt used to drive the timer services and the function property of the relevant HWI objects.

Enable CLK Manager. If checked, the on-device timer hardware is used to drive the high- and low-resolution times and to trigger execution of CLK functions.

Use high resolution time for internal timings. If checked, the high-resolution timer is used to monitor internal periods; otherwise the less intrusive, low-resolution timer is used.

Microseconds/Int. The number of microseconds between timer interrupts. The period register is set to a value that achieves the desired period as closely as possible.

Directly configure on-device timer registers. If checked, the period register can be directly set to the desired value. In this case, the Microseconds/Int field is computed based on the value in period register and the CPU clock speed.

PRD Register. This value is written to the PRD register.

Instructions/Int. The number of instruction cycles represented by the period specified above. This is an informational field only.

2.4.2 CLK Object Properties

The Clock Manager allows you to create an arbitrary number of clock functions. Clock functions are functions executed by the Clock Manager every time a timer interrupt occurs. These functions can invoke any DSP/BIOS operations allowable from within an HWI except HWI_enter or HWI_exit.

The following properties can be set for a clock function object on the CLK Object Properties dialog in the Configuration Tool:

- comment. Type a comment to identify this CLK object.

- function. The function to be executed when the timer hardware interrupt occurs. This function must be written like an HWI function; it must be written in C or assembly and must save and restore any registers this function modifies. However, this function can not call HWI_enter or HWI_exit because DSP/BIOS calls them internally before and after this function runs.

These functions should be very short as they are performed frequently.
Since all CLK functions are performed at the same periodic rate, functions that need to run at a multiple of that rate should either count the number of interrupts and perform their activities when the counter reaches the appropriate value or be configured as PRD objects.

If this function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code, which must use leading underscores when referencing C functions or labels.)

### 2.4.3 CLK - Code Composer Studio Interface

To enable CLK logging, choose DSP/BIOS → RTA Control Panel and put a check in the appropriate box. You see indicators for low resolution clock interrupts in the Time row of the Execution Graph, which you can open by choosing DSP/BIOS → Execution Graph.
CLK_countspms

**Number of hardware timer counts per millisecond**

**C Interface**

**Syntax**

```c
ncounts = CLK_countspms();
```

**Parameters**

Void

**Return Value**

LgUns ncounts;

**Assembly Interface**

**Syntax**

CLK_countspms

**Preconditions**

amr = 0

**Postconditions**

a4 = the number of hardware timer register ticks per millisecond

**Modifies**

a4

**Reentrant**

yes

**Description**

CLK_countspms returns the number of hardware timer register ticks per millisecond. This corresponds to the number of high-resolution ticks per millisecond.

CLK_countspms can be used to compute an absolute length of time from the number of hardware timer counts. For example, the following code returns the number of milliseconds since the 32-bit high-resolution time last wrapped back to 0:

```c
timeAbs = (CLK_getltime() * (CLK_getprd())) / CLK_countspms();
```

**See Also**

CLK_getltime
CLK_getprd
STS_delta
CLK_gethtime

Get high-resolution time

C Interface

Syntax
currtime = CLK_gethtime();

Parameters
Void

Return Value
LgUns currtime /* high-resolution time */

Assembly Interface

Syntax
CLK_gethtime

Preconditions
interrupts are disabled
b14 = pointer to the start of .bss
amr = 0

Postconditions
a4 = high-resolution time value

Modifies
a2, a3, a4, a5, b1, b2, b3, b4, b5

Reentrant
no

Description
CLK_gethtime returns the number of high resolution clock cycles that have occurred as a 32-bit time value. When the number of cycles reaches the maximum value that can be stored in 32 bits, the value wraps back to 0.

High-resolution time is the number of times the timer counter register has been incremented. When the CLK manager is enabled in the Configuration Tool, the timer counter register is incremented every four CPU cycles.

When this register reaches the value set for the period register, the counter is reset to 0 and a timer interrupt occurs. When a timer interrupt occurs, the HWI object for the selected timer runs the CLK_F_isr function.

In contrast, CLK_gethtime returns the number of timer interrupts that have occurred. When the timer counter register reaches the value set for the period register property of the CLK module, the counter is reset to 0 and a timer interrupt occurs.

High-resolution time is actually calculated by multiplying the low-resolution time by the value of the period register property and adding to it the current value of the timer counter register. Although the CLK_gethtime uses the period register value to calculate the high-resolution time, the value of the high-resolution time is independent of the actual value in the period register. This is because the timer counter register is divided by the period register value when incrementing the low-resolution time, and the result is multiplied by the same period register value to calculate the high-resolution time.
CLK_gethtime provides a value with greater accuracy than CLK_getlttime, but which wraps back to 0 more frequently. For example, if the device’s clock rate is 200 MHz, then regardless of the period register value, the CLK_gethtime value wraps back to 0 approximately every 86 seconds.

CLK_gethtime can be used in conjunction with STS_set and STS_delta to benchmark code. CLK_gethtime can also be used to add a time stamp to event logs.

Constraints and Calling Context

CLK_gethtime cannot be called from the program’s main function.

Example

```c
/* ======== showTime ======== */

Void showTicks
{
    LOG_printf(&trace, "time = %d", CLK_gethtime());
}
```

See Also

CLK_getlttime
PRD_getticks
STS_delta
CLK_gettime

Get low-resolution time

C Interface

Syntax

curtime = CLK_gettime();

Parameters

Void

Return Value

LgUns curtime /* low-resolution time */

Assembly Interface

Syntax

CLK_gettime

Preconditions

b14 = pointer to the start of .bss
amr = 0

Postconditions

a4 = low-resolution time value

Modifies

a4

Reentrant

yes

Description

CLK_gettime returns the number of timer interrupts that have occurred as a 32-bit time value. When the number of interrupts reaches the maximum value that can be stored in 32 bits, value wraps back to 0 on the next interrupt.

The low-resolution time is the number of timer interrupts that have occurred.

The timer counter is incremented every four CPU cycles. When this register reaches the value set for the period register property of the CLK module, the counter is reset to 0 and a timer interrupt occurs. When a timer interrupt occurs, all the functions specified by CLK objects are performed in sequence in the context of that HWI.

The default low resolution interrupt rate is 1 millisecond/interrupt. By adjusting the period register, you can set rates from less than 1 microsecond/interrupt to more than 1 second/interrupt.

If you use the default configuration, the system clock rate matches the low-resolution rate.

In contrast, CLK_gethtime returns the number of high resolution clock cycles that have occurred. When the timer counter register reaches the value set for the period register property of the CLK module, the counter is reset to 0 and a timer interrupt occurs.

Therefore, CLK_gethtime provides a value with greater accuracy than CLK_gettime, but which wraps back to 0 more frequently. For example, if the
device's clock rate is 200 MHz, and you use the default period register value of 50000, the CLK_gettime value wraps back to 0 approximately every 86 seconds, while the CLK_gettime value wraps back to 0 approximately every 49.7 days.

CLK_gettime is often used to add a time stamp to event logs for events that occur over a relatively long period of time.

**Constraints and Calling Context**

CLK_gettime cannot be called from the program's main function.

**Example**

```c
/* ======== showTicks ======== */

Void showTicks
{
    LOG_printf(&trace, "time = 0x%x", CLK_gettime());
}
```

**See Also**

CLK_gettime
PRD_getticks
STS_delta
CLK_getprd

Get period register value

C Interface

Syntax

period = CLK_getprd();

Parameters

Void

Return Value

Uns period /* period register value */

Assembly Interface

Syntax

CLK_getprd

Preconditions

amr = 0

Postconditions

a4

Modifies

a4

Reentrant

yes

Description

CLK_getprd returns the value set for the period register property of the CLK Manager in the Configuration Tool. CLK_getprd can be used to compute an absolute length of time from the number of hardware timer counts. For example, the following code returns the number of milliseconds since the 32-bit high-resolution time last wrapped back to 0:

```
timeAbs = (CLK_getltime() * (CLK_getprd())) / CLK_countspms();
```

See Also

CLK_countspms
CLK_gethtime
STS_delta
2.5 DEV Module

The DEV module is the device driver interface.

Functions

- DEV_match. Match device name with driver
- Dxx_close. Close device
- Dxx_ctrl. Device control
- Dxx_idle. Idle device
- Dxx_init. Initialize device
- Dxx_issue. Send frame to device
- Dxx_open. Open device
- Dxx_ready. Device ready
- Dxx_reclaim. Retrieve frame from device

Constants, Types, and Structures

```c
#define DEV_INPUT       0
#define DEV_OUTPUT      1

typedef struct DEV_Frame { /* frame object */
    QUE_Elem   link;       /* queue link */
    Ptr        addr;       /* buffer address */
    Uns        size;       /* buffer size */
    Arg        misc;       /* reserved for driver */
    Arg        arg;        /* user argument */
} DEV_Frame;

typedef struct DEV_Obj {/* device object */
    QUE_Handle todevice;   /* downstream frames here */
    QUE_Handle fromdevice; /* upstream frames here */
    Uns        bufsize;    /* buffer size */
    Uns        nbufs;      /* number of buffers */
    Int        segid;      /* buffer segment ID */
    Int        mode;       /* DEV_INPUT/DEV_OUTPUT */
    Int        devid;      /* device ID */
    Ptr        params;     /* device parameters */
    Ptr        object;     /* ptr to device instance obj */
    DEV_Fxns   fxns;       /* driver functions */
    Uns        timeout;    /* SIO_reclaim timeout value */
    Uns        align;      /* buffer alignment */
} DEV_Obj;

typedef struct DEV_Fxns { /* driver function table */
    Int        (*close)( DEV_Handle );
    Int        (*ctrl)( DEV_Handle, Uns, Arg );
    Int        (*idle)( DEV_Handle, Bool );
    Int        (*issue)( DEV_Handle );
```
DEV Module

typedef struct DEV_Device { /* device specifier */
    String     name;        /* device name */
    DEV_Fxns   *fxns;       /* device function table*/
    Int        devid;       /* device ID */
    Ptr        params;      /* device parameters */
} DEV_Device;

Description

Using generic functions provided by the SIO module, programs indirectly invoke corresponding functions which manage the particular device attached to the stream. Unlike other modules, your application programs do not issue direct calls to driver functions that manipulate individual device objects managed by the module. Instead, each driver module exports a distinguished structure of type DEV_Fxns, which is used by the SIO module to route generic function calls to the proper driver function.

The Dxx functions are templates for driver functions. To ensure that all driver functions present an identical interface to DEV, the driver functions must follow these templates.

2.5.1 DEV Manager Properties

The default configuration contains managers for the following built-in device drivers:

- DGN software generator driver. A pseudo-device that generates one of several data streams, such as a sin/cos series or white noise. This driver can be useful for testing applications that require an input stream of data.
- DHL host link driver. A driver that uses the HST interface to send data to and from the DSP/BIOS Host Channel Control Analysis Tool.
- DPI pipe driver. A software device used to stream data between DSP/BIOS tasks.

To configure devices for other drivers, use the Configuration Tool to insert a User-defined Device object. There are no global properties for the user-defined device manager.

The following additional device drivers are supplied with DSP/BIOS:

- DAX. Generic streaming device driver
- DGS. Stackable gather/scatter driver
- DNL. Null driver
DEV Module

- DOV. Stackable overlap driver
- DST. Stackable “split” driver
- DTR. Stackable streaming transformer driver

2.5.2 DEV Object Properties

The following properties can be set on the DEV Object Properties dialog in the Configuration Tool for a user-defined device:

- **comment.** Type a comment to identify this object.

- **DEV_Fxns table.** Specify the name of the device functions table contained in dxx.c. This table should have a name with the format DXX_FXNS where XX is the two-letter code for the driver used by this device.

  Use a leading underscore before the table name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.)

- **Parameters.** If this device uses additional parameters, provide the name of the parameter structure. This structure should have a name with the format DXX_Params where XX is the two-letter code for the driver used by this device.

  Use a leading underscore before the structure name.

- **Device ID.** Specify the device ID. If the value you provide is non-zero, the value takes the place of a value that would be appended to the device name in a call to SIO_create. The purpose of such a value is driver-specific.

- **Init Fxn.** Specify the function to run to initialize this device. Use a leading underscore before the function name if the function is written in C.

- **Stacking Device.** Put a checkmark in this box if device uses a stacking driver.
**DEV_match**  
*Match a device name with a driver*

**C Interface**

**Syntax**

\[
\text{substr} = \text{DEV\_match(name, device);} 
\]

**Parameters**

- String \text{name}; /* device name */
- DEV\_Device **\text{device}; /* pointer to device table entry */

**Return Value**

- String \text{substr}; /* remaining characters after match */

**Assembly Interface** none

**Description**

DEV\_match searches the device table for the first device name that matches a prefix of name. The output parameter, device, points to the appropriate entry in the device table if successful and is set to NULL on error.

A pointer to the characters remaining after the match is returned in substr. This string is used by stacking devices to specify the name(s) of underlying devices (for example, /scale10/sine might match /scale10 a stacking device which would, in turn, use /sine to open the underlying generator device).

**See Also**

SIO\_create
Dxx_close

Close device

C Interface

Syntax
status = Dxx_close(device);

Parameters
DEV_Handle device; /* device handle */

Return Value
Int status; /* result of operation */

Assembly Interface
none

Description
Dxx_close closes the device associated with device and returns an error code indicating success (SYS_OK) or failure. device is bound to the device through a prior call to Dxx_open.

SIO_delete first calls Dxx_idle to idle the device. Then it calls Dxx_close.

Once device has been closed, the underlying device is no longer accessible via this descriptor.

Constraints and Calling Context
Device must be bound to a device by a prior call to Dxx_open.

See Also
Dxx_idle
Dxx_open
SIO_delete
**Dxx_ctrl**

*Device control operation*

**C Interface**

**Syntax**

```
status = Dxx_ctrl(device, cmd, arg);
```

**Parameters**

- `DEV_Handle device` /* device handle */
- `Uns cmd;` /* driver control code */
- `Arg arg;` /* control operation argument */

**Return Value**

- `Int status;` /* result of operation */

**Assembly Interface**

`none`

**Description**

`Dxx_ctrl` performs a control operation on the device associated with `device` and returns an error code indicating success (SYS_OK) or failure. The actual control operation is designated through `cmd` and `arg`, which are interpreted in a driver-dependent manner.

`Dxx_ctrl` is called by `SIO_ctrl` to send control commands to a device.

**Constraints and Calling Context**

- Device must be bound to a device by a prior call to `Dxx_open`.

**See Also**

- `SIO_ctrl`
**Dxx_idle**

*Idle device*

**C Interface**

**Syntax**

```
status = Dxx_idle(device, flush);
```

**Parameters**

- `DEV_Handle device; /* device handle */`
- `Bool flush; /* flush output flag */`

**Return Value**

- `Int status; /* result of operation */`

**Assembly Interface**

none

**Description**

Dxx_idle places the device associated with device into its idle state and returns an error code indicating success (SYS_OK) or failure. Devices are initially in this state after they are opened with Dxx_open.

Dxx_idle returns the device to its initial state. Dxx_idle should move any frames from the device->todevice queue to the device->fromdevice queue. In SIO_ISSUERECLAIM mode, any outstanding buffers issued to the stream must be reclaimed in order to return the device to its true initial state.

Dxx_idle is called by SIO_idle, SIO_flush, and SIO_delete to recycle frames to the appropriate queue.

flush is a boolean parameter that indicates what to do with any pending data of an output stream. If flush is TRUE, all pending data is discarded and Dxx_idle does not block waiting for data to be processed. If flush is FALSE, the Dxx_idle function does not return until all pending output data has been rendered. All pending data in an input stream is always discarded, without waiting.

**Constraints and Calling Context**

Device must be bound to a device by a prior call to Dxx_open.

**See Also**

- SIO_delete
- SIO_idle
- SIO_flush
<table>
<thead>
<tr>
<th><strong>Dxx_init</strong></th>
<th><em>Initialize device</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C Interface</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Syntax</strong></td>
<td>Dxx_init();</td>
</tr>
<tr>
<td><strong>Parameters</strong></td>
<td>Void</td>
</tr>
<tr>
<td><strong>Return Value</strong></td>
<td>Void</td>
</tr>
<tr>
<td><strong>Assembly Interface</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Dxx_init is used to initialize the device driver module for a particular device. This initialization often includes resetting the actual device to its initial state. Dxx_init is called at system startup, before the application’s main function is called.</td>
</tr>
</tbody>
</table>
**Dxx_issue**

*Send a buffer to the device*

**C Interface**

**Syntax**

```c
status = Dxx_issue(device);
```

**Parameters**

- `DEV_Handle device; /* device handle */`

**Return Value**

```c
Int status; /* result of operation */
```

**Assembly Interface**

none

**Description**

Dxx_issue is used to notify a device that a new frame has been placed on the device->todevice queue. If the device was opened in DEV_INPUT mode then Dxx_issue uses this frame for input. If the device was opened in DEV_OUTPUT mode, Dxx_issue processes the data in the frame, then outputs it. In either mode, Dxx_issue ensures that the device has been started, and returns an error code indicating success (SYS_OK) or failure.

Dxx_issue does not block. In output mode it processes the buffer and places it in a queue to be rendered. In input mode, it places a buffer in a queue to be filled with data, then returns.

Dxx_issue is used in conjunction with Dxx_reclaim to operate a stream. The Dxx_issue call sends a buffer to a stream, and the Dxx_reclaim retrieves a buffer from a stream. Dxx_issue performs processing for output streams, and provides empty frames for input streams. The Dxx_reclaim recovers empty frames in output streams, retrieves full frames, and performs processing for input streams.

SIO_issue calls Dxx_issue after placing a new input frame on the device->todevice. If Dxx_issue fails, it should return an error code. Before attempting further I/O through the device, the device should be idled, and all pending buffers should be flushed if the device was opened for DEV_OUTPUT.

In a stacking device, Dxx_issue must preserve all information in the DEV_Frame object except link and misc. On a device opened for DEV_INPUT, Dxx_issue should preserve the size and the arg fields. On a device opened for DEV_OUTPUT, Dxx_issue should preserve the buffer data (transformed as necessary), the size (adjusted as appropriate by the transform) and the arg field. The DEV_Frame objects themselves do not need to be preserved, only the information they contain.

Dxx_issue must preserve and maintain buffers sent to the device so they can be returned in the order they were received, by a call to Dxx_reclaim.
Constraints and Calling Context

Device must be bound to a device by a prior call to Dxx_open.

See Also

Dxx_reclaim
SIO_issue
SIO_get
SIO_put
**Dxx_open**

*Open device*

**C Interface**

**Syntax**

```c
status = Dxx_open(device, name);
```

**Parameters**

- `DEV_Handle device; /* driver handle */`
- `String name; /* device name */`

**Return Value**

```c
Int status; /* result of operation */
```

**Assembly Interface**

None

**Description**

`Dxx_open` is called by SIO_create to open a device. `Dxx_open` opens a device and returns an error code indicating success (SYS_OK) or failure.

The device parameter points to a DEV_Obj whose fields have been initialized by the calling function (that is, SIO_create). These fields can be referenced by `Dxx_open` to initialize various device parameters. `Dxx_open` is often used to attach a device-specific object to device->object. This object typically contains driver-specific fields that can be referenced in subsequent Dxx driver calls.

`name` is the string remaining after the device name has been matched by SIO_create using DEV_match.

**See Also**

- `Dxx_close`
- SIO_create
Dxx_ready

Check if device is ready for I/O

C Interface

Syntax

status = Dxx_ready(device, sem);

Parameters

DEV_Handle device; /* device handle */
SEM_Handle sem;   /* semaphore to post when ready */

Return Value

Bool status; /* TRUE if device is ready */

Assembly Interface

none

Description

Dxx_ready is called by SIO_select to determine if the device is ready for an I/O operation. In this context, ready means a call that retrieves a buffer from a device does not block. If a frame exists, Dxx_ready returns TRUE, indicating that the next SIO_get, SIO_put, or SIO_reclaim operation on the device does not cause the calling task to block. If there are no frames available, Dxx_ready returns FALSE. This informs the calling task that a call to SIO_get, SIO_put, or SIO_reclaim for that device would result in blocking.

If the device is an input device that is not started, Dxx_ready starts the device.

Dxx_ready registers the device’s ready semaphore with the SIO_select semaphore sem. In cases where SIO_select calls Dxx_ready for each of several devices, each device registers its own ready semaphore with the unique SIO_select semaphore. The first device that becomes ready calls SEM_post on the semaphore.

SIO_select calls Dxx_ready twice; the second time, sem = NULL. This results in each device’s ready semaphore being set to NULL. This information is needed by the Dxx HWI that normally calls SEM_post on the device’s ready semaphore when I/O is completed; if the device ready semaphore is NULL, the semaphore should not be posted.

See Also

SIO_select
Dxx_reclaim

Retrieve a buffer from a device

C Interface

Syntax

status = Dxx_reclaim(device);

Parameters

DEV_Handle device; /* device handle */

Return Value

Int status; /* result of operation */

Assembly Interface

none

Description

Dxx_reclaim is used to request a buffer back from a device. Dxx_reclaim does not return until a buffer is available for the client in the device->fromdevice queue. If the device was opened in DEV_INPUT mode then Dxx_reclaim blocks until an input frame has been filled with the number of MADUs requested, then processes the data in the frame and place it on the device->fromdevice queue. If the device was opened in DEV_OUTPUT mode, Dxx_reclaim blocks until an output frame has been emptied, then place the frame on the device->fromdevice queue. In either mode, Dxx_reclaim blocks until it has a frame to place on the device->fromdevice queue, or until the stream’s timeout expires, and it returns an error code indicating success (SYS_OK) or failure.

If device->timeout is not equal to SYS_FOREVER or 0, the task suspension time can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

If device->timeout is SYS_FOREVER, the task remains suspended until a frame is available on the device’s fromdevice queue. If timeout is 0, Dxx_reclaim returns immediately.

If timeout expires before a buffer is available on the device’s fromdevice queue, Dxx_reclaim returns SYSETIMEOUT. Otherwise Dxx_reclaim returns SYS_OK for success, or an error code.

If Dxx_reclaim fails due to a time out or any other reason, it does not place a frame on the device->fromdevice queue.

Dxx_reclaim is used in conjunction with Dxx_issue to operate a stream. The Dxx_issue call sends a buffer to a stream, and the Dxx_reclaim retrieves a buffer from a stream. Dxx_issue performs processing for output streams, and provides empty frames for input streams. The Dxx_reclaim recovers empty frames in output streams, and retrieves full frames and performs processing for input streams.

SIO_reclaim calls Dxx_reclaim, then it gets the frame from the device->fromdevice queue.
In a stacking device, Dxx_reclaim must preserve all information in the DEV_Frame object except link and misc. On a device opened for DEV_INPUT, Dxx_reclaim should preserve the buffer data (transformed as necessary), the size (adjusted as appropriate by the transform), and the arg field. On a device opened for DEV_OUTPUT, Dxx_reclaim should preserve the size and the arg field. The DEV_Frame objects themselves do not need to be preserved, only the information they contain.

Dxx_reclaim must preserve buffers sent to the device. Dxx_reclaim should never return a buffer that was not received from the client through the Dxx_issue call. Dxx_reclaim always preserves the ordering of the buffers sent to the device, and returns with the oldest buffer that was issued to the device.

**Constraints and Calling Context**

Device must be bound to a device by a prior call to Dxx_open.

**See Also**

Dxx_issue
SIO_issue
SIO_get
SIO_put
**DAX Driver**

**Description**

The DAX driver works with most interrupt-driven A/D D/A devices or serial port devices. It requires a “controller” module for each device. The controller module consists of external functions bind, start, stop, and unbind, which DAX calls, in that order.

Individual controllers are configured for use by DAX via the DAX_Params parameter structure and the Configuration Tool. The bind, start, stop, and unbind parameters are required, while the ctrl, outputdelay, and arg parameters are optional.

**Configuring a DAX Device**

To add a DAX device, right-click on the User-defined Devices icon in the Configuration Tool, and select Insert UDEV. From the Object menu, choose Rename and type a new name for the device. Open the Properties dialog for the device you created and modify its properties as follows.

- **DEV_FXNS table**: Type _DAX_FXNS
- **Parameters**: Type 0 (zero) to use the default parameters. To use different values, you must declare a DAX_Params structure (as described after this list) containing the values to use for the parameters.
- **Device ID**: Type 0 (zero).
- **Init Fxn**: Type 0 (zero).
- **Stacking Device**: Do not put a checkmark in this box.

**DAX_Params Elements**

DAX_Params is defined in dax.h as follows:

```c
/* ======== DAX_Params ======== */
typedef struct DAX_Params {
    Fxn ctrl;  /* controller ctrl function */
    Fxn stop;  /* controller stop function */
    Fxn unbind; /* controller unbind function */
    Arg arg;    /* controller argument */
    Int outputdelay; /* buffer delay before output */
} DAX_Params;
```

- **bind** is a controller function that initializes controller data structures and the actual device. The default is an empty function that returns 0. The bind function has the following parameters:

  ```c
  Cxx_bind(DAX_Handle port, String name);
  ```

  name is a character string that can be used to specify additional parameters (for example, sample rate) for the controller.

  For example, an A/D device might be configured with the name a2d. The application could create a stream with the Configuration Tool that uses
the a2d device and the string value 32 in the Device Control Parameter property. The string 32 is passed by the DAX driver to Cxx_bind, that presumably would parse 32 and initialize the device for a 32 kHz sample rate.

Alternatively, if the stream were created dynamically with SIO_create, the application code would make the following call to cause the same effect:

```c
stream = SIO_create("/a2d:32", SIO_INPUT, 128, NULL);
```

- **ctrl** is a controller function that is used to send control commands to the device (for example to change the sample rate). The default is an empty function that returns 0. The ctrl function has the following parameters:

  ```c
  Cxx_ctrl(DEV_Handle device, Uns cmd, Arg arg);
  ```

- **start** is a controller function that starts the flow of data to or from the device. The default is an empty function that returns 0. The start function has the following parameters:

  ```c
  Cxx_start(DAX_Handle port);
  ```

- **stop** is a controller function that stops the flow of data to or from the device. The stop function has the following parameters:

  ```c
  Cxx_stop(DAX_Handle port);
  ```

- **unbind** is a controller function that resets controller data structures and frees any memory allocated by the bind function. The default is an empty function that returns 0. The unbind function has the following parameters:

  ```c
  Cxx_unbind(DAX_Handle port);
  ```

- **arg** is an optional parameter which can be used by the controller for configuration parameters specific for that controller. The default is 0, meaning there are no controller-specific parameters.

- **outputdelay** is an optional parameter that specifies the number of output buffers to delay before actually starting the output. The default is 1, meaning that output is double-buffered and does not start until the second SIO_put call.

### Data Streaming

DAX devices can be opened for input or output. The DAX driver places no restriction on the size or memory segment of the data buffers used when streaming to or from the device (though the associated controller can). Two or more buffers should be used with DAX devices to obtain appropriate buffering for the application.
DAX Driver

Tasks block when calling SIO_get if a full buffer is not available from DAX. Tasks block when calling SIO_put if an empty buffer is not available from DAX.

Example

The following example declares DAX_PRMS as a DAX_Params structure:

```c
#include <dax.h>
#include <cry.h>
DAX_Params DAX_PRMS {
    CRY_bind;
    CRY_ctrl;
    CRY_start;
    CRY_stop;
    CRY_unbind;
    0;
    1;
}
```

By typing `_DAX_PRMS` for the Parameters property of a device, the values above are used as the parameters for this device.
DGN Driver

Software generator driver

Comments

The DGN driver manages a class of software devices known as generators, which produce an input stream of data through successive application of some arithmetic function. DGN devices are used to generate sequences of constants, sine waves, random noise, or other streams of data defined by a user function. The number of active generator devices in the system is limited only by the availability of memory.

Configuring a DGN Device

To add a DGN device, right-click on the DGN - Software Generator Driver icon and select Insert DGN. From the Object menu, choose Rename and type a new name for the DGN device. Open the Properties dialog for the device you created and modify its properties.

Data Streaming

DGN generator devices can be opened for input data streaming only; generators cannot be used as output devices.

The DGN driver places no inherent restrictions on the size or memory segment of the data buffers used when streaming from a generator device. Since generators are fabricated entirely in software and do not overlap I/O with computation, no more than one buffer is required to attain maximum performance.

Since DGN generates data "on demand," tasks do not block when calling SIO_get, SIO_put, or SIO_reclaim on a DGN data stream. High-priority tasks must, therefore, be careful when using these streams since lower- or even equal-priority tasks do not get a chance to run until the high-priority task suspends execution for some other reason.

DGN Driver Properties

There are no global properties for the DGN driver manager.

DGN Object Properties

The following properties can be set for a DGN device on the DGN Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this object.

- **Device category.** The device category (user, sine, random, constant, printHex, or printInt) determines the type of data stream produced by the device. A sine, random, or constant device can be opened for input data streaming only. A printHex or printInt device can be opened for output data streaming only.
  - **user.** Uses a custom function to produce or consume a data stream
  - **sine.** Produce a stream of sine wave samples
  - **random.** Produces a stream of random values
- **constant.** Produces a constant stream of data
- **printHex.** Writes the stream data buffers to the trace buffer in hexadecimal format
- **printInt.** Writes the stream data buffers to the trace buffer in integer format

- **Use default parameters.** Check this box if you want to use the default parameters shown in this dialog for the Device category you selected.
- **Device ID.** This field is set automatically when you select a Device category.
- **Constant value.** The constant value to be generated if the Device category is constant.
- **Seed value.** The initial seed value used by an internal pseudo-random number generator if the Device category is random. Used to produce a uniformly distributed sequence of numbers ranging between Lower limit and Upper limit.
- **Lower limit.** The lowest value to be generated if the Device category is random.
- **Upper limit.** The highest value to be generated if the Device category is random.
- **Gain.** The amplitude scaling factor of the generated sine wave if the Device category is sine. The scaling factor is applied to each data point.
  
  To improve performance, the sine wave magnitude (maximum and minimum) value is approximated to the nearest power of two. This is done by computing a shift value by which each entry in the table is right-shifted before being copied into the input buffer. For example, if you set the Gain to 100, the sine wave magnitude is 128, the nearest power of two.

- **Frequency.** The frequency of the generated sine wave (in cycles per second) if the Device category is sine.
  
  DGN uses a static (256 word) sine table to approximate a sine wave. Only frequencies that divide evenly into 256 can be represented exactly with DGN. A "step" value is computed at open time to be used when stepping through this table:
  
  \[
  \text{step} = \left(256 \times \frac{\text{sine.freq}}{\text{sine.rate}}\right)
  \]

- **Phase.** The phase of the generated sine wave (in radians) if the Device category is sine.
- **Sample rate.** The sampling rate of the generated sine wave (in sample points per second) if the Device category is sine.
- **User function.** If the Device category is user, specifies the function to be used to compute the successive values of the data sequence in an input device, or to be used to process the data stream, in an output device. If this function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.)

- **User function argument.** An argument to pass to the User function.

  A user function must have the following form:

  \[
  \text{fxn(Arg arg, Ptr buf, Uns nmadus)}
  \]

  where buf contains the values generated or to be processed. buf and nmadus correspond to the buffer address and buffer size (in MADUs), respectively, for an SIO_get operation.
**DGS Driver**

**Stackable gather/scatter driver**

The DGS driver manages a class of stackable devices which compress or expand a data stream by applying a user-supplied function to each input or output buffer. This driver might be used to pack data buffers before writing them to a disk file or to unpack these same buffers when reading from a disk file. All (un)packing must be completed on frame boundaries as this driver (for efficiency) does not maintain remainders across I/O operations.

On opening a DGS device by name, DGS uses the unmatched portion of the string to recursively open an underlying device.

This driver requires a transform function and a packing/unpacking ratio which are used when packing/unpacking buffers to/from the underlying device.

### Configuring a DGS Device

To add a DGS device, right-click on the User-defined Devices icon in the Configuration Tool, and select Insert UDEV. From the Object menu, choose Rename and type a new name for the device. Open the Properties dialog for the device you created and modify its properties as follows.

- **DEV_FXNS table.** Type _DGS_FXNS_
- **Parameters.** Type 0 (zero) to use the default parameters. To use different values, you must declare a DGS_Params structure (as described after this list) containing the values to use for the parameters.
- **Device ID.** Type 0 (zero).
- **Init Fxn.** Type 0 (zero).
- **Stacking Device.** Put a checkmark in this box.

DGS_Params is defined in dgs.h as follows:

```c
/* ======== DGS_Params ======== */
typedef struct DGS_Params {       /* device parameters */
    Fxn   createFxn;
    Fxn   deleteFxn;
    Fxn   transFxn;
    Arg   arg;
    Int   num;
    Int   den;
} DGS_Params;
```

The device parameters are:

- **create function.** Optional, default is NULL. Specifies a function that is called to create and/or initialize a transform specific object. If non-NULL, the create function is called in DGS_open upon creating the stream with
argument as its only parameter. The return value of the create function is passed to the transform function.

- **delete function.** Optional, default is NULL. Specifies a function to be called when the device is closed. It should be used to free the object created by the create function.

- **transform function.** Required, default is localcopy. Specifies the transform function that is called before calling the underlying device’s output function in output mode and after calling the underlying device’s input function in input mode. Your transform function should have the following interface:

  \[
  \text{dstsize} = \text{myTrans} (\text{Arg arg, Void *src, Void *dst, Int srcsize})
  \]

  where arg is an optional argument (either argument or created by the create function), and *src and *dst specify the source and destination buffers, respectively. srcsize specifies the size of the source buffer and dstsize specifies the size of the resulting transformed buffer (srcsize * numerator/denominator).

- **arg.** Optional argument, default is 0. If the create function is non-NULL, the arg parameter is passed to the create function and the create function’s return value is passed as a parameter to the transform function; otherwise, argument is passed to the transform function.

- **num** and **den** (numerator and denominator). Required, default is 1 for both parameters. These parameters specify the size of the transformed buffer. For example, a transformation that compresses two 32-bit words into a single 32-bit word would have numerator = 1 and denominator = 2 since the buffer resulting from the transformation is 1/2 the size of the original buffer.

**Transform Functions**

The following transform functions are already provided with the DGS driver:

- **u32tou8/u8tou32.** These functions provide conversion to/from packed unsigned 8-bit integers to unsigned 32-bit integers. The buffer must contain a multiple of 4 number of 32-bit/8-bit unsigned values.

- **u16tou32/u32tou16.** These functions provide conversion to/from packed unsigned 16-bit integers to unsigned 32-bit integers. The buffer must contain an even number of 16-bit/32-bit unsigned values.

- **i16toi32/i32toi16.** These functions provide conversion to/from packed signed 16-bit integers to signed 32-bit integers. The buffer must contain an even number of 16-bit/32-bit integers.

- **u8toi16/i16tou8.** These functions provide conversion to/from a packed 8-bit format (two 8-bit words in one 16-bit word) to a one word per 16 bit format.
Data Streaming

DGS devices can be opened for input or output. DGS_open allocates buffers for use by the underlying device. For input devices, the size of these buffers is \((\text{bufsize} \times \text{numerator}) / \text{denominator}\). For output devices, the size of these buffers is \((\text{bufsize} \times \text{denominator}) / \text{numerator}\). Data is transformed into or out of these buffers before or after calling the underlying device’s output or input functions respectively.

You can use the same stacking device in more than one stream, provided that the terminating device underneath it is not the same. For example, if u32tou8 is a DGS device, you can create two streams dynamically as follows:

```c
stream = SIO_create("/u32tou8/codec", SIO_INPUT, 128, NULL);
...
stream = SIO_create("/u32tou8/port", SIO_INPUT, 128, NULL);
```

You can also create the streams with the Configuration Tool. To do that, add two new SIO objects. Enter `/codec` (or any other configured terminal device) as the Device Control Parameter for the first stream. Then select the DGS device configured to use u32tou8 in the Device property. For the second stream, enter `/port` as the Device Control Parameter. Then select the DGS device configured to use u32tou8 in the Device property.

Example

The following code example declares DGS_PRMS as a DGS_Params structure:

```c
#include <dgs.h>

DGS_Params DGS_PRMS {
    NULL,  /* optional create function */
    NULL,  /* optional delete function */
    u32tou8,  /* required transform function */
    0,     /* optional argument */
    4,     /* numerator */
    1,     /* denominator */
}
```

By typing `DGS_PRMS` for the Parameters property of a device, the values above are used as the parameters for this device.

See Also

DTR
**DHL Driver**  

**Description**  
The DHL driver manages data streaming between the host and the DSP. Each DHL device has an underlying HST object. The DHL device allows the target program to send and receive data from the host through an HST channel using the SIO streaming API rather than using pipes. The DHL driver copies data between the stream’s buffers and the frames of the pipe in the underlying HST object.

**Configuring a DHL Device**  
To add a DHL device you must first add an HST object and make it available to the DHL driver. Right click on the HST – Host Channel Manager icon and add a new HST object. Open the Properties dialog of the HST object and put a checkmark in the Make this channel available for a new DHL device box. If you plan to use this channel for an output DHL device, make sure that you select output as the mode of the HST channel.

Once there are HST channels available for DHL, right click on the DHL – Host Link Driver icon and select Insert DHL. You can rename the DHL device and then open the Properties dialog to select which HST channel, of those available for DHL, is used by this DHL device. If you plan to use the DHL device for output to the host, be sure to select an HST channel whose mode is output. Otherwise, select an HST channel with input mode.

Note that once you have selected an HST channel to be used by a DHL device, that channel is now owned by the DHL device and is no longer available to other DHL channels.

**Data Streaming**  
DHL devices can be opened for input or output data streaming. A DHL device used by a stream created in output mode must be associated with an output HST channel. A DHL device used by a stream created in input mode must be associated with an input HST channel. If these conditions are not met, a SYS_EBADOBJ error is reported in the system log during startup when the BIOS_start routine calls the DHL_open function for the device.

To use a DHL device in a stream created with the Configuration Tool, select the device from the drop-down list in the Device box of its Properties dialog.

To use a DHL device in a stream created dynamically with SIO_create, use the DHL device name (as it appears in the Configuration Tool) preceded by “/” (forward slash) as the first parameter of SIO_create:

```c
stream = SIO_create("/dhl0", SIO_INPUT, 128, NULL);
```

To enable data streaming between the target and the host through streams that use DHL devices, you must bind and start the underlying HST channels of the DHL devices from the Host Channels Control in Code Composer Studio, just as you would with other HST objects.
DHL drivers copy the data between the frames in the HST channel's pipe and the stream's buffers. In input mode, it is the size of the frame in the HST channel that drives the data transfer. In other words, when all the data in a frame has been transferred to stream buffers, the DHL device returns the current buffer to the stream's fromdevice queue, making it available to the application. (If the stream buffers can hold more data than the HST channel frames, the stream buffers always come back partially full.) In output mode it is the opposite: the size of the buffers in the stream drives the data transfer so that when all the data in a buffer has been transferred to HST channel frames, the DHL device returns the current frame to the channel's pipe. In this situation, if the HST channel's frames can hold more data than the stream's buffers, the frames always return to the HST pipe partially full.

The maximum performance in a DHL device is obtained when you configure the frame size of its HST channel to match the buffer size of the stream that uses the device. The second best alternative is to configure the stream buffer (or HST frame) size to be larger than, and a multiple of, the size of the HST frame (or stream buffer) size for input (or output) devices. Other configuration settings also work since DHL does not impose restrictions on the size of the HST frames or the stream buffers, but performance is reduced.

**Constraints**
- HST channels used by DHL devices are not available for use with PIP APIs.
- Multiple streams cannot use the same DHL device. If more than one stream attempts to use the same DHL device, a SYS_EBUSY error is reported in the system LOG during startup when the BIOS_start routing calls the DHL_open function for the device.

**DHL Driver Properties**
The following global property can be set for the DHL - Host Link Driver on the DHL Properties dialog in the Configuration Tool:

- **Object memory.** Enter the memory segment from which to allocate DHL objects. Note that this does not affect the memory segments from where the underlying HST object or its frames are allocated. The memory segment for HST objects and their frames can be set in the HST Manager Properties and HST Object Properties dialogs of the Configuration Tool.

**DHL Object Properties**
The following properties can be set for a DHL device using the DHL Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this object.
- **Underlying HST Channel.** Select the underlying HST channel from the drop-down list. Only HST objects whose properties have a checkmark in the Make this channel available for a new DHL device box are listed
- **Mode.** This informational property shows the mode (input or output) of the underlying HST channel. This becomes the mode of the DHL device.
DNL Driver

Null driver

Description
The DNL driver manages “empty” devices which nondestructively produce or consume data streams. The number of empty devices in the system is limited only by the availability of memory; DNL instantiates a new object representing an empty device on opening, and frees this object when the device is closed.

The DNL driver does not define device ID values or a params structure which can be associated with the name used when opening an empty device. The driver also ignores any unmatched portion of the name declared in the system configuration file when opening a device.

Configuring a DNL Device
To add a DNL device, right-click on the User-defined Devices icon in the Configuration Tool, and select Insert UDEV. From the Object menu, choose Rename and type a new name for the device. Open the Properties dialog for the device you created and modify its properties as follows.

- DEV_FXNS table. Type _DNL_FXNS
- Parameters. Type 0 (zero).
- Device ID. Type 0 (zero).
- Init Fxn. Type 0 (zero).
- Stacking Device. Do not put a checkmark in this box.

Data Streaming
DNL devices can be opened for input or output data streaming. Note that these devices return buffers of undefined data when used for input.

The DNL driver places no inherent restrictions on the size or memory segment of the data buffers used when streaming to or from an empty device. Since DNL devices are fabricated entirely in software and do not overlap I/O with computation, no more that one buffer is required to attain maximum performance.

Tasks do not block when using SIO_get, SIO_put, or SIO_reclaim with a DNL data stream.
DOV Driver  

**Description**

The DOV driver manages a class of stackable devices that generate an overlapped stream by retaining the last N minimum addressable data units (MADUs) of each buffer input from an underlying device. These N points become the first N points of the next input buffer. MADUs are equivalent to a 16-bit word in the data address space of the processor on the C54x and C55x platforms and to an 8-bit word on the C6x platforms.

**Configuring a DOV Device**

To add a DOV device, right-click on the User-defined Devices icon in the Configuration Tool, and select Insert UDEV. From the Object menu, choose Rename and type a new name for the device. Open the Properties dialog for the device you created and modify its properties as follows.

- **DEV_FXNS table.** Type _DOV_FXNS
- **Parameters.** Type 0 (zero) or the length of the overlap as described after this list.
- **Device ID.** Type 0 (zero).
- **Init Fxn.** Type 0 (zero).
- **Stacking Device.** Put a checkmark in this box.

If you enter 0 for the Device ID, you need to specify the length of the overlap when you create the stream with SIO_create by appending the length of the overlap to the device name. If you create the stream with the Configuration Tool instead, enter the length of the overlap in the Device Control Parameter for the stream.

For example, if you create a device called overlap with the Configuration Tool, and enter 0 as its Device ID, you can open a stream with:

```c
stream = SIO_create("/overlap16/codec", SIO_INPUT, 128, NULL);
```

This causes SIO to open a stack of two devices. /overlap16 designates the device called overlap, and 16 tells the driver to use the last 16 MADUs of the previous frame as the first 16 MADUs of the next frame. codec specifies the name of the physical device which corresponds to the actual source for the data.

If, on the other hand you add a device called overlap and enter 16 as its Device ID, you can open the stream with:

```c
stream = SIO_create("/overlap/codec", SIO_INPUT, 128, NULL);
```
This causes SIO to open a stack of two devices. /overlap designates the device called overlap, which you have configured to use the last 16 MADUs of the previous frame as the first 16 MADUs of the next frame. As in the previous example, codec specifies the name of the physical device that corresponds to the actual source for the data.

If you create the stream with the Configuration Tool and enter 16 as the Device ID property, leave the Device Control Parameter blank.

In addition to the Configuration Tool properties, you need to specify the value that DOV uses for the first overlap, as in the example:

```c
#include <dov.h>
static DOV_Config DOV_CONFIG = {
    (Char) 0
};
DOV_Config *DOV = &DOV_CONFIG;
```

If floating point 0.0 is required, the initial value should be set to (Char) 0.0.

**Data Streaming**

DOV devices can only be opened for input.

The overlap size, specified in the string passed to SIO_create, must be greater than 0 and less than the size of the actual input buffers.

DOV does not support any control calls. All SIO_ctrl calls are passed to the underlying device.

You can use the same stacking device in more than one stream, provided that the terminating device underneath it is not the same. For example, if overlap is a DOV device with a Device ID of 0:

```c
stream = SIO_create("/overlap16/codec", SIO_INPUT, 128, NULL);
...
stream = SIO_create("/overlap4/port", SIO_INPUT, 128, NULL);
```

or if overlap is a DOV device with positive Device ID:

```c
stream = SIO_create("/overlap/codec", SIO_INPUT, 128, NULL);
...
stream = SIO_create("/overlap/port", SIO_INPUT, 128, NULL);
```

To create the same streams with the Configuration Tool (rather than dynamically with SIO_create), add SIO objects with the Configuration Tool. Enter the string that identifies the terminating device preceded by "/" (forward
slash) in the SIO object’s Device Control Parameters (for example, /codec, /port). Then select the stacking device (overlap, overlapio) from the Device property.

See Also

DTR
DGS
DPI Driver

### Description

The DPI driver is a software device used to stream data between tasks on a single processor. It provides a mechanism similar to that of UNIX named pipes; a reader and a writer task can open a named pipe device and stream data to/from the device. Thus, a pipe simply provides a mechanism by which two tasks can exchange data buffers.

Any stacking driver can be stacked on top of DPI. DPI can have only one reader and one writer task.

It is possible to delete one end of a pipe with SIO_delete and recreate that end with SIO_create without deleting the other end.

### Configuring a DPI Device

To add a DPI device, right-click on the DPI - Pipe Driver folder, and select Insert DPI. From the Object menu, choose Rename and type a new name for the DPI device.

### Data Streaming

After adding a DPI device called pipe0 in the Configuration Tool, you can use it to establish a communication pipe between two tasks. You can do this dynamically, by calling in the function for one task:

```c
inStr = SIO_create("/pipe0", SIO_INPUT, bufsize, NULL);
...
SIO_get(inStr, bufp);
```

And in the function for the other task:

```c
outStr = SIO_create("/pipe0", SIO_OUTPUT, bufsize, NULL);
...
SIO_put(outStr, bufp, nmadus);
```

or by adding with the Configuration Tool two streams that use pipe0, one in output mode (outStream) and the other one in input mode(inStream). Then, from the reader task call:

```c
extern SIO_Obj inStream;
SIO_handle inStr = &inStream
...
SIO_get(inStr, bufp);
```

and from the writer task call:

```c
extern SIO_Obj outStream;
SIO_handle outStr = &outStream
...
SIO_put(outStr, bufp, nmadus);
```
The DPI driver places no inherent restrictions on the size or memory segments of the data buffers used when streaming to or from a pipe device, other than the usual requirement that all buffers be the same size.

Tasks block within DPI when using SIO_get, SIO_put, or SIO_reclaim if a buffer is not available. SIO_select can be used to guarantee that a call to one of these functions do not block. SIO_select can be called simultaneously by both the input and the output sides.

In the SIO_ISSUERECLAIM streaming model, an application reclaims the buffers from a stream in the same order as they were previously issued. To preserve this mechanism of exchanging buffers with the stream, the default implementation of the DPI driver for ISSUERECLAIM copies the full buffers issued by the writer to the empty buffers issued by the reader.

A more efficient version of the driver that exchanges the buffers across both sides of the stream, rather than copying them, is also provided. To use this variant of the pipe driver for ISSUERECLAIM, edit the C source file dpi.c provided in the C:\ti\c6000\bios\src\drivers folder. Comment out the following line:

#define COPYBUFS

Rebuild dpi.c. Link your application with this version of dpi.obj instead of the one in the spoxdev library. To do this, add this version of dpi.obj to your link line explicitly, or add it to a library that is linked ahead of the spoxdev library.

This buffer exchange alters the way in which the streaming mechanism works. When using this version of the DPI driver, the writer reclaims first the buffers issued by the reader rather than its own issued buffers, and vice versa.

This version of the pipe driver is not suitable for applications in which buffers are broadcasted from a writer to several readers. In this situation it is necessary to preserve the ISSUERECLAIM model original mechanism, so that the buffers reclaimed on each side of a stream are the same that were issued on that side of the stream, and so that they are reclaimed in the same order that they were issued. Otherwise, the writer reclaims two or more different buffers from two or more readers, when the number of buffers it issued was only one.

It is trivial to convert a single-processor application using tasks and pipes into a multiprocessor application using tasks and communication devices. If using SIO_create, the calls in the source code would change to use the names of the communication devices instead of pipes. (If the communication devices were given names like /pipe0, there would be no source change at all.) If the streams were created with the Configuration Tool instead, you would need to change the Device property for the stream in the configuration template, save
and rebuild your application for the new configuration. No source change would be necessary.

**Constraints**

- Only one reader and one writer can open the same pipe.

**DPI Driver Properties**

- There are no global properties for the DPI driver manager.

**DPI Object Properties**

The following property can be set for a DPI device on the DPI Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this object.

**Allow virtual instances of this device.** Put a checkmark in this box if you want to be able to use SIO_create to dynamically create multiple streams that will use this DPI device. DPI devices are used by SIO stream objects, which you create with the DSP/BIOS Configuration Tool or the SIO_create function.

If this box is checked, when you use SIO_create, you can create multiple streams that use the same DPI driver by appending numbers to the end of the name. For example, if the DPI object is named "pipe", you can call SIO_create to create pipe0, pipe1, and pipe2. Only integer numbers can be appended to the name.

If this box is not checked, when you use SIO_create, the name of the SIO object must exactly match the name of the DPI object. As a result, only one open stream can use the DPI object. For example, if the DPI object is named "pipe", an attempt to use SIO_create to create pipe0 will fail.
DST Driver

Stackable split driver

Description
This stacking driver can be used to input or output buffers that are larger than the physical device can actually handle. For output, a single (large) buffer is split into multiple smaller buffers which are then sent to the underlying device. For input, multiple (small) input buffers are read from the device and copied into a single (large) buffer.

Configuring a DST Device
To add a DST device, right-click on the User-defined Devices icon in the Configuration Tool, and select Insert UDEV. From the Object menu, choose Rename and type a new name for the device. Open the Properties dialog for the device you created and modify its properties as follows.

- DEV_FXNS table. Type _DST_FXNS
- Parameters. Type 0 (zero).
- Device ID. Type 0 (zero) or the number of small buffers corresponding to a large buffer as described after this list.
- Init Fxn. Type 0 (zero).
- Stacking Device. Put a checkmark in this box.

If you enter 0 for the Device ID, you need to specify the number of small buffers corresponding to a large buffer when you create the stream with SIO_create, by appending it to the device name.

Example 1:
For example, if you create a user-defined device called split with the Configuration Tool, and enter 0 as its Device ID property, you can open a stream with:

```c
stream = SIO_create("/split4/codec", SIO_INPUT, 1024, NULL);
```

This causes SIO to open a stack of two devices: /split4 designates the device called split, and 4 tells the driver to read four 256-word buffers from the codec device and copy the data into 1024-word buffers for your application. codec specifies the name of the physical device which corresponds to the actual source for the data.

Alternatively, you can create the stream with the Configuration Tool (rather than by calling SIO_create at run-time). To do so, first create and configure two user-defined devices called split and codec. Then, create an SIO object. Type 4/codec as the Device Control Parameter. Select split from the Device list.
Example 2: Conversely, you can open an output stream that accepts 1024-word buffers, but breaks them into 256-word buffers before passing them to /codec, as follows:

```c
stream = SIO_create("/split4/codec", SIO_OUTPUT, 1024, NULL);
```

To create this output stream with the Configuration Tool, you would follow the steps for example 1, but would select output for the Mode property of the SIO object.

Example 3: If, on the other hand, you add a device called split and enter 4 as its Device ID, you need to open the stream with:

```c
stream = SIO_create("/split/codec", SIO_INPUT, 1024, NULL);
```

This causes SIO to open a stack of two devices: /split designates the device called split, which you have configured to read four buffers from the codec device and copy the data into a larger buffer for your application. As in the previous example, codec specifies the name of the physical device that correlates to the actual source for the data.

When you type 4 as the Device ID, you do not need to type 4 in the Device Control Parameter for an SIO object created with the Configuration Tool. Type only/codec for the Device Control Parameter.

Data Streaming  DST stacking devices can be opened for input or output data streaming.

Constraints  

- The size of the application buffers must be an integer multiple of the size of the underlying buffers.
- This driver does not support any SIO_ctrl calls.
**DTR Driver**

**Description**

The DTR driver manages a class of stackable devices known as transformers, which modify a data stream by applying a function to each point produced or consumed by an underlying device. The number of active transformer devices in the system is limited only by the availability of memory; DTR instantiates a new transformer on opening a device, and frees this object when the device is closed.

Buffers are read from the device and copied into a single (large) buffer.

**Configuring a DTR Device**

To add a DTR device, right-click on the User-defined Devices icon in the Configuration Tool, and select Insert UDEV. From the Object menu, choose Rename and type a new name for the device. Open the Properties dialog for the device you created and modify its properties as follows.

- **DEV_FXNS table.** Type _DTR_FXNS
- **Parameters.** Enter the name of a DTR_Params structure declared in your C application code. See the information following this list for details.
- **Device ID.** Type 0 (zero) or _DTR_multiply.
  
  If you type 0, you need to supply a user function in the device parameters. This function is called by the driver as follows to perform the transformation on the data stream:

  ```c
  if (user.fxn != NULL) {
      (*user.fxn)(user.arg, buffer, size);
  }
  ```

  If you type _DTR_multiply, a data scaling operation is performed on the data stream to multiply the contents of the buffer by the scale.value of the device parameters.

- **Init Fxn.** Type 0 (zero).
- **Stacking Device.** Put a checkmark in this box.

The DTR_Params structure is defined in dtr.h as follows:

```c
/* ======== DTR_Params ======== */
typedef struct {
    struct {
        DTR_Scale  value;  /* scaling factor */
    } scale;
    struct {
        Arg        arg;    /* user-defined argument */
        Fxn        fxn;    /* user-defined function */
    } user;
} DTR_Params;
```
In the following code example, DTR_PRMS is declared as a DTR_Params structure:

```c
#include <dtr.h>
...
struct DTR_Params DTR_PRMS = {
    10.0,
    NULL,
    NULL
};
```

By typing _DTR_PRMS as the Parameters property of a DTR device, the values above are used as the parameters for this device.

You can also use the default values that the driver assigns to these parameters by entering _DTR_PARAMS for this property. The default values are:

```c
DTR_Params DTR_PARAMS = {
    { 1 },          /* scale.value */
    { (Arg)NULL,    /* user.arg */
        (Fxn)NULL },  /* user.fxn */
};
```

scale.value is a floating-point quantity multiplied with each data point in the input or output stream.

user.fx and user.arg define a transformation that is applied to inbound or outbound blocks of data, where buffer is the address of a data block containing size points; if the value of user.fx is NULL, no transformation is performed at all.

```c
if (user.fx != NULL) {
    (*user.fx)(user.arg, buffer, size);
}
```

### Data Streaming

DTR transformer devices can be opened for input or output and use the same mode of I/O with the underlying streaming device. If a transformer is used as a data source, it inputs a buffer from the underlying streaming device and then transforms this data in place. If the transformer is used as a data sink, it outputs a given buffer to the underlying device after transforming this data in place.

The DTR driver places no inherent restrictions on the size or memory segment of the data buffers used when streaming to or from a transformer device; such restrictions, if any, would be imposed by the underlying streaming device.

Tasks do not block within DTR when using SIO. A task can, of course, block as required by the underlying device.
2.6 Global Settings

This module is the global settings manager.

Functions

None

Description

This module does not manage any individual objects, but rather allows you to control global or system-wide settings used by other modules.

2.6.1 Global Settings Properties

The following Global Settings can be made:

- **Target Board Name.** The type of board on which your target device is mounted.

- **DSP Speed In MHz (CLKOUT).** This number, times 1000000, is the number of instructions the processor can execute in 1 second. This value is used by the CLK manager to calculate register settings for the on-device timers.

- **DSP Type.** Target CPU family. Specifies which family of C6x is being used. It is normally unwritable, and is controlled by the Chip Support Library (CSL) property. When the CSL is specified as other, this field becomes writable. This value determines which DSP family tab in the Properties dialog contains writable fields.

- **Chip Support Library (CSL).** Specifies the specific chip type, such as 6201, 6711, 6400, etc. This controls which CSL library is linked with the application and also controls the DSP Type property. Select other to remove support for the CSL and to allow you to select a DSP family in the DSP Type field.

- **Chip Support Library Name.** Specifies the name of the CSL library that will be linked with the application. This property is informational only. It is not writable.

- **DSP Endian Mode.** This setting controls which libraries are used to link the application. If you change this setting, you must set the compiler and linker options to correspond. This field must match the setting in the DSP’s CSR register.

- **Call User Init Function.** Put a checkmark in this box if you want an initialization function to be called early during program initialization, after .cinit processing and before the main function.

- **User Init Function.** Type the name of the initialization function. This function runs early in the initialization process and is intended to be used to perform hardware setup that needs to run before DSP/BIOS is initialized. The code in this function should not use any DSP/BIOS API
calls, since a number of DSP/BIOS modules have not been initialized when this function runs. In contrast, the Initialization function that may be specified for HOOK objects runs later and is intended for use in setting up data structures used by other functions of the same HOOK object.

- **Enable Real Time Analysis.** Remove the checkmark from this box if you want to remove support for DSP/BIOS implicit instrumentation from the program. This optimizes a program by reducing code size, but removes support for the analysis tools and the LOG, STS, and TRC module APIs.

- **Enable All TRC Trace Event Classes.** Remove the checkmark from this box if you want all types of tracing to be initially disabled when the program is loaded. If you disable tracing, you can still use the RTA Control Panel or the TRC_enable function to enable tracing at run-time.

- **CDB path relative to .out.** Type the relative path from the target executable on the host to the directory containing the application’s CDB file. Use a single backslash (\) or slash (/) character as a directory separator, and do not end the path with a backslash. For example, ..\..\configs or ../configs could be the path. If specified, the CDB path is stored in the .vers section of the COFF file. This path allows the DSP/BIOS Real-Time Analysis Tools to locate the CDB file, which they use to obtain host-based information about static objects. If this path is not specified, the analysis tools look for the CDB file in the . and .. directories relative to the executable.

- **Program Cache Control - CSR(PCC).** This field in the DSP family tabs specifies the cache mode for the DSP at program initiation.

- **Configure L2 Memory Settings.** (621x/671x and 641x tabs) You can check this box for DSPs that have a L1/L2 cache (for example, the c6211). The following fields are available if this box is checked.

- **L2 Mode - CCFG(L2MODE).** (621x/671x and 641x tabs) Sets the L2 cache mode. See the *c6000 Peripherals Manual* for details.

- **L2 MAR 0-15 - bitmask used to initialize MARs.** (621x/671x tab) Only bit 0 of each of these 32-bit registers is modifiable by the user. All other bits are reserved. Specify a bitmask for the 16 modifiable bits in registers MAR0 through MAR15.

- **MAR96-101 - bitmask controls EMIFB CE space.** (641x tab) Only bit 0 of each of these 32-bit registers is modifiable by the user. All other bits are reserved. Specify a bitmask for the modifiable bits in registers MAR96 through MAR101.

- **MAR128-143 - bitmask controls EMIFA CE0 space.** (641x tab) Only bit 0 of each of these 32-bit registers is modifiable by the user. All other bits are reserved. Specify a bitmask for the modifiable bits in registers MAR128 through MAR143.
Global Settings

- **MAR144-159 - bitmask controls EMIFA CE1 space.** (641x tab) Only bit 0 of each of these 32-bit registers is modifiable by the user. All other bits are reserved. Specify a bitmask for the modifiable bits in registers MAR144 through MAR159.

- **MAR160-175 - bitmask controls EMIFA CE2 space.** (641x tab) Only bit 0 of each of these 32-bit registers is modifiable by the user. All other bits are reserved. Specify a bitmask for the modifiable bits in registers MAR160 through MAR175.

- **MAR176-191 - bitmask controls EMIFA CE3 space.** (641x tab) Only bit 0 of each of these 32-bit registers is modifiable by the user. All other bits are reserved. Specify a bitmask for the modifiable bits in registers MAR176 through MAR191.

- **L2 Requestor Priority - CCFG(P).** (641x tab) Specifies the CPU/DMA cache priority. See the *c6000 Peripherals Manual* for details.

- **Configure Priority Queues.** (641x tab) Put a checkmark in this box if you want to configure the maximum number of transfer requests on the L2 priority queues.

  - **Max L2 Transfer Requests on URGENT Queue (L2ALLOC0).** (641x tab) Select a number from 0 to 7 for the maximum number of L2 transfer requests permitted on the URGENT queue.

  - **Max L2 Transfer Requests on HIGH Queue (L2ALLOC1).** (641x tab) Select a number from 0 to 7 for the maximum number of L2 transfer requests permitted on the HIGH priority queue.

  - **Max L2 Transfer Requests on MEDIUM Queue (L2ALLOC2).** (641x tab) Select a number from 0 to 7 for the maximum number of L2 transfer requests permitted on the MEDIUM priority queue.

  - **Max L2 Transfer Requests on LOW Queue (L2ALLOC3).** (641x tab) Select a number from 0 to 7 for the maximum number of L2 transfer requests permitted on the LOW priority queue.
2.7 HOOK Module

The HOOK module is the Hook Function manager.

**Functions**

- **HOOK_getenv.** Get environment pointer for a given HOOK and TSK combination.
- **HOOK_setenv.** Set environment pointer for a given HOOK and TSK combination.

**Constants, Types, and Structures**

```c
typedef Int HOOK_Id; /* HOOK instance id */
typedef Void (*HOOK_InitFxn)(HOOK_Id id);
typedef Void (*HOOK_CreateFxn)(TSK_Handle task);
typedef Void (*HOOK_DeleteFxn)(TSK_Handle task);
typedef Void (*HOOK_ExitFxn)(Void);
typedef Void (*HOOK_ReadyFxn)(TSK_Handle task);
typedef Void (*HOOK_SwitchFxn)(TSK_Handle prev,
                               TSK_Handle next);
```

**Description**

The HOOK module is an extension to the TSK function hooks. It allows multiple sets of hook functions to be performed at key execution points. For example, an application that integrates third-party software may need to perform both its own hook functions and the hook functions required by the third-party software.

In addition, each HOOK object can maintain private data environments for each task for use by its hook functions.

The key execution points at which hook functions can be executed are during program initialization and at several TSK function execution points.

The HOOK module manages objects that reference a set of hook functions. Each HOOK object is assigned a numeric identifier during DSP/BIOS initialization. If your program needs to call the HOOK API functions, you must implement an initialization function for the HOOK instance that records the identifier in a variable of type HOOK_Id. DSP/BIOS passes the HOOK object’s ID to the initialization function as the lone parameter.

The following function, myInit, could be configured as the Initialization function for a HOOK object using the DSP/BIOS Configuration Tool.

```c
#include <hook.h>
HOOK_Id myId;

Void myInit(HOOK_Id id)
{
    myId = id;
}
```
The HOOK_setenv function allows you to associate an environment pointer to any data structure with a particular HOOK object and TSK object combination.

There is no limit to the number of HOOK objects that can be created. However, each object requires a small amount of memory in the .bss section to contain the object.

A HOOK object initially has all of its functions set to FXN_F_nop. You can set a few of the hook functions and use this no-op function for the remaining events. Since the switch and ready events occur frequently during real-time processing, a checkbox controls whether any function is called.

When you create a HOOK object, any TSK module hook functions you have specified are automatically placed in a HOOK object called HOOK_KNL. To set any properties of this object other than the Initialization function, use the TSK module. To set the Initialization function property of the HOOK_KNL object, use the HOOK module.

When an event occurs, all the HOOK functions for that event are called in the order they are listed in the DSP/BIOS Configuration Tool. When you select the HOOK manager in the DSP/BIOS Configuration Tool, you can change the execution order by dragging objects within the ordered list.

### 2.7.1 HOOK Manager Properties

There are no global properties for the HOOK manager. HOOK objects are placed in the C Variables Section (.bss).

### 2.7.2 HOOK Object Properties

The following properties can be set for a HOOK object:

- **Comment.** A comment to identify this HOOK object.
- **Initialization function.** The name of a function to call during program initialization. Such functions run during the BIOS init portion of application startup, which runs before the program's main function. Initialization functions can call most functions that can be called from the main() function. However, they should not call TSK module functions, because the TSK module is initialized after initialization functions run. In addition to code specific to the module hook, this function should be used to record the object's ID, if it is needed in a subsequent hook function. This initialization function is intended for use in setting up data structures used by other functions of the same HOOK object. In contrast, the User Init Function property of the Global Settings module runs early in the
initialization process and is intended to be used to perform hardware setup that needs to run before DSP/BIOS is initialized.

- **Create function.** The name of a function to call when any task is created. This includes tasks that are created statically in the Configuration Tool, or created dynamically using TSK_create. If this function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.) The TSK_create topic describes the Create function.

- **Delete function.** The name of a function to call when any task is deleted at run-time with TSK_delete. If this function is written in C, use a leading underscore before the C function name. The TSK_delete topic describes the Delete function.

- **Exit function.** The name of a function to call when any task exits. If this function is written in C, use a leading underscore before the C function name. The TSK_exit topic describes the Exit function.

- **Call switch function.** Check this box if you want a function to be called when any task switch occurs.

- **Switch function.** The name of a function to call when any task switch occurs. This function can give the application access to both the current and next task handles. If this function is written in C, use a leading underscore before the C function name. The TSK Module topic describes the Switch function.

- **Call ready function.** Check this box if you want a function to be called when any task becomes ready to run.

- **Ready function.** The name of a function to call when any task becomes ready to run. If this function is written in C, use a leading underscore before the C function name. The TSK Module topic describes the Ready function.
HOOK_getenv

Get environment pointer for a given HOOK and TSK combination

C Interface

Syntax

```
envir = HOOK_getenv(task, id);
```

Parameters

- `TSK_Handle task; /* task object handle */`
- `HOOK_Id id; /* HOOK instance id */`

Return Value

- `Ptr environ; /* environment pointer */`

Assembly Interface

none

Reentrant

yes

Description

HOOK_getenv returns the environment pointer associated with the specified HOOK and TSK objects. The environment pointer, environ, references the data structure specified in a previous call to HOOK_setenv.

See Also

HOOK_setenv
TSK_getenv
HOOK_setenv

Set environment pointer for a given HOOK and TSK combination

C Interface

Syntax

HOOK_setenv(task, id, environ);

Parameters

TSK_Handle task; /* task object handle */
HOOK_Idx id; /* HOOK instance id */
Ptr environ; /* environment pointer */

Return Value

Void

Assembly Interface

none

Reentrant

yes

Description

HOOK_setenv sets the environment pointer associated with the specified
HOOK and TSK objects to environ. The environment pointer, environ, should
reference an data structure to be used by the hook functions for a task or
tasks.

Each HOOK object may have a separate environment pointer for each task.
A HOOK object may also point to the same data structure for all tasks,
depending on its data sharing needs.

The HOOK_getenv function can be used to get the environ pointer for a
particular HOOK and TSK object combination.

See Also

HOOK_getenv

TSK_setenv
2.8 HST Module

The HST module is the host channel manager.

Functions

- HST_getpipe. Get corresponding pipe object

Description

The HST module manages host channel objects, which allow an application to stream data between the target and the host. Host channels are statically configured for input or output. Input channels (also called the source) read data from the host to the target. Output channels (also called the sink) transfer data from the target to the host.

Note:

HST channel names cannot begin with a leading underscore (_).

Each host channel is internally implemented using a data pipe (PIP) object. To use a particular host channel, the program uses HST_getpipe to get the corresponding pipe object and then transfers data by calling the PIP_get and PIP_free operations (for input) or PIP_alloc and PIP_put operations (for output).

During early development, especially when testing software interrupt processing algorithms, programs can use host channels to input canned data sets and to output the results. Once the algorithm appears sound, you can replace these host channel objects with I/O drivers for production hardware built around DSP/BIOS pipe objects. By attaching host channels as probes to these pipes, you can selectively capture the I/O channels in real time for offline and field-testing analysis.

The notify function is called in the context of the code that calls PIP_free or PIP_put. This function can be written in C or assembly. The code that calls PIP_free or PIP_put should preserve any necessary registers.

The other end of the host channel is managed by the LNK_dataPump IDL object. Thus, a channel can only be used when some CPU capacity is available for IDL thread execution.

2.8.1 HST Manager Properties

The following global properties can be set for the HST module on the HST Manager Properties dialog in the Configuration Tool:

- **Object Memory.** The memory segment containing HST objects.
- **Host Link Type.** The underlying physical link to be used for host-target data transfer. If None is selected, no instrumentation or host channel data
is transferred between the target and host in real time. The Analysis Tool windows are updated only when the target is halted (for example, at a breakpoint). The program code size is smaller when the Host Link Type is set to None because RTDX code is not included in the program.

### 2.8.2 HST Object Properties

A host channel maintains a buffer partitioned into a fixed number of fixed length frames. All I/O operations on these channels deal with one frame at a time; although each frame has a fixed length, the application can put a variable amount of data in each frame.

The following properties can be set for a host file object on the HST Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this HST object.
- **mode.** The type of channel: input or output. Input channels are used by the target to read data from the host; output channels are used by the target to transfer data from the target to the host.
- **bufseg.** The memory segment from which the buffer is allocated; all frames are allocated from a single contiguous buffer (of size framesize x numframes).
- **bufalign.** The alignment (in words) of the buffer allocated within the specified memory segment.
- **framesize.** The length of each frame (in words)
- **numframes.** The number of frames
- **statistics.** Check this box if you want to monitor this channel with an STS object. You can display the STS object for this channel to see a count of the number of frames transferred with the Statistics View Analysis Tool.
- **Make this channel available for a new DHL device.** Check this box if you want to use this HST object with a DHL device. DHL devices allow you to manage data I/O between the host and target using the SIO module, rather than the PIP module. See the DHL driver topic for more details.
- **notify.** The function to execute when a frame of data for an input channel (or free space for an output channel) is available. To avoid problems with recursion, this function should not directly call any of the PIP module functions for this HST object.
- **arg0, arg1.** Two 32-bit arguments passed to the notify function. They can be either unsigned 32-bit constants or symbolic labels.
2.8.3  HST - Host Channel Control Interface

If you are using host channels, use the Host Channel Control to bind each channel to a file on your host computer and start the channels.

1) Choose the DSP/BIOS→Host Channel Control menu item. You see a window that lists your host input and output channels.

   ![Host Channel Control Window]

<table>
<thead>
<tr>
<th>Channel</th>
<th>Transferr...</th>
<th>Limit</th>
<th>State</th>
<th>Mode</th>
<th>Binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>input</td>
<td>0 B 0 KB</td>
<td>Unbound</td>
<td>Input</td>
<td>&lt;unbound&gt;</td>
<td></td>
</tr>
<tr>
<td>output</td>
<td>0 B 0 KB</td>
<td>Unbound</td>
<td>Output</td>
<td>&lt;unbound&gt;</td>
<td></td>
</tr>
</tbody>
</table>

2) Right-click on a channel and choose Bind from the pop-up menu.

3) Select the file to which you want to bind this channel. For an input channel, select the file that contains the input data. For an output channel, you can type the name of a file that does not exist or choose any file that you want to overwrite.

4) Right-click on a channel and choose Start from the pop-up menu. For an input channel, this causes the host to transfer the first frame of data and causes the target to run the function for this HST object. For an output channel, this causes the target to run the function for this HST object.
HST_getpipe

Get corresponding pipe object

C Interface

Syntax

pipe = HST_getpipe(hst);

Parameters

HST_Handle hst /* host object handle */

Return Value

PIP_Handle pip /* pipe object handle*/

Assembly Interface

Syntax

HST_getpipe

Preconditions

a4 = HST channel object pointer
amr = 0

Postconditions

a4 = address of the pipe object

Modifies

a4

Reentrant

yes

Description

HST_getpipe gets the address of the pipe object for the specified host channel object.

Example

Void copy(HST_Obj *input, HST_Obj *output)
{
    PIP_Obj *in, *out;
    Uns *src, *dst;
    Uns size;

    in = HST_getpipe(input);
    out = HST_getpipe(output);

    if (PIP_getReaderNumFrames == 0 ||
        PIP_getWriterNumFrames == 0) {
        error;
    }

    /* get input data and allocate output frame */
    PIP_get(in);
    PIP_alloc(out);

    /* copy input data to output frame */
    src = PIP_getReaderAddr(in);
    dst = PIP_getWriterAddr(out);
    size = PIP_getReaderSize() ;
    out->writerSize = size;
for (; size > 0; size--) {
    *dst++ = *src++;
}

/* output copied data and free input frame */
PIP_put(out);
PIP_free(in);

See Also
PIP_alloc
PIP_free
PIP_get
PIP_put
2.9 **HWI Module**

The HWI module is the hardware interrupt manager.

### Functions

- HWI_disable. Disable hardware interrupts
- HWI_dispatchPlug. Plug the HWI dispatcher
- HWI_enable. Enable hardware interrupts
- HWI_enter. Hardware ISR prolog
-HWI_exit. Hardware ISR epilog
- HWI_restore. Restore hardware interrupt state

### Description

The HWI module manages hardware interrupts. Using the Configuration Tool, you can assign routines that run when specific hardware interrupts occur. Some routines are assigned to interrupts automatically by the HWI module. For example, the interrupt for the timer that you select for the CLK global properties is automatically configured to run a function that increments the low-resolution time. See the CLK module for more details.

You can also dynamically assign routines to interrupts at run-time using the HWI_dispatchPlug function or the C62_plug or C64_plug function.

Interrupt routines can be written completely in assembly, completely in C, or in a mix of assembly and C. In order to support interrupt routines written completely in C, an HWI dispatcher is provided that performs the requisite prolog and epilog for an interrupt routine.

The HWI dispatcher is the preferred method for handling an interrupt. When enabled, the HWI objects that run functions for the CLK and RTDX modules use the dispatcher.

When an HWI object does not use the dispatcher, the HWI_enter assembly macro must be called prior to any DSP/BIOS API calls that affect other DSP/BIOS objects, such as posting an SWI or a semaphore, and the HWI_exit assembly macro must be called at the very end of the function’s code.

When an HWI object is configured to use the dispatcher, the dispatcher handles the HWI_enter prolog and the HWI_exit epilog, and the HWI function can be completely written in C. It would, in fact, cause a system crash were the dispatcher to call a function that contains the HWI_enter/HWI_exit macro pair. Using the dispatcher allows you to save code space by including only one instance of the HWI_enter/HWI_exit code.
Note:

CLK functions should not call HWI_enter and HWI_exit as these are called internally by the HWI dispatcher when it runs CLK_F_isr. Additionally, CLK functions should not use the interrupt keyword or the INTERRUPT pragma in C functions.

Whether a hardware interrupt is dispatched by the HWI dispatcher or handled with the HWI_enter/HWI_exit macros, a common interrupt stack (called the system stack) is used for the duration of the HWI. This same stack is also used by all SWI routines.

In the following notes, references to the usage of HWI_enter/HWI_exit also apply to usage of the HWI dispatcher since, in effect, the dispatcher calls HWI_enter/HWI_exit.

Note:

Do not call SWI_disable or SWI_enable within an HWI function.

Note:

Do not call HWI_enter, HWI_exit, or any other DSP/BIOS functions from a non-maskable interrupt (NMI) service routine.

Note:

Do not call HWI_enter/HWI_exit from a HWI function that is invoked by the dispatcher.

The DSP/BIOS API calls that require an HWI function to use HWI_enter and HWI_exit are:

- SWI_andn
- SWI_andnHook
- SWI_dec
- SWI_inc
- SWI_or
- SWI_orHook
- SWI_post
- PIP_alloc
- PIP_free
- PIP_get
- PIP_put
PRD_tick  
SEM_post  
MBX_post  
TSK_yield  
TSK_tick

**Note:**

Any PIP API call can cause the pipe’s notifyReader or notifyWriter function to run. If an HWI function calls a PIP function, the notification functions run as part of the HWI function.

**Note:**

An HWI function must use HWI_enter and HWI_exit or must be dispatched by the HWI dispatcher if it indirectly runs a function containing any of the API calls listed above.

If your HWI function and the functions it calls do not call any of these API operations, you do not need to disable software interrupt scheduling by calling HWI_enter and HWI_exit.

The register mask argument to HWI_enter and HWI_exit allows you to save and restore registers used within the function. Other arguments allow the HWI to control the settings of the IEMASK and the cache control field.

Hardware interrupts always interrupt software interrupts unless hardware interrupts have been disabled with HWI_disable.

**Note:**

By using HWI_enter and HWI_exit as an HWI function’s prolog and epilog, an HWI function can be interrupted; that is, a hardware interrupt can interrupt another interrupt. You can use the IEMASK parameter for the HWI_enter API to prevent this from occurring.

### 2.9.1 HWI Manager Properties

DSP/BIOS manages the hardware interrupt vector table and provides basic hardware interrupt control functions; for example, enabling and disabling the execution of hardware interrupts.

The following global properties can be set for the HWI module on the HWI Manager Properties dialog in the Configuration Tool:
Generate RESET vector at address 0. Check this box in order to place the interrupt vector table at address 0. This option is available only if address 0 currently exists within the memory configuration.

External Interrupt Pin 4-7 Polarity. Choose whether the device connected to this pin causes an interrupt when a high-to-low transition occurs, or when a low-to-high transition occurs.

2.9.2 HWI Object Properties

The following properties can be set for a hardware interrupt service routine object on the HWI Object Properties dialog in the Configuration Tool:

- comment A comment is provided to identify each HWI object.
- interrupt source. Select the pin, DMA channel, timer, or other source of the interrupt.
- function The function to execute. Interrupt routines that use the dispatcher can be written completely in C or any combination of assembly and C but must not call the HWI_enter/HWI_exit macro pair. Interrupt routines that don’t use the dispatcher must be written at least partially in assembly language. Within an HWI function that does not use the dispatcher, the HWI_enter assembly macro must be called prior to any DSP/BIOS API calls that affect other DSP/BIOS objects, such as posting an SWI or a semaphore. HWI functions can post software interrupts, but they do not run until your HWI function (or the dispatcher) calls the HWI_exit assembly macro, which must be the last statement in any HWI function that calls HWI_enter.
- monitor If set to anything other than Nothing, an STS object is created for this HWI that is passed the specified value on every invocation of the interrupt service routine. The STS update occurs just before entering the HWI routine.

Be aware that when the monitor property is enabled for a particular HWI object, a code preamble is inserted into the HWI routine to make this monitoring possible. The overhead for monitoring is 20 to 30 instructions per interrupt, per HWI object monitored. Leaving this instrumentation turned on after debugging is not recommended, since HWI processing is the most time-critical part of the system.

- addr If the monitor field above is set to Data Address, this field lets you specify a data memory address to be read; the word-sized value is read and passed to the STS object associated with this HWI object.
- type. The type of the value to be monitored: unsigned or signed. Signed quantities are sign extended when loaded into the accumulator; unsigned quantities are treated as word-sized positive values.
The operation to be performed on the value monitored. You can choose one of several STS operations.

- **Use Dispatcher.** A check box that controls whether the HWI dispatcher is used.

- **Arg.** This argument is passed to the function as its only parameter. You can use either a literal integer or a symbol defined by the application. This property is available only when using the HWI dispatcher.

- **Interrupt Mask.** A drop-down menu that specifies which interrupts the dispatcher should disable before calling the function. This property is available only when using the HWI dispatcher.

- **Interrupt Bit Mask.** An integer field that is writable when the interrupt mask is set as bitmask. This should be a hexadecimal integer bitmask specifying the interrupts to disable.

- **Don’t modify cache control.** A check box that chooses between not modifying the cache at all or enabling the individual drop-down menus for program and data cache control masks. This property is available only when using the HWI dispatcher.

- **Program Cache Control Mask.** A drop-down menu that becomes writable when the “don’t modify cache control” box is not checked. The choices (mapped, cache enable, cache bypass, cache freeze) are the same choices available from the GBL properties.

- **Data Cache Control Mask.** A drop-down menu that becomes writable when the “don’t modify cache control” box is not checked. The choices (mapped, cache enable, cache bypass, cache freeze) are the same choices available from the “program cache control mask” menu.

Although it is not possible to create new HWI objects, most interrupts supported by the device architecture have a precreated HWI object. Your application can require that you select interrupt sources other than the default values in order to rearrange interrupt priorities or to select previously unused interrupt sources.

In addition to the precreated HWI objects, some HWI objects are preconfigured for use by certain DSP/BIOS modules. For example, the CLK module configures an HWI object that uses the dispatcher. As a result, you can modify the dispatcher’s parameters for the CLK HWI, such as the cache setting or the interrupt mask. However, you cannot disable use of the dispatcher for the CLK HWI.

Table 2-1 lists these precreated objects and their default interrupt sources. The HWI object names are the same as the interrupt names.
Table 2-1. HWI Interrupts for the TMS320C6000

<table>
<thead>
<tr>
<th>Name</th>
<th>Default Interrupt Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWI_RESET</td>
<td>Reset</td>
</tr>
<tr>
<td>HWI_NMI</td>
<td>NMI</td>
</tr>
<tr>
<td>HWI_INT4</td>
<td>INT4</td>
</tr>
<tr>
<td>HWI_INT5</td>
<td>INT5</td>
</tr>
<tr>
<td>HWI_INT6</td>
<td>INT6</td>
</tr>
<tr>
<td>HWI_INT7</td>
<td>INT7</td>
</tr>
<tr>
<td>HWI_INT8</td>
<td>INT8</td>
</tr>
<tr>
<td>HWI_INT9</td>
<td>INT9</td>
</tr>
<tr>
<td>HWI_INT10</td>
<td>INT10</td>
</tr>
<tr>
<td>HWI_INT11</td>
<td>INT11</td>
</tr>
<tr>
<td>HWI_INT12</td>
<td>INT12</td>
</tr>
<tr>
<td>HWI_INT13</td>
<td>INT13</td>
</tr>
<tr>
<td>HWI_INT14</td>
<td>INT14</td>
</tr>
<tr>
<td>HWI_INT15</td>
<td>INT15</td>
</tr>
</tbody>
</table>

2.9.3 HWI - Execution Graph Interface

Time spent performing HWI functions is not directly traced for performance reasons. However, if you configure the HWI object properties to perform any STS operations on a register, address, or pointer, you can track time spent performing HWI functions in the Statistics View window, which you can open by choosing DSP/BIOS → Statistics View.
**HWI_disable**

*Disable hardware interrupts*

**C Interface**

**Syntax**

```c
oldCSR = HWI_disable();
```

**Parameters**

Void

**Return Value**

Uns oldCSR;

**Assembly Interface**

**Syntax**

```asm
HWI_disable
```

**Preconditions**

amr = 0

**Postconditions**

GIE = 0  

a4 = csr when HWI_disable was invoked

**Modifies**

a4, b0, csr

**Reentrant**

yes

**Description**

HWI_disable disables hardware interrupts by clearing the GIE bit in the Control Status Register (CSR). Call HWI_disable before a portion of a function that needs to run without interruption. When critical processing is complete, call HWI_restore or HWI_enable to reenable hardware interrupts.

Interrupts that occur while interrupts are disabled are postponed until interrupts are reenabled. However, if the same type of interrupt occurs several times while interrupts are disabled, the interrupt’s function is executed only once when interrupts are reenabled.

A context switch can occur when calling HWI_enable or HWI_restore if an enabled interrupt occurred while interrupts are disabled.

**Constraints and Calling Context**

HWI_disable cannot be called from the program’s main function.

**Example**

```c
old = HWI_disable();  
   ’do some critical operation’  
HWI_restore(old);
```

**See Also**

HWI_enable  
HWI_restore  
SWI_disable  
SWI_enable
**HWI_dispatchPlug**

Plug the HWI dispatcher

**C Interface**

**Syntax**

```
HWI_dispatchPlug(vecid, fxn, dmachan, attrs);
```

**Parameters**

- `Int vecid; /* interrupt id */`
- `Fxn fxn; /* pointer to HWI function */`
- `Int dmachan; /* DMA channel to use for performing plug */`
- `HWI_Attrs *attrs /*pointer to HWI dispatcher attributes */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Reentrant**

`yes`

**Description**

HWI_dispatchPlug writes an Interrupt Service Fetch Packet (ISFP) into the Interrupt Service Table (IST), at the address corresponding to `vecid`. The op-codes written in the ISFP create a branch to the HWI dispatcher.

The HWI dispatcher table gets filled with the function specified by the `fxn` parameter and the attributes specified by the `attrs` parameter.

If the IST is stored in external RAM, a DMA (Direct Memory Access) channel is not necessary and the `dmachan` parameter can be set to -1 to cause a CPU copy instead. A DMA channel can still be used to plug a vector in external RAM. A DMA channel must be used to plug a vector in internal program RAM.

If a DMA channel is specified by the `dmachan` parameter, HWI_dispatchPlug assumes that the DMA channel is available for use, and stops the DMA channel before programming it. If the DMA channel is shared with other code, a semaphore or other DSP/BIOS signaling method should be used to provide mutual exclusion before calling C62_plug, C64_plug or HWI_dispatchPlug.

HWI_dispatchPlug does not enable the interrupt. Use C62_enableIER or C64_enableIER to enable specific interrupts.

If `attrs` is NULL, the HWI’s dispatcher properties are assigned a default set of attributes. Otherwise, the HWI’s dispatcher properties are specified by a structure of type `HWI_Attrs` defined as follows:

```c
typedef struct HWI_Attrs {
    Uns intrMask; /* IER bitmask, 1="self" (default) */
    Uns ccMask    /* CSR CC bitmask, 1="leave alone" */
    Arg arg;      /* fxn arg (default = 0)*/
} HWI_Attrs;
```
HWI_dispatchPlug

The intrMask element is a bitmask that specifies which interrupts to mask off while executing the HWI. Bit positions correspond to those of the IER. A value of 1 indicates an interrupt is being plugged. The default value is 1.

The ccMask element is a bitfield that corresponds to the cache control bitfield in the CSR. A value of 1 indicates that the HWI dispatcher should not modify the cache control settings at all. The default value is 1.

The arg element is a generic argument that is passed to the plugged function as its only parameter. The default value is 0.

**Constraints and Calling Context**

- vecid must be a valid interrupt ID in the range of 0-15.
- dmachan must be 0, 1, 2, or 3 if the IST is in internal program memory.

**See Also**

- HWI_enable
- HWI_restore
- SWI_disable
- SWI_enable
**HWI_enable**  
*Enable interrupts*

### C Interface

**Syntax**

```c
HWI_enable();
```

**Parameters**

Void

**Return Value**

Void

### Assembly Interface

**Syntax**

```assembly
HWI_enable
```

**Preconditions**

amr = 0

**Postconditions**

GIE = 1

**Modifies**

b0, csr

**Reentrant**

yes

**Description**

HWI_enable enables hardware interrupts by setting the GIE bit in the Control Status Register (CSR).

Hardware interrupts are enabled unless a call to HWI_disable disables them. DSP/BIOS enables hardware interrupts after the program’s main() function runs. Your main function can enable individual interrupt mask bits, but it should not call HWI_enable to globally enable interrupts.

Interrupts that occur while interrupts are disabled are postponed until interrupts are reenabled. However, if the same type of interrupt occurs several times while interrupts are disabled, the interrupt’s function is executed only once when interrupts are reenabled. A context switch can occur when calling HWI_enable/HWI_restore if an enabled interrupt occurs while interrupts are disabled.

Any call to HWI_enable enables interrupts, even if HWI_disable has been called several times.

**Constraints and Calling Context**

HWI_enable cannot be called from the program’s main() function.

**Example**

```c
HWI_disable();
"critical processing takes place"
HWI_enable();
"non-critical processing"
```
See Also

HWI_disable
HWI_restore
SWI_disable
SWI_enable
**HWI_enter**

*Hardware ISR prolog*

**C Interface**

- **Syntax**: none
- **Parameters**: none
- **Return Value**: none

**Assembly Interface**

- **Syntax**: `HWI_enter ABMASK, CMASK, IEMASK, CCMASK`
- **Preconditions**: interrupts are globally disabled (that is, GIE == 0)
- **Postconditions**: amr = 0
  GIE = 1
  dp (b14) = .bss
- **Modifies**: a0, a1, a2, a3, amr, b0, b1, b2, b3, b14, b15, csr, ier
- **Reentrant**: yes
- **Description**: HWI_enter is an API (assembly macro) used to save the appropriate context for a DSP/BIOS interrupt service routine (ISR).

  HWI_enter is used by ISRs that are user-dispatched, as opposed to ISRs that are handled by the HWI dispatcher. HWI_enter must not be issued by ISRs that are handled by the HWI dispatcher.

  If the HWI dispatcher is not used by an HWI object, HWI_enter must be used in the ISR before any DSP/BIOS API calls that could trigger other DSP/BIOS objects, such as posting an SWI or semaphore. HWI_enter is used in tandem with HWI_exit to ensure that the DSP/BIOS SWI or TSK manager is called at the appropriate time. Normally, HWI_enter and HWI_exit must surround all statements in any DSP/BIOS assembly language ISRs that call C functions.

**Note:**

For the C64 device, substitute 64 in each instance where 62 appears below unless otherwise specified.

---

Common masks are defined in the device-specific assembly macro files, c62.h62 and c64.h64. The c62.h62 file defines C62_ABTEMPS and C62_CTEMPS. The c64.h64 file defines C64_ATEMPS, C64_BTEMPS, and
C64_CTEMPS. These masks specify the C temporary registers and should be used when saving the context for an ISR that is written in C.

The input parameter CCMASK specifies the program cache control (PCC) and data cache control (DCC) codes you need to use in the context of the ISR. Some typical values for this mask are defined in c62.h62 (or c64.h64). The PCC code and DCC code can be ORed together (for example, C62_PCC_ENABLE | C62_PCC_DISABLE) to generate CCMASK. If you use 0 as CCMASK, C62_CCDEFAULT is used. C62_CCDEFAULT is defined in c62.h62 as C62_PCC_DISABLE | C62_PCC_DISABLE. You set this value in the Global Settings Properties in the Configuration Tool. The following parameters and constants are available for HWI_enter:

- **ABMASK.** Register mask specifying A, B registers to save
  - **C62_ABTEMPS.** Mask to use if calling C function from within ISR; defined in c62.h62
  - **C62_A0 - C62_A15, C62_B0 - C62_B15.** Individual register constants; can be ORed together for more precise control than using C62_ABTEMPS
  - **C64_A0 - C64_A31, C64_B0 - C64_B31.** Individual register constants; can be ORed together for more precise control than using C64_ATEMPS and C64_BTEMPS

- **CMASK.** Register mask specifying control registers to save
  - **C62_CTEMPS.** Mask to use if calling C function from within ISR; defined in c62.h62
  - **C62_AMR, C62_CSR, C62_IER, C62IRST, C62_IRP, C62_NRP.** Individual register constants; can be ORed together for more precise control than using C62_CTEMPS

- **IEMASK.** Bit mask specifying IER bits to disable. Any bit mask can be specified, with bits having a one-to-one correspondence with the assigned values in the IER. The following convenience macros can be ORed together to specify the mask of interrupts to disable
  - **C62_NMIE
  - C62_IE4 - C62_IE15

- **CCMASK.** Bit mask specifying cache control bits in the CSR. The following macros directly correspond to the possible modes of the program cache specified in the CSR.
  - **C62_PCC_DISABLE
  - C62_PCC_ENABLE
  - C62_PCC_FREEZE
  - C62_PCC_BYPASS
Note that if HWI_enter modifies CSR bits, those changes will be lost when interrupt processing is complete. HWI_exit restores the CSR to its value when interrupt processing began no matter what the value of CCMASK.

**Constraints and Calling Context**

- This API should not be used for the NMI HWI function.
- This API must not be called if the HWI object that runs this function uses the HWI dispatcher.
- This API cannot be called from the program’s main function.
- This API cannot be called from a SWI, TSK, or IDL function.
- This API cannot be called from a CLK function.
- Unless the HWI dispatcher is used, this API must be called within any hardware interrupt function (except NMI’s HWI function) before the first operation in an ISR that uses any DSP/BIOS API calls that might post or affect a software interrupt or semaphore. Such functions must be written in assembly language. Alternatively, the HWI dispatcher can be used instead of this API, allowing the function to be written completely in C and allowing you to reduce code size.
- If an interrupt function calls HWI_enter, it must end by calling HWI_exit.
- Do not use the interrupt keyword or the INTERRUPT pragma in C functions that run in the context of an HWI.

**Example**

```
CLK_isr:

HWI_enter C62_ABTEMPS, C62_CTEMPS, 0XF0,
C62_PCC_ENABLE|C62_PCC_DISABLE
PRD_tick
HWI_exit C62_ABTEMPS, C62_CTEMPS, 0XF0,
C62_PCC_ENABLE|C62_PCC_DISABLE
```

**See Also**

HWI_exit
HWI_exit

Hardware ISR epilog

C Interface

Syntax none
Parameters none
Return Value none

Assembly Interface

Syntax HWI_exit ABMASK CMASK IERRESTOREMASK CCMASK
Preconditions b14 = pointer to the start of .bss
amr = 0
Postconditions none
Modifies a0, a1, amr, b0, b1, b2, b3, b14, b15, csr, ier, irp
Reentrant yes

Description

HWI_exit is an API (assembly macro) which is used to restore the context that existed before a DSP/BIOS interrupt service routine (ISR) was invoked.

HWI_exit is used by ISRs that are user-dispatched, as opposed to ISRs that are handled by the HWI dispatcher. HWI_exit must not be issued by ISRs that are handled by the HWI dispatcher.

If the HWI dispatcher is not used by an HWI object, HWI_exit must be the last statement in an ISR that uses DSP/BIOS API calls which could trigger other DSP/BIOS objects, such as posting an SWI or semaphore.

HWI_exit restores the registers specified by ABMASHNK and CMASK. These masks are used to specify the set of registers that were saved by HWI_enter.

HWI_exit and HWI_exit must surround all statements in any DSP/BIOS assembly language ISRs that call C functions only for ISRs that are not dispatched by the HWI dispatcher.

HWI_exit calls the DSP/BIOS Software Interrupt manager if DSP/BIOS itself is not in the middle of updating critical data structures, or if no currently interrupted ISR is also in a HWI Enter/ HWI_exit region. The DSP/BIOS SWI manager services all pending SWI handlers (functions).

Of the interrupts in IERRESTOREMASK, HWI_exit only restores those enabled upon entering the ISR. HWI_exit does not affect the status of interrupt bits that are not in IERRESTOREMASK. If upon exiting an ISR you
do not wish to restore an interrupt that was disabled with HWI_enter, do not set that interrupt bit in the IERRESTOREMASK in HWI_exit.

If upon exiting an ISR you wish to enable an interrupt that was disabled upon entering the ISR, set the corresponding bit in IER register. (Including a bit in IER in the IERRESTOREMASK of HWI_exit does not enable the interrupt if it was disabled when the ISR was entered.)

Note:
For the C64 device, substitute 64 in each instance where 62 appears below unless otherwise specified.

The following parameters and constants are available for HWI_exit:

- **ABMASK**. Register mask specifying A, B registers to restore.
  - C62_ABTEMPS. Mask to use if calling C function from within ISR; defined in c62.h62.
  - C62_A0 - C62_A15, C62_B0 - C62_B15. Individual register constants; can be ORed together for more precise control than using C62_ABTEMPS.
  - C64_A0 - C64_A31, C64_B0 - C64_B31. Individual register constants; can be ORed together for more precise control than using C64_ATEMPS and C64_BTEMPS

- **CMASK**. Register mask specifying control registers to restore.
  - C62_CTEMPS. Mask to use if calling C function from within ISR; defined in c62.h62.
  - C62_AMR, C62_CSR, C62_IER, C62_IST, C62_IRP, C62_NRP. Individual register constants; can be ORed together for more precise control than using C62_CTEMPS.

- **IERRESTOREMASK**. Bit mask specifying IER bits to restore. Any bit mask can be specified, with bits having a one-to-one correspondence with the assigned values in the IER. The following convenience macros can be ORed together to specify the mask of interrupts to restore.
  - C62_NMIE
  - C62_IE4 - C62_IE15

- **CCMASK**. Bit mask specifying cache control bits in CSR. The following macros directly correspond to the possible modes of the program cache specified in the CSR.
  - C62_PCC_DISABLE
To be symmetrical, even though CCMASK has no effect on HWI_exit, you should use the same CCMASK that is used in HWI_enter for HWI_exit. HWI_exit restores the CSR to its value when interrupt processing began no matter what the value of CCMASK.

**Constraints and Calling Context**

- This API should not be used for the NMI HWI function.
- This API must not be called if the HWI object that runs the ISR uses the HWI dispatcher.
- If the HWI dispatcher is not used, this API must be the last operation in an ISR that uses any DSP/BIOS API calls that might post or affect a software interrupt or semaphore. The HWI dispatcher can be used instead of this API, allowing the function to be written completely in C and allowing you to reduce code size.
- The ABMASK and CMASK parameters must match the corresponding parameters used for HWI_enter.
- This API cannot be called from the program’s main function.
- This API cannot be called from an SWI, TSK, or IDL function.
- This API cannot be called from a CLK function.

**Example**

```c
CLK_isr:

HWI_enter C62_ABTEMPS, C62_CTEMPS, 0XF0,
C62_PCC_ENABLE|C62_PCC_DISABLE
PRD_tick
HWI_exit C62_ABTEMPS, C62_CTEMPS, 0XF0,
C62_PCC_DISABLE
```

**See Also**

HWI_enter
**HWI_restore**  
*Restore global interrupt enable state*

**C Interface**

**Syntax**  
HWI_restore(oldCSR);

**Parameters**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uns</td>
<td>oldCSR</td>
</tr>
</tbody>
</table>

**Returns**

Void

**Assembly Interface**

**Syntax**

HWI_restore

**Preconditions**

- a4 = mask (GIE is set to the value of bit 0)
- GIE = 0
- amr = 0

**Postconditions**

none

**Modifies**

a1, b0, csr

**Reentrant**

yes

**Description**

HWI_restore sets the global interrupt enable (GIE) bit in the Control Status Register (CSR) using the least significant bit of the oldCSR parameter. If bit 0 is 0, the GIE bit is not modified. If bit 0 is 1, the GIE bit is set to 1, which enables interrupts.

When you call HWI_disable, the previous contents of the register are returned. You can use this returned value with HWI_restore.

A context switch may occur when calling HWI_restore if HWI_restore reenables interrupts and if a higher-priority HWI occurred while interrupts were disabled.

**Constraints and Calling Context**

- HWI_restore cannot be called from the program’s main function.
- HWI_restore must be called with interrupts disabled. The parameter passed to HWI_restore must be the value returned by HWI_disable.

**Example**

```c
oldCSR = HWI_disable();  /* disable interrupts */
    /* do some critical operation */
HWI_restore(oldCSR);
    /* re-enable interrupts if they were enabled at the start of the critical section */
```

**See Also**

HWI_enable  
HWI_disable

2-102
2.10 IDL Module

The IDL module is the idle thread manager.

**Functions**

- **IDL_run.** Make one pass through idle functions.

**Description**

The IDL module manages the lowest-level threads in the application. In addition to user-created functions, the IDL module executes DSP/BIOS functions that handle host communication and CPU load calculation.

There are four kinds of threads that can be executed by DSP/BIOS programs: hardware interrupts (HWI module), software interrupts (SWI module), tasks (TSK module), and background threads (IDL module). Background threads have the lowest priority, and execute only if no hardware interrupts, software interrupts, or tasks need to run.

An application’s main function must return before any DSP/BIOS threads can run. After the return, DSP/BIOS runs the idle loop. Once an application is in this loop, HWI hardware interrupts, SWI software interrupts, PRD periodic functions, TSK task functions, and IDL background threads are all enabled.

The functions for IDL objects registered with the Configuration Tool are run in sequence each time the idle loop runs. IDL functions are called from the IDL context. IDL functions can be written in C or assembly and must follow the C calling conventions described in the compiler manual.

When RTA is enabled (see page 2-73), an application contains an IDL_cpuLoad object, which runs a function that provides data about the CPU utilization of the application. In addition, the LNK_dataPump function handles host I/O in the background, and the RTA_dispatch function handles run-time analysis communication.

The IDL Function Manager allows you to insert additional functions that are executed in a loop whenever no other processing (such as hardware ISRs or higher-priority tasks) is required.

2.10.1 IDL Manager Properties

The following global properties can be set for the IDL module on the IDL Manager Properties dialog in the Configuration Tool:

- **Object Memory.** The memory segment that contains the IDL objects.

- **Auto calculate idle loop instruction count.** When this box is checked, the program runs the IDL functions one or more times at system startup to get an approximate value for the idle loop instruction count. This value, saved in the global variable CLK_D_idletime, is read by the host and used in the CPU load calculation. By default, the instruction count
includes all IDL functions, not just LNK_dataPump, RTA_dispatcher, and IDL_cpuLoad. You can remove an IDL function from the calculation by removing the checkmark from the Include in CPU load calibration box in an IDL object's Properties dialog.

Remember that functions included in the calibration are run before the main function runs. These functions should not access data structures that are not initialized before the main function runs. In particular, functions that perform any of the following actions should not be included in the idle loop calibration:

- enabling hardware interrupts or the SWI or TSK schedulers
- using CLK APIs to get the time
- accessing PIP objects
- blocking tasks
- creating dynamic objects

**Idle Loop Instruction Count.** This is the number of instruction cycles required to perform the IDL loop and the default IDL functions (LNK_dataPump, RTA_dispatcher, and IDL_cpuLoad) that communicate with the host. Since these functions are performed whenever no other processing is needed, background processing is subtracted from the CPU load before it is displayed.

### 2.10.2 IDL Object Properties

Each idle function runs to completion before another idle function can run. It is important, therefore, to ensure that each idle function completes (that is, returns) in a timely manner. The following properties can be set for an IDL object:

- **comment.** Type a comment to identify this IDL object.
- **function.** The function to be executed. If this function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.)
- **Include in CPU load calibration.** You can remove an individual IDL function from the CPU load calculation by removing the checkmark from this box. The CPU load calibration is performed only if the Auto calculate idle loop instruction count box is checked in the IDL Manager Properties. You should remove a function from the calculation if it blocks or depends on variables or structures that are not initialized until the main function runs.
2.10.3 IDL- Execution Graph Interface

Time spent performing IDL functions is not directly traced. However, the Other Threads row in the Execution Graph, which you can open by choosing DSP/BIOS→Execution Graph, includes time spent performing both HWI and IDL functions.
IDL_run

IDL_run (Make one pass through idle functions)

C Interface

Syntax

IDL_run();

Parameters

Void

Return Value

Void

Assembly Interface

none

Description

IDL_run makes one pass through the list of configured IDL objects, calling one function after the next. IDL_run returns after all IDL functions have been executed one time. IDL_run is not used by most DSP/BIOS applications since the IDL functions are executed in a loop when the application returns from main. IDL_run is provided to allow easy integration of the real-time analysis features of DSP/BIOS (for example, LOG and STS) into existing applications.

IDL_run must be called to transfer the real-time analysis data to and from the host computer. Though not required, this is usually done during idle time when no HWI or SWI threads are running.

Note:

BIOS_init and BIOS_start must be called before IDL_run to ensure that DSP/BIOS has been initialized. For example, the DSP/BIOS boot file contains the following system calls around the call to main:

```c
BIOS_init(); /* initialize DSP/BIOS */
main();
BIOS_start() /* start DSP/BIOS */
IDL_loop(); /* call IDL_run in an infinite loop */
```

Constraints and Calling Context

IDL_run cannot be called by an HWI or SWI function.
2.11 LCK Module

The LCK module is the resource lock manager.

**Functions**

- LCK_create. Create a resource lock
- LCK_delete. Delete a resource lock
- LCK_pend. Acquire ownership of a resource lock
- LCK_post. Relinquish ownership of a resource lock

**Constants, Types, and Structures**

```c
typedef struct LCK_Obj *LCK_Handle; /* resource handle */
/* lock object */
typedef struct LCK_Attrs LCK_Attrs;

struct LCK_Attrs {
    Int dummy;
};

LCK_Attrs LCK_ATTRS = {0}; /* default attribute values */
```

**Description**

The lock module makes available a set of functions that manipulate lock objects accessed through handles of type LCK_Handle. Each lock implicitly corresponds to a shared global resource, and is used to arbitrate access to this resource among several competing tasks.

The LCK module contains a pair of functions for acquiring and relinquishing ownership of resource locks on a per-task basis. These functions are used to bracket sections of code requiring mutually exclusive access to a particular resource.

LCK lock objects are semaphores that potentially cause the current task to suspend execution when acquiring a lock.

### 2.11.1 LCK Manager Properties

The following global property can be set for the LCK module on the LCK Manager Properties dialog in the Configuration Tool:

**Object Memory.** The memory segment that contains the LCK objects created with the Configuration Tool.

### 2.11.2 LCK Object Properties

The following property can be set for a LCK object on the LCK Object Properties dialog in the Configuration Tool:

**comment.** Type a comment to identify this LCK object.
LCK_create

Create a resource lock

C Interface

Syntax
lock = LCK_create(attrs);

Parameters
LCK_Attrs  attrs;    /* pointer to lock attributes */

Return Value
LCK_Handle lock;     /* handle for new lock object */

Description
LCK_create creates a new lock object and returns its handle. The lock has no current owner and its corresponding resource is available for acquisition through LCK_pend.

If attrs is NULL, the new lock is assigned a default set of attributes. Otherwise the lock’s attributes are specified through a structure of type LCK_Attrs.

Note:
At present, no attributes are supported for lock objects.

All default attribute values are contained in the constant LCK_ATTRS, which can be assigned to a variable of type LCK_Attrs prior to calling LCK_create.

LCK_create calls MEM_alloc to dynamically create the object’s data structure. MEM_alloc must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, then there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module, page 2-135.

Constraints and Calling Context

- LCK_create cannot be called from an SWI or HWI.
- You can reduce the size of your application program by creating objects with the Configuration Tool rather than using the XXX_create functions.

See Also
LCK_delete
LCK_pend
LCK_post
LCK_delete

Delete a resource lock

C Interface

Syntax

LCK_delete(lock);

Parameters

LCK_Handle lock; /* lock handle */

Return Value

Void

C Interface

Assembly Interface

none

Description

LCK_delete uses MEM_free to free the lock referenced by lock.

LCK_delete calls MEM_free to delete the LCK object. MEM_free must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- LCK_delete cannot be called from an SWI or HWI.
- No task should be awaiting ownership of the lock.
- No check is performed to prevent LCK_delete from being used on a statically-created object. If a program attempts to delete a lock object that was created using the Configuration Tool, SYS_error is called.

See Also

LCK_create
LCK_post
LCK_pend
**LCK_pend**

*Acquire ownership of a resource lock*

**C Interface**

**Syntax**

```c
status = LCK_pend(lock, timeout);
```

**Parameters**

- `LCK_Handle lock; /* lock handle */`
- `Uns timeout; /* return after this many system clock ticks */`

**Return Value**

- `Bool status; /* TRUE if successful, FALSE if timeout */`

**Assembly Interface**

none

**Description**

LCK_pend acquires ownership of lock, which grants the current task exclusive access to the corresponding resource. If lock is already owned by another task, LCK_pend suspends execution of the current task until the resource becomes available.

The task owning lock can call LCK_pend any number of times without risk of blocking, although relinquishing ownership of the lock requires a balancing number of calls to LCK_post.

LCK_pend results in a context switch if this LCK timeout is greater than 0 and the lock is already held by another thread.

LCK_pend returns TRUE if it successfully acquires ownership of lock, returns FALSE if timeout.

**Constraints and Calling Context**

- lock must be a handle for a resource lock object created through a prior call to LCK_create.
- This function is callable by SWI and HWI threads with timeout equal to zero only.

**See Also**

- LCK_create
- LCK_delete
- LCK_post
**LCK_post**

*Relinquish ownership of a resource LCK*

**C Interface**

**Syntax**

LCK_post(lock);

**Parameters**

LCK_Handle lock; /* lock handle */

**Return Value**

Void

**Assembly Interface**

none

**Description**

LCK_post relinquishes ownership of lock, and resumes execution of the first task (if any) awaiting availability of the corresponding resource. If the current task calls LCK_pend more than once with lock, ownership remains with the current task until LCK_post is called an equal number of times.

LCK_post results in a context switch if a higher priority thread is currently pending on the lock.

**Constraints and Calling Context**

- lock must be a handle for a resource lock object created through a prior call to LCK_create.
- When called within an HWI, the code sequence calling LCK_post must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

**See Also**

LCK_create
LCK_delete
LCK_pend
2.12 LOG Module

The LOG module captures events in real time.

Functions

- LOG_disable. Disable the system log.
- LOG_enable. Enable the system log.
- LOG_error. Write a user error event to the system log.
- LOG_event. Append unformatted message to message log.
- LOG_message. Write a user message event to the system log.
- LOG_printf. Append formatted message to message log.
- LOG_reset. Reset the system log.

Description

The Event Log is used to capture events in real time while the target program executes. You can use the system log, or create user-defined logs. If the logtype is circular, the log buffer of size buflen contains the last buflen elements. If the logtype is fixed, the log buffer contains the first buflen elements.

The system log stores messages about system events for the types of log tracing you have enabled. See the TRC Module, page 2-302, for a list of events that can be traced in the system log.

You can add messages to user logs or the system log by using LOG_printf or LOG_event. To reduce execution time, log data is always formatted on the host.

LOG_error writes a user error event to the system log. This operation is not affected by any TRC trace bits; an error event is always written to the system log. LOG_message writes a user message event to the system log, provided that both TRC_GBLHOST and TRC_GBLTARG (the host and target trace bits, respectively) traces are enabled.

When a problem is detected on the target, it is valuable to put a message in the system log. This allows you to correlate the occurrence of the detected event with the other system events in time. LOG_error and LOG_message can be used for this purpose.

Log buffers are of a fixed size and reside in data memory. Individual messages use four words of storage in the log’s buffer. The first word holds a sequence number that allows the Event Log to display logs in the correct order. The remaining three words contain data specified by the call that wrote the message to the log.

See the Code Composer Studio online tutorial for examples of how to use the LOG Manager.
2.12.1 LOG Manager Properties

The following global property can be set for the LOG module on the LOG Manager Properties dialog in the Configuration Tool:

Object Memory. The memory segment that contains the LOG objects.

2.12.2 LOG Object Properties

The following properties can be set for a log object on the LOG Object Properties dialog in the Configuration Tool:

- comment. Type a comment to identify this LOG object.
- buflen. The name of a memory segment to contain the log buffer.
- buflen. The length of the log buffer (in words).
- logtype. The type of the log: circular or fixed. Events added to a full circular log overwrite the oldest event in the buffer, whereas events added to a full fixed log are dropped.
  - Fixed. The log stores the first messages it receives and stops accepting messages when its message buffer is full.
  - Circular. The log automatically overwrites earlier messages when its buffer is full. As a result, a circular log stores the last events that occur.
- datatype. Choose printf if you use LOG_printf to write to this log and provide a format string.
  Choose raw data if you want to use LOG_event to write to this log and have the Event Log apply a printf-style format string to all records in the log.
- format. If you choose raw data as the datatype, type a printf-style format string in this field. Provide up to three (3) conversion characters (such as %d) to format words two, three, and four in all records in the log. Do not put quotes around the format string. The format string can use %d, %x, %o, %s, %r, and %p conversion characters; it cannot use other types of conversion characters.

See LOG_printf, page 2-123, and LOG_event, page 2-121, for information about the structure of a log record.
2.12.3 LOG - Code Composer Studio Interface

You can view log messages in real time while your program is running with the Event Log. A pull-down menu provides a list of the logs you can view. To see the system log as a graph, choose DSP/BIOS → Execution Graph Details. To see a user log, choose DSP/BIOS → Event Log and select the log or logs you want to see. The Property Page for the Message Log allows you to select a file to which the log messages will be written. Right-click on the Message Log and select Property Page to name this file. You cannot open the named log file until you close the Message Log window.

You can also control how frequently the host polls the target for log information. Right-click on the RTA Control Panel and choose the Property Page to set the refresh rate as shown in Figure 2-1. If you set the refresh rate to 0, the host does not poll the target unless you right-click on the log window and choose Refresh Window from the pop-up menu.

Figure 2-1. RTA Control Panel Properties Page
LOG_disable

Enable a message log

C Interface

Syntax

LOG_disable(log);

Parameters

LOG_Handle log;  /* log object handle */

Return Value

Void

Assembly Interface

Syntax

LOG_disable

Preconditions

a4 = address of the LOG object
amr = 0

Postconditions

none

Modifies

a0

Reentrant

no

Description

LOG_disable disables the logging mechanism and prevents the log buffer from being modified.

Example

LOG_disable(&trace);

See Also

LOG_enable
LOG_reset
LOG_enable

Enable a message log

C Interface

Syntax
LOG_enable(log);

Parameters
LOG_Handle log; /* log object handle */

Return Value
Void

Assembly Interface

Syntax
LOG_enable

Preconditions
a4 = address of the LOG object
amr = 0

Postconditions
none

Modifies
a0

Reentrant
no

Description
LOG_enable enables the logging mechanism and allows the log buffer to be modified.

Example
LOG_enable(&trace);

See Also
LOG_disable
LOG_reset
**LOG_error**

*Write an error message to the system log*

**C Interface**

**Syntax**

```c
LOG_error(format, arg0);
```

**Parameters**

- `String format; /* printf-style format string */`
- `Arg arg0; /* copied to second word of log record */`

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

```asm
LOG_error format [section]
```

**Preconditions**

- `a4 = format`
- `b4 = arg0`
- `b14 = address of the start of .bss`
- `amr = 0`

**Postconditions**

- none (see the description of the section argument below)

**Modifies**

- `a0, a1, a2, a3, a4, a6, a7, b0, b2, b3, b5, b6, b7`

**Reentrant**

- `yes`

**Description**

`LOG_error` writes a program-supplied error message to the system log, which is defined in the default configuration by the `LOG_system` object. `LOG_error` is not affected by any TRC bits; an error event is always written to the system log.

The format argument can contain any of the conversion characters supported for `LOG_printf`. See `LOG_printf` for details.

The `LOG_error` assembly macro takes an optional section argument. If you omit this argument, assembly code following the macro is assembled into the `.text` section. If you want your program to be assembled into another section, specify another section name when calling the macro.

**Example**

```c
Void UTL_doError(String s, Int errno)
{
    LOG_error("SYS_error called: error id = 0x%x", errno);
    LOG_error("SYS_error called: string = '%s'", s);
}
```
See Also

LOG_event
LOG_message
LOG_printf
TRC_disable
TRC_enable
LOG_message

Write a program-supplied message to the system log

C Interface

Syntax

LOG_message(format, arg0);

Parameters

String format; /* printf-style format string */
Arg arg0; /* copied to second word of log record */

Return Value

Void

Assembly Interface

Syntax

LOG_message format [section]

Preconditions

a4 = format
b4 = arg0
b14 = address of the start of .bss
amr = 0

Postconditions

none (see the description of the section argument below)

Modifies

a0, a1, a2, a3, a4, a6, a7, b0, b2, b3, b5, b6, b7

Reentrant

yes

Description

LOG_message writes a program-supplied message to the system log, provided that both the host and target trace bits are enabled.

The format argument passed to LOG_message can contain any of the conversion characters supported for LOG_printf. See LOG_printf, page 2-123, for details.

The LOG_message assembly macro takes an optional section argument. If you do not specify a section argument, assembly code following the macro is assembled into the .text section by default. If you do not want your program to be assembled into the .text section, you should specify the desired section name when calling the macro.

Example

Void UTL_doMessage(String s, Int errno)
{
    LOG_message("SYS_error called: error id = 0x%x", errno);
    LOG_message("SYS_error called: string = \"%s\", s);
}
See Also

LOG_error
LOG_event
LOG_printf
TRC_disable
TRC_enable


## LOG_event

*Append an unformatted message to a message log*

### C Interface

**Syntax**

```c
LOG_event(log, arg0, arg1, arg2);
```

**Parameters**

- `LOG_Handle log; /* log objecthandle */`
- `Arg arg0; /* copied to second word of log record */`
- `Arg arg1; /* copied to third word of log record */`
- `Arg arg2; /* copied to fourth word of log record */`

**Return Value**

`Void`

### Assembly Interface

**Syntax**

`LOG_event`

**Preconditions**

- `a4 = address of the LOG object`
- `b4 = val1`
- `a6 = val2`
- `b6 = val3`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

`a0, a1, a2, a3, a7, b0, b2, b3, b5, b7`

**Reentrant**

`yes`

**Description**

LOG_event copies a sequence number and three arguments to the specified log buffer. Each log message uses four words. The contents of the four words written by LOG_event are shown here:

<table>
<thead>
<tr>
<th>LOG_event</th>
<th>Sequence #</th>
<th>arg0</th>
<th>arg1</th>
<th>arg2</th>
</tr>
</thead>
</table>

You can format the log by using LOG_printf instead of LOG_event.

If you want the Event Log to apply the same printf-style format string to all records in the log, use the Configuration Tool to choose raw data for the datatype property of this log object and typing a format string for the format property.
If the logtype is circular, the log buffer of size buflen contains the last buflen elements. If the logtype is fixed, the log buffer contains the first buflen elements.

Any combination of threads can write to the same log. Internally, hardware interrupts are temporarily disabled during a call to LOG_event. Log messages are never lost due to thread preemption.

**Example**

`LOG_event(&trace, (Arg)value1, (Arg)value2, CLK_gethtime);`

**See Also**

LOG_error
LOG_printf
TRC_disable
TRC_enable
LOG_printf

Append a formatted message to a message log

C Interface

Syntax

LOG_printf(log, format);
or
LOG_printf(log, format, arg0);
or
LOG_printf(log, format, arg0, arg1);

Parameters

LOG_Handle log; /* log object handle */
String format; /* printf format string */
Arg arg0; /* value for first format string token */
Arg arg1; /* value for second format string token */

Return Value

Void

Assembly Interface

Syntax

LOG_printf format [section]

Preconditions

a4 = address of the LOG object
b4 = arg0
a6 = arg1
amr = 0

Postconditions

none (see the description of the section parameter below)

Modifies

a0, a1, a2, a3, a7, b0, b2, b3, b5, b6, b7

Reentrant

yes

Description

As a convenience for C (as well as assembly language) programmers, the LOG module provides a variation of the ever-popular printf. LOG_printf copies a sequence number, the format address, and two arguments to the specified log buffer.

To reduce execution time, log data is always formatted on the host. The format string is stored on the host and accessed by the Event Log.

The arguments passed to LOG_printf must be integers, strings, or a pointer if the special %r conversion character is used. The format string can use any of the conversion characters found in Table 2-2.
Table 2-2. Conversion Characters for LOG_printf

<table>
<thead>
<tr>
<th>Conversion Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>%d</td>
<td>Signed integer</td>
</tr>
<tr>
<td>%x</td>
<td>Unsigned hexadecimal integer</td>
</tr>
<tr>
<td>%o</td>
<td>Unsigned octal integer</td>
</tr>
<tr>
<td>%s</td>
<td>Character string</td>
</tr>
<tr>
<td></td>
<td>This character can only be used with constant string pointers. That is, the string must appear in the source and be passed to LOG_printf. For example, the following is supported:</td>
</tr>
<tr>
<td></td>
<td>char *msg = &quot;Hello world!&quot;;</td>
</tr>
<tr>
<td></td>
<td>LOG_printf(&amp;trace, &quot;%s&quot;, msg);</td>
</tr>
<tr>
<td></td>
<td>However, the following example is not supported:</td>
</tr>
<tr>
<td></td>
<td>char msg[100];</td>
</tr>
<tr>
<td></td>
<td>strcpy(msg, &quot;Hello world!&quot;);</td>
</tr>
<tr>
<td></td>
<td>LOG_printf(&amp;trace, &quot;%s&quot;, msg);</td>
</tr>
<tr>
<td></td>
<td>If the string appears in the COFF file and a pointer to the string is passed to LOG_printf, then the string in the COFF file is used by the Event Log to generate the output.</td>
</tr>
<tr>
<td></td>
<td>If the string can not be found in the COFF file, the format string is replaced with *** ERROR: 0x%x 0x%x ***\n, which displays all arguments in hexadecimal.</td>
</tr>
<tr>
<td>%r</td>
<td>Symbol from symbol table</td>
</tr>
<tr>
<td></td>
<td>This is an extension of the standard printf format tokens. This character treats its parameter as a pointer to be looked up in the symbol table of the executable and displayed. That is, %r displays the symbol (defined in the executable) whose value matches the value passed to %r. For example:</td>
</tr>
<tr>
<td></td>
<td>Int testval = 17;</td>
</tr>
<tr>
<td></td>
<td>LOG_printf(&quot;%r = %d&quot;, &amp;testval, testval);</td>
</tr>
<tr>
<td></td>
<td>displays:</td>
</tr>
<tr>
<td></td>
<td>testval = 17</td>
</tr>
<tr>
<td></td>
<td>If no symbol is found for the value passed to %r, the Event Log uses the string &lt;unknown symbol&gt;.</td>
</tr>
<tr>
<td>%p</td>
<td>pointer</td>
</tr>
</tbody>
</table>

If you want the Event Log to apply the same printf-style format string to all records in the log, use the Configuration Tool to choose raw data for the datatype property of this log object and typing a format string for the format property.
The LOG_printf assembly macro takes an optional section parameter. If you do not specify a section parameter, assembly code following the LOG_printf macro is assembled into the .text section by default. If you do not want your program to be assembled into the .text section, you should specify the desired section name as the second parameter to the LOG_printf call.

Each log message uses four words. The contents of the four words written by LOG_printf are shown here:

<table>
<thead>
<tr>
<th>LOG_printf</th>
<th>Sequence #</th>
<th>arg0</th>
<th>arg1</th>
<th>Format address</th>
</tr>
</thead>
</table>

You configure the characteristics of a log in the Configuration Tool. If the log type is circular, the log buffer of size buflen contains the last buflen elements. If the log type is fixed, the log buffer contains the first buflen elements.

Any combination of threads can write to the same log. Internally, hardware interrupts are temporarily disabled during a call to LOG_printf. Log messages are never lost due to thread preemption.

Constraints and Calling Context

- LOG_printf (even the C version) supports 0, 1, or 2 arguments after the format string.
- The format string address is put in b6 as the third value for LOG_event.

Example

```
LOG_printf(&trace, "hello world");
LOG_printf(&trace, "Size of Int is: %d", sizeof(Int));
```

See Also

LOG_error
LOG_event
TRC_disable
TRC_enable
**LOG_reset**  
*Reset a message log*

**C Interface**

**Syntax**

`LOG_reset(log);`

**Parameters**

- `LOG_Handle log        /* log object handle */`

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

`LOG_reset`

**Preconditions**

- `a4 = address of the LOG object`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

`a0, a1`

**Reentrant**

`no`

**Description**

LOG_reset enables the logging mechanism and allows the log buffer to be modified starting from the beginning of the buffer, with sequence number starting from 0.

LOG_reset does not disable interrupts or otherwise protect the log from being modified by an HWI or other thread. It is therefore possible for the log to contain inconsistent data if LOG_reset is preempted by an HWI or other thread that uses the same log.

**Example**

`LOG_reset(&trace);`

**See Also**

- `LOG_disable`
- `LOG_enable`
2.13 MBX Module

The MBX module is the mailbox manager.

**Functions**

- MBX_create. Create a mailbox
- MBX_delete. Delete a mailbox
- MBX_pend. Wait for a message from mailbox
- MBX_post. Post a message to mailbox

**Constants, Types, and Structures**

typedef struct MBX_Obj *MBX_Handle;
    /* handle for mailbox object */

struct MBX_Attrs {
    /* mailbox attributes */
    Int    segid;
};

MBX_Attrs MBX_ATTRS = {/* default attribute values */
    0,
};

**Description**

The MBX module makes available a set of functions that manipulate mailbox objects accessed through handles of type MBX_Handle. Mailboxes can hold up to the number of messages specified by the Mailbox Length property in the Configuration Tool.

MBX_pend is used to wait for a message from a mailbox. The timeout parameter to MBX_pend allows the task to wait until a timeout. A timeout value of SYS_FOREVER causes the calling task to wait indefinitely for a message. A timeout value of zero (0) causes MBX_pend to return immediately. MBX_pend’s return value indicates whether the mailbox was signaled successfully.

MBX_post is used to send a message to a mailbox. The timeout parameter to MBX_post specifies the amount of time the calling task waits if the mailbox is full. If a task is waiting at the mailbox, MBX_post removes the task from the queue and puts it on the ready queue. If no task is waiting and the mailbox is not full, MBX_post simply deposits the message and returns.

2.13.1 MBX Manager Properties

The following global property can be set for the MBX module on the MBX Manager Properties dialog in the Configuration Tool:

**Object Memory.** The memory segment that contains the MBX objects created with the Configuration Tool.
2.13.2  MBX Object Properties

The following properties can be set for an MBX object on the MBX Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this MBX object.
- **Message Size.** The size (in MADUs, 8-bit bytes) of the messages this mailbox can contain.
- **Mailbox Length.** The number of messages this mailbox can contain.
- **Element memory segment.** The memory segment to contain the mailbox data buffers.

2.13.3  MBX Code Composer Studio Interface

The MBX tab of the Kernel/Object View shows information about mailbox objects.
**MBX_create**

*Create a mailbox*

**C Interface**

**Syntax**

\[\text{mbx = MBX\_create(msgsize, mbxlength, attrs);}\]

**Parameters**

- `Uns msgsize; /* size of message */`
- `Uns mbxlength; /* length of mailbox */`
- `MBX\_Attrs *attrs; /* pointer to mailbox attributes */`

**Return Value**

- `MBX\_Handle mbx; /* mailbox object handle */`

**Assembly Interface**

none

**Description**

MBX_create creates a mailbox object which is initialized to contain up to `mbxlength` messages of size `msgsize`. If successful, MBX_create returns the handle of the new mailbox object. If unsuccessful, MBX_create returns NULL unless it aborts (for example, because it directly or indirectly calls SYS_error, and SYS_error causes an abort).

If `attrs` is NULL, the new mailbox is assigned a default set of attributes. Otherwise, the mailbox’s attributes are specified through a structure of type `MBX\_Attrs`.

All default attribute values are contained in the constant `MBX\_ATTRS`, which can be assigned to a variable of type `MBX\_Attrs` prior to calling MBX_create.

MBX_create calls MEM_alloc to dynamically create the object’s data structure. MEM_alloc must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, then there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module, page 2-135.

**Constraints and Calling Context**

- MBX_create cannot be called from an SWI or HWI.
- You can reduce the size of your application program by creating objects with the Configuration Tool rather than using the XXX_create functions.

**See Also**

- MBX_delete
- SYS_error

---

*Application Program Interface* 2-129
MBX_delete

Delete a mailbox

C Interface

Syntax

```c
MBX_delete(mbx);
```

Parameters

MBX_Handle mbx; /* mailbox object handle */

Return Value

Void

Assembly Interface

none

Description

MBX_delete frees the mailbox object referenced by mbx.

MBX_delete calls MEM_free to delete the MBX object. MEM_free must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- No tasks should be pending on mbx when MBX_delete is called.
- MBX_delete cannot be called from an SWI or HWI.
- No check is performed to prevent MBX_delete from being used on a statically-created object. If a program attempts to delete a mailbox object that was created using the Configuration Tool, SYS_error is called.

See Also

MBX_create
MBX_pend

Wait for a message from mailbox

C Interface

Syntax

```c
status = MBX_pend(mbx, msg, timeout);
```

Parameters

- `MBX_Handle mbx; /* mailbox object handle */`
- `Ptr msg; /* message pointer */`
- `Uns timeout; /* return after this many system clock ticks */`

Return Value

- `Bool status; /* TRUE if successful, FALSE if timeout */`

Assembly Interface

none

Description

If the mailbox is not empty, MBX_pend copies the first message into `msg` and returns TRUE. Otherwise, MBX_pend suspends the execution of the current task until MBX_post is called or the timeout expires. The actual time of task suspension can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

If timeout is SYS_FOREVER, the task remains suspended until MBX_post is called on this mailbox. If timeout is 0, MBX_pend returns immediately.

If timeout expires (or timeout is 0) before the mailbox is available, MBX_pend returns FALSE. Otherwise MBX_pend returns TRUE.

A task switch occurs when calling MBX_pend if the mailbox is empty and timeout is not 0, or if a higher priority task is blocked on MBX_post.

Constraints and Calling Context

- MBX_pend can only be called from an HWI or SWI if timeout is 0.
- MBX_pend can only be called from within a TSK_disable / TSK_enable block if the timeout is 0.
- MBX_pend cannot be called from the program’s main function.

See Also

MBX_post
**MBX_post**

Post a message to mailbox

**C Interface**

**Syntax**

```c
status = MBX_post(mbx, msg, timeout);
```

**Parameters**

- `MBX_Handle mbx /* mailbox object handle */`
- `Ptr msg; /* message pointer */`
- `Uns timeout; /* return after this many system clock ticks */`

**Return Value**

- `Bool status; /* TRUE if successful, FALSE if timeout */`

**Assembly Interface**

`none`

**Description**

`MBX_post` checks to see if there are any free message slots before copying `msg` into the mailbox. `MBX_post` readies the first task (if any) waiting on `mbx`.

If the mailbox is full and `timeout` is `SYS_FOREVER`, the task remains suspended until `MBX_pend` is called on this mailbox. If `timeout` is 0, `MBX_post` returns immediately. Otherwise, the task is suspended for `timeout` system clock ticks. The actual time of task suspension can be up to 1 system clock tick less than `timeout` due to granularity in system timekeeping.

If `timeout` expires (or `timeout` is 0) before the mailbox is available, `MBX_post` returns `FALSE`. Otherwise `MBX_post` returns `TRUE`.

A task switch occurs when calling `MBX_post` if a higher priority task is made ready to run, or if there are no free message slots and `timeout` is not 0.

**Constraints and Calling Context**

- `MBX_post` can only be called from within a `TSK_disable / TSK_enable` block if the `timeout` is 0.
- This function is callable by SWI and HWI threads with `timeout` equal to zero only.
- `MBX_post` can be called from the program’s main function. However, the number of calls should not be greater than the number of messages the mailbox can hold. Additional calls have no effect.

**See Also**

- `MBX_pend`
2.14 MEM Module

The MEM module is the memory segment manager.

Functions

- MEM_alloc. Allocate from a memory segment.
- MEM_calloc. Allocate and initialize to 0.
- MEM_define. Define a new memory segment.
- MEM_free. Free a block of memory.
- MEM_redefine. Redefine an existing memory segment.
- MEM_stat. Return the status of a memory segment.
- MEM_valloc. Allocate and initialize to a value.

Constants, Types, and Structures

MEM->MALLOCSEG = 0;  /* segid for malloc, free */

#define MEM_HEADERSIZE /* free block header size */
#define MEM_HEADERMASK /* mask to align on MEM_HEADERSIZE */
#define MEM_ILLEGAL    /* illegal memory address */

MEM_Attrs MEM_ATTRS ={ /* default attribute values */
    0
};

typedef struct MEM_Segment {
    Ptr    base;     /* base of the segment */
    Uns    length;   /* size of the segment */
    Uns    space;    /* memory space */
} MEM_Segment;

typedef struct MEM_Stat {
    Uns  size;   /* original size of segment */
    Uns  used;   /* MADUs used in segment */
    Uns  length; /* largest contiguous block length */
} MEM_Stat;

Description

The MEM module provides a set of functions used to allocate storage from one or more disjointed segments of memory. These memory segments are specified with the Configuration Tool.

MEM always allocates an even number of MADUs and always aligns buffers on an even boundary. This behavior is used to insure that free buffers are always at least two MADUs in length. This behavior does not preclude you from allocating two 512 buffers from a 1K region of on-device memory, for example. It does, however, mean that odd allocations consume one more MADU than expected.
If small code size is important to your application, you can reduce code size significantly by removing the capability to dynamically allocate and free memory. To do this, put a checkmark in the No Dynamic Memory Heaps box in the Properties dialog for the MEM manager. If you remove this capability, your program cannot call any of the MEM functions or any object creation functions (such as TSK_create). You will need to create all objects that will be used by your program with the Configuration Tool. You can also use the Configuration Tool to create or remove the dynamic memory heap from an individual memory segment.

Software modules in DSP/BIOS that allocate storage at run-time use MEM functions; DSP/BIOS does not use the standard C function malloc. DSP/BIOS modules use MEM to allocate storage in the segment selected for that module with the Configuration Tool.

The MEM Manager property, Segment for malloc()/free(), is used to implement the standard C malloc, free, and calloc functions. These functions actually use the MEM functions (with segid = Segment for malloc/free) to allocate and free memory.

**Note:**

The MEM module does not set or configure hardware registers associated with a DSP’s memory subsystem. Such configuration is the responsibility of the user and is typically handled by software loading programs, or in the case of Code Composer Studio, the startup or menu options. For example, to access external memory on a c6000 platform, the External Memory Interface (EMIF) registers must first be set appropriately before any access. The earliest opportunity for EMIF initialization within DSP/BIOS would be during the user initialization hook (see Global Settings in the API Reference Guide).

### 2.14.1 MEM Manager Properties

The DSP/BIOS Memory Section Manager allows you to specify the memory segments required to locate the various code and data sections of a DSP/BIOS application.

Note that settings you specify in the Visual Linker normally override settings you specify in the DSP/BIOS Configuration Tool. See the Visual Linker help for details on using the Visual Linker with DSP/BIOS.

The following global properties can be set for the MEM module on the MEM Manager Properties dialog in the Configuration Tool:
**MEM Module**

**General tab**

- **Reuse Startup Code Space.** If this box is checked, the startup code section (.sysinit) can be reused after startup is complete.

- **Map Mode.** Select c6000 Memory Map 0 or Memory Map 1. Changing this property affects the base address for some pre-defined memory segments.

- **Argument Buffer Size.** The size of the .args section. The .args section contains the argc, argv, and envp arguments to the program’s main function. Code Composer loads arguments for the main function into the .args section. The .args section is parsed by the boot file.

- **Stack Size.** The size of the global stack in MADUs. The upper-left corner of the Configuration Tool window shows the estimated minimum global stack size required for this application (as a decimal number).

  This size is shown as a hex value in Minimum Addressable Data Units (MADUs). An MADU is the smallest unit of data storage that can be read or written by the CPU. For the c6000 this is an 8-bit byte.

- **No Dynamic Memory Heaps.** Put a checkmark in this box to completely disable the ability to dynamically allocate memory and the ability to dynamically create and delete objects. If this box is checked, your program may not call the MEM_alloc, MEM_valloc, MEM_calloc, and malloc or the XXX_create function for any DSP/BIOS module. If this box is checked, the Segment For DSP/BIOS Objects, Segment for malloc()/free(), and Stack segment for dynamic tasks properties are set to MEM_NULL.

**BIOS Data tab**

- **Argument Buffer Section (.args).** The memory segment containing the .args section.

- **Stack Section (.stack).** The memory segment containing the global stack. This segment should be located in RAM.

- **DSP/BIOS Init Tables (.gblinit).** The memory segment containing the DSP/BIOS global initialization tables.

- **TRC Initial Value (.trcdata).** The memory segment containing the TRC mask variable and its initial value. This segment must be placed in RAM.

- **DSP/BIOS Kernel State (.sysdata).** The memory segment containing system data about the DSP/BIOS kernel state.

- **DSP/BIOS Conf Sections (.obj).** The memory segment containing configuration properties that can be read by the target program.

- **Segment For DSP/BIOS Objects.** The default memory segment that will contain objects created at run-time with an XXX_create function. The XXX_Attrs structure passed to the XXX_create function can override this.
default. If you select MEM_NULL for this property, creation of DSP/BIOS objects at run-time via the XXX_create functions is disabled.

- **Segment For malloc() / free().** The memory segment from which space is allocated when a program calls malloc and from which space is freed when a program calls free. If you select MEM_NULL for this property, dynamic memory allocation at run-time is disabled.

### BIOS Code tab

- **BIOS Code Section (.bios).** The memory segment containing the DSP/BIOS code.

- **Startup Code Section (.sysinit).** The memory segment containing DSP/BIOS startup initialization code; this memory can be reused after main starts executing.

- **Function Stub Memory (.hwi).** The memory segment containing dispatch code for interrupt service routines that are configured to be monitored.

- **Interrupt Service Table Memory (.hwi_vec).** The memory segment containing the Interrupt Service Table (IST). The IST can be placed anywhere on the memory map, but a copy of the RESET vector always remains at address 0x00000000.

- **RTDX Text Segment (.rtdx_text).** The memory segment containing the code sections for the RTDX module.

### Compiler Sections tab

- **User .cmd File For Non-DSP/BIOS Sections.** Put a checkmark in this box if you want to have full control over the memory used for the sections that follow. You will need to create your own linker command file that begins by including the linker command file created by the Configuration Tool. Your linker command file should then assign memory for the items normally handled by the following properties. See the *TMS320C6000 Optimizing Compiler User's Guide* for more details.

- **Text Section (.text).** The memory segment containing the executable code, string literals, and compiler-generated constants. This segment can be located in ROM or RAM.

- **Switch Jump Tables (.switch).** The memory segment containing the jump tables for switch statements. This segment can be located in ROM or RAM.

- **C Variables Section (.bss).** The memory segment containing global and static C variables. At boot or load time, the data in the .cinit section is copied to this segment. This segment should be located in RAM.

- **C Variables Section (.far).** The memory segment containing global and static variables declared as far variables.
MEM Module

- **Data Initialization Section (.cinit)**. The memory segment containing tables for explicitly initialized global and static variables and constants. This segment can be located in ROM or RAM.

- **C Function Initialization Table (.pinit)**. The memory segment containing the table of global object constructors. Global constructors must be called during program initialization. The C/C++ compiler produces a table of constructors to be called at startup. The table is contained in a named section called .pinit. The constructors are invoked in the order that they occur in the table. This segment can be located in ROM or RAM.

- **Constant Section (.const)**. The memory segment containing string constants and data defined with the const C qualifier. If the C compiler is not used, this parameter is unused. This segment can be located in ROM or RAM.

- **Data Section (.data)**. This memory segment contains program data. This segment can be located in ROM or RAM.

- **Data Section (.cio)**. This memory segment contains C standard I/O buffers.

**Load Address tab**

- **Specify Separate Load Addresses**. If you put a checkmark in this box, you can select separate load addresses for the sections listed on this tab. Load addresses are useful when, for example, your code must be loaded into ROM, but would run faster in RAM. The linker allows you to allocate sections twice: once to set a load address and again to set a run address.

  If you do not select a separate load address for a section, the section loads and runs at the same address.

  If you do select a separate load address, the section is allocated as if it were two separate sections of the same size. The load address is where raw data for the section is placed. References to items in the section refer to the run address. The application must copy the section from its load address to its run address. For details, see the topics on Runtime Relocation and the .label Directive in the Code Generation Tools help or manual.

- **Load Address - BIOS Code Section (.bios)**. The memory segment containing the load allocation of the section that contains DSP/BIOS code.

- **Load Address - Startup Code Section (.sysinit)**. The memory segment containing the load allocation of the section that contains DSP/BIOS startup initialization code.
MEM Module

- **Load Address - DSP/BIOS Init Tables (.gblinit)**. The memory segment containing the load allocation of the section that contains the DSP/BIOS global initialization tables.

- **Load Address - TRC Initial Value (.trcdata)**. The memory segment containing the load allocation of the section that contains the TRC mask variable and its initial value.

- **Load Address - Text Section (.text)**. The memory segment containing the load allocation of the section that contains the executable code, string literals, and compiler-generated constants.

- **Load Address - Switch Jump Tables (.switch)**. The memory segment containing the load allocation of the section that contains the jump tables for switch statements.

- **Load Address - Data Initialization Section (.cinit)**. The memory segment containing the load allocation of the section that contains tables for explicitly initialized global and static variables and constants.

- **Load Address - C Function Initialization Table (.pinit)**. The memory segment containing the load allocation of the section that contains the table of global object constructors.

- **Load Address - Constant Section (.const)**. The memory segment containing the load allocation of the section that contains string constants and data defined with the const C qualifier.

- **Load Address - Function Stub Memory (.hwi)**. The memory segment containing the load allocation of the section that contains dispatch code for interrupt service routines configured to be monitored.

- **Load Address - Interrupt Service Table Memory (.hwi_vec)**. The memory segment containing the load allocation of the section that contains the Interrupt Service Table (IST).

- **Load Address - RTDX Text Segment (.rtdx_text)**. The memory segment containing the load allocation of the section that contains the code sections for the RTDX module.

### 2.14.2 MEM Object Properties

A memory segment represents a contiguous length of code or data memory in the address space of the processor.

Note that settings you specify in the Visual Linker normally override settings you specify in the DSP/BIOS Configuration Tool. See the Visual Linker help for details on using the Visual Linker with DSP/BIOS.
The following properties can be set for MEM objects on the MEM Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this MEM object.

- **base.** The address at which this memory segment begins. This value is shown in hex.

- **len.** The length of this memory segment in MADUs. This value is shown in hex.

- **create a heap in this memory.** If this box is checked, a heap is created in this memory segment. Memory can be allocated dynamically from a heap. In order to remove the heap from a memory segment, you can select another memory segment that contains a heap for properties that dynamically allocate memory in this memory segment. The properties you should check are in the Memory Section Manager (the Segment for DSP/BIOS objects and Segment for malloc/free properties) and the Task Manager (the Default stack segment for dynamic tasks property). If you disable dynamic memory allocation in the Memory Section Manager, you cannot create a heap in any memory segment.

- **heap size.** The size of the heap in MADUs to be created in this memory segment. You cannot control the location of the heap within its memory segment except by making the segment and heap the same sizes.

- **enter a user defined heap identifier.** If this box is checked, you can define your own identifier label for this heap.

- **heap identifier label.** If the box above is checked, type a name for this segment’s heap.

- **space.** Type of memory segment. This is set to code for memory segments that store programs, and data for memory segments that store program data.

The predefined memory segments in a configuration file, particularly those for external memory, are dependent on the board template you select. In general, Table 2-3 and Table 2-4 list segments that can be defined for the c6000:
MEM Module

Table 2-3. Typical Memory Segments for c6x EVM Boards

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPRAM</td>
<td>Internal (on-device) program memory</td>
</tr>
<tr>
<td>IDRAM</td>
<td>Internal (on-device) data memory</td>
</tr>
<tr>
<td>SBSRAM</td>
<td>External SBSRAM on CE0</td>
</tr>
<tr>
<td>SDRAM0</td>
<td>External SDRAM on CE2</td>
</tr>
<tr>
<td>SDRAM1</td>
<td>External SDRAM on CE3</td>
</tr>
</tbody>
</table>

Table 2-4. Typical Memory Segment for c6711 DSK Boards

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDRAM</td>
<td>External SDRAM</td>
</tr>
</tbody>
</table>

2.14.3 MEM Code Composer Studio Interface

The MEM tab of the Kernel/Object View shows information about memory segments.
MEM_alloc  Allocate from a memory segment

C Interface

Syntax

```
addr = MEM_alloc(segid, size, align);
```

Parameters

- `Int segid; /* memory segment identifier */`
- `Uns size; /* block size in MADUs */`
- `Uns align; /* block alignment */`

Return Value

- `Void *addr; /* address of allocated block of memory */`

Assembly Interface

none

Description

MEM_alloc allocates a contiguous block of storage from the memory segment identified by `segid` and returns the address of this block.

The `segid` parameter identifies the memory segment from which memory is to be allocated. This identifier can be an integer or a memory segment name defined in the Configuration Tool. The files created by the Configuration Tool define each configured segment name as a variable with an integer value.

The block contains `size` MADUs and starts at an address that is a multiple of `align`. If `align` is 0 or 1, there is no alignment constraint.

MEM_alloc does not initialize the allocated memory locations.

If the memory request cannot be satisfied, MEM_alloc calls SYS_error with SYS_EALLOC and returns MEM_ILLEGAL.

Memory management functions require that the caller obtain a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- `segid` must identify a valid memory segment.
- MEM_alloc cannot be called from an SWI or HWI.
- `align` must be 0, or a power of 2 (for example, 1, 2, 4, 8).

See Also

MEMcalloc
MEM_free
MEM_valloc
SYS_error
C library stdlib.h
MEM_calloc

Allocate from a memory segment and set value to 0

C Interface

Syntax

```c
addr = MEM_calloc(segid, size, align)
```

Parameters

- `Int segid; /* memory segment identifier */`
- `Uns size; /* block size in MADUs */`
- `Uns align; /* block alignment */`

Return Value

- `Void *addr; /* address of allocated block of memory */`

Assembly Interface

None

Description

MEM_calloc is functionally equivalent to calling MEM_valloc with value set to 0.

MEM_calloc allocates a contiguous block of storage from the memory segment identified by segid and returns the address of this block.

The segid parameter identifies the memory segment from which memory is to be allocated. This identifier can be an integer or a memory segment name defined in the Configuration Tool. The files created by the Configuration Tool define each configured segment name as a variable with an integer value.

The block contains size MADUs and starts at an address that is a multiple of align. If align is 0 or 1, there is no alignment constraint.

If the memory request cannot be satisfied, MEM_calloc calls SYS_error with SYS_EALLOC and returns MEM_ILLEGAL.

Memory management functions require that the caller obtain a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- `segid must identify a valid memory segment.`
- `MEM_calloc cannot be called from an SWI or HWI.`
- `align must be 0, or a power of 2 (for example, 1, 2, 4, 8).`

See Also

- MEM_alloc
- MEM_free
- MEM_valloc
- SYS_error
- C library stdlib.h
MEM_define  

Define a new memory segment

C Interface

Syntax  

\[
\text{segid} = \text{MEM\_define}(\text{base}, \text{length}, \text{attrs});
\]

Parameters  

- \text{Ptr base; /* base address of new segment */}
- \text{Uns length; /* length (in MADUs) of new segment */}
- \text{MEM\_Attrs *attrs; /* segment attributes */}

Return Value  

- \text{Int segid; /* ID of new segment */}

Assembly Interface  

none

Description  

\begin{enumerate}
\item MEM\_define defines a new memory segment for use by the DSP/BIOS memory module, MEM.
\item The new segment contains length MADUs starting at base. A new table entry is allocated to define the segment, and the entry’s index into this table is returned as the segid.
\item The new block should be aligned on a MEM\_HEADERSIZE boundary, and the length should be a multiple of MEM\_HEADERSIZE, otherwise the entire block is not available for allocation.
\item If attrs is NULL, the new segment is assigned a default set of attributes. Otherwise, the segment’s attributes are specified through a structure of type MEM\_Attrs.
\end{enumerate}

\textbf{Note:}

No attributes are supported for segments, and the type MEM\_Attrs is defined as a dummy structure.

Constraints and Calling Context  

- At least one segment must exist at the time MEM\_define is called.
- MEM\_define and MEM\_redefine must not be called when a context switch is possible. To guard against a context switch, these functions should only be called in the main function.
- MEM\_define should not be called from the function specified by the User Init Function property of the Global Settings module. The MEM module has not been initialized at the time the User Init Function runs.

See Also  

MEM\_redefine
MEM_free

Free a block of memory

C Interface

Syntax

status = MEM_free(segid, addr, size);

Parameters

Int segid; /* memory segment identifier */
Ptr addr; /* block address pointer */
Uns size; /* block length in MADUs*/

Return Value

Bool status; /* TRUE if successful */

Assembly Interface

none

Description

MEM_free places the memory block specified by addr and size back into the free pool of the segment specified by segid. The newly freed block is combined with any adjacent free blocks. This space is then available for further allocation by MEM_alloc. The segid can be an integer or a memory segment name defined in the Configuration Tool

Memory management functions require that the caller obtain a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- addr must be a valid pointer returned from a call to MEM_alloc.
- segid and size are those values used in a previous call to MEM_alloc.
- MEM_free cannot be called by HWI or SWI functions.

See Also

MEM_alloc
C library stdlib.h
MEM_redefine

Redefine an existing memory segment

C Interface

Syntax

MEM_redefine(segid, base, length);

Parameters

Int segid; /* segment to redefine */
Ptr base; /* base address of new block */
Uns length; /* length (in MADUs) of new block */

Return Value

Void

Assembly Interface

none

Reentrant

no

Description

MEM_redefine redefines an existing memory segment managed by the DSP/BIOS memory module, MEM. All pointers in the old segment memory block are automatically freed, and the new segment block is completely available for allocations.

The new block should be aligned on a MEM_HEADERSIZE boundary, and the length should be a multiple of MEM_HEADERSIZE, otherwise the entire block is not available for allocation.

Constraints and Calling Context

MEM_define and MEM_redefine must not be called when a context switch is possible. To guard against a context switch, these functions should only be called in the main function.

See Also

MEM_define
MEM_stat

Return the status of a memory segment

C Interface

Syntax

```c
status = MEM_stat(segid, statbuf);
```

Parameters

- `Int segid; /* memory segment identifier */`
- `MEM_Stat *statbuf; /* pointer to stat buffer */`

Return Value

- `Bool status; /* TRUE if successful */`

Assembly Interface

none

Description

MEM_stat returns the status of the memory segment specified by `segid` in the status structure pointed to by `statbuf`.

```c
struct MEM_Stat {
    Uns size;   /* original size of segment */
    Uns used;   /* number of MADUs used in segment */
    Uns length; /* largest free contiguous block length */
}
```

All values are expressed in terms of minimum addressable units (MADUs).

MEM_stat returns TRUE if `segid` corresponds to a valid memory segment, and FALSE otherwise. If MEM_stat returns FALSE, the contents of `statbuf` are undefined.

Memory management functions require that the caller obtain a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

MEM_stat cannot be called from an SWI or HWI.
MEM_valloc

Allocate from a memory segment and set value

C Interface

Syntax

addr = MEM_valloc(segid, size, align, value);

Parameters

Int segid; /* memory segment identifier */
Uns size; /* block size in MADUs */
Uns align; /* block alignment */
Char value; /* character value */

Return Value

Void *addr; /* address of allocated block of memory */

Assembly Interface

none

Description

MEM_valloc uses MEM_alloc to allocate the memory before initializing it to value.

The segid parameter identifies the memory segment from which memory is to be allocated. This identifier can be an integer or a memory segment name defined in the Configuration Tool. The files created by the Configuration Tool define each configured segment name as a variable with an integer value.

The block contains size MADUs and starts at an address that is a multiple of align. If align is 0 or 1, there is no alignment constraint.

If the memory request cannot be satisfied, MEM_valloc calls SYS_error with SYS_EALLOC and returns MEM_ILLEGAL.

Memory management functions require that the caller obtain a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- segid must identify a valid memory segment.
- MEM_valloc cannot be called from an SWI or HWI.
- align must be 0, or a power of 2 (for example, 1, 2, 4, 8).

See Also

MEM_alloc
MEMcalloc
MEM_free
SYS_error
C library stdlib.h
2.15 PIP Module

The PIP module is the buffered pipe manager.

**Functions**
- **PIP_alloc.** Get an empty frame from the pipe.
- **PIP_free.** Recycle a frame back to the pipe.
- **PIP_get.** Get a full frame from the pipe.
- **PIP_getReaderAddr.** Get the value of the readerAddr pointer of the pipe.
- **PIP_getReaderNumFrames.** Get the number of pipe frames available for reading.
- **PIP_getReaderSize.** Get the number of words of data in a pipe frame.
- **PIP_getWriterAddr.** Get the value of the writerAddr pointer of the pipe.
- **PIP_getWriterNumFrames.** Get the number of pipe frames available to write to.
- **PIP_getWriterSize.** Get the number of words that can be written to a pipe frame.
- **PIP_peek.** Get the pipe frame size and address without actually claiming the pipe frame.
- **PIP_put.** Put a full frame into the pipe.
- **PIP_reset.** Reset all fields of a pipe object to their original values.
- **PIP_setWriterSize.** Set the number of valid words written to a pipe frame.

**PIP_Obj Structure**

**Members**
- **Ptr readerAddr.** Pointer to the address to begin reading from after calling PIP_get.
- **Uns readerSize.** Number of words of data in the frame read with PIP_get.
- **Uns readerNumFrames.** Number of frames available to be read.
- **Ptr writerAddr.** Pointer to the address to begin writing to after calling PIP_alloc.
- **Uns writerSize.** Number of words available in the frame allocated with PIP_alloc.
- **Uns writerNumFrames.** Number of frames available to be written to.

**Description**

The PIP module manages data pipes, which are used to buffer streams of input and output data. These data pipes provide a consistent software data structure you can use to drive I/O between the DSP device and all kinds of real-time peripheral devices.
Each pipe object maintains a buffer divided into a fixed number of fixed length frames, specified by the numframes and framesize properties. All I/O operations on a pipe deal with one frame at a time; although each frame has a fixed length, the application can put a variable amount of data in each frame up to the length of the frame.

A pipe has two ends, as shown in Figure 2-2. The writer end (also called the producer) is where your program writes frames of data. The reader end (also called the consumer) is where your program reads frames of data.

Figure 2-2. Pipe Schematic

Internally, pipes are implemented as a circular list; frames are reused at the writer end of the pipe after PIP_free releases them.

The notifyReader and notifyWriter functions are called from the context of the code that calls PIP_put or PIP_free. These functions can be written in C or assembly. To avoid problems with recursion, the notifyReader and notifyWriter functions normally should not directly call any of the PIP module functions for the same pipe. Instead, they should post a software interrupt that uses the PIP module functions. However, PIP calls may be made from the notifyReader and notifyWriter functions if the functions have been protected against re-entrancy. The audio example, located on your distribution CD in `c:\ti\examples\target\bios\audio` folder, where `target` matches your board, is a good example of this. (If you installed in a path other than `c:\ti`, substitute your appropriate path.)

**Note:**

When DSP/BIOS starts up, it calls the notifyWriter function internally for each created pipe object to initiate the pipe’s I/O.

The code that calls PIP_free or PIP_put should preserve any necessary registers.
Often one end of a pipe is controlled by an HWI and the other end is controlled by a SWI function.

HST objects use PIP objects internally for I/O between the host and the target. Your program only needs to act as the reader or the writer when you use an HST object, because the host controls the other end of the pipe.

Pipes can also be used to transfer data within the program between two application threads.

2.15.1 PIP Manager Properties

The pipe manager manages objects that allow the efficient transfer of frames of data between a single reader and a single writer. This transfer is often between an HWI and an application software interrupt, but pipes can also be used to transfer data between two application threads.

The following global property can be set for the PIP module on the PIP Manager Properties dialog in the Configuration Tool:

Object Memory. The memory segment that contains the PIP objects.

2.15.2 PIP Object Properties

A pipe object maintains a single contiguous buffer partitioned into a fixed number of fixed length frames. All I/O operations on a pipe deal with one frame at a time; although each frame has a fixed length, the application can put a variable amount of data in each frame (up to the length of the frame).

The following properties can be set for a pipe object on the PIP Object Properties dialog in the Configuration Tool:

- comment. Type a comment to identify this PIP object.
- bufseg. The memory segment that the buffer is allocated within; all frames are allocated from a single contiguous buffer (of size framesize x numframes).
- bufalign. The alignment (in words) of the buffer allocated within the specified memory segment.
- framesize. The length of each frame (in words)
- numframes. The number of frames
- monitor. The end of the pipe to be monitored by a hidden STS object. Can be set to reader, writer, or nothing. In the Statistics View analysis tool, your choice determines whether the STS display for this pipe shows
a count of the number of frames handled at the reader or writer end of the pipe.

- **notifyWriter.** The function to execute when a frame of free space is available. This function should notify (for example, by calling SWI_andn) the object that writes to this pipe that an empty frame is available. The notifyWriter function is performed as part of the thread that called PIP_free or PIP_alloc. To avoid problems with recursion, the notifyWriter function should not directly call any of the PIP module functions for the same pipe.

  - **nwarg0, nwarg1.** Two Arg type arguments for the notifyWriter function.

- **notifyReader.** The function to execute when a frame of data is available. This function should notify (for example, by calling SWI_andn) the object that reads from this pipe that a full frame is ready to be processed. The notifyReader function is performed as part of the thread that called PIP_put or PIP_get. To avoid problems with recursion, the notifyReader function should not directly call any of the PIP module functions for the same pipe.

  - **nrarg0, nrarg1.** Two Arg type arguments for the notifyReader function.

### 2.15.3 PIP - Code Composer Studio Interface

To enable PIP accumulators, choose DSP/BIOS→RTA Control Panel and put a check in the appropriate box. Then choose DSP/BIOS→Statistics View, which lets you select objects for which you want to see statistics. If you choose a PIP object, you see a count of the number of frames read from or written to the pipe.
**PIP_alloc**

Allocate an empty frame from a pipe

**C Interface**

**Syntax**

```c
PIP_alloc(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle */`

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

`PIP_alloc`

**Preconditions**

- `a4 = address of the pipe object`
- `pipe.writerNumFrames > 0`
- `amr = 0`

**Postconditions**

- `none`

**Modifies**

- `a0, a1, a2, a3, a4, a5, a6, a7, a8, a9, b0, b1, b2, b3, b4, b5, b6, b7, b8, b9`

**Reentrant**

- `no`

**Description**

`PIP_alloc` allocates an empty frame from the pipe you specify. You can write to this frame and then use `PIP_put` to put the frame into the pipe.

If empty frames are available after `PIP_alloc` allocates a frame, `PIP_alloc` runs the function specified by the `notifyWriter` property of the PIP object. This function should notify (for example, by calling `SWI_andn`) the object that writes to this pipe that an empty frame is available. The `notifyWriter` function is performed as part of the thread that calls `PIP_free` or `PIP_alloc`. To avoid problems with recursion, the `notifyWriter` function should not directly call any `PIP` module functions for the same pipe.

**Constraints and Calling Context**

- Before calling `PIP_alloc`, a function should check the `writerNumFrames` member of the `PIP_Obj` structure by calling `PIP_getWriterNumFrames` to make sure it is greater than 0 (that is, at least one empty frame is available).

- `PIP_alloc` can only be called one time before calling `PIP_put`. You cannot operate on two frames from the same pipe simultaneously.

**Note:**

Registers used by `notifyWriter` functions might also be modified.
Example

```c
Void copy(HST_Obj *input, HST_Obj *output)
{
    PIP_Obj     *in, *out;
    Uns         *src, *dst;
    Uns         size;

    in = HST_getpipe(input);
    out = HST_getpipe(output);

    if (PIP_getReaderNumFrames(in) == 0 ||
        PIP_getWriterNumFrames(out) == 0) {
        error;
    }

    /* get input data and allocate output frame */
    PIP_get(in);
    PIP_alloc(out);

    /* copy input data to output frame */
    src = PIP_getReaderAddr(in);
    dst = PIP_getWriterAddr(out);
    size = PIP_getReaderSize(in);
    PIP_setWriterSize(out, size);
    for (; size > 0; size--) {
        *dst++ = *src++;
    }

    /* output copied data and free input frame */
    PIP_put(out);
    PIP_free(in);
}
```

The example for HST_getpipe, page 2-83, also uses a pipe with host channel objects.

See Also

- PIP_free
- PIP_get
- PIP_put
- HST_getpipe
**PIP_free**

Recycle a frame that has been read to a pipe

### C Interface

**Syntax**

```
PIP_free(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle */`

**Return Value**

`Void`

### Assembly Interface

**Syntax**

`PIP_free`

**Preconditions**

- `a4 = address of the pipe object`
- `amr = 0`

**Postconditions**

none

**Modifies**

- `a1, a2, a3, a4, a5, b0, b1, b2, b3, b4`

**Reentrant**

`no`

**Description**

`PIP_free` releases a frame after you have read the frame with `PIP_get`. The frame is recycled so that `PIP_alloc` can reuse it.

After `PIP_free` releases the frame, it runs the function specified by the `notifyWriter` property of the PIP object. This function should notify (for example, by calling `SWI_andn`) the object that writes to this pipe that an empty frame is available. The `notifyWriter` function is performed as part of the thread that called `PIP_free` or `PIP_alloc`. To avoid problems with recursion, the `notifyWriter` function should not directly call any of the PIP module functions for the same pipe.

**Constraints and Calling Context**

When called within an HWI ISR, the code sequence calling `PIP_free` must be either wrapped within an HWI enter/HWI exit pair or invoked by the HWI dispatcher.

**Note:**

Registers used by `notifyWriter` functions might also be modified.

**Example**

See the example for `PIP_alloc`, page 2-152. The example for `HST_getpipe`, page 2-83, also uses a pipe with host channel objects.
See Also

PIP_alloc
PIP_get
PIP_put
HST_getpipe
**PIP_get**

*Get a full frame from the pipe*

**C Interface**

**Syntax**

```c
PIP_get(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle */`

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

```assembly
PIP_get
```

**Preconditions**

- `a4 = address of the pipe object`
- `pipe.readerNumFrames > 0`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

- `a0, a1, a2, a3, a4, a5, a6, a7, a8, a9, b0, b1, b2, b3, b4, b5, b6, b7, b8, b9`

**Reentrant**

`no`

**Description**

`PIP_get` gets a frame from the pipe after some other function puts the frame into the pipe with `PIP_put`.

If full frames are available after `PIP_get` gets a frame, `PIP_get` runs the function specified by the `notifyReader` property of the PIP object. This function should notify (for example, by calling `SWI_andn`) the object that reads from this pipe that a full frame is available. The `notifyReader` function is performed as part of the thread that calls `PIP_get` or `PIP_put`. To avoid problems with recursion, the `notifyReader` function should not directly call any PIP module functions for the same pipe.

**Constraints and Calling Context**

- Before calling `PIP_get`, a function should check the `readerNumFrames` member of the PIP_Obj structure by calling `PIP_getReaderNumFrames` to make sure it is greater than 0 (that is, at least one full frame is available).

- `PIP_get` can only be called one time before calling `PIP_free`. You cannot operate on two frames from the same pipe simultaneously.

**Note:**

Registers used by `notifyReader` functions might also be modified.
**Example**

See the example for PIP_alloc, page 2-152. The example for HST_getpipe, page 2-83, also uses a pipe with host channel objects.

**See Also**

- PIP_alloc
- PIP_free
- PIP_put
- HST_getpipe
**PIP_getReaderAddr**

Get the value of the readerAddr pointer of the pipe

### C Interface

**Syntax**

```c
readerAddr = PIP_getReaderAddr(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle */`

**Return Value**

`Ptr readerAddr`

### Assembly Interface

**Syntax**

```assembly
mvk pipe, a4;
mvkh pipe, a4;
ldw *(a4(PIP_READPTR)), a4;
nop 4
```

**Preconditions**

`amr = 0`

**Postconditions**

none

**Modifies**

none

**Reentrant**

yes

**Description**

`PIP_getReaderAddr` is a C function that returns the value of the readerAddr pointer of a pipe object. The readerAddr pointer is normally used following a call to `PIP_get`, as the address to begin reading from.

**Example**

```c
Void audio(PIP_Obj *in, PIP_Obj *out)
{
    Uns *src, *dst;
    Uns size;

    if (PIP_getReaderNumFrames(in) == 0 ||
        PIP_getWriterNumFrames(out) == 0) {
        error;
    }
    PIP_get(in); /* get input data */
    PIP_alloc(out); /* allocate output buffer */

    /* copy input data to output buffer */
    src = PIP_getReaderAddr(in);
    dst = PIP_getWriterAddr(out);
    size = PIP_getReaderSize(in);
    PIP_setWriterSize(out, size);
    for (; size > 0; size--) {
        *dst++ = *src++;
    }
}
```
/* output copied data and free input buffer */
PPIP_put(out);
PPIP_free(in);
}
**PIP_getReaderNumFrames**

*Get the number of pipe frames available for reading*

**C Interface**

**Syntax**

```c
num = PIP_getReaderNumFrames(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pip object handle */`

**Return Value**

- `Uns num; /* number of filled frames to be read */`

**Assembly Interface**

**Syntax**

```assembly
mvk pipe, a4;
mvkh pipe, a4;
ldw *(a4(PIP_FULLBUFS)), a4;
nop 4
```

**Preconditions**

- `amr = 0`

**Postconditions**

- `none`

**Modifies**

- `none`

**Reentrant**

- `yes`

**Description**

`PIP_getReaderNumFrames` is a C function that returns the value of the `readerNumFrames` element of a pipe object.

Before a function attempts to read from a pipe it should call `PIP_getReaderNumFrames` to ensure at least one full frame is available.

**Example**

See the example for `PIP_getReaderAddr`, page 2-158.
**PIP_getReaderSize**  
*Get the number of words of data in a pipe frame*

### C Interface

**Syntax**

```c
num = PIP_getReaderSize(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle*/`

**Return Value**

- `Uns num; /* number of words to be read from filled frame */`

### Assembly Interface

**Syntax**

```assembly
mvk    pipe, a4;
mvkh   pipe, a4;
ldw    *(+a4(PIP_READCNT)), a4;
nop    4
```

**Preconditions**

- `amr = 0`

**Postconditions**

- `none`

**Modifies**

- `none`

**Reentrant**

- `yes`

**Description**

`PIP_getReaderSize` is a C function that returns the value of the readerSize element of a pipe object.

As a function reads from a pipe it should use `PIP_getReaderSize` to determine the number of valid words of data in the pipe frame.

**Example**

See the example for `PIP_getReaderAddr`, page 2-158.
**C Interface**

**Syntax**

```c
writerAddr = PIP_getWriterAddr(pipe);
```

**Parameters**

- `PIP_Handle pipe;` /* pipe object handle */

**Return Value**

`Ptr writerAddr;`

**Assembly Interface**

**Syntax**

```assembly
mvk   pipe, a4;
mvkh  pipe, a4;
ldw   *+a4(PIP_WRITEPTR), a4;
nop   4
```

**Preconditions**

`amr = 0`

**Postconditions**

`none`

**Modifies**

`none`

**Reentrant**

`yes`

**Description**

`PIP_getWriterAddr` is a C function that returns the value of the `writerAddr` pointer of a pipe object.

The `writerAddr` pointer is normally used following a call to `PIP_alloc`, as the address to begin writing to.

**Example**

See the example for `PIP_getReaderAddr`, page 2-158.
**PIP_getWriterNumFrames**  
*Get number of pipe frames available to be written to*

**C Interface**

**Syntax**
```
num = PIP_getWriterNumFrames(pipe);
```

**Parameters**
- `PIP_Handle pipe;` /* pipe object handle*/

**Return Value**
- `Uns num;` /* number of empty frames to be written */

**Assembly Interface**

**Syntax**
```
mvk    pipe, a4;
mvkh   pipe, a4;
ldw    *+a4(PIP_EMPTYBUFS), a4;
nop    4
```

**Preconditions**
- `amr = 0`

**Postconditions**
- `none`

**Modifies**
- `none`

**Reentrant**
- `yes`

**Description**

`PIP_getWriterNumFrames` is a C function that returns the value of the `writerNumFrames` element of a pipe object.

Before a function attempts to write to a pipe, it should call `PIP_getWriterNumFrames` to ensure at least one empty frame is available.

**Example**

See the example for `PIP_getReaderAddr`, page 2-158.
**PIP_getWriterSize**  
*Get the number of words that can be written to a pipe frame*

**C Interface**

- **Syntax**
  ```c
  num = PIP_getWriterSize(pipe);
  ```
- **Parameters**
  - `PIP_Handle pipe;` /* pipe object handle*/
- **Return Value**
  - `Uns num;` /* number of words to be written in empty frame */

**Assembly Interface**

- **Syntax**
  ```assembly
  mvk    pipe, a4;
  mvkh   pipe, a4;
  ldw    *(+a4(PIP_WRITECNT)), a4;
  nop    4
  ```
- **Preconditions**
  - `amr = 0`
- **Postconditions**
  - `none`
- **Modifies**
  - `none`
- **Reentrant**
  - `yes`

**Description**

`PIP_getWriterSize` is a C function that returns the value of the `writerSize` element of a pipe object.

As a function writes to a pipe, it can use `PIP_getWriterSize` to determine the maximum number words that can be written to a pipe frame.

**Example**

```c
if (PIP_getWriterNumFrames(rxPipe) > 0) {
    PIP_alloc(rxPipe);
    DSS_rxPtr = PIP_getWriterAddr(rxPipe);
    DSS_rxCnt = PIP_getWriterSize(rxPipe);
}
```
**PIP_peek**

Get pipe frame size and address without actually claiming pipe frame

**C Interface**

**Syntax**

framesize = PIP_peek(pipe, addr, rw);

**Parameters**

- PIP_Handle pipe; /* pipe object handle */
- Ptr *addr; /* the address of the variable that keeps the frame address */
- Uns rw; /* the flag that indicates the reader or writer side */

**Return Value**

Int framesize; /* the frame size */

**Assembly Interface**

none

**Description**

PIP_peek can be used before calling PIP_alloc or PIP_get to get the pipe frame size and address without actually claiming the pipe frame.

The pipe parameter is the pipe object handle, the addr parameter is the address of the variable that keeps the retrieved frame address, and the rw parameter is the flag that indicates what side of the pipe PIP_peek is to operate on. If rw is PIP.Reader, then PIP_peek operates on the reader side of the pipe. If rw is PIP.Writer, then PIP_peek operates on the writer side of the pipe.

PIP_getReaderNumFrames or PIP_getWriterNumFrames can be called to ensure that a frame exists before calling PIP_peek, although PIP_peek returns -1 if no pipe frame exists.

PIP_peek returns the frame size, or -1 if no pipe frames are available. If the return value of PIP_peek in frame size is not -1, then *addr is the location of the frame address.

**See Also**

- PIP_alloc
- PIP_free
- PIP_get
- PIP_put
- PIP_reset
PIP_put

**Put a full frame into the pipe**

### C Interface

**Syntax**

```c
PIP_put(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle */`

**Return Value**

`Void`

### Assembly Interface

**Syntax**

```c
PIP_put
```

**Preconditions**

- `a4 = address of the pipe object`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

- `a0, a1, a2, a3, a4, a5, b0, b1, b2, b3, b4`

**Reentrant**

`no`

**Description**

`PIP_put` puts a frame into a pipe after you have allocated the frame with `PIP_alloc` and written data to the frame. The reader can then use `PIP_get` to get a frame from the pipe.

After `PIP_put` puts the frame into the pipe, it runs the function specified by the `notifyReader` property of the PIP object. This function should notify (for example, by calling `SWI_andnHook`) the object that reads from this pipe that a full frame is ready to be processed. The `notifyReader` function is performed as part of the thread that called `PIP_get` or `PIP_put`. To avoid problems with recursion, the `notifyReader` function should not directly call any of the PIP module functions for the same pipe.

---

**Note:**

Registers used by `notifyReader` functions might also be modified.

---

**Constraints and Calling Context**

When called within an HWI ISR, the code sequence calling `PIP_put` must be either wrapped within an `HWI_enter/HWI_exit` pair or invoked by the HWI dispatcher.

**Example**

See the example for `PIP_alloc`, page 2-152. The example for `HST_getpipe`, page 2-83, also uses a pipe with host channel objects.
See Also

- PIP_alloc
- PIP_free
- PIP_get
- HST_getpipe
**PIP_reset**

*Reset all fields of a pipe object to their original values*

**C Interface**

**Syntax**

```c
PIP_reset(pipe);
```

**Parameters**

- `PIP_Handle pipe; /* pipe object handle */`

**Return Value**

`Void`

**Assembly Interface**

- `none`

**Description**

`PIP_reset` resets all fields of a pipe object to their original values. The pipe parameter specifies the address of the pipe object that is to be reset.

**Constraints and Calling Context**

- `PIP_reset` should not be called between the `PIP_alloc` call and the `PIP_put` call or between the `PIP_get` call and the `PIP_free` call.
- `PIP_reset` should be called when interrupts are disabled to avoid the race condition.

**See Also**

- `PIP_alloc`
- `PIP_free`
- `PIP_get`
- `PIP_peek`
- `PIP_put`
**PIP_setWriterSize**  
*Set the number of valid words written to a pipe frame*

**C Interface**

**Syntax**

```c
PIP_setWriterSize(pipe, size);
```

**Parameters**

- `PIP_Handle pipe;` /* pipe object handle */
- `Uns size;` /* size to be set */

**Return Value**

Void

**Assembly Interface**

**Syntax**

```assembly
mvk    pipe, a4;
mvkh   pipe, a4;
mv    SIZE, b4;
mvkh   SIZE, b4;
stw    b4, *+a4(PIP_WRITECNT);
```

**Preconditions**

`amr = 0`

**Postconditions**

none

**Modifies**

none

**Reentrant**

no

**Description**

PIP_setWriterSize is a C function that sets the value of the writerSize element of a pipe object.

As a function writes to a pipe, it can use PIP_setWriterSize to indicate the number of valid words being written to a pipe frame.

**Example**

See the example for PIP_getReaderAddr, page 2-158.
The PRD module is the periodic function manager.

**Functions**
- PRD_getticks. Get the current tick count.
- PRD_start. Arm a periodic function for one-time execution.
- PRD_stop. Stop a periodic function from continuous execution.
- PRD_tick. Advance tick counter, dispatch periodic functions.

**Description**
While some applications can schedule functions based on a real-time clock, many applications need to schedule functions based on I/O availability or some other programmatic event.

The PRD module allows you to create PRD objects that schedule periodic execution of program functions. The period can be driven by the CLK module or by calls to PRD_tick whenever a specific event occurs. There can be several PRD objects, but all are driven by the same period counter. Each PRD object can execute its functions at different intervals based on the period counter.

- **To schedule functions based on a real-time clock.** Set the clock interrupt rate you want to use in the Clock Manager property sheet. Put a checkmark in the Use On-chip Clock (CLK) box for the Periodic Function Manager. Set the frequency of execution (in number of ticks) in the period field for the individual period object.

- **To schedule functions based on I/O availability or some other event.** Remove the checkmark from the Use On-chip Clock (CLK) property field for the Periodic Function Manager. Set the frequency of execution (in number of ticks) in the period field for the individual period object. Your program should call PRD_tick to increment the tick counter.

The function executed by a PRD object is statically defined in the Configuration Tool. PRD functions are called from the context of the function run by the PRD_swi SWI object. PRD functions can be written in C or assembly and must follow the C calling conventions described in the compiler manual.

The PRD module uses an SWI object (called PRD_swi by default) which itself is triggered on a periodic basis to manage execution of period objects. Normally, this SWI object should have the highest software interrupt priority to allow this software interrupt to be performed once per tick. This software interrupt is automatically created (or deleted) by the Configuration Tool if one or more (or no) PRD objects exist.

See the *Code Composer Studio* online tutorial for an example that demonstrates the interaction between the PRD module and the SWI module.
When the PRD_swi object runs its function, the following actions occur:

```c
for ("Loop through period objects") {
    if ("time for a periodic function")
        "run that periodic function";
}
```

### 2.16.1 PRD Manager Properties

The DSP/BIOS Periodic Function Manager allows the creation of an arbitrary number of objects that encapsulate a function, two arguments, and a period specifying the time between successive invocations of the function. The period is expressed in ticks, where a tick is defined as a single invocation of the PRD_tick operation. The time between successive invocations of PRD_tick defines the period represented by a tick.

The following global properties can be set for the PRD module on the PRD Manager Properties dialog in the Configuration Tool:

- **Object Memory.** The memory segment containing the PRD objects.
- **Use CLK Manager to drive PRD.** If this field is checked, the on-device timer hardware (managed by CLK) is used to advance the tick count; otherwise, the application must invoke PRD_tick on a periodic basis.
- **Microseconds/Tick.** The number of microseconds between ticks. If the Use CLK Manager to drive PRD field above is checked, this field is automatically set by the CLK module; otherwise, you must explicitly set this field.

### 2.16.2 PRD Object Properties

The following properties can be set for each PRD object on the PRD Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this PRD object.
- **period (ticks).** The function executes after period ticks have elapsed.
- **mode.** If continuous is selected the function executes every period ticks; otherwise it executes just once after each call to PRD_tick.
- **function.** The function to be executed
- **arg0, arg1.** Two Arg type arguments for the user-specified function above.
- **period (ms).** The number of milliseconds represented by the period specified above. This is an informational field only.
2.16.3 PRD - Code Composer Studio Interface

To enable PRD logging, choose DSP/BIOS→RTA Control Panel and put a check in the appropriate box. You see indicators for PRD ticks in the PRD ticks row of the Execution Graph, which you can open by choosing DSP/BIOS→Execution Graph. In addition, you see a graph of activity, including PRD function execution.

You can also enable PRD accumulators in the RTA Control Panel. Then you can choose DSP/BIOS→Statistics View, which lets you select objects for which you want to see statistics. If you choose a PRD object, you see statistics about the number of ticks elapsed from the time the PRD object is ready to run until it finishes execution. It is important to note, however, if your system is not meeting its timing constraints, the Max value displayed by the Statistics View results in a value that reflects the accumulation of missed deadlines for the PRD object. If Max value becomes greater than the PRD object’s period, you can divide Max value by the period to determine how many real-time deadlines your PRD object has missed. While most statistical information can be cleared by right-clicking on the Statistics View and selecting Clear from the pull-down menu, once a periodic function has missed a real-time deadline, the max value will return to its high point as soon as it is recomputed. This is because the information stored about the PRD object used to compute Max value still reflects the fact that the PRD object has missed deadlines.
PRD_getticks

Get the current tick count

C Interface

Syntax
num = PRD_getticks();

Parameters
Void

Return Value
LgUns num /* current tick counter */

Assembly Interface

Syntax
PRD_getticks

Preconditions
b14 = pointer to the start of .bss
amr = 0

Postconditions
a4 = PRD_D_tick

Modifies
a4

Reentrant
yes

Description
PRD_getticks returns the current period tick count as a 32-bit value.

If the periodic functions are being driven by the on-device timer, the tick value is the number of low resolution clock ticks that have occurred since the program started running. When the number of ticks reaches the maximum value that can be stored in 32 bits, the value wraps back to 0. See the CLK Module, page 2-26, for more details.

If the periodic functions are being driven programmatically, the tick value is the number of times PRD_tick has been called.

Example

/* ======== showTicks ======== */
Void showTicks
{
    LOG_printf(&trace, "ticks = %d", PRD_getticks());
}

See Also
PRD_start
PRD_tick
CLK_gethtime
CLK_getltime
STS_delta
PRD_start

Arm a periodic function for one-shot execution

C Interface

Syntax
PRD_start(prd);

Parameters
PRD_Handle prd; /* prd object handle*/

Return Value
Void

Assembly Interface

Syntax
PRD_start

Preconditions
a4 = address of the PRD object
amr = 0

Postconditions
none

Modifies
a1, b1

Reentrant
no

Description
PRD_start starts a period object that has its mode property set to one-shot in the Configuration Tool.

Unlike PRD objects that are configured as continuous, one-shot PRD objects do not automatically continue to run. A one-shot PRD object runs its function only after the specified number of ticks have occurred after a call to PRD_start.

For example, you might have a function that should be executed a certain number of periodic ticks after some condition is met.

When you use PRD_start to start a period object, the exact time the function runs can vary by nearly one tick cycle. As Figure 2-3 shows, PRD ticks occur at a fixed rate and the call to PRD_start can occur at any point between ticks.
Due to implementation details, if a PRD function calls PRD_start for a PRD object that is lower in the list of PRD objects, the function sometimes runs a full tick cycle early.

**Example**

```c
/* ======== startPRD ======== */
Void startPrd(Int periodID)
{
    if ("condition met") {
        PRD_start(&periodID);
    }
}
```

**See Also**

PRD_tick
PRD_getticks
PRD_stop

Stop a period object to prevent its function execution

C Interface

Syntax
PRD_stop(prd);

Parameters
PRD_Handle prd; /* prd object handle*/

Return Value
Void

Assembly Interface

Syntax
PRD_stop

Preconditions
a4 = address of the PRD object
amr = 0

Postconditions
none

Modifies
a1, b1

Reentrant
no

Description
PRD_stop stops a period object to prevent its function execution. In most cases, PRD_stop is used to stop a period object that has its mode property set to one-shot in the Configuration Tool.

Unlike PRD objects that are configured as continuous, one-shot PRD objects do not automatically continue to run. A one-shot PRD object runs its function only after the specified numbers of ticks have occurred after a call to PRD_start.

PRD_stop is the way to stop those one-shot PRD objects once started and before their period counters have run out.

Example
PRD_stop(&prd);

See Also
PRD_getticks
PRD_start
PRD_tick
**PRD_tick**

*Advance tick counter, enable periodic functions*

**C Interface**

**Syntax**

PRD_tick();

**Parameters**

Void

**Return Value**

Void

**Assembly Interface**

**Syntax**

PRD_tick

**Preconditions**

GIE = 0 (interrupts are disabled)
amr = 0

**Postconditions**

none

**Modifies**

a0, a1, a2, a3, a4, a5, a6, a7, a8, a9, b0, b1, b2, b3, b4, b5, b6, b7, b8, csr

**Reentrant**

no

**Description**

PRD_tick advances the period counter by one tick. Unless you are driving PRD functions using the on-device clock, PRD objects execute their functions at intervals based on this counter.

For example, a hardware ISR could perform PRD_tick to notify a periodic function when data is available for processing.

**Constraints and Calling Context**

- All the registers that are modified by this API should be saved and restored, before and after the API is invoked, respectively.

- When called within an HWI ISR, the code sequence calling PRD_tick must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

- Interrupts need to be disabled before calling PRD_tick.

**See Also**

PRD_start

PRD_getticks
2.17 QUE Module

The QUE module is the atomic queue manager.

**Functions**
- QUE_create. Create an empty queue.
- QUE_delete. Delete an empty queue.
- QUE_dequeue. Remove from front of queue (non-atomically).
- QUE_empty. Test for an empty queue.
- QUE_enqueue. Insert at end of queue (non-atomically).
- QUE_get. Remove element from front of queue (atomically).
- QUE_head. Return element at front of queue.
- QUE_insert. Insert in middle of queue (non-atomically).
- QUE_new. Set a queue to be empty.
- QUE_next. Return next element in queue (non-atomically).
- QUE_prev. Return previous element in queue (non-atomically).
- QUE_put. Put element at end of queue (atomically).
- QUE_remove. Remove from middle of queue (non-atomically).

**Constants, Types, and Structures**

```c
typedef struct QUE_Obj *QUE_Handle; /* queue obj handle */
struct QUE_Attrs{ /* queue attributes */
    Int  dummy; /* DUMMY */
};

QUE_Attrs QUE_ATTRS = { /* default attribute values */
    0,
};

typedef QUE_Elem; /* queue element */
```

**Description**

The QUE module makes available a set of functions that manipulate queue objects accessed through handles of type QUE_Handle. Each queue contains an ordered sequence of zero or more elements referenced through variables of type QUE_Elem, which are generally embedded as the first field within a structure. The QUE_Elem item is used as an internal pointer.

For example, the DEV_Frame structure which is used by SIO and DEV to enqueue and dequeue I/O buffers is defined as follows:

```c
struct DEV_Frame{
    QUE_Elem link; /* must be first field! */
    Ptr    addr;
    Uns    size;
}
```
Many QUE module functions either are passed or return a pointer to an element having the structure defined for QUE elements.

The functions QUE_put and QUE_get are atomic in that they manipulate the queue with interrupts disabled. These functions can therefore be used to safely share queues between tasks, or between tasks and SWIs or HWIs. All other QUE functions should only be called by tasks, or by tasks and SWIs or HWIs when they are used in conjunction with some mutual exclusion mechanism (for example, SEM_pend / SEM_post, TSK_disable / TSK_enable).

Once a queue has been created, use MEM_alloc to allocate elements for the queue. You can view examples of this in the program code for quetest and semtest located on your distribution CD in c:\ti\examples\target\bios\semtest folder, where target matches your board. (If you installed in a path other than c:\ti, substitute your appropriate path.)

2.17.1 QUE Manager Properties

The following global property can be set for the QUE module on the QUE Manager Properties dialog in the Configuration Tool:

Object Memory. The memory segment that contains the QUE objects.

2.17.2 QUE Object Properties

The following property can be set for a QUE object on the QUE Object Properties dialog in the Configuration Tool:

comment. Type a comment to identify this QUE object.
**QUE_create**

*Create an empty queue*

**C Interface**

**Syntax**

```c
queue = QUE_create(attrs);
```

**Parameters**

- `QUE_Attrs *attrs; /* pointer to queue attributes */`

**Return Value**

- `QUE_Handle queue; /* handle for new queue object */`

**Assembly Interface**

`none`

**Description**

`QUE_create` creates a new queue which is initially empty. If successful, `QUE_create` returns the handle of the new queue. If unsuccessful, `QUE_create` returns `NULL` unless it aborts (for example, because it directly or indirectly calls `SYS_error`, and `SYS_error` is configured to abort).

If `attrs` is `NULL`, the new queue is assigned a default set of attributes. Otherwise, the queue’s attributes are specified through a structure of type `QUE_Attrs`.

**Note:**

At present, no attributes are supported for queue objects, and the type `QUE_Attrs` is defined as a dummy structure.

All default attribute values are contained in the constant `QUE_ATTRS`, which can be assigned to a variable of type `QUE_Attrs` prior to calling `QUE_create`.

You can also create a queue by declaring a variable of type `QUE_Obj` and initializing the queue with `QUE_new`. You can find an example of this in the `semtest` code example on your distribution CD in `c:\ti\examples\target\bios\semtest` folder, where `target` matches your board. (If you installed in a path other than `c:\ti`, substitute your appropriate path.)

`QUE_create` calls `MEM_alloc` to dynamically create the object’s data structure. `MEM_alloc` must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, then there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module, page 2-135.

**Constraints and Calling Context**

- `QUE_create` cannot be called from an SWI or HWI.
- You can reduce the size of your application program by creating objects with the Configuration Tool rather than using the `XXX_create` functions.
See Also

MEM_alloc
QUE_empty
QUE_delete
SYS_error
**QUE_delete**

*Delete an empty queue*

**C Interface**

**Syntax**

```c
QUE_delete(queue);
```

**Parameters**

- `QUE_Handle queue; /* queue handle */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

`QUE_delete` uses `MEM_free` to free the queue object referenced by `queue`.

`QUE_delete` calls `MEM_free` to delete the QUE object. `MEM_free` must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

**Constraints and Calling Context**

- queue must be empty.
- `QUE_delete` cannot be called from an SWI or HWI.
- No check is performed to prevent `QUE_delete` from being used on a statically-created object. If a program attempts to delete a queue object that was created using the Configuration Tool, `SYS_error` is called.

**See Also**

- `QUE_create`
- `QUE_empty`
## QUE_dequeue

**Remove from front of queue (non-atomically)**

### C Interface

<table>
<thead>
<tr>
<th>Syntax</th>
<th>elem = QUE_dequeue(queue);</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>QUE_Handle queue; /* queue object handle */</td>
</tr>
<tr>
<td>Return Value</td>
<td>Ptr elem; /* pointer to former first element */</td>
</tr>
</tbody>
</table>

### Assembly Interface

none

### Description

QUE_dequeue removes the element from the front of queue and returns elem.

The return value, elem, is a pointer to the element at the front of the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type QUE_Elem and is used as an internal pointer.

---

**Note:**

QUE_get must be used instead of QUE_dequeue if queue is shared by multiple tasks, or tasks and SWIs or HWIs (unless another mutual exclusion mechanism is used). QUE_get runs atomically and will never be interrupted; QUE_dequeue performs the same action but runs non-atomically. While QUE_dequeue is somewhat faster than QUE_get, you should not use it unless you know your QUE operation cannot be preempted by another thread that operates on the same queue.

### See Also

QUE_get
**QUE_empty**

*Test for an empty queue*

### C Interface

**Syntax**

```c
empty = QUE_empty(queue);
```

**Parameters**

QUE_Handle queue; /* queue object handle */

**Return Value**

Bool empty; /* TRUE if queue is empty */

### Assembly Interface

none

### Description

QUE_empty returns TRUE if there are no elements in queue, and FALSE otherwise.

### See Also

QUE_get
**QUE_enqueue**  
*Insert at end of queue (non-atomically)*

**C Interface**

**Syntax**

QUE_enqueue(queue, elem);

**Parameters**

- QUE_Handle queue; /* queue object handle */
- Ptr elem; /* pointer to queue element */

**Return Value**

Void

**Assembly Interface**

none

**Description**

QUE_enqueue inserts elem at the end of queue.

The elem parameter must be a pointer to an element to be placed in the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type QUE_Elem and is used as an internal pointer.

**Note:**

QUE_put must be used instead of QUE_enqueue if queue is shared by multiple tasks, or tasks and SWIs or HWIs (unless another mutual exclusion mechanism is used). QUE_put runs atomically and will never be interrupted; QUE_enqueue performs the same action but runs non-atomically. While QUE_enqueue is somewhat faster than QUE_put, you should not use it unless you know your QUE operation cannot be preempted by another thread that operates on the same queue.

**See Also**

QUE_put
QUENCY_get

**QUERY_get**  
Get element from front of queue (atomically)

**C Interface**

**Syntax**

```
elem = QUE_get(queue);
```

**Parameters**

- `QUE_Handle queue; /* queue object handle */`

**Return Value**

```
Void *elem; /* pointer to former first element */
```

**Assembly Interface**

```
none
```

**Description**

QUERY_get removes the element from the front of queue and returns `elem`.

The return value, `elem`, is a pointer to the element at the front of the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type QUE_Elem and is used as an internal pointer.

Since QUERY_get manipulates the queue with interrupts disabled, the queue can be shared by multiple tasks, or by tasks and SWIs or HWIs.

Calling QUERY_get with an empty queue returns the queue itself. This provides a means for using a single atomic action to check if a queue is empty, and to remove and return the first element if it is not empty:

```
if ((QUERY_Handle)(elem = QUEUE_get(q)) != q)
  ' process elem '
```

**See Also**

- QUEUE_create
- QUEUE_empty
- QUEUE_put
QUE_head

Return element at front of queue

C Interface

Syntax

```
elem = QUE_head(queue);
```

Parameters

- `QUE_Handle queue; /* queue object handle */`

Return Value

- `QUE_Elem *elem; /* pointer to first element */`

Assembly Interface

none

Description

QUE_head returns a pointer to the element at the front of queue. The element is not removed from the queue.

The return value, elem, is a pointer to the element at the front of the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type QUE_Elem and is used as an internal pointer.

Calling QUE_head with an empty queue returns the queue itself.

See Also

- QUE_create
- QUE_empty
- QUE_put
**QUE_insert** *Insert in middle of queue (non-atomically)*

**C Interface**

**Syntax**

```
QUE_insert(qelem, elem);
```

**Parameters**

- `Ptr qelem; /* element already in queue */`
- `Ptr elem; /* element to be inserted in queue */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

QUE_insert inserts elem in the queue in front of qelem.

The qelem parameter is a pointer to an existing element of the QUE. The elem parameter is a pointer to an element to be placed in the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type QUE_Elem and is used as an internal pointer.

**Note:**

If the queue is shared by multiple tasks, or tasks and SWIs or HWIs, QUE_insert should be used in conjunction with some mutual exclusion mechanism (for example, SEM_pend/SEM_post, TSK_disable/TSK_enable).

**See Also**

- QUE_head
- QUE_next
- QUE_prev
- QUE_remove
**QUE_new**  
*Set a queue to be empty*

**C Interface**

**Syntax**

QUE_new(queue);

**Parameters**

QUE_Handle queue; /* pointer to queue object */

**Return Value**

Void

**Assembly Interface**

none

**Description**

QUE_new adjusts a queue object to make the queue empty. This operation is not atomic. A typical use of QUE_new is to initialize a queue object that has been statically declared instead of being created with QUE_create. Note that if the queue is not empty, the element(s) in the queue are not freed or otherwise handled, but are simply abandoned.

If you created a queue by declaring a variable of type QUE_Obj, you can initialize the queue with QUE_new. You can find an example of this in the semtest code example on your distribution CD in `c:\ti\examples\target\bios\semtest` folder, where target matches your board. (If you installed in a path other than `c:\ti`, substitute your appropriate path.)

**See Also**

QUE_create
QUE_delete
QUE_empty
**QUE_next**

*Return next element in queue (non-atomically)*

**C Interface**

**Syntax**

```c
elem = QUE_next(qelem);
```

**Parameters**

- `Ptr qelem; /* element in queue */`

**Return Value**

- `Ptr elem; /* next element in queue */`

**Assembly Interface**

none

**Description**

QUE_next returns `elem` which points to the element in the queue after `qelem`.

The `qelem` parameter is a pointer to an existing element of the QUE. The return value, `elem`, is a pointer to the next element in the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type `QUE_Elem` and is used as an internal pointer.

Since QUE queues are implemented as doubly linked lists with a dummy node at the head, it is possible for QUE_next to return a pointer to the queue itself. Be careful not to call QUE_remove(elem) in this case.

**Note:**

If the queue is shared by multiple tasks, or tasks and SWIs or HWIs, QUE_next should be used in conjunction with some mutual exclusion mechanism (for example, SEM_pend/SEM_post, TSK_disable/TSK_enable).

**See Also**

- QUE_get
- QUE_insert
- QUE_prev
- QUE_remove
QUE_prev

Return previous element in queue (non-atomically)

C Interface

Syntax

elem = QUE_prev(qelem);

Parameters

Ptr qelem; /* element in queue */

Return Value

Ptr elem; /* previous element in queue */

Assembly Interface

none

Description

QUE_prev returns elem which points to the element in the queue before qelem.

The qelem parameter is a pointer to an existing element of the QUE. The return value, elem, is a pointer to the previous element in the QUE. Such elements have a structure defined similarly to that in the example in the QUE module topic. The first field in the structure must be of type QUE_ELEM and is used as an internal pointer.

Since QUE queues are implemented as doubly linked lists with a dummy node at the head, it is possible for QUE_prev to return a pointer to the queue itself. Be careful not to call QUE_remove(elem) in this case.

Note:

If the queue is shared by multiple tasks, or tasks and SWIs or HWIs, QUE_prev should be used in conjunction with some mutual exclusion mechanism (for example, SEM_pend/SEM_post, TSK_disable/TSK_enable).

See Also

QUE_head
QUE_insert
QUE_next
QUE_remove
**QUE_put**

*Put element at end of queue (atomically)*

**C Interface**

**Syntax**

```c
QUE_put(queue, elem);
```

**Parameters**

- `QUE_Handle queue; /* queue object handle */`
- `Void *elem; /* pointer to new queue element */`

**Return Value**

`Void`

**Assembly Interface**

none

**Description**

`QUE_put` puts `elem` at the end of the `QUE`. Such elements have a structure defined similarly to that in the example in the `QUE` module topic. The first field in the structure must be of type `QUE_Elem` and is used as an internal pointer.

Since `QUE_put` manipulates queues with interrupts disabled, queues can be shared by multiple tasks, or by tasks and SWIs or HWIs.

**See Also**

- `QUE_get`
- `QUE_head`
QUE_remove

Remove from middle of queue (non-atomically)

C Interface

Syntax
QUE_remove(qelem);

Parameters
Ptr qelem; /* element in queue */

Return Value
Void

Assembly Interface
none

Description
QUE_remove removes qelem from the queue.

The qelem parameter is a pointer to an existing element to be removed from
the QUE. Such elements have a structure defined similarly to that in the
example in the QUE module topic. The first field in the structure must be of
type QUE_Elem and is used as an internal pointer.

Since QUE queues are implemented as doubly linked lists with a dummy
node at the head, be careful not to remove the header node. This can happen
when qelem is the return value of QUE_next or QUE_prev. The following
code sample shows how qelem should be verified before calling
QUE_remove.

QUE_Elem *qelem;.
/* get pointer to first element in the queue */
qelem = QUE_head(queue);

/* scan entire queue for desired element */
while (qelem != queue) {
  if (' qelem is the elem we’re looking for ' ) { 
    break;
  }
  qelem = QUE_next(queue);
}

/* make sure qelem is not the queue itself */
if (qelem != queue) { 
  QUE_remove(qelem);
}
**QUE_remove**

**Note:**

If the queue is shared by multiple tasks, or tasks and SWIs or HWIs, `QUE_remove` should be used in conjunction with some mutual exclusion mechanism (for example, `SEM_pend/ SEM_post` and `TSK_disable / TSK_enable`).

**Constraints and Calling Context**

`QUE_remove` should not be called when `qelem` is equal to the queue itself.

**See Also**

- `QUE_head`
- `QUE_insert`
- `QUE_next`
- `QUE_prev`
2.18 RTDX Module

The RTDX modules manage the real-time data exchange settings.

RTDX Data Declaration

- RTDX_CreateInputChannel
- RTDX_CreateOutputChannel

Function Macros

- RTDX_disableInput
- RTDX_disableOutput
- RTDX_enableInput
- RTDX_enableOutput
- RTDX_read
- RTDX_readNB
- RTDX_sizeofInput
- RTDX_write

Channel Test Macros

- RTDX_channelBusy
- RTDX_isInputEnabled
- RTDX_isOutputEnabled

Description

The RTDX module provides the data types and functions for:

- Sending data from the target to the host.
- Sending data from the host to the target.

Data channels are represented by globally declared structures. A data channel can be used either for input or output, but not both. The contents of an input or output structure are not known to the user. A channel structure contains two states: enabled and disabled. When a channel is enabled, any data written to the channel is sent to the host. Channels are initialized to be disabled.

The RTDX assembly interface, rtdx.i, is a macro interface file that can be used to interface to RTDX at the assembly level.

2.18.1 RTDX Manager Properties

The following settings refer to target configuration parameters:

- **Enable Real-Time Data Exchange (RTDX).** This box should be checked if you want to link RTDX support into your application.

- **RTDX Mode.** Select the port configuration mode RTDX should use to establish communication between the host and target. The default is JTAG for most targets. Set this to simulator if you are using a simulator. The HS-RTDX emulation technology is also available. If this property is set incorrectly you will see a message that says "RTDX target application does not match emulation protocol" when you load the program.
RTDX Data Segment (.rtdx_data). The memory segment used for buffering target-to-host data transfers. The RTDX message buffer and state variables are placed in this segment.

RTDX Buffer Size (MADUs). The size of the RTDX target-to-host message buffer, in minimum addressable data units (MADUs). The default size is 1032 to accommodate a 1024-byte block and two control words. HST channels using RTDX are limited by this value.

RTDX Interrupt Mask. This mask identifies RTDX clients and protects RTDX critical sections. The mask specifies the interrupts to be temporarily disabled inside RTDX critical sections. This also temporarily disables other RTDX clients and prevents another RTDX function call. See the RTDX on-line help for details.

2.18.2 RTDX Object Properties

The following properties can be set for an RTDX object on the RTDX Object Properties dialog in the Configuration Tool:

- **comment**: Type a comment to identify this RTDX object.
- **Channel Mode**: Select output if the RTDX channel handles output from the DSP to the host. Select input if the RTDX channel handles input to the DSP from the host.

**Examples**

An Excel example is located in the `c:\ti\examples\hostapps\rtdx` folder. The file is called `rtdx.xls`. (If you installed in a path other than `c:\ti`, substitute your appropriate path.)

The examples are described below.

- **Ta_write.asm**: Target to Host transmission example. This example sends 100 consecutive integers starting from 0. In the `rtdx.xls` file, use the `h_read` VB macro to view data on the host.

- **Ta_read.asm**: Host to target transmission example. This example reads 100 integers. Use the `h_write` VB macro of the `rtdx.xls` file to send data to the target.

- **Ta_readNB.asm**: Host to target transmission example. This example reads 100 integers. Use the `h_write` VB macro of the `rtdx.xls` file to send data to the target. This example demonstrates how to use the non-blocking read, RTDX_readNB, function.

**Note:**

Programs must be linked with C run-time libraries and contain the symbol `_main`. 

---

2-196
RTDX_channelBusy

Return status indicating whether data channel is busy

C Interface

Syntax
int RTDX_channelBusy( RTDX_inputChannel *pichan );

Parameters
pichan /* Identifier for the input data channel */

Return Value
int /* Status: 0 = Channel is not busy. */
/* non-zero = Channel is busy. */

Assembly Interface
Use C function calling standards.

Reentrant
yes

Description
RTDX_channelBusy is designed to be used in conjunction with RTDX_readNB. The return value indicates whether the specified data channel is currently in use or not. If a channel is busy reading, the test/control flag (TC) bit of status register 0 (STO) is set to 1. Otherwise, the TC bit is set to 0.

Constraints and Calling Context
RTDX_channelBusy cannot be called by an HWI function.

See Also
RTDX_readNB
**RTDX_CreateInputChannel Declare input channel structure**

**C Interface**

**Syntax**

```c
RTDX_CreateInputChannel( ichan );
```

**Parameters**

- `ichan` /* Label for the input channel */

**Return Value**

- `none`

**Assembly Interface**

Use C function calling standards.

**Reentrant**

- `no`

**Description**

This macro declares and initializes to 0, the RTDX data channel for input.

Data channels must be declared as global objects. A data channel can be used either for input or output, but not both. The contents of an input or output data channel are unknown to the user.

A channel can be in one of two states: enabled or disabled. Channels are initialized as disabled.

Channels can be enabled or disabled via a User Interface function. They can also be enabled or disabled remotely from Code Composer or its COM interface.

**Constraints and Calling Context**

RTDX_CreateInputChannel cannot be called by an HWI function.

**See Also**

RTDX_CreateOutputChannel
**RTDX_CreateOutputChannel** *Declare output channel structure*

**C Interface**

**Syntax**

```
RTDX_CreateOutputChannel( ochan );
```

**Parameters**

- `ochan` /* Label for the output channel */

**Return Value**

- `none`

**Assembly Interface**

- Use C function calling standards.

**Reentrant**

- `no`

**Description**

This macro declares and initializes the RTDX data channels for output.

Data channels must be declared as global objects. A data channel can be used either for input or output, but not both. The contents of an input or output data channel are unknown to the user.

A channel can be in one of two states: enabled or disabled. Channels are initialized as disabled.

Channels can be enabled or disabled via a User Interface function. They can also be enabled or disabled remotely from Code Composer Studio or its OLE interface.

**Constraints and Calling Context**

- RTDX_CreateOutputChannel cannot be called by an HWI function.

**See Also**

- RTDX_CreateInputChannel
**RTDX_disableInput**  
*Disable an input data channel*

**C Interface**

**Syntax**

```c
void RTDX_disableInput( RTDX_inputChannel *ichan );
```

**Parameters**

- `ichan /* Identifier for the input data channel */`

**Return Value**

`void`

**Assembly Interface**

Use C function calling standards.

**Reentrant**

`yes`

**Description**

A call to a disable function causes the specified input channel to be disabled.

**Constraints and Calling Context**

RTDX_disableInput cannot be called by an HWI function.

**See Also**

- RTDX_disableOutput
- RTDX_enableInput
- RTDX_read
RTDX_disableOutput (Disable an output data channel)

C Interface

Syntax

```c
void RTDX_disableOutput( RTDX_outputChannel *ochan );
```

Parameters

- `ochan` /* Identifier for an output data channel */

Return Value

`void`

Assembly Interface

Use C function calling standards.

Reentrant

Yes

Description

A call to a disable function causes the specified data channel to be disabled.

Constraints and Calling Context

RTDX_disableOutput cannot be called by an HWI function.

See Also

- RTDX_disableInput
- RTDX_enableOutput
- RTDX_read
**RTDX_enableInput**

*Enable an input data channel*

**C Interface**

**Syntax**

```c
void RTDX_enableInput( RTDX_inputChannel *ichan );
```

**Parameters**

- ochan /* Identifier for an output data channel */
- ichan /* Identifier for the input data channel */

**Return Value**

`void`

**Assembly Interface**

Use C function calling standards.

**Reentrant**

Yes

**Description**

A call to an enable function causes the specified data channel to be enabled.

**Constraints and Calling Context**

RTDX_enableInput cannot be called by an HWI function.

**See Also**

- RTDX_disableInput
- RTDX_enableOutput
- RTDX_read
**RTDX_enableOutput**  
*Enable an output data channel*

**C Interface**

**Syntax**

```c
void RTDX_enableOutput( RTDX_outputChannel *ochan );
```

**Parameters**

- `ochan /* Identifier for an output data channel */`

**Return Value**

`void`

**Assembly Interface**

Use C function calling standards.

**Reentrant**

`yes`

**Description**

A call to an enable function causes the specified data channel to be enabled.

**Constraints and Calling Context**

RTDX_enableOutput cannot be called by an HWI function.

**See Also**

- RTDX_disableOutput
- RTDX_enableInput
- RTDX_write
**RTDX_isInputEnabled**  
*Return status of the input data channel*

### C Interface

- **Syntax**
  
  ```c
  RTDX_isInputEnabled( ichan );
  ```

- **Parameter**
  
  `ichan` /* Identifier for an input channel. */

- **Return Value**
  
  0 /* Not enabled. */
  
  non-zero /* Enabled. */

### Assembly Interface

Use C function calling standards.

### Reentrant

yes

### Description

The `RTDX_isInputEnabled` macro tests to see if an input channel is enabled and sets the test/control flag (TC bit) of status register 0 to 1 if the input channel is enabled. Otherwise, it sets the TC bit to 0.

### Constraints and Calling Context

`RTDX_isInputEnabled` cannot be called by an HWI function.

### See Also

`RTDX_isOutputEnabled`
RTDX_isOutputEnabled

Return status of the output data channel

C Interface

Syntax
RTDX_isOutputEnabled(ohan);

Parameter
ochan /* Identifier for an output channel. */

Return Value
0 /* Not enabled. */
non-zero /* Enabled. */

Assembly Interface
Use C function calling standards.

Reentrant
yes

Description
The RTDX_isOutputEnabled macro tests to see if an output channel is enabled and sets the test/control flag (TC bit) of status register 0 to 1 if the output channel is enabled. Otherwise, it sets the TC bit to 0.

Constraints and Calling Context
RTDX_isOutputEnabled cannot be called by an HWI function.

See Also
RTDX_isInputEnabled
RTDX_read

Read from an input channel

C Interface

Syntax

```c
int RTDX_read( RTDX_inputChannel *ichan, void *buffer, int bsize );
```

Parameters

- **ichan**: /* Identifier for the input data channel */
- **buffer**: /* A pointer to the buffer that receives the data */
- **bsize**: /* The size of the buffer in address units */

Return Value

- > 0 /* The number of address units of data actually supplied in buffer. */
- 0 /* Failure. Cannot post read request */
- RTDX_READ_ERROR /* Failure. Channel currently busy or not enabled. */

Assembly Interface

Use C function calling standards.

Reentrant

yes

Description

RTDX_read causes a read request to be posted to the specified input data channel. If the channel is enabled, RTDX_read waits until the data has arrived. On return from the function, the data has been copied into the specified buffer and the number of address units of data actually supplied is returned. The function returns RTDX_READ_ERROR immediately if the channel is currently busy reading or is not enabled.

When RTDX_read is used, the target application notifies the RTDX Host Library that it is ready to receive data and then waits for the RTDX Host Library to write data to the target buffer. When the data is received, the target application continues execution.

The specified data is to be written to the specified output data channel, provided that channel is enabled. On return from the function, the data has been copied out of the specified user buffer and into the RTDX target buffer. If the channel is not enabled, the write operation is suppressed. If the RTDX target buffer is full, failure is returned.

When RTDX_readNB is used, the target application notifies the RTDX Host Library that it is ready to receive data, but the target application does not wait. Execution of the target application continues immediately. Use RTDX_channelBusy and RTDX_sizeOfInput to determine when the RTDX Host Library has written data to the target buffer.

Constraints and Calling Context

RTDX_read cannot be called by an HWI function.
RTDX_read

See Also

RTDX_channelBusy
RTDX_readNB
RTDX_sizeofInput
RTDX_readNB

Read from input channel without blocking

C Interface

Syntax

```c
int RTDX_readNB( RTDX_inputChannel *ichan, void *buffer, int bsize );
```

Parameters

- `ichan` /* Identifier for the input data channel */
- `buffer` /* A pointer to the buffer that receives the data */
- `bsize` /* The size of the buffer in address units */

Return Value

- `RTDX_OK` /* Success.*/
- 0 (zero) /* Failure. The target buffer is full. */
- `RTDX_READ_ERROR` /* Channel is currently busy reading. */

Assembly Interface

Use C function calling standards.

Reentrant

yes

Description

RTDX_readNB is a nonblocking form of the function RTDX_read. RTDX_readNB issues a read request to be posted to the specified input data channel and immediately returns. If the channel is not enabled or the channel is currently busy reading, the function returns `RTDX_READ_ERROR`. The function returns 0 if it cannot post the read request due to lack of space in the RTDX target buffer.

When the function RTDX_readNB is used, the target application notifies the RTDX Host Library that it is ready to receive data but the target application does not wait. Execution of the target application continues immediately. Use the RTDX_channelBusy and RTDX_sizeofInput functions to determine when the RTDX Host Library has written data into the target buffer.

When RTDX_read is used, the target application notifies the RTDX Host Library that it is ready to receive data and then waits for the RTDX Host Library to write data into the target buffer. When the data is received, the target application continues execution.

Constraints and Calling Context

RTDX_readNB cannot be called by an HWI function.

See Also

- RTDX_channelBusy
- RTDX_read
- RTDX_sizeofInput
**RTDX_sizeofInput**

*Return the number of MADUs read from a data channel*

**C Interface**

**Syntax**

```c
int RTDX_sizeofInput( RTDX_inputChannel *pichan );
```

**Parameters**

- `pichan` /* Identifier for the input data channel */

**Return Value**

- `int` /* Number of sizeof units of data actually */
  /* supplied in buffer */

**Assembly Interface**

Use C function calling standards.

**Reentrant**

yes

**Description**

RTDX_sizeofInput is designed to be used in conjunction with RTDX_readNB after a read operation has completed. The function returns the number of sizeof units actually read from the specified data channel into the accumulator (register A).

**Constraints and Calling Context**

RTDX_sizeofInput cannot be called by an HWI function.

**See Also**

RTDX_readNB
RTDX_write

Write to an output channel

C Interface

Syntax

```c
int RTDX_write( RTDX_outputChannel *ochan, void *buffer, int bsize );
```

Parameters

- `ochan` /* Identifier for the output data channel */
- `buffer` /* A pointer to the buffer containing the data */
- `bsize` /* The size of the buffer in address units */

Return Value

```c
int
```
/* Status: non-zero = Success. 0 = Failure. */

Assembly Interface

Use C function calling standards.

Reentrant

yes

Description

RTDX_write causes the specified data to be written to the specified output data channel, provided that channel is enabled. On return from the function, the data has been copied out of the specified user buffer and into the RTDX target buffer. If the channel is not enabled, the write operation is suppressed. If the RTDX target buffer is full, Failure is returned.

Constraints and Calling Context

RTDX_write cannot be called by an HWI function.

See Also

RTDX_read
2.19 SEM Module

The SEM module is the semaphore manager.

Functions

- SEM_count. Get current semaphore count
- SEM_create. Create a semaphore
- SEM_delete. Delete a semaphore
- SEM_ipost. Signal a semaphore (interrupt only)
- SEM_new. Initialize a semaphore
- SEM_pend. Wait for a semaphore
- SEM_post. Signal a semaphore
- SEM_reset. Reset semaphore

Constants, Types, and Structures

```c
typedef struct SEM_Obj  *SEM_Handle;
/* handle for semaphore object */

struct SEM_Attrs { /* semaphore attributes */
    Int    dummy;  /* DUMMY */
};

SEM_Attrs SEM_ATTRS = { /* default attribute values */
    0,
};
```

Description

The SEM module makes available a set of functions that manipulate semaphore objects accessed through handles of type SEM_Handle. SEM semaphores are counting semaphores that can be used for both task synchronization and mutual exclusion.

SEM_pend is used to wait for a semaphore. The timeout parameter to SEM_pend allows the task to wait until a timeout, wait indefinitely, or not wait at all. SEM_pend’s return value is used to indicate if the semaphore was signaled successfully.

SEM_post is used to signal a semaphore. If a task is waiting for the semaphore, SEM_post removes the task from the semaphore queue and puts it on the ready queue. If no tasks are waiting, SEM_post simply increments the semaphore count and returns.
2.19.1 SEM Manager Properties

The following global property can be set for the SEM module on the SEM Manager Properties dialog in the Configuration Tool:

**Object Memory.** The memory segment that contains the SEM objects created with the Configuration Tool.

2.19.2 SEM Object Properties

The following properties can be set for a SEM object on the SEM Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this SEM object.
- **Initial semaphore count.** Set this property to the desired initial semaphore count.

2.19.3 SEM - Code Composer Studio Interface

The SEM tab of the Kernel/Object View shows information about semaphore objects.
SEM_count

*Get current semaphore count*

**C Interface**

**Syntax**

```c
count = SEM_count(sem);
```

**Parameters**

SEM_Handle sem; /* semaphore handle */

**Return Value**

Int count; /* current semaphore count */

**Assembly Interface**

none

**Description**

SEM_count returns the current value of the semaphore specified by sem.
SEM_create

Create a semaphore

C Interface

Syntax

```c
sem = SEM_create(count, attrs);
```

Parameters

- `Int count; /* initial semaphore count */`
- `SEM_Attrs *attrs; /* pointer to semaphore attributes */`

Return Value

- `SEM_Handle sem; /* handle for new semaphore object */`

Assembly Interface

none

Description

SEM_create creates a new semaphore object which is initialized to count. If successful, SEM_create returns the handle of the new semaphore. If unsuccessful, SEM_create returns NULL unless it aborts (for example, because it directly or indirectly calls SYS_error, and SYS_error is configured to abort).

If `attrs` is NULL, the new semaphore is assigned a default set of attributes. Otherwise, the semaphore’s attributes are specified through a structure of type `SEM_Attrs`.

Note:

At present, no attributes are supported for semaphore objects, and the type `SEM_Attrs` is defined as a dummy structure.

Default attribute values are contained in the constant `SEM_ATTRS`, which can be assigned to a variable of type `SEM_Attrs` before calling `SEM_create`.

SEM_create calls `MEM_alloc` to dynamically create the object’s data structure. `MEM_alloc` must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module.

Constraints and Calling Context

- count must be greater than or equal to 0.
- SEM_create cannot be called from an SWI or HWI.
- You can reduce the size of your application by creating objects with the Configuration Tool rather than using the XXX_create functions.

See Also

- `MEM_alloc`
- `SEM_delete`
- `SYS_error`
SEM_delete

Delete a semaphore

C Interface

Syntax

SEM_delete(sem);

Parameters

SEM_Handle sem; /* semaphore object handle */

Return Value

Void

Assembly Interface

none

Description

SEM_delete uses MEM_free to free the semaphore object referenced by sem.

SEM_delete calls MEM_free to delete the SEM object. MEM_free must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Constraints and Calling Context

- No tasks should be pending on sem when SEM_delete is called.
- SEM_delete cannot be called from an SWI or HWI.
- No check is performed to prevent SEM_delete from being used on a statically-created object. If a program attempts to delete a semaphore object that was created using the Configuration Tool, SYS_error is called.

See Also

SEM_create
**SEM_ipost**

*Signal a semaphore (interrupt use only)*

**C Interface**

**Syntax**

```
SEM_ipost(sem);
```

**Parameters**

- `SEM_Handle sem; /* semaphore object handle */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

`SEM_ipost` readies the first task waiting for the semaphore. If no task is waiting, `SEM_ipost` simply increments the semaphore count and returns.

`SEM_ipost` is similar to `SEM_post`.

Use either `SEM_ipost` or `SEM_post` within an HWI or SWI. `SEM_ipost` is slightly more efficient than `SEM_post`, because it does not check to see whether it is being called from within a SWI or HWI.

Use `SEM_post` (not `SEM_ipost`) within a task.

**Constraints and Calling Context**

- When called within an HWI ISR, the code sequence calling `SEM_ipost` must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

- `SEM_ipost` should not be called from a TSK function.

- `SEM_ipost` cannot be called from the program's main function.

**See Also**

- `SEM_pend`
- `SEM_post`
**SEM_new**

*Initialize semaphore object*

**C Interface**

**Syntax**

Void SEM_new(sem, count);

**Parameters**

- SEM_Handle sem; /* pointer to semaphore object */
- Int count; /* initial semaphore count */

**Return Value**

Void

**Assembly Interface**

none

**Description**

SEM_new initializes the semaphore object pointed to by sem with count. The function should be used on a statically created semaphore for initialization purposes only. No task switch occurs when calling SEM_new.

**Constraints and Calling Context**

- count must be greater than or equal to 0
- no tasks should be pending on the semaphore when SEM_new is called

**See Also**

QUE_new
SEM_pend

Wait for a semaphore

C Interface

Syntax

status = SEM_pend(sem, timeout);

Parameters

SEM_Handle sem; /* semaphore object handle */
Uns timeout; /* return after this many system clock ticks */

Return Value

Bool status; /* TRUE if successful, FALSE if timeout */

Assembly Interface

none

Description

If the semaphore count is greater than zero, SEM_pend decrements the count and returns TRUE. Otherwise, SEM_pend suspends the execution of the current task until SEM_post is called or the timeout expires. If timeout is not equal to SYS_FOREVER or 0, the task suspension time can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

If timeout is SYS_FOREVER, the task remains suspended until SEM_post is called on this semaphore. If timeout is 0, SEM_pend returns immediately.

If timeout expires (or timeout is 0) before the semaphore is available, SEM_pend returns FALSE. Otherwise SEM_pend returns TRUE.

A task switch occurs when calling SEM_pend if the semaphore count is 0 and timeout is not zero.

Constraints and Calling Context

- SEM_pend can only be called from an HWI or SWI if timeout is 0.
- SEM_pend cannot be called from the program’s main function.
- SEM_pend can only be called from within a TSK_disable / TSK_enable block if timeout is 0.
- SEM_pend should not be called from within an IDL function. Doing so prevents analysis tools from gathering run-time information.

See Also

SEM_post
**SEM_post**

*Signal a semaphore*

**C Interface**

- **Syntax**
  
  ```c
  SEM_post(sem);
  ```

- **Parameters**
  
  ```c
  SEM_Handle sem; /* semaphore object handle */
  ```

- **Return Value**
  
  Void

**Assembly Interface**

none

**Description**

SEM_post readies the first task waiting for the semaphore. If no task is waiting, SEM_post simply increments the semaphore count and returns.

A task switch occurs when calling SEM_post if a higher priority task is made ready to run.

**Constraints and Calling Context**

- When called within an HWI ISR, the code sequence calling SEM_post must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

- SEM_post cannot be called from within a TSK_disable/TSK_enable block.

**See Also**

- SEM_ipost
- SEM_pend
**SEM_reset**  
*Reset semaphore count*

### C Interface

**Syntax**

```c
SEM_reset(sem, count);
```

**Parameters**

- `SEM_Handle sem;` /* semaphore object handle */
- `Int count;` /* semaphore count */

**Return Value**

Void

### Assembly Interface

none

### Description

SEM_reset resets the semaphore count to count.

No task switch occurs when calling SEM_reset.

### Constraints and Calling Context

- count must be greater than or equal to 0.
- No tasks should be waiting on the semaphore when SEM_reset is called.
- SEM_reset cannot be called by an HWI or a SWI.

### See Also

SEM_create
2.20 SIO Module

The SIO module is the stream input and output manager.

**Functions**

- SIO_bufsize. Size of the buffers used by a stream
- SIO_create. Create stream
- SIO_ctrl. Perform a device-dependent control operation
- SIO_delete. Delete stream
- SIO_flush. Idle a stream by flushing buffers
- SIO_get. Get buffer from stream
- SIO_idle. Idle a stream
- SIO_issue. Send a buffer to a stream
- SIO_put. Put buffer to a stream
- SIO_reclaim. Request a buffer back from a stream
- SIO_segid. Memory segment used by a stream
- SIO_select. Select a ready device
- SIO_staticbuf. Acquire static buffer from stream

**Constants, Types, and Structures**

```c
#define SIO_STANDARD   0 /* open stream for */
#define SIO_ISSUERECLAIM 1 /* open stream for */
#define SIO_INPUT       0  /* open for input */
#define SIO_OUTPUT      1  /* open for output */
typedef SIO_Handle;   /* stream object handle */

struct SIO_Attrs {    /* stream attributes */
    Int     nbufs;      /* number of buffers */
    Int     segid;      /* buffer segment ID */
    Int     align;      /* buffer alignment */
    Bool    flush;      /* TRUE = don’t block in DEV_idle */
    Uns     model;      /* usage model: */
    /* SIO_STANDARD/SIO_ISSUERECLAIM */
    Uns     timeout;    /* timeout value used by device*/
};

SIO_Attrs SIO_ATTRS = {
    2,       /* nbufs */
    0,       /* segid */
    0,       /* align */
    FALSE,   /* flush */
```

---

*SIO Module*

*Application Program Interface* 2-221
SIO Module

SIO_STANDARD,      /* model */
SYS_FOREVER        /* timeout */
};

Description

The stream manager provides efficient real-time device-independent I/O through a set of functions that manipulate stream objects accessed through handles of type SIO_Handle. The device independence is afforded by having a common high-level abstraction appropriate for real-time applications, continuous streams of data, that can be associated with a variety of devices. All I/O programming is done in a high-level manner using these stream handles to the devices and the stream manager takes care of dispatching into the underlying device drivers.

For efficiency, streams are treated as sequences of fixed-size buffers of data rather than just sequences of MADUs.

Streams can be opened and closed at any point during program execution using the functions SIO_create and SIO_delete, respectively.

The SIO_issue and SIO_reclaim function calls are enhancements to the basic DSP/BIOS device model. These functions provide a second usage model for streaming, referred to as the issue/reclaim model. It is a more flexible streaming model that allows clients to supply their own buffers to a stream, and to get them back in the order that they were submitted. The SIO_issue and SIO_reclaim functions also provide a user argument that can be used for passing information between the stream client and the stream devices.

2.20.1 SIO Manager Properties

The following global properties can be set for the SIO module on the SIO Manager Properties dialog in the Configuration Tool:

- **Object Memory.** The memory segment that contains the SIO objects created with the Configuration Tool

2.20.2 SIO Object Properties

The following properties can be set for an SIO object on the SIO Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this SIO object.
- **Device.** Select the device to which you want to bind this SIO object. User-defined devices are listed along with DGN and DPI devices.
- **Device Control Parameter.** Type the device suffix to be passed to any devices stacked below the device connected to this stream.
Mode. Select input if this stream is to be used for input to the application program and output if this stream is to be used for output.

Buffer size. If this stream uses the Standard model, this property controls the size of buffers (in MADUs) allocated for use by the steam. If this stream uses the Issue/Reclaim model, the stream can handle buffers of any size.

Number of buffers. If this stream uses the Standard model, this property controls the number of buffers allocated for use by the steam. If this stream uses the Issue/Reclaim model, the stream can handle up to the specified Number of buffers.

Place buffers in memory segment. Select the memory segment to contain the stream buffers if Model is Standard.

Buffer alignment. Specify the memory alignment to use for stream buffers if Model is Standard. For example, if you select 16, the buffer must begin at an address that is a multiple of 16. The default is 1, which means the buffer can begin at any address.

Flush. Check this box if you want the stream to discard all pending data and return without blocking if this object is idled at run-time with SIO_idle.

Model. Select Standard if you want all buffers to be allocated when the stream is created. Select Issue/Reclaim if your program is to allocate the buffers and supply them using SIO_issue.

Allocate Static Buffer(s). If this box is checked, the Configuration Tool allocates stream buffers for the user. The SIO_staticbuf function is used to acquire these buffers from the stream. When the Standard model is used, checking this box causes one buffer more than the Number of buffers property to be allocated. When the Issue/Reclaim model is used, buffers are not normally allocated. Checking this box causes the number of buffers specified by the Number of buffers property to be allocated.

Timeout for I/O operation. This parameter specifies the length of time the I/O operations SIO_get, SIO_put, and SIO_reclaim wait for I/O. The device driver’s Dxx_reclaim function typically uses this timeout while waiting for I/O. If the timeout expires before a buffer is available, the I/O operation returns (-1 * SYSETIMEOUT) and no buffer is returned.
**SIO_bufsize**

Return the size of the buffers used by a stream

### C Interface

**Syntax**

\[
\text{size} = \text{SIO_bufsize}(\text{stream});
\]

**Parameters**

SIO_Handle stream;

**Return Value**

Uns size;

### Assembly Interface

none

### Description

SIO_bufsize returns the size of the buffers used by stream.

### See Also

SIO_segid
SIO_create

Open a stream

C Interface

Syntax

```c
stream = SIO_create(name, mode, bufsize, attrs);
```

Parameters

- `String name; /* name of device */`
- `Int mode; /* SIO_INPUT or SIO_OUTPUT */`
- `Uns bufsize; /* stream buffer size */`
- `SIO_Attrs *attrs; /* pointer to stream attributes */`

Return Value

```c
SIO_Handle stream; /* stream object handle */
```

Assembly Interface

none

Description

SIO_create creates a new stream object and opens the device specified by name. If successful, SIO_create returns the handle of the new stream object. If unsuccessful, SIO_create returns NULL unless it aborts (for example, because it directly or indirectly calls SYS_error, and SYS_error is configured to abort).

Internally, SIO_create calls Dxx_open to open a device.

The mode parameter specifies whether the stream is to be used for input (SIO_INPUT) or output (SIO_OUTPUT).

If the stream is being opened in SIO_STANDARD mode, SIO_create allocates buffers of size bufsize for use by the stream. Initially these buffers are placed on the device todevice queue for input streams, and the device fromdevice queue for output streams.

If the stream is being opened in SIO_ISSUERECLAIM mode, SIO_create does not allocate any buffers for the stream. In SIO_ISSUERECLAIM mode all buffers must be supplied by the client via the SIO_issue call. It does, however, prepare the stream for a maximum number of buffers of the specified size.

If the attrs parameter is NULL, the new stream is assigned the default set of attributes specified by SIO_ATTRS. The following stream attributes are currently supported:

```c
struct SIO_Attrs {
    Int    nbufs;
    Int    segid;
    Int    align;
    Bool   flush;
    Uns    model;
    Uns    timeout;
};
```
The `nbufs` attribute specifies the number of buffers allocated by the stream in the SIO_STANDARD usage model, or the number of buffers to prepare for in the SIO_ISSUERECLAIM usage model. The default value of `nbufs` is 2. In the SIO_ISSUERECLAIM usage model, `nbufs` is the maximum number of buffers that can be outstanding (that is, issued but not reclaimed) at any point in time.

The `segid` attribute specifies the memory segment for stream buffers. Use the memory segment names defined using the Configuration Tool. The default value is 0, meaning that buffers are to be allocated from the Segment for DSP/BIOS objects defined for the MEM manager.

The `align` attribute specifies the memory alignment for stream buffers. The default value is 0, meaning that no alignment is needed.

The `flush` attribute indicates the desired behavior for an output stream when it is deleted. If `flush` is TRUE, a call to SIO_delete causes the stream to discard all pending data and return without blocking. If `flush` is FALSE, a call to SIO_delete causes the stream to block until all pending data has been processed. The default value is FALSE.

The `model` attribute indicates the usage model that is to be used with this stream. The two usage models are SIO_ISSUERECLAIM and SIO_STANDARD. The default usage model is SIO_STANDARD.

The `timeout` attribute specifies the length of time the device driver waits for I/O completion before returning an error (for example, SYS_ETIMEDOUT). `timeout` is usually passed as a parameter to SEM_pend by the device driver. The default is SYS_FOREVER which indicates that the driver waits forever. If `timeout` is SYS_FOREVER, the task remains suspended until a buffer is available to be returned by the stream. The timeout attribute applies to the I/O operations SIO_get, SIO_put, and SIO_reclaim. If `timeout` is 0, the I/O operation returns immediately. If the timeout expires before a buffer is available to be returned, the I/O operation returns the value of (-1 * SYS_ETIMEDOUT). Otherwise the I/O operation returns the number of valid MADUs in the buffer, or -1 multiplied by an error code.

SIO_create calls MEM_alloc to dynamically create the object’s data structure. MEM_alloc must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, then there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module, page 2-135.

Constraints and Calling Context

- A stream can only be used by one task simultaneously. Catastrophic failure can result if more than one task calls SIO_get (or SIO_issue / SIO_reclaim) on the same input stream, or more than one task calls SIO_put (or SIO_issue / SIO_reclaim) on the same output stream.
SIO_create creates a stream dynamically. Do not call SIO_create on a stream that was created with the Configuration Tool.

You can reduce the size of your application program by creating objects with the Configuration Tool rather than using the XXX_create functions. However, streams that are to be used with stacking drivers must be created dynamically with SIO_create.

SIO_create cannot be called from an SWI or HWI.

See Also

Dxx_open
MEM_alloc
SEM_pend
SIO_delete
SIO_issue
SIO_reclaim
SYS_error
**SIO_ctrl**

*Perform a device-dependent control operation*

**C Interface**

**Syntax**

```c
status = SIO_ctrl(stream, cmd, arg);
```

**Parameters**

- `SIO_Handle stream; /* stream handle */`
- `Uns cmd; /* command to device */`
- `Arg arg; /* arbitrary argument */`

**Return Value**

- `Int status; /* device status */`

**Assembly Interface**

`none`

**Description**

SIO_ctrl causes a control operation to be issued to the device associated with stream. cmd and arg are passed directly to the device.

SIO_ctrl returns SYS_OK if successful, and a non-zero device-dependent error value if unsuccessful.

Internally, SIO_ctrl calls Dxx_ctrl to send control commands to a device.

**Constraints and Calling Context**

SIO_ctrl cannot be called from an SWI or HWI.

**See Also**

Dxx_ctrl
**SIO_delete**

*Close a stream and free its buffers*

**C Interface**

**Syntax**

```c
status = SIO_delete(stream);
```

**Parameters**

- `SIO_Handle stream;` /* stream object */

**Return Value**

- `Int status;` /* result of operation */

**Assembly Interface**

none

**Description**

SIO_delete idles the device before freeing the stream object and buffers.

If the stream being deleted was opened for input, then any pending input data is discarded. If the stream being deleted was opened for output, the method for handling data is determined by the value of the object's Flush property in the Configuration Tool or the flush field in the SIO_Attrs structure (passed in with SIO_create). If flush is TRUE, SIO_delete discards all pending data and return without blocking. If flush is FALSE, SIO_delete blocks until all pending data has been processed by the stream.

SIO_delete returns SYS_OK if and only if the operation is successful.

SIO_delete calls MEM_free to delete a stream. MEM_free must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Internally, SIO_delete first calls Dxx_idle to idle the device. Then it calls Dxx_close.

**Constraints and Calling Context**

- SIO_delete cannot be called from an SWI or HWI.
- No check is performed to prevent SIO_delete from being used on a statically-created object. If a program attempts to delete a stream object that was created using the Configuration Tool, SYS_error is called.
- In SIO_ISSUERECLAIM mode, all buffers issued to a stream must be reclaimed before SIO_delete is called. Failing to reclaim such buffers causes a memory leak.

**See Also**

- SIO_create
- SIO_flush
- SIO_idle
- Dxx_idle
- Dxx_close
SIO_flush

Flush a stream

C Interface

Syntax
status = SIO_flush(stream);

Parameters
SIO_Handle stream; /* stream handle */

Return Value
Int status; /* result of operation */

Assembly Interface
none

Description
SIO_flush causes all pending data to be discarded regardless of the mode of
the stream. SIO_flush differs from SIO_idle in that SIO_flush never suspends
program execution to complete processing of data, even for a stream created
in output mode.

The underlying device connected to stream is idled as a result of calling
SIO_flush. In general, the interrupt is disabled for the device.

One of the purposes of this function is to provide synchronization with the
external environment.

SIO_flush returns SYS_OK if and only if the stream is successfully idled.

Internally, SIO_flush calls Dxx_idle and flushes all pending data.

Constraints and
Calling Context
SIO_flush cannot be called from an SWI or HWI.

See Also
Dxx_idle
SIO_create
SIO_idle
SIO_get

Get a buffer from stream

C Interface

Syntax

```c
nmadus = SIO_get(stream, bufp);
```

Parameters

- `stream`: stream handle
- `bufp`: pointer to a buffer

Return Value

- `nmadus`: number of MADUs read or error if negative

Assembly Interface

none

Description

SIO_get exchanges an empty buffer with a non-empty buffer from stream. The `bufp` parameter is an input/output parameter which points to an empty buffer when SIO_get is called. When SIO_get returns, `bufp` points to a new (different) buffer, and `nmadus` indicates success or failure of the SIO_get call.

SIO_get blocks until a buffer can be returned to the caller, or until the stream’s timeout attribute expires (see SIO_create). If a timeout occurs, the value `-1 * SYS_ETIMEOUT` is returned. If timeout is not equal to SYS_FOREVER or 0, the task suspension time can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

To indicate success, SIO_get returns a positive value for `nmadus`. As a success indicator, `nmadus` is the number of MADUs received from the stream. To indicate failure, SIO_get returns a negative value for `nmadus`. As a failure indicator, `nmadus` is the actual error code multiplied by -1.

Since this operation is generally accomplished by redirection rather than by copying data, references to the contents of the buffer pointed to by `bufp` must be recomputed after the call to SIO_get.

A task switch occurs when calling SIO_get if there are no non-empty data buffers in stream.

Internally, SIO_get calls Dxx_issue and Dxx_reclaim for the device.

Constraints and Calling Context

- The stream must not be created with attrs.model set to SIO_ISSUERECLAIM. The results of calling SIO_get on a stream created for the issue/reclaim streaming model are undefined.
- SIO_get cannot be called from an SWI or HWI.

See Also

- Dxx_issue
- Dxx_reclaim
- SIO_create
- SIO_put
**SIO_idle**

*Idle a stream*

**C Interface**

**Syntax**

```c
status = SIO_idle(stream);
```

**Parameters**

- `SIO_Handle stream; /* stream handle */`

**Return Value**

- `Int status; /* result of operation */`

**Assembly Interface**

- `none`

**Description**

If stream is being used for output, SIO_idle causes any currently buffered data to be transferred to the output device associated with stream. SIO_idle suspends program execution for as long as is required for the data to be consumed by the underlying device.

If stream is being used for input, SIO_idle causes any currently buffered data to be discarded. The underlying device connected to stream is idled as a result of calling SIO_idle. In general, the interrupt is disabled for this device.

If discarding of unrendered output is desired, use SIO_flush instead.

One of the purposes of this function is to provide synchronization with the external environment.

SIO_idle returns SYS_OK if and only if the stream is successfully idled.

Internally, SIO_idle calls Dxx_idle to idle the device.

**Constraints and Calling Context**

SIO_idle cannot be called from an SWI or HWI.

**See Also**

- Dxx_idle
- SIO_create
- SIO_flush
SIO_issue

Send a buffer to a stream

C Interface

Syntax

```c
status = SIO_issue(stream, pbuf, nmadus, arg);
```

Parameters

- `SIO_Handle stream;` /* stream handle */
- `Ptr pbuf;` /* pointer to a buffer */
- `Uns nmadus;` /* number of MADUs in the buffer */
- `Arg arg;` /* user argument */

Return Value

- `Int status;` /* result of operation */

Assembly Interface

- `none`

Description

SIO_issue is used to send a buffer and its related information to a stream. The buffer-related information consists of the logical length of the buffer (nmadus), and the user argument to be associated with that buffer. SIO_issue sends a buffer to the stream and return to the caller without blocking. It also returns an error code indicating success (SYS_OK) or failure of the call.

Internally, SIO_issue calls Dxx_issue after placing a new input frame on the driver’s device->todevice queue.

Failure of SIO_issue indicates that the stream was not able to accept the buffer being issued or that there was a device error when the underlying Dxx_issue was called. In the first case, the application is probably issuing more frames than the maximum MADUs allowed for the stream, before it reclaims any frames. In the second case, the failure reveals an underlying device driver or hardware problem. If SIO_issue fails, SIO_idle should be called for an SIO_INPUT stream, and SIO_flush should be called for an SIO_OUTPUT stream, before attempting more I/O through the stream.

The interpretation of nmadus, the logical size of a buffer, is direction-dependent. For a stream opened in SIO_OUTPUT mode, the logical size of the buffer indicates the number of valid MADUs of data it contains. For a stream opened in SIO_INPUT mode, the logical length of a buffer indicates the number of MADUs being requested by the client. In either case, the logical size of the buffer must be less than or equal to the physical size of the buffer.

The argument arg is not interpreted by DSP/BIOS, but is offered as a service to the stream client. DSP/BIOS and all DSP/BIOS-compliant device drivers preserve the value of arg and maintain its association with the data that it was issued with. arg provides a user argument as a method for a client to associate additional information with a particular buffer of data.
SIO_issue is used in conjunction with SIO_reclaim to operate a stream opened in SIO_ISSUERECLAIM mode. The SIO_issue call sends a buffer to a stream, and SIO_reclaim retrieves a buffer from a stream. In normal operation each SIO_issue call is followed by an SIO_reclaim call. Short bursts of multiple SIO_issue calls can be made without an intervening SIO_reclaim call, but over the life of the stream SIO_issue and SIO_reclaim must be called the same number of times.

At any given point in the life of a stream, the number of SIO_issue calls can exceed the number of SIO_reclaim calls by a maximum of nbufs. The value of nbufs is determined by the SIO_create call or by setting the Number of buffers property for the object in the Configuration Tool.

**Note:**
An SIO_reclaim call should not be made without at least one outstanding SIO_issue call. Calling SIO_reclaim with no outstanding SIO_issue calls has undefined results.

**Constraints and Calling Context**
- The stream must be created with attrs.model set to SIO_ISSUERECLAIM.
- SIO_issue cannot be called from an SWI or HWI.

**See Also**
- Dxx_issue
- SIO_create
- SIO_reclaim
**SIO_put**  
*Put a buffer to a stream*

**C Interface**

**Syntax**

$nmadus = SIO\_put(stream, bufp, nmadus);$  

**Parameters**

- `SIO\_Handle stream; /* stream handle */`
- `Ptr *bufp; /* pointer to a buffer */`
- `Uns nmadus; /* number of MADUs in the buffer */`

**Return Value**

- `Int nmadus; /* number of MADUs, negative if error */`

**Assembly Interface**

None

**Description**

SIO\_put exchanges a non-empty buffer with an empty buffer. The `bufp` parameter is an input/output parameter that points to a non-empty buffer when SIO\_put is called. When SIO\_put returns, `bufp` points to a new (different) buffer, and `nmadus` indicates success or failure of the call.

SIO\_put blocks until a buffer can be returned to the caller, or until the stream’s timeout attribute expires (see SIO\_create). If a timeout occurs, the value (-1 * SYS\_ETIMEOUT) is returned. If timeout is not equal to SYS\_FOREVER or 0, the task suspension time can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

To indicate success, SIO\_put returns a positive value for `nmadus`. As a success indicator, `nmadus` is the number of valid MADUs in the buffer returned by the stream (usually zero). To indicate failure, SIO\_put returns a negative value (the actual error code multiplied by -1).

Since this operation is generally accomplished by redirection rather than by copying data, references to the contents of the buffer pointed to by `bufp` must be recomputed after the call to SIO\_put.

A task switch occurs when calling SIO\_put if there are no empty data buffers in the stream.

Internally, SIO\_put calls Dxx\_issue and Dxx\_reclaim for the device.

**Constraints and Calling Context**

- The stream must not be created with `attrs.model` set to `SIO\_ISSUERECLAIM`. The results of calling SIO\_put on a stream created for the issue/reclaim model are undefined.

- SIO\_put cannot be called from an SWI or HWI.

**See Also**

- Dxx\_issue
- Dxx\_reclaim
- SIO\_create
- SIO\_get
SIO_reclaim

Request a buffer back from a stream

C Interface

Syntax

```c
nmadus = SIO_reclaim(stream, pbufp, parg);
```

Parameters

- `stream`: stream handle
- `pbufp`: pointer to the buffer
- `parg`: pointer to a user argument

Return Value

- `nmadus`: number of MADUs or error if negative

Assembly Interface

none

Description

SIO_reclaim is used to request a buffer back from a stream. It returns a pointer to the buffer, the number of valid MADUs in the buffer, and a user argument (parg). After the SIO_reclaim call parg points to the same value that was passed in with this buffer using the SIO_issue call.

Internally, SIO_reclaim calls Dxx_reclaim, then it gets the frame from the driver’s device->fromdevice queue.

If the stream was created in SIO_OUTPUT mode, then SIO_reclaim returns an empty buffer, and nmadus is zero, since the buffer is empty. If the stream was opened in SIO_INPUT mode, SIO_reclaim returns a non-empty buffer, and nmadus is the number of valid MADUs of data in the buffer. In either mode SIO_reclaim blocks until a buffer can be returned to the caller, or until the stream’s timeout attribute expires (see SIO_create), and it returns a positive number or zero (indicating success), or a negative number (indicating an error condition). If timeout is not equal to SYS_FOREVER or 0, the task suspension time can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

To indicate success, SIO_reclaim returns a positive value for nmadus. As a success indicator, nmadus is the number of valid MADUs in the buffer. To indicate failure, SIO_reclaim returns a negative value for nmadus. As a failure indicator, nmadus is the actual error code multiplied by -1.

Failure of SIO_reclaim indicates that no buffer was returned to the client. Therefore, if SIO_reclaim fails, the client should not attempt to de-reference pbufp, since it is not guaranteed to contain a valid buffer pointer.

SIO_reclaim is used in conjunction with SIO_issue to operate a stream opened in SIO_ISSUERECLAIM mode. The SIO_issue call sends a buffer to a stream, and SIO_reclaim retrieves a buffer from a stream. In normal operation each SIO_issue call is followed by an SIO_reclaim call. Short bursts of multiple SIO_issue calls can be made without an intervening SIO_reclaim call, but over the life of the stream SIO_issue and SIO_reclaim
must be called the same number of times. The number of SIO_issue calls can exceed the number of SIO_reclaim calls by a maximum of nbufs at any given time. The value of nbufs is determined by the SIO_create call or by setting the Number of buffers property for the object in the Configuration Tool.

**Note:**

An SIO_reclaim call should not be made without at least one outstanding SIO_issue call. Calling SIO_reclaim with no outstanding SIO_issue calls has undefined results.

SIO_reclaim only returns buffers that were passed in using SIO_issue. It also returns the buffers in the same order that they were issued.

A task switch occurs when calling SIO_reclaim if timeout is not set to 0, and there are no data buffers available to be returned.

**Constraints and Calling Context**

- The stream must be created with attrs.model set to SIO_ISSUERECLAIM.
- There must be at least one outstanding SIO_issue when an SIO_reclaim call is made.
- All frames issued to a stream must be reclaimed before closing the stream.
- SIO_reclaim cannot be called from an SWI or HWI.

**See Also**

Dxx_reclaim
SIO_issue
SIO_create
SIO_segid

Return the memory segment used by the stream

C Interface

Syntax

segid = SIO_segid(stream);

Parameters

SIO_Handle stream;

Return Value

Int segid; /* memory segment ID */

Assembly Interface

none

Description

SIO_segid returns the identifier of the memory segment that stream uses for buffers.

See Also

SIO_bufsize
SIO_select

Select a ready device

C Interface

Syntax

```
mask = SIO_select(streamtab, nstreams, timeout);
```

Parameters

- `SIO_Handle streamtab; /* stream table */`
- `Int nstreams; /* number of streams */`
- `Uns timeout; /* return after this many system clock ticks */`

Return Value

- `Uns mask; /* stream ready mask */`

Assembly Interface

none

Description

SIO_select waits until one or more of the streams in the streamtab[] array is ready for I/O (that is, it does not block when an I/O operation is attempted).

streamtab[] is an array of streams where nstreams < 16. The timeout parameter indicates the number of system clock ticks to wait before a stream becomes ready. If timeout is 0, SIO_select returns immediately. If timeout is SYS_FOREVER, SIO_select waits until one of the streams is ready. Otherwise, SIO_select waits for up to 1 system clock tick less than timeout due to granularity in system timekeeping.

The return value is a mask indicating which streams are ready for I/O. A 1 in bit position j indicates the stream streamtab[j] is ready.

SIO_select results in a context switch if no streams are ready for I/O.

Internally, SIO_select calls Dxx_ready to determine if the device is ready for an I/O operation.

Constraints and Calling Context

- streamtab must contain handles of type SIO_Handle returned from prior calls to SIO_create.
- streamtab[] is an array of streams; streamtab[i] corresponds to bit position i in mask.
- SIO_select cannot be called from an SWI or HWI.

See Also

Dxx_ready
SIO_get
SIO_put
SIO_reclaim
**SIO_staticbuf**

*Acquire static buffer from stream*

**C Interface**

**Syntax**

```c
nmadus = SIO_staticbuf(stream, bufp);
```

**Parameters**

- `SIO_Handle stream; /* stream handle */`
- `Ptr *bufp; /* pointer to a buffer */`

**Return Value**

- `Int nmadus; /* number of MADUs in buffer */`

**Assembly Interface**

none

**Description**

SIO_staticbuf returns buffers for static streams that were configured using the Configuration Tool. Buffers are allocated for static streams by checking the Allocate Static Buffer(s) check box for the related SIO object.

SIO_staticbuf returns the size of the buffer or 0 if no more buffers are available from the stream.

SIO_staticbuf can be called multiple times for SIO_ISSUERECLAIM model streams.

SIO_staticbuf must be called to acquire all static buffers before calling SIO_get, SIO_put, SIO_issue or SIO_reclaim.

**Constraints and Calling Context**

- SIO_staticbuf should only be called for streams that are defined statically using the Configuration Tool.
- SIO_staticbuf should only be called for static streams whose Allocate Static Buffer(s) check box has been checked.
- SIO_staticbuf cannot be called after SIO_get, SIO_put, SIO_issue or SIO_reclaim have been called for the given stream.
- SIO_staticbuf cannot be called from an SWI or HWI.

**See Also**

SIO_get
2.21 STS Module

The STS module is the statistics objects manager.

Functions

- STS_add. Update statistics using provided value
- STS_delta. Update statistics using difference between provided value and setpoint
- STS_reset. Reset values stored in STS object
- STS_set. Save a setpoint value

Constants, Types, and Structures

```c
struct STS_Obj {
    LgInt    num;     /* count */
    LgInt    acc;     /* total value */
    LgInt    max;     /* maximum value */
}
```

Note:

STS objects should not be shared across threads. Therefore, STS_add, STS_delta, STS_reset, and STS_set are not reentrant.

Description

The STS module manages objects called statistics accumulators. Each STS object accumulates the following statistical information about an arbitrary 32-bit wide data series:

- **Count.** The number of values in an application-supplied data series
- **Total.** The sum of the individual data values in this series
- **Maximum.** The largest value already encountered in this series

Using the count and total, the Statistics View analysis tool calculates the average on the host.

Statistics are accumulated in 32-bit variables on the target and in 64-bit variables on the host. When the host polls the target for real-time statistics, it resets the variables on the target. This minimizes space requirements on the target while allowing you to keep statistics for long test runs.

Default STS Tracing

In the RTA Control Panel, you can enable statistics tracing for the following modules by marking the appropriate checkbox. You can also set the HWI object properties to perform various STS operations on registers, addresses, or pointers.

Except for tracing TSK execution, your program does not need to include any calls to STS functions in order to gather these statistics. The default units for the statistics values are shown in Table 2-5.
Custom STS Objects

You can create custom STS objects using the Configuration Tool. The STS_add operation updates the count, total, and maximum using the value you provide. The STS_set operation sets a previous value. The STS_delta operation accumulates the difference between the value you pass and the previous value and updates the previous value to the value you pass.

By using custom STS objects and the STS operations, you can do the following:

- **Count the number of occurrences of an event.** You can pass a value of 0 to STS_add. The count statistic tracks how many times your program calls STS_add for this STS object.

- **Track the maximum and average values for a variable in your program.** For example, suppose you pass amplitude values to STS_add. The count tracks how many times your program calls STS_add for this STS object. The total is the sum of all the amplitudes. The maximum is the largest value. The Statistics View calculates the average amplitude.

- **Track the minimum value for a variable in your program.** Negate the values you are monitoring and pass them to STS_add. The maximum is the negative of the minimum value.

- **Time events or monitor incremental differences in a value.** For example, suppose you want to measure the time between hardware interrupts. You would call STS_set when the program begins running and STS_delta each time the interrupt routine runs, passing the result of CLK_gethtime each time. STS_delta subtracts the previous value from the current value. The count tracks how many times the interrupt routine was performed. The maximum is the largest number of clock counts between interrupt routines. The Statistics View also calculates the average number of clock counts.

---

**Table 2-5. Statistics Units for HWI, PIP, PRD, and SWI Modules**

<table>
<thead>
<tr>
<th>Module</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWI</td>
<td>Gather statistics on monitored values within HWIs</td>
</tr>
<tr>
<td>PIP</td>
<td>Number of frames read from or written to data pipe (count only)</td>
</tr>
<tr>
<td>PRD</td>
<td>Number of ticks elapsed from time that the PRD object is ready to run to end of execution</td>
</tr>
<tr>
<td>SWI</td>
<td>Instruction cycles elapsed from time posted to completion</td>
</tr>
<tr>
<td>TSK</td>
<td>Instruction cycles elapsed from time TSK is made ready to run until the application calls TSK_deltatime</td>
</tr>
</tbody>
</table>
Monitor differences between actual values and desired values. For example, suppose you want to make sure a value stays within a certain range. Subtract the midpoint of the range from the value and pass the absolute value of the result to STS_add. The count tracks how many times your program calls STS_add for this STS object. The total is the sum of all deviations from the middle of the range. The maximum is the largest deviation. The Statistics View calculates the average deviation.

You can further customize the statistics data by setting the STS object properties to apply a printf format to the Total, Max, and Average fields in the Statistics View window and choosing a formula to apply to the data values on the host.

The statistics manager allows the creation of any number of statistics objects, which in turn can be used by the application to accumulate simple statistics about a time series. This information includes the 32-bit maximum value, the last 32-bit value passed to the object, the number of samples (up to \(2^{32} - 1\) samples), and the 32-bit sum of all samples.

These statistics are accumulated on the target in real-time until the host reads and clears these values on the target. The host, however, continues to accumulate the values read from the target in a host buffer which is displayed by the Statistics View real-time analysis tool. Provided that the host reads and clears the target statistics objects faster than the target can overflow the 32-bit wide values being accumulated, no information loss occurs.

Using the Configuration Tool, you can select a Host Operation for an STS object. The statistics are filtered on the host using the operation and variables you specify. Figure 2-4 shows the effects of the \((A \times X + B) / C\) operation.
2.21.1 STS Manager Properties

The following global property can be set for the STS module on the STS Manager Properties dialog in the Configuration Tool:

**Object Memory.** The memory segment that contains the STS objects.

2.21.2 STS Object Properties

The following properties can be set for a statistics object on the STS Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this STS object
- **prev.** The initial 32-bit history value to use in this object
- **unit type.** The unit type property enables you to choose the type of time base units.
  - Not time based. When you select this unit type, the values are displayed in the Statistics View without applying any conversion.
  - High-resolution time based. When you select this unit type, the Statistics View, by default, presents the results in units of instruction cycles.
  - Low-resolution time based. When you select this unit type, the Statistics View, by default, presents the results in units of timer interrupts.
- **host operation.** The expression evaluated (by the host) on the data for this object before it is displayed by the Statistics View real-time analysis tool. The operation can be:
  - \( A \times X \)
  - \( A \times X + B \)
  - \( (A \times X + B) / C \)
A, B, C. The integer parameters used by the expression specified by the Host Operation field above.

2.21.3 STS - Statistics View Interface

You can view statistics in real-time with the Statistics View analysis tool by choosing the DSP/BIOS → Statistics View menu item.

By default, the Statistics View displays all STS objects available. To limit the list of STS objects, right-click on the Statistics View and select Property Page from the pop-up menu. This presents a list of all STS objects. Hold down the control key while selecting the STS object that you wish to observe in the Statistics View. To copy data from the Statistics View, right-click on the Statistics View and select Copy from the pop-up menu. This places the window data in tab-delimited format to the clipboard.

### Note: Updating Task Statistics

If TSK_deltatime is not called by a task, its STS object will never be updated in the Statistics View, even if TSK accumulators are enabled in the RTA Control Panel.

TSK statistics are handled differently than other statistics because TSK functions typically run an infinite loop that blocks when waiting for other threads. In contrast, HWI and SWI functions run to completion without blocking. Because of this difference, DSP/BIOS allows programs to identify the “beginning” of a TSK function’s processing loop by calling TSK_settime and the “end” of the loop by calling TSK_deltatime.

To modify the units of time-based STS objects or to provide unit labels for STS objects that are not time based, select the Units tab from the Statistics View Property Page. Select an STS object from the list of STS objects available. The unit options displayed on the right are the unit options for the selected STS object. If the STS object is high-resolution based, you can...
choose instruction cycles, microseconds, or milliseconds. If your STS object is low-resolution time based, you can choose interrupts, microseconds, or milliseconds. If your STS object is not time based, you can provide a unit label.

When you run your program, the Statistics View displays the Count, Total, Max and Average statistic values for the STS objects. To pause the display, right-click on this window and choose Pause from the pop-up menu. To reset the values to 0, right-click on this window and choose Clear from the pop-up menu.

You can also control how frequently the host polls the target for statistics information. Right-click on the RTA Control Panel and choose the Property Page to set the refresh rate as seen in Figure 2-5. If you set the refresh rate to 0, the host does not poll the target unless you right-click on the Statistics View window and choose Refresh Window from the pop-up menu.

Figure 2-5. RTA Control Panel Properties Page

See the Code Composer Studio online tutorial for more information on how to monitor statistics with the Statistics View analysis tool.
**STS_add**  
*Update statistics using the provided value*

**C Interface**

**Syntax**

```c
STS_add(sts, value);
```

**Parameters**

- `STS_Handle sts; /* statistics object handle */`
- `LgInt value; /* new value to update statistics object */`

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

```asm
STS_add
```

**Preconditions**

- `a4 = STS object handle`
- `b4 = 32-bit sample`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

`a1, a3, b1, b2, b3`

**Reentrant**

`no`

**Description**

`STS_add` updates a custom STS object’s Total, Count, and Max fields using the data value you provide.

For example, suppose your program passes 32-bit amplitude values to `STS_add`. The Count field tracks how many times your program calls `STS_add` for this STS object. The Total field tracks the total of all the amplitudes. The Max field holds the largest value passed to this point. The Statistics View analysis tool calculates the average amplitude.

You can count the occurrences of an event by passing a dummy value (such as 0) to `STS_add` and watching the Count field.

You can view the statistics values with the Statistics View analysis tool by enabling statistics in the DSP/BIOS→RTA Control Panel window and choosing your custom STS object in the DSP/BIOS→Statistics View window.

**See Also**

- `STS_delta`
- `STS_reset`
- `STS_set`
- `TRC_disable`
- `TRC_enable`
**STS_delta**

*Update statistics using the difference between the provided value and the setpoint*

**C Interface**

<table>
<thead>
<tr>
<th>Syntax</th>
<th>STS_delta(sts,value);</th>
</tr>
</thead>
</table>
| Parameters   | STS_Handle sts; /* statistics object handle */  
|              | LgInt value; /* new value to update statistics object */ |
| Return Value | Void                   |

**Assembly Interface**

<table>
<thead>
<tr>
<th>Syntax</th>
<th>STS_delta</th>
</tr>
</thead>
</table>
| Preconditions| a4 = STS object handle  
|              | b4 = 32-bit sample  
|              | amr = 0 |
| Postconditions| none |
| Modifies     | a1, a3, b1, b2, b3, b4, b5 |
| Reentrant    | no |
| Description  | Each STS object contains a previous value that can be initialized with the Configuration Tool or with a call to STS_set. A call to STS_delta subtracts the previous value from the value it is passed and then invokes STS_add with the result to update the statistics. STS_delta also updates the previous value with the value it is passed.  
|              | STS_delta can be used in conjunction with STS_set to monitor the difference between a variable and a desired value or to benchmark program performance. |
|              | You can benchmark your code by using paired calls to STS_set and STS_delta that pass the value provided by CLK_gethtime. |

```c
STS_set(&sts, CLK_gethtime());  
  "processing to be benchmarked"  
STS_delta(&sts, CLK_gethtime());
```

**Constraints and Calling Context**

Before the first call to STS_delta is made, the previous value of the STS object should be initialized either with a call to STS_set or by setting the prev property of the STS object using the Configuration Tool.
Example

```c
STS_set(&sts, targetValue);
"processing"
STS_delta(&sts, currentValue);
"processing"
STS_delta(&sts, currentValue);
"processing"
STS_delta(&sts, currentValue);
```

See Also

- STS_add
- STS_reset
- STS_set
- CLK_gethtime
- CLK_gettime
- PRD_getticks
- TRC_disable
- TRC_enable
**STS_reset**

Reset the values stored in an STS object

### C Interface

**Syntax**

STS_reset(sts);

**Parameters**

STS_Handle sts; /* statistics object handle */

**Return Value**

Void

### Assembly Interface

**Syntax**

STS_reset

**Preconditions**

a4 = STS object handle
amr = 0

**Postconditions**

none

**Modifies**

a1

**Reentrant**

no

**Description**

STS_reset resets the values stored in an STS object. The Count and Total fields are set to 0 and the Max field is set to the largest negative number. STS_reset does not modify the value set by STS_set.

After the Statistics View analysis tool polls statistics data on the target, it performs STS_reset internally. This keeps the 32-bit total and count values from wrapping back to 0 on the target. The host accumulates these values as 64-bit numbers to allow a much larger range than can be stored on the target.

**Example**

STS_reset(&sts);
STS_set(&sts, value);

**See Also**

STS_add
STS_delta
STS_set
TRC_disable
TRC_enable
**STS_set**

*Save a value for STS_delta*

**C Interface**

**Syntax**

```
STS_set(sts, value);
```

**Parameters**

- `STS_Handle sts; /* statistics object handle */`
- `LgInt value; /* new value to update statistics object */`

**Return Value**

Void

**Assembly Interface**

**Syntax**

```
STS_set
```

**Preconditions**

- `a4 = STS object handle`
- `b4 = new 32-bit value to store as previous`
- `amr = 0`

**Postconditions**

none

**Modifies**

none

**Reentrant**

no

**Description**

`STS_set` can be used in conjunction with `STS_delta` to monitor the difference between a variable and a desired value or to benchmark program performance. `STS_set` saves a value as the previous value in an STS object. `STS_delta` subtracts this saved value from the value it is passed and invokes `STS_add` with the result.

`STS_delta` also updates the previous value with the value it was passed. Depending on what you are measuring, you can need to use `STS_set` to reset the previous value before the next call to `STS_delta`.

You can also set a previous value for an STS object in the Configuration Tool. `STS_set` changes this value.

See `STS_delta` for details on how to use the value you set with `STS_set`.

**Example**

This example gathers performance information for the processing between `STS_set` and `STS_delta`.

```
STS_set(&sts, CLK_getltime());
"processing to be benchmarked"
STS_delta(&sts, CLK_getltime());
```

This example gathers information about a value's deviation from the desired value.
STS_set

STS_set(&sts, targetValue);  
   "processing"
STS_delta(&sts, currentValue);  
   "processing"
STS_delta(&sts, currentValue);  
   "processing"
STS_delta(&sts, currentValue);

This example gathers information about a value's difference from a base value.

STS_set(&sts, baseValue);  
   "processing"
STS_delta(&sts, currentValue);
STS_set(&sts, baseValue);  
   "processing"
STS_delta(&sts, currentValue);
STS_set(&sts, baseValue);

See Also

STS_add  
STS_delta  
STS_reset  
TRC_disable  
TRC_enable
2.22 SWI Module

The SWI module is the software interrupt manager.

Functions

- SWI_andn. Clear bits from SWI's mailbox; post if becomes 0
- SWI_andnHook. Specialized version of SWI_andn for use as hook function for configured DSP/BIOS objects. Both its arguments are of type (Arg).
- SWI_create. Create a software interrupt
- SWI_dec. Decrement SWI's mailbox value; post if becomes 0
- SWI_delete. Delete a software interrupt
- SWI_disable. Disable software interrupts
- SWI_enable. Enable software interrupts
- SWI_getattrs. Get attributes of a software interrupt
- SWI_getmbox. Return an SWI's mailbox value
- SWI_getpri. Return an SWI's priority mask
- SWI_inc. Increment SWI's mailbox value
- SWI_or. Or mask with value contained in SWI's mailbox field
- SWI_orHook. Specialized version of SWI_or for use as hook function for configured DSP/BIOS objects. Both its arguments are of type (Arg).
- SWI_post. Post a software interrupt
- SWI_raisepri. Raise an SWI's priority
- SWI_restorepri. Restore an SWI's priority
- SWI_self. Return address of currently executing SWI object
- SWI_setattrs. Set attributes of a software interrupt

Description

The SWI module manages software interrupt service routines, which are patterned after HWI hardware interrupt service routines.

DSP/BIOS manages four distinct levels of execution threads: hardware interrupt service routines, software interrupts, tasks, and background idle functions. A software interrupt is an object that encapsulates a function to be executed and a priority. Software interrupts are prioritized, preempt tasks, and are preempted by hardware interrupt service routines.
Note:

SWI functions are called after the processor register state has been saved. SWI functions can be written in C or assembly and must follow the C calling conventions described in the compiler manual.

Note:

The processor registers that are saved before SWI functions are called include a0-a9 and b0-b9. These registers are the parent-preserved registers mentioned in the TMS320C6000 Optimizing Compiler User’s Guide. The child-preserved registers, a10-a15 and b10-b15, are not saved.

Each software interrupt has a priority level. A software interrupt preempts any lower-priority software interrupt currently executing.

A target program uses an API call to post an SWI object. This causes the SWI module to schedule execution of the software interrupt’s function. When a software interrupt is posted by an API call, the SWI object’s function is not executed immediately. Instead, the function is scheduled for execution. DSP/BIOS uses the software interrupt’s priority to determine whether to preempt the thread currently running. Note that if a software interrupt is posted several times before it begins running, because HWIs and higher priority interrupts are running, the software interrupt only runs one time.

Software interrupts can be scheduled for execution with a call to SWI_post or a number of other SWI functions. Each SWI object has a 32-bit mailbox which is used either to determine whether to post the software interrupt or as a value that can be evaluated within the software interrupt's function. SWI_andn and SWI_dec post the software interrupt if the mailbox value transitions to 0. SWI_or and SWI_inc also modify the mailbox value. (SWI_or sets bits, and SWI_andn clears bits.)

<table>
<thead>
<tr>
<th></th>
<th>Treat mailbox as bitmask</th>
<th>Treat mailbox as counter</th>
<th>Does not modify mailbox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always post</td>
<td>SWI_or</td>
<td>SWI_inc</td>
<td>SWI_post</td>
</tr>
<tr>
<td>Post if becomes 0</td>
<td>SWI_andn</td>
<td>SWI_dec</td>
<td></td>
</tr>
</tbody>
</table>
The SWI_disable and SWI_enable operations allow you to post several software interrupts and enable them all for execution at the same time. The software interrupt priorities then determine which software interrupt runs first.

All software interrupts run to completion; you cannot suspend a software interrupt while it waits for something (for example, a device) to be ready. So, you can use the mailbox to tell the software interrupt when all the devices and other conditions it relies on are ready. Within a software interrupt processing function, a call to SWI_getmbox returns the value of the mailbox when the software interrupt started running. The mailbox is automatically reset to its original value when a software interrupt runs.

Software interrupts can have up to 15 priority levels. The highest level is SWI_MAXPRI (14). The lowest is SWI_MINPRI (0). The priority level of 0 is reserved for the KNL_swi object, which runs the task scheduler.

A software interrupt preempts any currently running software interrupt with a lower priority. If two software interrupts with the same priority level have been posted, the software interrupt that was posted first runs first. Hardware interrupts in turn preempt any currently running software interrupt, allowing the target to respond quickly to hardware peripherals. For information about setting software interrupt priorities, you can choose Help -> Help Topics in the Configuration Tool, click the Index tab, and type priority.

Interrupt threads (including hardware interrupts and software interrupts) are all executed using the same stack. A context switch is performed when a new thread is added to the top of the stack. The SWI module automatically saves the processor’s registers before running a higher-priority software interrupt that preempts a lower-priority software interrupt. After the higher-priority software interrupt finishes running, the registers are restored and the lower-priority software interrupt can run if no other higher-priority software interrupts have been posted. (A separate task stack is used by each task thread.)

See the Code Composer Studio online tutorial for more information on how to post software interrupts and scheduling issues for the Software Interrupt manager.

### 2.22.1 SWI Manager Properties

The following global property can be set for the SWI module on the SWI Manager Properties dialog in the Configuration Tool:

**Object Memory.** The memory segment that contains the SWI objects.
2.22.2 SWI Object Properties

The following properties can be set for an SWI object on the SWI Object Properties dialog in the Configuration Tool:

- **comment.** Type a comment to identify this SWI object
- **function.** The function to execute
- **priority.** This field shows the numeric priority level for this SWI object. Software interrupts can have up to 15 priority levels. The highest level is SWI_MAXPRI (14). The lowest is SWI_MINPRI (0). The priority level of 0 is reserved for the KNL_swi object, which runs the task scheduler. Instead of typing a number in this field, you change the relative priority levels of SWI objects by dragging the objects in the ordered collection view.
- **mailbox.** The initial value of the 32-bit word used to determine if this software interrupt should be posted.
- **arg0, arg1.** Two arbitrary pointer type (Arg) arguments to the above configured user function.

2.22.3 SWI - Code Composer Studio Interface

The SWI tab of the Kernel/Object View shows information about software interrupt objects.

To enable SWI logging, choose DSP/BIOS→RTA Control Panel and put a check in the appropriate box. To view a graph of activity that includes SWI function execution, choose DSP/BIOS→Execution Graph.

You can also enable SWI accumulators in the RTA Control Panel. Then you can choose DSP/BIOS→Statistics View, which lets you select objects for which you want to see statistics. If you choose an SWI object, you see statistics about the number of instruction cycles elapsed from the time the SWI was posted to the SWI function’s completion.

Note:

Static SWIs have an STS object associated with them, while dynamic SWIs do not. The STS pointer is located in the SWI object structure for static SWIs only. Therefore, they may be accessed by the user and used for STS operations.
SWI_andn

Clear bits from SWI's mailbox and post if mailbox becomes 0

C Interface

Syntax

    SWI_andn(swi, mask);

Parameters

    SWI_Handle swi; /* SWI object handle*/
    Uns mask /* value to be ANDed */

Return Value

    Void

Assembly Interface

Syntax

    SWI_andn

Preconditions

    a4 = address of the SWI object
    b4 = mask
    amr = 0

Postconditions

    none

Modifies

    a0, a1, a2, a3, a4, a5, a6, a7, a9, b0, b1, b2, b3, b4, b5, b6, b7, csr

Reentrant

    yes

Description

SWI_andn is used to conditionally post a software interrupt. SWI_andn clears the bits specified by a mask from SWI's internal mailbox. If SWI's mailbox becomes 0, SWI_andn posts the software interrupt. The bitwise logical operation performed is:

    mailbox = mailbox AND (NOT MASK)

For example, if there are multiple conditions that must all be met before a software interrupt can run, you should use a different bit in the mailbox for each condition. When a condition is met, clear the bit for that condition.

SWI_andn results in a context switch if the SWI's mailbox becomes zero and the SWI has higher priority than the currently executing thread.

You specify a software interrupt's initial mailbox value in the Configuration Tool. The mailbox value is automatically reset when the software interrupt executes.

Note:

Use the specialized version, SWI_andnHook, when SWI_andn functionality is required for a DSP/BIOS object hook function.
The following figure shows an example of how a mailbox with an initial value of 3 can be cleared by two calls to SWI_andn with values of 2 and 1. The entire mailbox could also be cleared with a single call to SWI_andn with a value of 3.

Constraints and Calling Context

- If this macro (API) is invoked outside the context of an interrupt service routine, interrupts must be enabled.
- When called within an HWI ISR, the code sequence calling SWI_andn must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

Example

```c
/* ======== ioReady ======== */

Void ioReady(unsigned int mask)
{
    /* clear bits of "ready mask" */
    SWI_andn(&copySWI, mask);
}
```

See Also

SWI_andnHook
SWI_dec
SWI_getmbox
SWI_inc
SWI_or
SWI_orHook
SWI_post
SWI_self
SWI_andnHook

Clear bits from SWI's mailbox and post if mailbox becomes 0

C Interface

Syntax

SWI_andnHook(swi, mask);

Parameters

Arg swi; /* SWI object handle*/
Arg mask /* value to be ANDed */

Return Value

Void

Assembly Interface

Syntax

SWI_andnHook

Preconditions

a4 = address of the SWI object
b4 = mask
amr = 0

Postconditions

none

Modifies

a0, a1, a2, a3, a4, a5, a6, a7, a9, b0, b1, b2, b3, b4, b5, b6, b7, csr

Reentrant

yes

Description

SWI_andnHook is a specialized version of SWI_andn for use as hook function for configured DSP/BIOS objects. SWI_andnHook clears the bits specified by a mask from SWI's internal mailbox and also moves the arguments to the correct registers for proper interface with low level DSP/BIOS assembly code. If SWI's mailbox becomes 0, SWI_andnHook posts the software interrupt. The bitwise logical operation performed is:

mailbox = mailbox AND (NOT MASK)

For example, if there are multiple conditions that must all be met before a software interrupt can run, you should use a different bit in the mailbox for each condition. When a condition is met, clear the bit for that condition.

SWI_andnHook results in a context switch if the SWI's mailbox becomes zero and the SWI has higher priority than the currently executing thread.

You specify a software interrupt's initial mailbox value in the Configuration Tool. The mailbox value is automatically reset when the software interrupt executes.

Constraints and Calling Context

- If this macro (API) is invoked outside the context of an interrupt service routine, interrupts must be enabled.
When called within an HWI ISR, the code sequence calling SWI_andnHook must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

Example

```c
/* ======== ioReady ======== */

Void ioReady(unsigned int mask)
{
    /* clear bits of "ready mask" */
    SWI_andn(&copySWI, mask);
}
```

See Also

SWI_andn
SWI_dec
SWI_getmbox
SWI_inc
SWI_or
SWI_orHook
SWI_post
SWI_self
**SWI_create**

*C Interface*

**Syntax**

```c
swi = SWI_create(attrs);
```

**Parameters**

- `SWI_Attrs *attrs; /* pointer to swi attributes */`

**Return Value**

- `SWI_Handle swi; /* handle for new swi object */`

*Assembly Interface*

none

**Description**

SWI_create creates a new SWI object. If successful, SWI_create returns the handle of the new SWI object. If unsuccessful, SWI_create returns NULL unless it aborts. For example, SWI_create can abort if it directly or indirectly calls SYS_error, and SYS_error is configured to abort.

The `attrs` parameter, which can be either NULL or a pointer to a structure that contains attributes for the object to be created, facilitates setting the SWI object’s attributes. If `attrs` is NULL, the new SWI object is assigned a default set of attributes. Otherwise, the SWI object’s attributes are specified through a structure of type `SWI_Attrs` defined as follows:

```c
struct SWI_Attrs {
    SWI_Fxn  fxn;
    Arg    arg0;
    Arg    arg1;
    Int    priority;
    Uns    mailbox;
};
```

The `fxn` attribute, which is the address of the SWI function, serves as the entry point of the software interrupt service routine.

The `arg0` and `arg1` attributes specify the arguments passed to the SWI function, `fxn`.

The priority attribute specifies the SWI object’s execution priority and must range from 0 to 14. The highest level is `SWI_MAXPRI` (14). The lowest is `SWI_MINPRI` (0). The priority level of 0 is reserved for the KNL_sw object, which runs the task scheduler.

The mailbox attribute is used either to determine whether to post the SWI or as a value that can be evaluated within the SWI function.

All default attribute values are contained in the constant `SWI_ATTRS`, which can be assigned to a variable of type `SWI_Attrs` prior to calling `SWI_create`. 
SWI_create calls MEM_alloc to dynamically create the object’s data structure. MEM_alloc must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, then there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module, page 2-135.

**Constraints and Calling Context**

- SWI_create cannot be called from an SWI or HWI.
- The fxn attribute cannot be NULL.
- The priority attribute must be less than or equal to 14 and greater than or equal to 1.

**See Also**

- SWI_delete
- SWI_getattrs
- SWI_setattrs
- SYS_error
SWI_dec is used to conditionally post a software interrupt. SWI_dec decrements the value in SWI’s mailbox by 1. If SWI’s mailbox value becomes 0, SWI_dec posts the software interrupt. You can increment a mailbox value by using SWI_inc, which always posts the software interrupt.

For example, you would use SWI_dec if you wanted to post a software interrupt after a number of occurrences of an event.

You specify a software interrupt’s initial mailbox value in the Configuration Tool. The mailbox value is automatically reset when the software interrupt executes.

SWI_dec results in a context switch if the SWI’s mailbox becomes zero and the SWI has higher priority than the currently executing thread.

Example

```c
/* ======== strikeOrBall ======== */

Void strikeOrBall(unsigned int call)
{
    if (call == 1) {
```
/* initial mailbox value is 3 */
SWI_dec(&strikeoutSwi);
if (call == 2) {
    /* initial mailbox value is 4 */
    SWI_dec(&walkSwi);
}

See Also
SWI_delete
SWI_getmbox
SWI_inc
SWI_or
SWI_post
SWI_self
## SWI_delete

Delete a software interrupt

### C Interface

**Syntax**

```
SWI_delete(swi);
```

**Parameters**

- `SWI_Handle swi; /* SWI object handle */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

SWI_delete uses MEM_free to free the SWI object referenced by `swi`.

SWI_delete calls MEM_free to delete the SWI object. MEM_free must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

**Constraints and Calling Context**

- swi cannot be the currently executing SWI object (SWI_self)
- SWI_delete cannot be called from an SWI or HWI.
- SWI_delete must not be used to delete a statically-created SWI object. No check is performed to prevent SWI_delete from being used on a statically-created object. If a program attempts to delete a SWI object that was created using the Configuration Tool, SYS_error is called.

**See Also**

- SWI_create
- SWI_getattrs
- SWI_setattrs
- SYS_error
**SWI_disable**

*Disable software interrupts*

**C Interface**

**Syntax**

SWI_disable();

**Parameters**

Void

**Return Value**

Void

**Assembly Interface**

**Syntax**

SWI_disable

**Preconditions**

b14 = address of the start of .bss

GIE = 1 (interrupts must be enabled)

amr = 0

**Postconditions**

none

**Modifies**

a4

**Reentrant**

yes

**Description**

SWI_disable and SWI_enable control SWI software interrupt processing. SWI_disable disables all other SWI functions from running until SWI_enable is called. Hardware interrupts can still run.

SWI_disable and SWI_enable allow you to ensure that statements that must be performed together during critical processing are not interrupted. In the following example, the critical section is not preempted by any software interrupts.

```c
SWI_disable();
    `critical section`
SWI_enable();
```

You can also use SWI_disable and SWI_enable to post several software interrupts and allow them to be performed in priority order. See the example that follows.

SWI_disable calls can be nested. The number of nesting levels is stored internally. Software interrupt handling is not reenabled until SWI_enable has been called as many times as SWI_disable.
The calls to HWI_enter and HWI_exit required in any hardware ISRs that schedules software interrupts automatically disable and reenable software interrupt handling. You should not call SWI_disable or SWI_enable within a hardware ISR.

- SWI_disable cannot be called from the program's main function.

Example

```c
/* ======= postEm ======= */
Void postEm
{
    SWI_disable();
    SWI_post(&encoderSwi);
    SWI_andn(&copySwi, mask);
    SWI_dec(&strikeoutSwi);
    SWI_enable();
}
```

See Also

- HWI_disable
- HWI_enable
- SWI_enable
**SWI_enable**

*Enable software interrupts*

**C Interface**

**Syntax**

SWI_enable();

**Parameters**

Void

**Return Value**

Void

**Assembly Interface**

**Syntax**

SWI_enable

**Preconditions**

SWI_D_lock>= 0 (SWI execution is disabled; that is, locked)
GIE = 1 (interrupts must be enabled)
amr = 0

**Postconditions**

none

**Modifies**

a1, a4, b0, b1, b3, b4, csr

**Reentrant**

yes

**Description**

SWI_disable and SWI_enable control SWI software interrupt processing. SWI_disable disables all other software interrupt functions from running until SWI_enable is called. Hardware interrupts can still run. See the SWI_disable section for details.

SWI_disable calls can be nested. The number of nesting levels is stored internally. Software interrupt handling is not be reenabled until SWI_enable has been called as many times as SWI_disable.

SWI_enable results in a context switch if a higher-priority SWI is ready to run.

**Constraints and Calling Context**

- The calls to HWI_enter and HWI_exit required in any hardware ISRs that schedules software interrupts automatically disable and reenable software interrupt handling. You should not call SWI_disable or SWI_enable within a hardware ISR.
- SWI_enable cannot be called from the program’s main function.

**See Also**

HWI_disable
HWI_enable
SWI_disable
**C Interface**

**Syntax**

```c
SWI_getattrs(swi, attrs);
```

**Parameters**

- `SWI_Handle swi; /* handle of the swi */`
- `SWI_Attrs *attrs; /* pointer to swi attributes */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

`SWI_getattrs` retrieves attributes of an existing SWI object.

The `swi` parameter specifies the address of the SWI object whose attributes are to be retrieved. The `attrs` parameter, which is the pointer to a structure that contains the retrieved attributes for the SWI object, facilitates retrieval of the attributes of the SWI object.

The SWI object’s attributes are specified through a structure of type `SWI_Attrs` defined as follows:

```c
struct SWI_Attrs {
    SWI_Fxn    fnx;
    Arg        arg0;
    Arg        arg1;
    Int        priority;
    Uns        mailbox;
};
```

The `fnx` attribute, which is the address of the SWI function, serves as the entry point of the software interrupt service routine.

The `arg0` and `arg1` attributes specify the arguments passed to the SWI function, `fnx`.

The priority attribute specifies the SWI object’s execution priority and ranges from 0 to 14. The highest level is `SWI_MAXPRI` (14). The lowest is `SWI_MINPRI` (0). The priority level of 0 is reserved for the `KNL_swi` object, which runs the task scheduler.

The mailbox attribute is used either to determine whether to post the SWI or as a value that can be evaluated within the SWI function.

The following example uses `SWI_getattrs`:

```c
extern  SWI_Handle swi;
SWI_Attrs attrs;
```
SWI_getattrs

SWI_getattrs(swi, &attrs);
attrs.priority = 5;
SWI_setattrs(swi, &attrs);

**Constraints and Calling Context**

- SWI_getattrs cannot be called from an SWI or HWI.
- The attrs parameter cannot be NULL.

**See Also**

- SWI_create
- SWI_delete
- SWI_setattrs
**SWI_getmbox**

*Return a SWI's mailbox value*

**C Interface**

**Syntax**

```
num = Uns SWI_getmbox();
```

**Parameters**

Void

**Return Value**

Uns num /* mailbox value */

**Assembly Interface**

**Syntax**

```
SWI_getmbox
```

**Preconditions**

\[ b14 = \text{address of the start of .bss} \]
\[ \text{amr} = 0 \]

**Postconditions**

\[\text{al4 = current software interrupt's mailbox value}\]

**Modifies**

a4

**Reentrant**

yes

**Description**

SWI_getmbox returns the value that SWI's mailbox had when the software interrupt started running. DSP/BIOS saves the mailbox value internally so that SWI_getmbox can access it at any point within an SWI object's function. DSP/BIOS then automatically resets the mailbox to its initial value (defined with the Configuration Tool) so that other threads can continue to use the software interrupt's mailbox.

SWI_getmbox should only be called within a function run by a SWI object.

**Constraints and Calling Context**

- SWI_getmbox cannot be called from an HWI or TSK level.
- SWI_getmbox cannot be called from the program's main function.

**Example**

This call could be used within a SWI object's function to use the mailbox value within the function. For example, if you use SWI_or or SWI_inc to post a software interrupt, different mailbox values can require different processing.

```
swicount = SWI_getmbox();
```
See Also

SWI_andn
SWI_andnHook
SWI_dec
SWI_inc
SWI_or
SWI_orHook
SWI_post
SWI_self
**SWI_getpri**  
*Return a SWI’s priority mask*

**C Interface**

**Syntax**

```c
key = SWI_getpri(swi);
```

**Parameters**

- SWI_Handle swi; /* SWI object handle*/

**Return Value**

- Uns key /* Priority mask of swi */

**Assembly Interface**

**Syntax**

`SWI_getpri`

**Preconditions**

- `a4` = address of the SWI object
- `b14` = address of start of `.bss`

**Postconditions**

- `a4` = SWI object’s priority mask

**Modifies**

- `a4`

**Reentrant**

- yes

**Description**

`SWI_getpri` returns the priority mask of the SWI passed in as the argument.

**Example**

```c
/* Get the priority key of swi1 */
key = SWI_getpri(&swi1);

/* Get the priorities of swi1 and swi3 */
key = SWI_getpri(&swi1) | SWI_getpri(&swi3);
```

**See Also**

- SWI_raisepri
- SWI_restorepri
**SWI_inc**

**Increment SWI's mailbox value**

**C Interface**

**Syntax**

```c
SWI_inc(swi);
```

**Parameters**

- `SWI_Handle swi; /* SWI object handle*/`

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

```asm
SWI_inc
```

**Preconditions**

- `a4 = address of the SWI object`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

- `a0, a1, a2, a3, a4, a5, a6, a7, a9, b0, b1, b2, b3, b4, b5, b6, b7, csr`

**Reentrant**

`no`

**Description**

SWI_inc increments the value in SWI’s mailbox by 1 and posts the software interrupt regardless of the resulting mailbox value. You can decrement a mailbox value by using SWI_dec, which only posts the software interrupt if the mailbox value is 0.

If a software interrupt is posted several times before it has a chance to begin executing, because HWIs and higher priority software interrupts are running, the software interrupt only runs one time. If this situation occurs, you can use SWI_inc to post the software interrupt. Within the software interrupt’s function, you could then use SWI_getmbox to find out how many times this software interrupt has been posted since the last time it was executed.

You specify a software interrupt's initial mailbox value in the Configuration Tool. The mailbox value is automatically reset when the software interrupt executes. To get the mailbox value, use SWI_getmbox.

SWI_inc results in a context switch if the SWI is higher priority than the currently executing thread.

**Constraints and Calling Context**

- If this macro (API) is invoked outside the context of an interrupt service routine, interrupts must be enabled.
- When called within an HWI ISR, the code sequence calling SWI_inc must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.
Example

```c
extern SWI_ObjMySwi;
/* ======== AddAndProcess ======== */

Void AddAndProcess(int count)
{
    int i;

    for (i = 1; i <= count; ++i)
        SWI_inc(&MySwi);
}
```

See Also

- SWI_andn
- SWI_dec
- SWI_getmbox
- SWI_or
- SWI_post
- SWI_self
**SWI_or**

*OR mask with the value contained in SWI's mailbox field*

### C Interface

**Syntax**

```
SWI_or(swi, mask);
```

**Parameters**

- `SWI_Handle swi;` /* SWI object handle*/
- `Uns mask;` /* value to be ORed */

**Return Value**

`Void`

### Assembly Interface

**Syntax**

```
SWI_or
```

**Preconditions**

- `a4 = address of the SWI object`
- `b4 = mask`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

`a0, a1, a2, a3, a4, a5, a6, a7, a9, b0, b1, b2, b3, b4, b5, b6, b7, csr`

**Reentrant**

`no`

### Description

`SWI_or` is used to post a software interrupt. `SWI_or` sets the bits specified by a mask in SWI's mailbox. `SWI_or` posts the software interrupt regardless of the resulting mailbox value. The bitwise logical operation performed on the mailbox value is:

```
mailbox = mailbox OR mask
```

You specify a software interrupt's initial mailbox value in the Configuration Tool. The mailbox value is automatically reset when the software interrupt executes. To get the mailbox value, use `SWI_getmbox`.

For example, you might use `SWI_or` to post a software interrupt if any of three events should cause a software interrupt to be executed, but you want the software interrupt's function to be able to tell which event occurred. Each event would correspond to a different bit in the mailbox.

`SWI_or` results in a context switch if the SWI is higher priority than the currently executing thread.

---

**Note:**

Use the specialized version, `SWI_orHook`, when `SWI_or` functionality is required for a DSP/BIOS object hook function.
Constraints and Calling Context

- If this macro (API) is invoked outside the context of an interrupt service routine, interrupts must be enabled.
- When called within an HWI ISR, the code sequence calling SWI_or must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

See Also
SWI_andn
SWI_andnHook
SWI_dec
SWI_getmbox
SWI_inc
SWI_orHook
SWI_post
SWI_self
**SWI_orHook**

**OR mask with the value contained in SWI's mailbox field**

### C Interface

**Syntax**

```c
SWI_orHook(swi, mask);
```

**Parameters**

- `Arg swi; /* SWI object handle*/`
- `Arg mask; /* value to be ORed */`

**Return Value**

`Void`

### Assembly Interface

**Syntax**

```
SWI_orHook
```

**Preconditions**

- `a4 = address of the SWI object`
- `b4 = mask`
- `amr = 0`

**Postconditions**

`none`

**Modifies**

`a0, a1, a2, a3, a4, a5, a6, a7, a9, b0, b1, b2, b3, b4, b5, b6, b7, csr`

**Reentrant**

`no`

**Description**

SWI_orHook is used to post a software interrupt, and should be used when hook functionality is required for DSP/BIOS hook objects. SWI_orHook sets the bits specified by a mask in SWI's mailbox and also moves the arguments to the correct registers for interfacing with low level DSP/BIOS assembly code. SWI_orHook posts the software interrupt regardless of the resulting mailbox value. The bitwise logical operation performed on the mailbox value is:

```
mailbox = mailbox OR mask
```

You specify a software interrupt's initial mailbox value in the Configuration Tool. The mailbox value is automatically reset when the software interrupt executes. To get the mailbox value, use SWI_getmbox.

For example, you might use SWI_orHook to post a software interrupt if any of three events should cause a software interrupt to be executed, but you want the software interrupt's function to be able to tell which event occurred. Each event would correspond to a different bit in the mailbox.

SWI_orHook results in a context switch if the SWI is higher priority than the currently executing thread.
Note:
Use the specialized version, SWI_orHook, when SWI_or functionality is required for a DSP/BIOS object hook function.

Constraints and Calling Context
- If this macro (API) is invoked outside the context of an interrupt service routine, interrupts must be enabled.
- When called within an HWI ISR, the code sequence calling SWI_orHook must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

See Also
- SWI_andn
- SWI_andnHook
- SWI_dec
- SWI_getmbox
- SWI_inc
- SWI_or
- SWI_post
- SWI_self
**SWI_post**

*Post a software interrupt*

**C Interface**

**Syntax**

```c
SWI_post(swi);
```

**Parameters**

- `SWI_Handle swi;` /* SWI object handle*/

**Return Value**

`Void`

**Assembly Interface**

**Syntax**

```assembly
SWI_post
```

**Preconditions**

- `a4 = address of the SWI object`
- `amr = 0`

**Postconditions**

- `none`

**Modifies**

- `a0, a1, a2, a3, a4, a5, a6, a7, a9, b0, b1, b2, b3, b4, b5, b6, b7, csr`

**Reentrant**

- `yes`

**Description**

`SWI_post` is used to post a software interrupt regardless of the mailbox value. No change is made to the SWI object’s mailbox value.

To have a PRD object post an SWI object’s function, you can set `_SWI_post` as the function property of a PRD object and the name of the software interrupt object you want to post its function as the arg0 property.

SWI_post results in a context switch if the SWI is higher priority than the currently executing thread.

**Constraints and Calling Context**

- ❑ If this macro (API) is invoked outside the context of an interrupt service routine, interrupts must be enabled.
- ❑ When called within an HWI ISR, the code sequence calling SWI_post must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

**See Also**

- `SWI_andn`
- `SWI_dec`
- `SWI_getmbox`
- `SWI_inc`
- `SWI_or`
- `SWI_self`
**SWI_raisepri**

*Raise a SWI’s priority*

**C Interface**

**Syntax**

```c
key = SWI_raisepri(mask);
```

**Parameters**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uns</td>
<td>mask; /* mask of desired priority level */</td>
</tr>
</tbody>
</table>

**Return Value**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uns</td>
<td>key; /* key for use with SWI_restorepri */</td>
</tr>
</tbody>
</table>

**Assembly Interface**

**Syntax**

```assembly
SWI_raisepri
```

**Preconditions**

- `b14 = address of start of .bss`
- `a4 = priority mask of desired priority level`

**Postconditions**

- `a4 = key for use with SWI_restorepri`

**Modifies**

- `a1, a2, a4`

**Reentrant**

- yes

**Description**

SWI_raisepri is used to raise the priority of the currently running SWI to the priority mask passed in as the argument.

SWI_raisepri can be used in conjunction with SWI_restorepri to provide a mutual exclusion mechanism without disabling software interrupts.

SWI_raisepri should be called before the shared resource is accessed, and SWI_restorepri should be called after the access to the shared resource.

A call to SWI_raisepri not followed by a SWI_restorepri keeps the SWI’s priority for the rest of the processing at the raised level. A SWI_post of the SWI posts the SWI at its original priority level.

A SWI object’s execution priority must range from 0 to 14. The highest level is SWI_MAXPRI (14). The lowest is SWI_MINPRI (0). The priority level of 0 is reserved for the KNL_swi object, which runs the task scheduler.

SWI_raisepri never lowers the current SWI priority.

**Constraints and Calling Context**

SWI_raisepri cannot be called from an HWI or TSK level.

**Example**

```c
/* raise priority to the priority of swi_1 */
key = SWI_raisepri(SWI_getpri(&swi_1));
--- access shared resource ---
SWI_restore(key);
```
See Also

- SWI_getpri
- SWI_restorepri
**SWI_restorepri**  
*Restore a SWI’s priority*

**C Interface**

**Syntax**

```
SWI_restorepri(key);
```

**Parameters**

Uns key; /* key to restore original priority level */

**Return Value**

Void

**Assembly Interface**

**Syntax**

```
SWI_restorepri
```

**Preconditions**

b14 = address of start of .bss  
a4 = return value from the SWI_raisepri call

**Postconditions**

none

**Modifies**

a1, a2, a4, b0, csr

**Reentrant**

yes

**Description**

SWI_restorepri restores the priority to the SWI’s priority prior to the SWI_raisepri call returning the key. SWI_restorepri can be used in conjunction with SWI_raisepri to provide a mutual exclusion mechanism without disabling all software interrupts.

SWI_raisepri should be called right before the shared resource is referenced, and SWI_restorepri should be called after the reference to the shared resource.

**Constraints and Calling Context**

- SWI_restorepri cannot be called from an HWI or TSK level.
- SWI_restorepri cannot be called from the program’s main function.

**Example**

```
/* raise priority to the priority of swi_1 */
key = SWI_raisepri(SWI_getpri(&swi_1));
--- access shared resource ---
SWI_restore(key);
```

**See Also**

SWI_getpri  
SWI_raisepri
SWI_self

Return address of currently executing SWI object

C Interface

Syntax
curswi = SWI_self();

Parameters
Void

Return Value
SWI_Handle swi; /* handle for current swi object */

Assembly Interface

Syntax
SWI_self

Preconditions
b14 = address of the start of .bss
amr = 0

Postconditions
a4 = address of the current SWI object

Modifies
a4, b4

Reentrant
yes

Description
SWI_self returns the address of the currently executing software interrupt.

Constraints and
Calling Context

- SWI_self cannot be called from an HWI or TSK level.
- SWI_self cannot be called from the program's main function.

Example
You can use SWI_self if you want a software interrupt to repost itself:

SWI_post(SWI_self());

See Also
SWI_andn
SWI_getmbox
SWI_post
**SWI_setattrs**  
*Set attributes of a software interrupt*

**C Interface**

**Syntax**

```c
SWI_setattrs(swi, attrs);
```

**Parameters**

- `SWI_Handle swi; /* handle of the swi */`
- `SWI_Attrs *attrs; /* pointer to swi attributes */`

**Return Value**

Void

**Assembly Interface**

none

**Description**

SWI_setattrs sets attributes of an existing SWI object.

The `swi` parameter specifies the address of the SWI object whose attributes are to be set.

The `attrs` parameter, which can be either NULL or a pointer to a structure that contains attributes for the SWI object, facilitates setting the attributes of the SWI object. If `attrs` is NULL, the new SWI object is assigned a default set of attributes. Otherwise, the SWI object’s attributes are specified through a structure of type `SWI_Attrs` defined as follows:

```c
struct SWI_Attrs {
    SWI_Fxn    fxn;
    Arg    arg0;
    Arg    arg1;
    Int    priority;
    Uns    mailbox;
};
```

The `fxn` attribute, which is the address of the swi function, serves as the entry point of the software interrupt service routine.

The `arg0` and `arg1` attributes specify the arguments passed to the swi function, `fxn`.

The priority attribute specifies the SWI object’s execution priority and must range from 1 to 14. Priority 14 is the highest priority. You cannot use a priority of 0; that priority is reserved for the system SWI that runs the TSK scheduler.

The mailbox attribute is used either to determine whether to post the SWI or as a value that can be evaluated within the SWI function.

All default attribute values are contained in the constant `SWI_ATTRS`, which can be assigned to a variable of type `SWI_Attrs` prior to calling `SWI_setattrs`.

The following example uses `SWI_setattrs`:

```c
SWI_setattrs
```
extern SWI_Handle swi;
SWI_Attrs attrs;

SWI_getattrs(swi, &attrs);
attrs.priority = 5;
SWI_setattrs(swi, &attrs);

Constraints and Calling Context

- SWI_setattrs must not be used to set the attributes of a SWI that is preempted or is ready to run.
- The fxn attribute cannot be NULL.
- The priority attribute must be less than or equal to 14 and greater than or equal to 1.

See Also

- SWI_create
- SWI_delete
- SWI_getattrs
2.23 SYS Module

The SYS modules manages system settings.

Functions

- SYS_abort. Abort program execution
- SYS_atexit. Stack an exit handler
- SYS_error. Flag error condition
- SYS_exit. Terminate program execution
- SYS_printf. Formatted output
- SYS_putchar. Output a single character
- SYS_sprintf. Formatted output to string buffer
- SYS_vprintf. Formatted output, variable argument list
- SYS_vsprintf. Output formatted data

Constants, Types, and Structures

```
#define SYS_FOREVER (Uns)-1 /* wait forever */
#define SYS_POLL (Uns)0 /* don’t wait */
#define SYS_OK 0 /* no error */
#define SYS_EALLOC 1 /* memory allocation error */
#define SYS_EFREE 2 /* memory free error */
#define SYS_ENODEV 3 /* device driver not found */
#define SYS_EBUSY 4 /* device driver busy */
#define SYS_EINVAL 5 /* invalid device parameter */
#define SYS_EBADIO 6 /* I/O failure */
#define SYS_EMODE 7 /* bad mode for device driver */
#define SYS_EDOMAIN 8 /* domain error */
#define SYS_ETIMEOUT 9 /* call timed out */
#define SYS_EEOF 10 /* end-of-file */
#define SYS_EDEAD 11 /* previously deleted obj */
#define SYS_EBADOBJ 12 /* invalid object */
#define SYS_EUSER 256 /* user errors start here */
```

```
#define SYS_NUMHANDLERS 8 /* # of atexit handlers */
extern String SYS_errors[]; /* array of error strings */
```

Description

The SYS module makes available a set of general-purpose functions that provide basic system services, such as halting program execution and printing formatted text. In general, each SYS function is patterned after a similar function normally found in the standard C library.

SYS does not directly use the services of any other DSP/BIOS module and therefore resides at the bottom of the system. Other DSP/BIOS modules use the services provided by SYS in lieu of similar C library functions. The SYS
module provides hooks for binding system-specific code. This allows programs to gain control wherever other DSP/BIOS modules call one of the SYS functions.

2.23.1 SYS Manager Properties

The following global properties can be set for the SYS module on the SYS Manager Properties dialog in the Configuration Tool:

- **Trace Buffer Size.** The size of the buffer that contains system trace information. For example, by default the Putc function writes to the trace buffer.
- **Trace Buffer Memory.** The memory segment that contains system trace information.
- **Abort Function.** The function to run if the application aborts by calling SYS_abort. The default function is _UTL_doAbort, which logs an error message and calls _halt. If this function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.)
- **Error Function.** The function to run if an error flagged by SYS_error occurs. The default function is _UTL_doError, which logs an error message and returns. If this function is written in C, use a leading underscore before the C function name.
- **Exit Function.** The function to run when the application exits by calling SYS_exit. The default function is UTL_halt, which loops forever with interrupts disabled and prevents other processing. If this function is written in C, use a leading underscore before the C function name.
- **Putc Function.** The function to run if the application calls SYS_putchar, SYS_printf, or SYS_vprintf. The default function is _UTL_doPutc, which writes a character to the trace buffer. If this function is written in C, use a leading underscore before the C function name.

2.23.2 SYS Object Properties

The SYS module does not support the creation of individual SYS objects.
### SYS_abort

**Abort program execution**

**C Interface**

- **Syntax**
  
  ```c
  SYS_abort(format, [arg,] ...);
  ```

- **Parameters**
  
  - `String format;` /* format specification string */
  - `Arg arg;` /* optional argument */

- **Return Value**
  
  `Void`

- **Assembly Interface**
  
  `none`

- **Description**
  
  SYS_abort aborts program execution by calling the function bound to the configuration parameter `Abort function`, where `vargs` is of type `va_list` and represents the sequence of `arg` parameters originally passed to SYS_abort.

  ```c
  (*(Abort_function))(format, vargs)
  ```

  The function bound to `Abort function` can elect to pass the format and `vargs` parameters directly to `SYS_vprintf` or `SYS_vsprintf` prior to terminating program execution.

  The default `Abort function` for the SYS manager is `_UTL_doAbort`, which logs an error message and calls `UTL_halt`, which is defined in the `boot.c` file. The `UTL_halt` function performs an infinite loop with all processor interrupts disabled.

- **Constraints and Calling Context**
  
  If the function bound to `Abort function` is not reentrant, SYS_abort must be called atomically.

- **See Also**
  
  - SYS_exit
  - SYS_printf
SYS_atexit

Stack an exit handler

C Interface

Syntax

success = SYS_atexit(handler);

Parameters

Fxn handler /* exit handler function */

Return Value

Bool success /* handler successfully stacked */

Assembly Interface

none

Description

SYS_atexit pushes handler onto an internal stack of functions to be executed when SYS_exit is called. Up to SYS_NUMHANDLERS(8) functions can be specified in this manner. SYS_exit pops the internal stack until empty and calls each function as follows, where status is the parameter passed to SYS_exit:

(*handler)(status)

SYS_atexit returns TRUE if handler has been successfully stacked; FALSE if the internal stack is full.

The handlers on the stack are called only if either of the following happens:

- SYS_exit is called.
- All tasks for which the Don’t shut down system while this task is still running property is TRUE have exited. (By default, this includes the TSK_idle task, which manages communication between the target and analysis tools.)

Constraints and Calling Context

handler cannot be NULL.
## SYS_error

### Flag error condition

#### C Interface

**Syntax**

```c
SYS_error(s, errno, [arg], ...);
```

**Parameters**

- `String s; /* error string */`
- `Int errno; /* error code */`
- `Arg arg; /* optional argument */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

SYS_error is used to flag DSP/BIOS error conditions. Application programs as well as internal functions use SYS_error to handle program errors.

SYS_error calls the function bound to Error function to handle errors.

The default Error function for the SYS manager is _UTL_doError, which logs an error message and returns.

**Constraints and Calling Context**

- The only valid error numbers are the error constants defined in sys.h (SYS_E*) or numbers greater than or equal to SYS_EUSER. Passing any other error values to SYS_error can cause DSP/BIOS to crash.
- The string passed to SYS_error must be non-NULL.
SYS_exit

<table>
<thead>
<tr>
<th>C Interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>SYS_exit(status);</td>
</tr>
<tr>
<td>Parameters</td>
<td>Int status; /* termination status code */</td>
</tr>
<tr>
<td>Return Value</td>
<td>Void</td>
</tr>
<tr>
<td>Assembly Interface</td>
<td>none</td>
</tr>
</tbody>
</table>

**Description**
SYS_exit first pops a stack of handlers registered through the function SYS_atexit, and then terminates program execution by calling the function bound to the configuration parameter Exit function, passing on its original status parameter.

\[
(*\text{handlerN})(\text{status}) \\
\ldots \\
(*\text{handler2})(\text{status}) \\
(*\text{handler1})(\text{status}) \\
(*\text{(Exit\_function)})(\text{status})
\]

The default Exit function for the SYS manager is UTL_halt, which performs an infinite loop with all processor interrupts disabled.

**Constraints and Calling Context**
If the function bound to Exit function or any of the handler functions is not reentrant, SYS_exit must be called atomically.

**See Also**
SYS_abort
SYS_atexit
SYS_printf

Output formatted data

C Interface

Syntax

SYS_printf(format, [arg,] ...);

Parameters

String format; /* format specification string */
Arg arg; /* optional argument */

Return Value

Void

Assembly Interface

none

Description

SYS_printf provides a subset of the capabilities found in the standard C library function printf.

Note:

SYS_printf and the related functions are code-intensive. If possible, applications should use LOG module functions to reduce code size and execution time.

Conversion specifications begin with a % and end with a conversion character. The conversion characters recognized by SYS_printf are limited to the characters shown in Table 2-6.

Table 2-6. Conversion Characters Recognized by SYS_printf

<table>
<thead>
<tr>
<th>Character</th>
<th>Corresponding Output Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>signed decimal integer</td>
</tr>
<tr>
<td>u</td>
<td>unsigned decimal integer</td>
</tr>
<tr>
<td>f</td>
<td>decimal floating point</td>
</tr>
<tr>
<td>o</td>
<td>octal integer</td>
</tr>
<tr>
<td>x</td>
<td>hexadecimal integer</td>
</tr>
<tr>
<td>c</td>
<td>single character</td>
</tr>
<tr>
<td>s</td>
<td>NULL-terminated string</td>
</tr>
<tr>
<td>p</td>
<td>pointer</td>
</tr>
</tbody>
</table>

Between the % and the conversion character, the following symbols or specifiers contained within square brackets can appear, in the order shown.
%[-][0][width]type

A dash (-) symbol causes the converted argument to be left-justified within a field of width characters with blanks following. A 0 (zero) causes the converted argument to be right-justified within a field of size width with leading 0s. If neither a dash nor 0 are given, the converted argument is right-justified in a field of size width, with leading blanks. The width is a decimal integer. The converted argument is not modified if it has more than width characters, or if width is not given.

The length modifier l can precede %d, %u, %o, and %x if the corresponding argument is a 40-bit long integer. If the argument is a 32-bit long integer (LgInt or LgUns), the l modifier should not be used.

SYS_vprintf is equivalent to SYS_printf, except that the optional set of arguments is replaced by a va_list on which the standard C macro va_start has already been applied. SYS_sprintf and SYS_vsprintf are counterparts of SYS_printf and SYS_vprintf, respectively, in which output is placed in a specified buffer.

Both SYS_printf and SYS_vprintf internally call the function SYS_putchar to output individual characters in a system-dependent fashion via the configuration parameter Putc function. This parameter is bound to a function that displays output on a debugger if one is running, or places output in an output buffer between PUTCEND and PUTCBEG.

Constraints and Calling Context

- On a DSP with floating-point support, SYS_printf prints an error for floating point numbers whose absolute value is greater than the maximum long int (defined as LONG_MAX in the <limits.h> ANSI header). This is because the integer part is computed by simply casting the float parameter to a long int local variable.
- On a DSP with floating-point support, SYS_printf only prints four digits after the decimal point for floating point numbers. Since SYS_printf does not support %e, floating point numbers have to be scaled approximately before being passed to SYS_printf.
- The function bound to Exit function or any of the handler functions are not reentrant; SYS_exit must be called atomically.

See Also

SYS_vprintf
SYS_sprintf
SYS_vsprintf
SYS_sprintf

Output formatted data

C Interface

Syntax

SYS_sprintf (buffer, format, [arg,] ...);

Parameters

String buffer; /* output buffer */
String format; /* format specification string */
Arg arg; /* optional argument */

Return Value

Void

Assembly Interface

none

Description

SYS_sprintf provides a subset of the capabilities found in the standard C library function printf.

Note:

SYS_sprintf and the related functions are code-intensive. If possible, applications should use LOG module functions to reduce code size and execution time.

Conversion specifications begin with a % and end with a conversion character. The conversion characters recognized by SYS_sprintf are limited to the characters in Table 2-7.

Table 2-7. Conversion Characters Recognized by SYS_sprintf

<table>
<thead>
<tr>
<th>Character</th>
<th>Corresponding Output Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>signed decimal integer</td>
</tr>
<tr>
<td>u</td>
<td>unsigned decimal integer</td>
</tr>
<tr>
<td>f</td>
<td>decimal floating point</td>
</tr>
<tr>
<td>o</td>
<td>octal integer</td>
</tr>
<tr>
<td>x</td>
<td>hexadecimal integer</td>
</tr>
<tr>
<td>c</td>
<td>single character</td>
</tr>
<tr>
<td>s</td>
<td>NULL-terminated string</td>
</tr>
<tr>
<td>p</td>
<td>pointer</td>
</tr>
</tbody>
</table>

Application Program Interface 2-295
Between the % and the conversion character, the following symbols or specifiers contained within square brackets can appear, in the order shown.

\[%[-][0][width]type\]

A dash (-) symbol causes the converted argument to be left-justified within a field of width characters with blanks following. A 0 (zero) causes the converted argument to be right-justified within a field of size width with leading 0s. If neither a dash nor 0 are given, the converted argument is right-justified in a field of size width, with leading blanks. The width is a decimal integer. The converted argument is not modified if it has more than width characters, or if width is not given.

The length modifier l can precede %d, %u, %o, and %x if the corresponding argument is a 40-bit long integer. If the argument is a 32-bit long integer (LgInt or LgUns), the l modifier should not be used.

SYS_vprintf is equivalent to SYS_printf, except that the optional set of arguments is replaced by a va_list on which the standard C macro va_start has already been applied. SYS_printf and SYS_vsprintf are counterparts of SYS_printf and SYS_vprintf, respectively, in which output is placed in a specified buffer.

Both SYS_printf and SYS_vprintf internally call the function SYS_putchar to output individual characters in a system-dependent fashion via the configuration parameter Putc function. This parameter is bound to a function that displays output on a debugger if one is running, or places output in an output buffer between PUTCEND and PUTCBEG.

### Constraints and Calling Context

- On a DSP with floating-point support, SYS_printf prints an error for floating point numbers whose absolute value is greater than the maximum long int (defined as LONG_MAX in the <limits.h> ANSI header). This is because the integer part is computed by simply casting the float parameter to a long int local variable.

- On a DSP with floating-point support, SYS_printf only prints four digits after the decimal point for floating point numbers. Since SYS_printf does not support %e, floating point numbers have to be scaled approximately before being passed to SYS_printf.

- The function bound to Exit function or any of the handler functions are not reentrant; SYS_exit must be called atomically.

### See Also

SYS_printf
SYS_vprintf
SYS_vsprintf
**SYS_vprintf**

*Output formatted data*

**C Interface**

**Syntax**

SYS_vprintf(format, vargs);

**Parameters**

- String format; /* format specification string */
- va_list vargs; /* variable argument list reference */

**Return Value**

Void

**Assembly Interface**

none

**Description**

SYS_vprintf provides a subset of the capabilities found in the standard C library function printf.

---

**Note:**

SYS_vprintf and the related functions are code-intensive. If possible, applications should use LOG module functions to reduce code size and execution time.

Conversion specifications begin with a % and end with a conversion character. The conversion characters recognized by SYS_vprintf are limited to the characters in Table 2-8.

**Table 2-8. Conversion Characters Recognized by SYS_vprintf**

<table>
<thead>
<tr>
<th>Character</th>
<th>Corresponding Output Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>signed decimal integer</td>
</tr>
<tr>
<td>u</td>
<td>unsigned decimal integer</td>
</tr>
<tr>
<td>f</td>
<td>decimal floating point</td>
</tr>
<tr>
<td>o</td>
<td>octal integer</td>
</tr>
<tr>
<td>x</td>
<td>hexadecimal integer</td>
</tr>
<tr>
<td>c</td>
<td>single character</td>
</tr>
<tr>
<td>s</td>
<td>NULL-terminated string</td>
</tr>
<tr>
<td>p</td>
<td>pointer</td>
</tr>
</tbody>
</table>

Between the % and the conversion character, the following symbols or specifiers contained within square brackets can appear, in the order shown.
%[-][0][width]type

A dash (-) symbol causes the converted argument to be left-justified within a field of width characters with blanks following. A 0 (zero) causes the converted argument to be right-justified within a field of size width with leading 0s. If neither a dash nor 0 are given, the converted argument is right-justified in a field of size width, with leading blanks. The width is a decimal integer. The converted argument is not modified if it has more than width characters, or if width is not given.

The length modifier l can precede %d, %u, %o, and %x if the corresponding argument is a 40-bit long integer. If the argument is a 32-bit long integer (LgInt or LgUns), the l modifier should not be used.

SYS_vprintf is equivalent to SYS_printf, except that the optional set of arguments is replaced by a va_list on which the standard C macro va_start has already been applied. SYS_sprintf and SYS_vsprintf are counterparts of SYS_printf and SYS_vprintf, respectively, in which output is placed in a specified buffer.

Both SYS_printf and SYS_vprintf internally call the function SYS_putchar to output individual characters in a system-dependent fashion via the configuration parameter Putc function. This parameter is bound to a function that displays output on a debugger if one is running, or places output in an output buffer between PUTCEND and PUTCBEG.

### Constraints and Calling Context

- On a DSP with floating-point support, SYS_printf prints an error for floating point numbers whose absolute value is greater than the maximum long int (defined as LONG_MAX in the <limits.h> ANSI header). This is because the integer part is computed by simply casting the float parameter to a long int local variable.
- On a DSP with floating-point support, SYS_printf only prints four digits after the decimal point for floating point numbers. Since SYS_printf does not support %e, floating point numbers have to be scaled approximately before being passed to SYS_printf.
- The function bound to Exit function or any of the handler functions are not reentrant; SYS_exit must be called atomically.

### See Also

SYS_printf
SYS_sprintf
SYS_vsprintf
SYS_vsprintf

Output formatted data

C Interface

Syntax
SYS_vsprintf(buffer, format, vargs);

Parameters
String buffer; /* output buffer */
String format; /* format specification string */
va_list vargs; /* variable argument list reference */

Return Value
Void

Assembly Interface
none

Description
SYS_vsprintf provides a subset of the capabilities found in the standard C library function printf.

Note:
SYS_vsprintf and the related functions are code-intensive. If possible, applications should use LOG module functions to reduce code size and execution time.

Conversion specifications begin with a % and end with a conversion character. The conversion characters recognized by SYS_vsprintf are limited to the characters in Table 2-9.

Table 2-9. Conversion Characters Recognized by SYS_vsprintf

<table>
<thead>
<tr>
<th>Character</th>
<th>Corresponding Output Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>signed decimal integer</td>
</tr>
<tr>
<td>u</td>
<td>unsigned decimal integer</td>
</tr>
<tr>
<td>f</td>
<td>decimal floating point</td>
</tr>
<tr>
<td>o</td>
<td>octal integer</td>
</tr>
<tr>
<td>x</td>
<td>hexadecimal integer</td>
</tr>
<tr>
<td>c</td>
<td>single character</td>
</tr>
<tr>
<td>s</td>
<td>NULL-terminated string</td>
</tr>
<tr>
<td>p</td>
<td>pointer</td>
</tr>
</tbody>
</table>
SYS_vsprintf

Between the % and the conversion character, the following symbols or specifiers contained within square brackets can appear, in the order shown.

%[-][0][width]type

A dash (-) symbol causes the converted argument to be left-justified within a field of width characters with blanks following. A 0 (zero) causes the converted argument to be right-justified within a field of size width with leading 0s. If neither a dash nor 0 are given, the converted argument is right-justified in a field of size width, with leading blanks. The width is a decimal integer. The converted argument is not modified if it has more than width characters, or if width is not given.

The length modifier I can precede %d, %u, %o, and %x if the corresponding argument is a 40-bit long integer. If the argument is a 32-bit long integer (LgInt or LgUns), the I modifier should not be used.

SYS_vprintf is equivalent to SYS_printf, except that the optional set of arguments is replaced by a va_list on which the standard C macro va_start has already been applied. SYS_sprintf and SYS_vsprintf are counterparts of SYS_printf and SYS_vprintf, respectively, in which output is placed in a specified buffer.

Both SYS_printf and SYS_vprintf internally call the function SYS_putchar to output individual characters in a system-dependent fashion via the configuration parameter Putc function. This parameter is bound to a function that displays output on a debugger if one is running, or places output in an output buffer between PUTCEND and PUTCBEG.

### Constraints and Calling Context

- On a DSP with floating-point support, SYS_printf prints an error for floating point numbers whose absolute value is greater than the maximum long int (defined as LONG_MAX in the <limits.h> ANSI header). This is because the integer part is computed by simply casting the float parameter to a long int local variable.
- On a DSP with floating-point support, SYS_printf only prints four digits after the decimal point for floating point numbers. Since SYS_printf does not support %e, floating point numbers have to be scaled approximately before being passed to SYS_printf.
- The function bound to Exit function or any of the handler functions are not reentrant; SYS_exit must be called atomically.

### See Also

SYS_printf
SYS_sprintf
SYS_vprintf
### SYS_putchar

**Output a single character**

**C Interface**

**Syntax**

SYS_putchar(c);

**Parameters**

Char c; /* next output character */

**Return Value**

Void

**Assembly Interface**

none

**Description**

SYS_putchar outputs the character c by calling the system-dependent function bound to the configuration parameter Putc function.

`((Putc function))(c)`

For systems with limited I/O capabilities, the function bound to Putc function might simply place c into a global buffer that can be examined after program termination.

The default Putc function for the SYS manager is _UTL_doPutc, which writes a character to the trace buffer.

SYS_putchar is also used internally by SYS_printf and SYS_vprintf when generating their output.

**Constraints and Calling Context**

If the function bound to Putc function is not reentrant, SYS_putchar must be called atomically.

**See Also**

SYS_printf
2.24 TRC Module

The TRC module is the trace manager.

**Functions**
- TRC_disable. Disable trace class(es)
- TRC_enable. Enable trace type(s)
- TRC_query. Query trace class(es)

**Description**
The TRC module manages a set of trace control bits which control the real-time capture of program information through event logs and statistics accumulators. For greater efficiency, the target does not store log or statistics information unless tracing is enabled.

Table 2-10 lists events and statistics that can be traced. The constants defined in trc.h, trc.h62, and trc.h64 are shown in the left column.

<table>
<thead>
<tr>
<th>Constant</th>
<th>Tracing Enabled/Disabled</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRC_LOGCLK</td>
<td>Log timer interrupts</td>
<td>off</td>
</tr>
<tr>
<td>TRC_LOGPRD</td>
<td>Log periodic ticks and start of periodic functions</td>
<td>off</td>
</tr>
<tr>
<td>TRC_LOGSWI</td>
<td>Log events when a software interrupt is posted and completes</td>
<td>off</td>
</tr>
<tr>
<td>TRC_LOGTSDK</td>
<td>Log events when a task is made ready, starts, becomes blocked, resumes</td>
<td>off</td>
</tr>
<tr>
<td>TRC_STSHWI</td>
<td>Gather statistics on monitored values within HWIs</td>
<td>off</td>
</tr>
<tr>
<td>TRC_STSPIP</td>
<td>Count number of frames read from or written to data pipe</td>
<td>off</td>
</tr>
<tr>
<td>TRC_STSPRD</td>
<td>Gather statistics on number of ticks elapsed during execution</td>
<td>off</td>
</tr>
<tr>
<td>TRC_STSSWI</td>
<td>Gather statistics on length of SWI execution</td>
<td>off</td>
</tr>
<tr>
<td>TRC_STSTSK</td>
<td>Gather statistics on length of TSK execution. Statistics are gathered from the time TSK is made ready to run until the application calls TSK_deltatime.</td>
<td>off</td>
</tr>
<tr>
<td>TRC_USER0 and TRC_USER1</td>
<td>Your program can use these bits to enable or disable sets of explicit instrumentation actions. You can use TRC_query to check the settings of these bits and either perform or omit instrumentation calls based on the result.</td>
<td>off</td>
</tr>
<tr>
<td>TRC_GBLHOST</td>
<td>This bit must be set in order for any implicit instrumentation to be performed. Simultaneously starts or stops gathering of all enabled types of tracing. This can be important if you are trying to correlate events of different types.</td>
<td>off</td>
</tr>
<tr>
<td>TRC_GBLTARG</td>
<td>This bit must also be set for any implicit instrumentation to be performed. This bit can only be set by the target program and is enabled by default.</td>
<td>on</td>
</tr>
</tbody>
</table>
All trace constants except TRC_GBLTARG are switched off initially. To enable tracing you can use calls to TRC_enable or the DSP/BIOS→RTA Control Panel, which uses the TRC module internally. You do not need to enable tracing for messages written with LOG_printf or LOG_event and statistics added with STS_add or STS_delta.

Your program can call the TRC_enable and TRC_disable operations to explicitly start and stop event logging or statistics accumulation in response to conditions encountered during real-time execution. This enables you to preserve the specific log or statistics information you need to see.

### 2.24.1 TRC - Code Composer Studio Interface

You can choose DSP/BIOS→RTA Control Panel to open a window that allows you to control run-time tracing.

Once you have enabled tracing, you can use DSP/BIOS→Execution Graph and DSP/BIOS→Event Log to see log information, and DSP/BIOS→Statistics View to see statistical information.

You can also control how frequently the host polls the target for trace information. Right-click on the RTA Control Panel and choose the Property Page to set the refresh rate as seen in Figure 2-6. If you set the refresh rate to 0, the host does not poll the target unless you right-click on the RTA Control Panel and choose Refresh Window from the pop-up menu.
Figure 2-6. RTA Control Panel Properties Page

See the Code Composer Studio online tutorial for more information on how to enable tracing in the RTA Control Panel.
# TRC_disable

*Disable trace class(es)*

## C Interface

**Syntax**

```c
TRC_disable(mask);
```

**Parameters**

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mask</td>
<td>Uns</td>
<td>trace type constant mask */</td>
</tr>
</tbody>
</table>

**Return Value**

Void

## Assembly Interface

**Syntax**

`TRC_disable mask`

**Inputs**

`mask`

**Preconditions**

constant - mask for trace types (TRC_LOGSWI, TRC_LOGPRD, ...)

b14 = address of the start of .bss

amr = 0

**Postconditions**

none

**Modifies**

a2, a4

**Reentrant**

no

**Description**

TRC_disable disables tracing of one or more trace types. Trace types are specified with a 32-bit mask. (See the TRC Module for a list of constants to use in the mask.)

The following C code would disable tracing of statistics for software interrupts and periodic functions:

```c
TRC_disable(TRC_LOGSWI | TRC_LOGPRD);
```

Internally, DSP/BIOS uses a bitwise AND NOT operation to disable multiple trace types.

For example, you might want to use TRC_disable with a circular log and disable tracing when an unwanted condition occurs. This allows test equipment to retrieve the log events that happened just before this condition started.

**See Also**

TRC_enable

TRC_query

LOG_printf

LOG_event

STS_add

STS_delta
TRC_enable

Enable trace type(s)

C Interface

Syntax

TRC_enable(mask);

Parameters

Uns mask; /* trace type constant mask */

Return Value

Void

Assembly Interface

Syntax

TRC_enable mask

Inputs

mask

Preconditions

constant - mask for trace types (TRC_LOGSWI, TRC_LOGPRD, ...)
b14 = address of the start of .bss
amr = 0

Postconditions

none

Modifies

a2, a4

Reentrant

no

Description

TRC_enable enables tracing of one or more trace types. Trace types are specified with a 32-bit mask. (See the TRC Module for a list of constants to use in the mask.)

The following C code would enable tracing of statistics for software interrupts and periodic functions:

TRC_enable(TRC_STSSWI | TRC_STSPRD);

Internally, DSP/BIOS uses a bitwise OR operation to enable multiple trace types.

For example, you might want to use TRC_enable with a fixed log to enable tracing when a specific condition occurs. This allows test equipment to retrieve the log events that happened just after this condition occurred.

See Also

TRC_disable
TRC_query
LOG_printf
LOG_event
STS_add
STS_delta
TRC_query

Query trace class(es)

C Interface

Syntax
result = TRC_query(mask);

Parameters
Uns mask; /* trace type constant mask */

Return Value
Int result /* indicates whether all trace types enabled */

Assembly Interface

Syntax
TRC_query mask

Inputs
mask

Preconditions
constant - mask for trace types
b14 = address of the start of .bss
amr = 0

Postconditions
a4 == 0 if all trace types in the mask are enabled
a4 != 0 if any trace type in the mask is disabled

Modifies
a2, a4

Reentrant
yes

Description
TRC_query determines whether particular trace types are enabled.
TRC_query returns 0 if all trace types in the mask are enabled. If any trace
types in the mask are disabled, TRC_query returns a value with a bit set for
each trace type in the mask that is disabled. (See the TRC Module for a list
of constants to use in the mask.)

Trace types are specified with a 32-bit mask. The full list of constants you can
use is included in the description of the TRC module.

For example, the following C code returns 0 if statistics tracing for the PRD
class is enabled:

result = TRC_query(TRC_STSPRD);

The following C code returns 0 if both logging and statistics tracing for the
SWI class are enabled:

result = TRC_query(TRC_LOGSWI | TRC_STSSWI);

Note that TRC_query does not return 0 unless the bits you are querying and
the TRC_GBLHOST and TRC_GBLTARG bits are set. TRC_query returns
non-zero if either TRC_GBLHOST or TRC_GBLTARG are disabled. This is
because no tracing is done unless these bits are set.

For example, if the TRC_GBLHOST, TRC_GBLTARG, and TRC_LOGSWI
bits are set, the following C code returns the results shown:

```c
result = TRC_query(TRC_LOGSWI)    /* returns 0 */
result = TRC_query(TRC_LOGPRD)    /* returns non-zero */
```

However, if only the TRC_GBLHOST and TRC_LOGSWI bits are set, the
same C code returns the results shown:

```c
result = TRC_query(TRC_LOGSWI)    /* returns non-zero */
result = TRC_query(TRC_LOGPRD)    /* returns non-zero */
```

See Also

TRC_enable
TRC_disable
2.25 TSK Module

The TSK module is the task manager.

Functions

- TSK_checkstacks. Check for stack overflow
- TSK_create. Create a task ready for execution
- TSK_delete. Delete a task
- TSK_deltatime. Update task STS with time difference
- TSK_disable. Disable DSP/BIOS task scheduler
- TSK_enable. Enable DSP/BIOS task scheduler
- TSK_exit. Terminate execution of the current task
- TSK_getenv. Get task environment
- TSK_geterr. Get task error number
- TSK_getname. Get task name
- TSK_getpri. Get task priority
- TSK_getsts. Get task STS object
- TSK_itick. Advance system alarm clock (interrupt only)
- TSK_self. Get handle of currently executing task
- TSK_setenv. Set task environment
- TSK_seterr. Set task error number
- TSK_setpri. Set a task’s execution priority
- TSK_settime. Set task STS previous time
- TSK_sleep. Delay execution of the current task
- TSK_stat. Retrieve the status of a task
- TSK_tick. Advance system alarm clock
- TSK_time. Return current value of system clock
- TSK_yield. Yield processor to equal priority task

Task Hook Functions

- Void TSK_createFxnn(TSK_Handle task);
- Void TSK_deleteFxnn(TSK_Handle task);
- Void TSK_exitFxnn(Void);
- Void TSK_readyFxnn(TSK_Handle newtask);
Void TSK_switchFxn(TSK_Handle oldtask, 
                   TSK_Handle newtask);

typedef struct TSK_OBJ *TSK_Handle;  
/* handle for task object */

struct TSK_Attrs {    /* task attributes */
   Int    priority;    /* execution priority */
   Ptr    stack;       /* pre-allocated stack */
   Uns    stacksize;  /* stack size in MADUs */
#ifdef_55_  
   Uns   sysstacksize; /*C55x system stack in MADUs */
#endif  
   Int    stackseg;   /* memory seg for stack allocation */
   Ptr    environ;    /* global environment data structure */
   String name;      /* printable name */
   Bool   exitflag;   /* program termination requires this */
   /* task to terminate */
   TSK_DBG_Mode debug /* indicates enum type TSK_DBG_YES */
   /* TSK_DBG_NO or TSK_DBG_MAYBE */
};

Int TSK_pid;          /* MP processor ID */

Int TSK_MAXARGS = 8;  /* maximum number of task arguments */
Int TSK_IDLEPRI = 0;  /* used for idle task */
Int TSK_MINPRI = 1;   /* minimum execution priority */
Int TSK_MAXPRI = 15;  /* maximum execution priority */
Int TRG_STACKSTAMP = 0xBEBEBEBE

TSK_Attrs TSK_ATTRS = { /* default attribute values */
   TSK->PRIORITY,      /* priority */
   NULL,               /* stack */
   TSK->STACKSIZE,     /* stacksize */
#ifdef _55_  
   TSK->SYSSTACKSIZE, /* C55x system stacksize in MADUs */
#endif  
   NULL,               /* stackseg */
   NULL,               /* environ */
   "",                 /* name */
   TRUE,               /* exitflag */
};

enum TSK_Mode {       /* task execution modes */
   TSK_RUNNING,       /* task is currently executing */
   TSK_READY,         /* task is scheduled for execution */
};

Constants, Types, and Structures
TSK_BLOCKED,       /* task is suspended from execution */
TSK_TERMINATED,    /* task is terminated from execution */
};

struct TSK_Stat {     /* task status structure */
    TSK_Attrs  attrs; /* task attributes */
    TSK_Mode   mode;  /* task execution mode */
    Ptr        sp;    /* task stack pointer */
    Uns        used;  /* task stack used */
};

Description

The TSK module makes available a set of functions that manipulate task objects accessed through handles of type TSK_Handle. Tasks represent independent threads of control that conceptually execute functions in parallel within a single C program; in reality, concurrency is achieved by switching the processor from one task to the next.

When you create a task, it is provided with its own run-time stack, used for storing local variables as well as for further nesting of function calls. The TRG_STACKSTAMP value is used to initialize the run-time stack. Each stack must be large enough to handle normal subroutine calls as well as a single task preemption context. A task preemption context is the context that gets saved when one task preempts another as a result of an interrupt thread readying a higher-priority task. All tasks executing within a single program share a common set of global variables, accessed according to the standard rules of scope defined for C functions.

Each task is in one of four modes of execution at any point in time: running, ready, blocked, or terminated. By design, there is always one (and only one) task currently running, even if it is a dummy idle task managed internally by TSK. The current task can be suspended from execution by calling certain TSK functions, as well as functions provided by other modules like SEM and SIO; the current task can also terminate its execution. In either case, the processor is switched to the next task that is ready to run.

You can assign numeric priorities to tasks through TSK. Tasks are readied for execution in strict priority order; tasks of the same priority are scheduled on a first-come, first-served basis. As a rule, the priority of the currently running task is never lower than the priority of any ready task. Conversely, the running task is preempted and re-scheduled for execution whenever there exists some ready task of higher priority.

You can use the DSP/BIOS Configuration Tool to specify one or more sets of application-wide hook functions that run whenever a task state changes in a particular way. For the TSK module, these functions are the Create, Delete, Exit, Switch, and Ready functions. The HOOK module adds an additional Initialization function.
A single set of hook functions can be specified for the TSK module itself. To create additional sets of hook functions, use the HOOK module. When you create the first HOOK object, any TSK module hook functions you have specified are automatically placed in a HOOK object called HOOK_KNL. To set any properties of this object other than the Initialization function, use the TSK module properties. To set the Initialization function property of the HOOK_KNL object, use the HOOK object properties. If you configure only a single set of hook functions using the TSK module, the HOOK module is not used.

The TSK_create topic describes the Create function. The TSK_delete topic describes the Delete function. The TSK_exit topic describes the Exit function.

If a Switch function is specified, it is invoked when a new task becomes the TSK_RUNNING task. The Switch function gives the application access to both the current and next task handles at task switch time. The function should use these argument types:

```c
Void mySwitchFxn(TSK_Handle currTask,
                 TSK_Handle nextTask);
```

This function can be used to save/restore additional task context (for example, external hardware registers), to check for task stack overflow, to monitor the time used by each task, etc.

If a Ready function is specified, it is invoked whenever a task is made ready to run. Even if a higher-priority thread is running, the Ready function runs. The Ready function will be called with a handle to the task being made ready to run as its argument. This example function prints the name of both the task that is ready to run and the task that is currently running:

```c
Void myReadyFxn(TSK_Handle task)
{
    String      nextName, currName;
    TSK_Handle  currTask = TSK_self();

    nextName = TSK_getname(task);
    LOG_printf(&trace, "Task %s Ready", nextName);

    currName = TSK_getname(currTask);
    LOG_printf(&trace, "Task %s Running", currName);
}
```

The Switch function and Ready function are called in such a way that they can use only functions allowed within a software interrupt handler. See Appendix A, Function Callability and Error Tables, for a list of functions that can be called by SWI handlers. There are no real constraints on what functions are called via the Create function, Delete function, or Exit function.
2.25.1 TSK Manager Properties

The following global properties can be set for the TSK module on the TSK Manager Properties dialog in the Configuration Tool:

- **Enable TSK Manager.** If no tasks are used by the program other than TSK_idle, you can optimize the program by disabling the task manager. The program must then not use TSK objects created with either the Configuration Tool or the TSK_create function. If the task manager is disabled, the idle loop still runs and uses the system stack instead of a task stack.

- **Object Memory.** The memory segment that contains the TSK objects created with the Configuration Tool.

- **Default stack size.** The default size of the stack (in MADUs) used by tasks. You can override this value for an individual task you create with the Configuration Tool or TSK_create. The estimated minimum task size is shown in the status bar of the Configuration Tool. This property applies to TSK objects created both with the Configuration Tool and with TSK_create.

- **Stack segment for dynamic tasks.** The default memory segment that will contain task objects created at run-time with the TSK_create function. The TSK_Attrs structure passed to the TSK_create function can override this default. If you select MEM_NULL for this property, creation of task objects at run-time is disabled.

- **Default task priority.** The default priority level for tasks that are created dynamically with TSK_create. This property applies to TSK objects created both with the Configuration Tool and with TSK_create.

- **TSK tick driven by.** Choose whether you want the system clock to be driven by the PRD module or by calls to TSK_tick and TSK_itick. This clock is used by TSK_sleep and functions such as SEM_pend that accept a timeout argument.

- **Create function.** The name of a function to call when any task is created. This includes tasks that are created statically in the DSP/BIOS Configuration Tool and those created dynamically using TSK_create. If the Create function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.) The TSK_create topic describes the Create function.

- **Delete function.** The name of a function to call when any task is deleted at run-time with TSK_delete. If this function is written in C, use a leading underscore before the C function name. The TSK_delete topic describes the Delete function.
- **Exit function**. The name of a function to call when any task exits. If this function is written in C, use a leading underscore before the C function name. The TSK_exit topic describes the Exit function.

- **Call switch function**. Check this box if you want a function to be called when any task switch occurs.

- **Switch function**. The name of a function to call when any task switch occurs. This function can give the application access to both the current and next task handles. If this function is written in C, use a leading underscore before the C function name. The TSK Module topic describes the Switch function.

- **Call ready function**. Check this box if you want a function to be called when any task becomes ready to run.

- **Ready function**. The name of a function to call when any task becomes ready to run. If this function is written in C, use a leading underscore before the C function name. The TSK Module topic describes the Ready function.

### 2.25.2 TSK Object Properties

The following properties can be set for a TSK object on the TSK Object Properties dialog in the Configuration Tool:

#### General tab

- **comment**. A comment to identify this TSK object.

- **Automatically allocate stack**. Check this box if you want the task's private stack space to be allocated automatically when this task is created. The task’s context is saved in this stack before any higher-priority task is allowed to block this task and run.

- **Manually allocated stack**. If you did not check the box to Automatically allocate stack, type the name of the manually allocated stack to use for this task. If the stack is defined in a C program, add a leading underscore before the stack name.

- **Stack size**. If you checked the box to Automatically allocate stack, enter the size (in MADUs) of the stack space to allocate for this task. Each stack must be large enough to handle normal subroutine calls as well as a single task preemption context. A task preemption context is the context that gets saved when one task preempts another as a result of an interrupt thread readying a higher priority task.

- **Stack Memory Segment**. If you checked the box to Automatically allocate stack, select the memory segment to contain the stack space for this task.

- **Priority**. The priority level for this task.
Function tab

- **Task function.** The function to be executed when the task runs. If this function is written in C, use a leading underscore before the C function name. (The Configuration Tool generates assembly code which must use the leading underscore when referencing C functions or labels.)

- **Task function argument 0-7.** The arguments to pass to the task function. Arguments can be integers or labels. For labels defined in a C program, add a leading underscore before the label name.

Advanced tab

- **Environment pointer.** A pointer to a globally-defined data structure this task can access. The task can get and set the task environment pointer with the TSK_getenv and TSK_setenv functions. If this structure is defined in C, use a leading underscore before the structure name. If your program uses multiple HOOK objects, HOOK_setenv allows you to set individual environment pointers for each HOOK and TSK object combination.

- **Don’t shut down system while this task is still running.** Check this box if you do not want the application to be able to end if this task is still running. The application can still abort. For example, you might clear this box for a monitor task that collects data whenever all other tasks are blocked. The application does not need to explicitly shut down this task.

- **Allocate Task Name on Target.** Check this box if you want the name of this TSK object to be retrievable by the TSK_getname function. Clearing this box saves a small amount of memory. The task name is available in analysis tools in either case.

2.25.3 TSK - DSP/BIOS Analysis Tool Interface

The TSK tab of the Kernel/Object View shows information about task objects.

To enable TSK logging, choosing DSP/BIOS→RTA Control Panel and check the appropriate box. Then you can open the system log by choosing View→System Log. You see a graph of activity that includes TSK function execution states.

Only TSK objects created with the Configuration Tool are traced. The System Log graph includes time spent performing dynamically created TSK functions in the Other Threads row.

You can also enable TSK accumulators in the RTA Control Panel. Then you can choose DSP/BIOS→Statistics View, which lets you select objects for which you want to see statistics. If you choose a TSK object, you see statistics about the time elapsed from the time the TSK was posted (made ready to run) until TSK_deltatime is called by the application. See TSK_settime on page 2-337 and TSK_deltatime on page 2-322 for more information on gathering statistics on TSK objects.
**TSK_checkstacks**

*Check for stack overflow*

**C Interface**

**Syntax**

```c
TSK_checkstacks(oldtask, newtask);
```

**Parameters**

- `TSK_Handle oldtask;` /* handle of task switched from */
- `TSK_Handle newtask;` /* handle of task switched to */

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

`TSK_checkstacks` calls `SYS_abort` with an error message if either `oldtask` or `newtask` has a stack in which the last location no longer contains the initial value TRG_STACKSTAMP. The presumption in one case is that `oldtask`’s stack overflowed, and in the other that an invalid store has corrupted `newtask`’s stack.

You can call `TSK_checkstacks` directly from your application. For example, you can check the current task’s stack integrity at any time with a call like the following:

```c
TSK_checkstacks(TSK_self(), TSK_self());
```

However, it is more typical to call `TSK_checkstacks` in the task Switch function specified for the TSK manager in your configuration file. This provides stack checking at every context switch, with no alterations to your source code.

If you want to perform other operations in the Switch function, you can do so by writing your own function (`myswitchfxn`) and then calling `TSK_checkstacks` from it.

```c
Void myswitchfxn(TSK_Handle oldtask, 
                 TSK_Handle newtask) 
{ 
    'your additional context switch operations' 
    TSK_checkstacks(oldtask, newtask);
    ...
}
```

**Constraints and Calling Context**

`TSK_checkstacks` cannot be called from an HWI or SWI.
**TSK_create**

Create a task ready for execution

C Interface

**Syntax**

```
task = TSK_create(fxn, attrs, [arg,] ...);
```

**Parameters**

- `Fxn fxn; /* pointer to task function */`
- `TSK_Attrs *attrs; /* pointer to task attributes */`
- `Arg arg; /* task arguments */`

**Return Value**

`TSK_Handle task; /* task object handle */`

Assembly Interface

none

Description

TSK_create creates a new task object. If successful, TSK_create returns the handle of the new task object. If unsuccessful, TSK_create returns NULL unless it aborts (for example, because it directly or indirectly calls SYS_error, and SYS_error is configured to abort).

The `fxn` parameter uses the `Fx` type to pass a pointer to the function the TSK object should run. For example, if `myFxn` is a function in your program, you can create a TSK object to call that function as follows:

```
task = TSK_create((Fx)(myFxn), NULL);
```

You can use the DSP/BIOS Configuration Tool to specify an application-wide Create function that runs whenever a task is created. This includes tasks that are created statically in the Configuration Tool and those created dynamically using TSK_create. The default Create function is a no-op function.

For TSK objects created statically, the Create function is called during the BIOS_start portion of the program startup process, which runs after the `main()` function and before the program drops into the idle loop.

For TSK objects created dynamically, the Create function is called after the task handle has been initialized but before the task has been placed on its ready queue.

Any DSP/BIOS function can be called from the Create function. DSP/BIOS passes the task handle of the task being created to your Create function. Your Create function declaration should be similar to the following:

```
Void myCreateFxn(TSK_Handle task);
```

The new task is placed in TSK_READY mode, and is scheduled to begin concurrent execution of the following function call:

```
(*fxn)(arg1, arg2, ... argN) /* N = TSK_MAXARGS = 8 */
```
As a result of being made ready to run, the task runs the application-wide Ready function if one has been specified.

TSK_exit is automatically called if and when the task returns from fxn.

If attrs is NULL, the new task is assigned a default set of attributes. Otherwise, the task’s attributes are specified through a structure of type TSK_Attrs defined as follows:

```c
struct TSK_Attrs {
    Int      priority;
    Ptr      stack;
    Uns      stacksize;
#ifdef _55_
    /*C55x system stack size in MADUs*/
    Uns      sysstacksize;
#endif
    Uns      stackseg;
    Ptr      environ;
    String   name;
    Bool     exitflag;
};
```

The priority attribute specifies the task’s execution priority and must be less than or equal to TSK_MAXPRI (15); this attribute defaults to the value of the configuration parameter Default task priority (preset to TSK_MINPRI). If priority is less than 0, task is barred from execution until its priority is raised at a later time by another task. A priority value of 0 is reserved for the TSK_idle task defined in the default configuration. You should not use a priority of 0 for any other tasks.

The stack attribute specifies a pre-allocated block of stacksize MADUs to be used for the task’s private stack; this attribute defaults to NULL, in which case the task’s stack is automatically allocated using MEM_alloc from the memory segment given by the stackseg attribute.

The stacksize attribute specifies the number of MADUs to be allocated for the task’s private stack; this attribute defaults to the value of the configuration parameter Default stack size (preset to 1024). Each stack must be large enough to handle normal subroutine calls as well as a single task preemption context. A task preemption context is the context that gets saved when one task preempts another as a result of an interrupt thread readying a higher priority task.

The stackseg attribute specifies the memory segment to use when allocating the task stack with MEM_alloc; this attribute defaults to the value of the configuration parameter Default stack segment.
The environ attribute specifies the task's global environment through a generic pointer that references an arbitrary application-defined data structure; this attribute defaults to NULL.

The name attribute specifies the task's printable name, which is a NULL-terminated character string; this attribute defaults to the empty string "". This name can be returned by TSK_getname.

The exitflag attribute specifies whether or not the task must terminate before the program as a whole can terminate; this attribute defaults to TRUE.

All default attribute values are contained in the constant TSK_ATTRS, which can be assigned to a variable of type TSK_Attrs prior to calling TSK_create.

A task switch occurs when calling TSK_create if the priority of the new task is greater than the priority of the current task.

TSK_create calls MEM_alloc to dynamically create the object's data structure. MEM_alloc must acquire a lock to the memory before proceeding. If another thread already holds a lock to the memory, then there is a context switch. The segment from which the object is allocated is described by the DSP/BIOS objects property in the MEM module, page 2-135.

- TSK_create cannot be called from an SWI or HWI.
- The fxn parameter and the name attribute cannot be NULL.
- The priority attribute must be less than or equal to TSK_MAXPRI and greater than or equal to TSK_MINPRI. The priority can be less than zero (0) for tasks that should not execute.
- The string referenced through the name attribute cannot be allocated locally.
- The stackseg attribute must identify a valid memory segment.
- Task arguments passed to TSK_create cannot be greater than 32 bits in length; that is, 40-bit integers and Double or Long Double data types cannot be passed as arguments to the TSK_create function.
- You can reduce the size of your application program by creating objects with the Configuration Tool rather than using the XXX_create functions.

See Also

MEM_alloc
SYS_error
TSK_delete
TSK_exit
TSK_delete

Delete a task

C Interface

Syntax

TSK_delete(task);

Parameters

TSK_Handle task;  /* task object handle */

Return Value

Void

Assembly Interface

none

Description

TSK_delete removes the task from all internal queues and calls MEM_free to free the task object and stack. task should be in a state that does not violate any of the listed constraints.

If all remaining tasks have their exitflag attribute set to FALSE, DSP/BIOS terminates the program as a whole by calling SYS_exit with a status code of 0.

You can use the DSP/BIOS Configuration Tool to specify an application-wide Delete function that runs whenever a task is deleted. The default Delete function is a no-op function. The Delete function is called before the task object has been removed from any internal queues and its object and stack are freed. Any DSP/BIOS function can be called from the Delete function. DSP/BIOS passes the task handle of the task being deleted to your Delete function. Your Delete function declaration should be similar to the following:

Void myDeleteFxn(TSK_Handle task);

TSK_delete calls MEM_free to delete the TSK object. MEM_free must acquire a lock to the memory before proceeding. If another task already holds a lock to the memory, then there is a context switch.

Note:

Unless the mode of the deleted task is TSK_TERMINATED, TSK_delete should be called with care. For example, if the task has obtained exclusive access to a resource, deleting the task makes the resource unavailable.

Constraints and Calling Context

- The task cannot be the currently executing task (TSK_self).
- TSK_delete cannot be called from an SWI or HWI.
- No check is performed to prevent TSK_delete from being used on a statically-created object. If a program attempts to delete a task object that was created using the Configuration Tool, SYS_error is called.
See Also

MEM_free
TSK_create
**TSK_deltatime**

*Update task statistics with difference between current time and time task was made ready*

### C Interface

**Syntax**

```
TSK_deltatime(task);
```

**Parameters**

- `TSK_Handle task; /* task object handle */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

This function accumulates the time difference from when a task is made ready to the time `TSK_deltatime` is called. These time differences are accumulated in the task’s internal STS object and can be used to determine whether or not a task misses real-time deadlines.

If `TSK_deltatime` is not called by a task, its STS object will never be updated in the Statistics View, even if TSK accumulators are enabled in the RTA Control Panel.

TSK statistics are handled differently than other statistics because TSK functions typically run an infinite loop that blocks when waiting for other threads. In contrast, HWI and SWI functions run to completion without blocking. Because of this difference, DSP/BIOS allows programs to identify the “beginning” of a TSK function’s processing loop by calling `TSK_settime` and the “end” of the loop by calling `TSK_deltatime`.

For example, if a task waits for data and then processes the data, you want to ensure that the time from when the data is made available until the processing is complete is always less than a certain value. A loop within the task can look something like the following:

```c
Void task
{
   'do some startup work'

   /* Initialize time in task’s STS object to current time */
   TSK_settime(TSK_self);

   for (;;) {
      /* Get data */
      SIO_get(...);

      'process data'
```
/* Get time difference and add it to task’s STS object */
TSK_deltatime(TSK_self);
}

In the example above, the task blocks on SIO_get and the device driver posts a semaphore that readies the task. DSP/BIOS sets the task’s statistics object with the current time when the semaphore becomes available and the task is made ready to run. Thus, the call to TSK_deltatime effectively measures the processing time of the task.

Constraints and Calling Context

- The results of calls to TSK_deltatime and TSK_settime are displayed in the Statistics View only if Enable TSK accumulators is selected in the RTA Control Panel.

See Also

- TSK_getsts
- TSK_settime
TSK_disable

Disable DSP/BIOS task scheduler

C Interface

Syntax

TSK_disable();

Parameters

Void

Return Value

Void

Assembly Interface

none

Description

TSK_disable disables the DSP/BIOS task scheduler. The current task continues to execute (even if a higher priority task can become ready to run) until TSK_enable is called.

TSK_disable does not disable interrupts, but is instead used before disabling interrupts to make sure a context switch to another task does not occur when interrupts are disabled.

TSK_disable handlers are disabled. TSK_disable maintains a count which allows nested calls to TSK_disable. Task switching is not reenabled until TSK_enable has been called as many times as TSK_disable. Calls to TSK_disable can be nested.

Since TSK_disable can prohibit ready tasks of higher priority from running it should not be used as a general means of mutual exclusion. SEM semaphores should be used for mutual exclusion when possible.

Constraints and Calling Context

- No kernel operations that can cause the current task to block can be made from within a TSK_disable / TSK_enable block. This includes SEM_pend (unless timeout is 0), TSK_sleep, and TSK_yield.
- TSK_yield cannot be called within a TSK_disable / TSK_enable block.
- TSK_disable cannot be called from an SWI or HWI.
- TSK_disable cannot be called from the program’s main function.

See Also

SEM Module
TSK_enable
### TSK_enable

**Enable DSP/BIOS task scheduler**

<table>
<thead>
<tr>
<th>C Interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>TSK_enable();</td>
</tr>
<tr>
<td>Parameters</td>
<td>Void</td>
</tr>
<tr>
<td>Return Value</td>
<td>Void</td>
</tr>
</tbody>
</table>

| Assembly Interface | none |

**Description**

TSK_enable is used to reenable the DSP/BIOS task scheduler after TSK_disable has been called. Since TSK_disable calls can be nested, the task scheduler is not enabled until TSK_enable is called the same number of times as TSK_disable.

A task switch occurs when calling TSK_enable only if there exists a TSK_READY task whose priority is greater than the currently executing task.

**Constraints and Calling Context**

- No kernel operations that can cause the current task to block (for example, SEM_pend, TSK_sleep, TSK_yield) can be made from within a TSK_disable / TSK_enable block.
- TSK_enable cannot be called from an SWI or HWI.
- TSK_enable cannot be called from the program’s main function.

**See Also**

- SEM Module
- TSK_disable
### TSK_exit

**Terminate execution of the current task**

#### C Interface

<table>
<thead>
<tr>
<th>Syntax</th>
<th>TSK_exit();</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>Void</td>
</tr>
<tr>
<td>Return Value</td>
<td>Void</td>
</tr>
</tbody>
</table>

#### Assembly Interface

none

#### Description

TSK_exit terminates execution of the current task, changing its mode from TSK_RUNNING to TSK_TERMINATED. If all tasks have been terminated, or if all remaining tasks have their exitflag attribute set to FALSE, then DSP/BIOS terminates the program as a whole by calling the function SYS_exit with a status code of 0.

TSK_exit is automatically called whenever a task returns from its top-level function.

You can use the DSP/BIOS Configuration Tool to specify an application-wide Exit function that runs whenever a task is terminated. The default Exit function is a no-op function. The Exit function is called before the task has been blocked and marked TSK_TERMINATED. Any DSP/BIOS function can be called from an Exit function. Calling TSK_self() within an Exit function returns the task being exited. Your Exit function declaration should be similar to the following:

```c
Void myExitFxn(Void);
```

A task switch occurs when calling TSK_exit unless the program as a whole is terminated.

#### Constraints and Calling Context

- TSK_exit cannot be called from an SWI or HWI.
- TSK_exit cannot be called from the program’s main function.

#### See Also

- MEM_free
- TSK_create
- TSK_delete
**TSK_getenv**

*Get task environment pointer*

**C Interface**

**Syntax**

```c
environ = TSK_getenv(task);
```

**Parameters**

- TSK_Handle task; /* task object handle */

**Return Value**

- Ptr environ; /* task environment pointer */

**Assembly Interface**

none

**Description**

TSK_getenv returns the environment pointer of the specified task. The environment pointer, environ, references an arbitrary application-defined data structure.

If your program uses multiple HOOK objects, HOOK_getenv allows you to get environment pointers you have set for a particular HOOK and TSK object combination.

**See Also**

- HOOK_getenv
- HOOK_setenv
- TSK_setenv
- TSK_seterr
- TSK_setpri
TSK_geterr

Get task error number

C Interface

Syntax

```
errno = TSK_geterr(task);
```

Parameters

- `TSK_Handle task; /* task object handle */`

Return Value

- `Int errno; /* error number */`

Assembly Interface

- `none`

Description

Each task carries a task-specific error number. This number is initially SYS_OK, but it can be changed by TSK_seterr. TSK_geterr returns the current value of this number.

See Also

- SYS_error
- TSK_setenv
- TSK_seterr
- TSK_setpri
**TSK_getname**  
*Get task name*

**C Interface**

**Syntax**

```c
name = TSK_getname(task);
```

**Parameters**

`TSK_Handle task; /* task object handle */`

**Return Value**

`String name; /* task name */`

**Assembly Interface**

`none`

**Description**

TSK_getname returns the task’s name.

For tasks created with the Configuration Tool, the name is available to this function only if the Allocate Task Name on Target box is checked in the properties for this task. For tasks created with TSK_create, TSK_getname returns the attrs.name field value, or an empty string if this attribute was not specified.

**See Also**

TSK_setenv  
TSK_seterr  
TSK_setpri
**TSK_getpri**  
*Get task priority*

**C Interface**

- **Syntax**
  
  ```c
  priority = TSK_getpri(task);
  ```

- **Parameters**
  
  - `TSK_Handle task; /* task object handle */`

- **Return Value**
  
  - `Int priority; /* task priority */`

**Assembly Interface**

- `none`

**Description**

- TSK_getpri returns the priority of task.

**See Also**

- TSK_setenv
- TSK_seterr
- TSK_setpri

---

2-330
**TSK_getsts**

*Get the handle of the task’s STS object*

**C Interface**

**Syntax**

\[
\text{sts = TSK_getsts(task);}
\]

**Parameters**

TSK_Handle task; /* task object handle */

**Return Value**

STS_Handle sts; /* statistics object handle */

**Assembly Interface**

none

**Description**

This function provides access to the task’s internal STS object. For example, you can want the program to check the maximum value to see if it has exceeded some value.

**See Also**

TSK_deltatime
TSK_settime
Advancing the System Alarm Clock (Interrupt Use Only)

C Interface

Syntax

`TSK_itick();`

Parameters

Void

Return Value

Void

Assembly Interface

none

Description

TSK_itick increments the system alarm clock, and readies any tasks blocked on TSK_sleep or SEM_pend whose timeout intervals have expired.

Constraints and Calling Context

- TSK_itick cannot be called by a TSK object.
- TSK_itick cannot be called from the program’s main function.
- When called within an HWI ISR, the code sequence calling TSK_itick must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

See Also

SEM_pend

TSK_sleep

TSK_tick
<table>
<thead>
<tr>
<th><strong>TSK_self</strong></th>
<th>Returns handle to the currently executing task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C Interface</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Syntax</strong></td>
<td>curtask = TSK_self();</td>
</tr>
<tr>
<td><strong>Parameters</strong></td>
<td>Void</td>
</tr>
<tr>
<td><strong>Return Value</strong></td>
<td>TSK_Handle curtask; /* handle for current task object */</td>
</tr>
<tr>
<td><strong>Assembly Interface</strong></td>
<td>none</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>TSK_self returns the object handle for the currently executing task. This function is useful when inspecting the object or when the current task changes its own priority through TSK_setpri. No task switch occurs when calling TSK_self.</td>
</tr>
<tr>
<td><strong>See Also</strong></td>
<td>TSK_setpri</td>
</tr>
</tbody>
</table>
**TSK_setenv**  
*Set task environment*

**C Interface**

**Syntax**

```c
TSK_setenv(task, environ);
```

**Parameters**

- `TSK_Handle task; /* task object handle */`
- `Ptr environ; /* task environment pointer */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

`TSK_setenv` sets the task environment pointer to `environ`. The environment pointer, `environ`, references an arbitrary application-defined data structure.

If your program uses multiple HOOK objects, `HOOK_setenv` allows you to set individual environment pointers for each HOOK and TSK object combination.

**See Also**

- `HOOK_getenv`
- `HOOK_setenv`
- `TSK_getenv`
- `TSK_geterr`
**TSK_seterr**  
*Set task error number*

### C Interface

**Syntax**

```c
TSK_seterr(task, errno);
```

**Parameters**

- `TSK_Handle task; /* task object handle */`
- `Int errno; /* error number */`

**Return Value**

Void

**Assembly Interface**

none

**Description**

Each task carries a task-specific error number. This number is initially SYS_OK, but can be changed to `errno` by calling TSK_seterr. TSK_geterr returns the current value of this number.

**See Also**

TSK_getenv  
TSK_geterr
**TSK_setpri**

*Set a task’s execution priority*

**C Interface**

**Syntax**

```c
oldpri = TSK_setpri(task, newpri);
```

**Parameters**

- `TSK_Handle task; /* task object handle */`
- `Int newpri; /* task's new priority */`

**Return Value**

- `Int oldpri; /* task's old priority */`

**Assembly Interface**

none

**Description**

`TSK_setpri` sets the execution priority of `task` to `newpri`, and returns that task’s old priority value. Raising or lowering a task’s priority does not necessarily force preemption and re-scheduling of the caller: tasks in the TSK_BLOCKED mode remain suspended despite a change in priority; and tasks in the TSK_READY mode gain control only if their (new) priority is greater than that of the currently executing task.

The maximum value of `newpri` is TSK_MAXPRI(15). If the minimum value of `newpri` is TSK_MINPRI(0). If `newpri` is less than 0, task is barred from further execution until its priority is raised at a later time by another task; if `newpri` equals TSK_MAXPRI, execution of task effectively locks out all other program activity, except for the handling of interrupts.

The current task can change its own priority (and possibly preempt its execution) by passing the output of `TSK_self` as the value of the task parameter.

A context switch occurs when calling `TSK_setpri` if a task makes its own priority lower than the priority of another currently ready task, or if the currently executing task makes a ready task’s priority higher than its own priority. `TSK_setpri` can be used for mutual exclusion.

**Constraints and Calling Context**

- `newpri` must be less than or equal to TSK_MAXPRI.
- The task cannot be TSK_TERMINATED.
- The new priority should not be zero (0). This priority level is reserved for the TSK_idle task.

**See Also**

- `TSK_self`
- `TSK_sleep`
**TSK_settime**

*Reset task statistics previous value to current time*

**C Interface**

**Syntax**

```
TSK_settime(task);
```

**Parameters**

- TSK_Handle *task*; /* task object handle */

**Return Value**

Void

**Assembly Interface**

none

**Description**

Your application can call TSK_settime before a task enters its processing loop in order to ensure your first call to TSK_deltatime is as accurate as possible and doesn’t reflect the time difference since the time the task was created. However, it is only necessary to call TSK_settime once for initialization purposes. After initialization, DSP/BIOS sets the time value of the task’s STS object every time the task is made ready to run.

TSK statistics are handled differently than other statistics because TSK functions typically run an infinite loop that blocks when waiting for other threads. In contrast, HWI and SWI functions run to completion without blocking. Because of this difference, DSP/BIOS allows programs to identify the “beginning” of a TSK function’s processing loop by calling TSK_settime and the “end” of the loop by calling TSK_deltatime.

For example, a loop within the task can look something like the following:

```
Void task
{
    ‘do some startup work’

    /* Initialize time in task’s 
     STS object to current time */
    TSK_settime(TSK_self());

    for (;;) {
        /* Get data */
        SIO_get(...);

        ‘process data’

        /* Get time difference and 
         add it to task’s STS object */
        TSK_deltatime(TSK_self());
    }
}
```

In the previous example, the task blocks on SIO_get and the device driver posts a semaphore that readies the task. DSP/BIOS sets the task’s statistics
object with the current time when the semaphore becomes available and the task is made ready to run. Thus, the call to TSK_deltatime effectively measures the processing time of the task.

**Constraints and Calling Context**

- TSK_settime cannot be called from the program's main function.
- The results of calls to TSK_deltatime and TSK_settime are displayed in the Statistics View only if Enable TSK accumulators is selected within the RTA Control Panel.

**See Also**

- TSK_deltatime
- TSK_getsts
**TSK_sleep**

*Delay execution of the current task*

**C Interface**

**Syntax**

```c
void TSK_sleep(unsigned int nticks);
```

**Parameters**

Uns nticks; /* number of system clock ticks to sleep */

**Return Value**

Void

**Assembly Interface**

none

**Description**

TSK_sleep changes the current task’s mode from TSK_RUNNING to TSK_BLOCKED, and delays its execution for nticks increments of the system clock. The actual time delayed can be up to 1 system clock tick less than timeout due to granularity in system timekeeping.

After the specified period of time has elapsed, the task reverts to the TSK_READY mode and is scheduled for execution.

A task switch always occurs when calling TSK_sleep if nticks > 0.

**Constraints and Calling Context**

- TSK_sleep cannot be called from an SWI or HWI, or within a TSK_disable / TSK_enable block.
- TSK_sleep cannot be called from the program’s main function.
- TSK_sleep should not be called from within an IDL function. Doing so prevents analysis tools from gathering run-time information.
- nticks cannot be SYS_FOREVER.
**TSK_stat**

*Retrieve the status of a task*

**C Interface**

**Syntax**

```c
TSK_stat(task, statbuf);
```

**Parameters**

- `TSK_Handle task; /* task object handle */`
- `TSK_Stat *statbuf; /* pointer to task status structure */`

**Return Value**

`Void`

**Assembly Interface**

`none`

**Description**

`TSK_stat` retrieves attribute values and status information about task; the current task can inquire about itself by passing the output of `TSK_self` as the first argument to `TSK_stat`.

Status information is returned through `statbuf`, which references a structure of type `TSK_Stat` defined as follows:

```c
struct TSK_Stat {    /* task status structure */
    TSK_Attrs attrs; /* task attributes */
    TSK_Mode mode;  /* task execution mode */
    Ptr sp;    /* task’s current stack pointer */
    Uns used;  /* max number of words ever */
               /* used on the task stack */
};
```

When a task is preempted by a software or hardware interrupt, the task execution mode returned for that task by `TSK_stat` is still `TSK_RUNNING` because the task will run when the preemption ends.

`TSK_stat` has a non-deterministic execution time. As such, it is not recommended to call this API from SWIs or HWIs.

**Constraints and Calling Context**

`statbuf` cannot be `NULL`.

**See Also**

`TSK_create`
TSK_tick

Advance the system alarm clock

C Interface

Syntax
TSK_tick();

Parameters
Void

Return Value
Void

Assembly Interface
none

Description
TSK_tick increments the system clock, and readies any tasks blocked on TSK_sleep or SEM_pend whose timeout intervals have expired. TSK_tick can be invoked by an ISR or by the currently executing task. The latter is particularly useful for testing timeouts in a controlled environment.

A task switch occurs when calling TSK_tick if the priority of any of the readied tasks is greater than the priority of the currently executing task.

Constraints and Calling Context
When called within an HWI ISR, the code sequence calling TSK_tick must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.

See Also
CLK Module
SEM_pend
TSK_itick
TSK_sleep
TSK_time

Return current value of system clock

C Interface

Syntax

curtime = TSK_time();

Parameters

Void

Return Value

Uns curtime; /* current time */

Assembly Interface

none

Description

TSK_time returns the current value of the system alarm clock.

Note that since the system clock is usually updated asynchronously by an interrupt service routine (via TSK_itick or TSK_tick), curtime can lag behind the actual system time. This lag can be even greater if a higher priority task preempts the current task between the call to TSK_time and when its return value is used. Nevertheless, TSK_time is useful for getting a rough idea of the current system time.
**TSK_yield**

*Yield processor to equal priority task*

**C Interface**

**Syntax**

TSK_yield();

**Parameters**

Void

**Return Value**

Void

**Assembly Interface**

none

**Description**

TSK_yield yields the processor to another task of equal priority.

A task switch occurs when you call TSK_yield if there is an equal priority task ready to run.

**Constraints and Calling Context**

- When called within an HWI ISR, the code sequence calling TSK_yield must be either wrapped within an HWI_enter/HWI_exit pair or invoked by the HWI dispatcher.
- TSK_yield cannot be called from the program’s main function.
- TSK_yield should not be called from within a TSK_disable/TSK_enable block.

**See Also**

TSK_sleep
2.26 std.h and stdlib.h Functions

This section contains descriptions of special utility macros found in std.h and DSP/BIOS standard library functions found in stdlib.h.

**Macros**
- `ArgToInt`. Cast an Arg type parameter as an integer type.
- `ArgToPtr`. Cast an Arg type parameter as a pointer type.

**Functions**
- `atexit`. Register an exit function.
- `calloc`. Allocate and clear memory.
- `exit`. Call the exit functions registered by atexit.
- `free`. Get environmental variable.
- `malloc. Allocate memory.
- `realloc`. Reallocate a memory packet.

**Syntax**
```c
#include <std.h>
ArgToInt (arg)
ArgToPtr (arg)

#include <stdlib.h>
int atexit (void (*fcn) (void));
void *calloc (size_t nobj, size_t size);
void exit (int status);
void free (void *p);
char *getenv (char *name);
void *malloc (size_t size);
void *realloc (void *p, size_t size);
```

**Description**
The DSP/BIOS library contains some C standard library functions which supersede the library functions bundled with the C compiler. These functions follow the ANSI C specification for parameters and return values. Consult Kernighan and Ritchie for a complete description of these functions.

The functions calloc, free, malloc, and realloc use MEM_alloc and MEM_free (with segid = Segment for malloc/free) to allocate and free memory.

`getenv` uses the _environ variable defined and initialized in the boot file to search for a matching environment string.

`exit` calls the exit functions registered by `atexit` before calling SYS_exit.
This chapter provides documentation for TMS320C6000 utilities that can be used to examine various files from the MS-DOS command line. These programs are provided with DSP/BIOS in the bin subdirectory. Any other utilities that may occasionally reside in the bin subdirectory and not documented here are for internal Texas Instruments' use only.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 cdbprint</td>
<td>3-2</td>
</tr>
<tr>
<td>3.2 gconfgen</td>
<td>3-3</td>
</tr>
<tr>
<td>3.3 nmti</td>
<td>3-6</td>
</tr>
<tr>
<td>3.4 sectti</td>
<td>3-7</td>
</tr>
<tr>
<td>3.5 sizeti</td>
<td>3-8</td>
</tr>
<tr>
<td>3.6 vers</td>
<td>3-9</td>
</tr>
</tbody>
</table>
cdbprint

3.1 cdbprint

**Prints a listing of all parameters defined in a configuration file**

**Syntax**

cdbprint [-a] [-l] [-w] cdb-file

**Description**

This utility reads a .cdb file created with the Configuration Tool and creates a list of all the objects and parameters. This tool can be used to compare two configuration files or to simply review the values of a single configuration file.

The -a flag causes cdbprint to list all objects and fields including those that are normally not visible (i.e., unconfigured objects and hidden fields). Without this flag, cdbprint ignores unconfigured objects or modules as well as any fields that are hidden.

The -l flag causes cdbprint to list the internal parameter names instead of the labels used by the Configuration Tool. Without this flag, cdbprint lists the labels used by the Configuration Tool.

The -w flag causes cdbprint to list only those parameters that can also be modified in the Configuration Tool. Without this flag, cdbprint lists both read-only and read-write parameters.

**Example**

The following sequence of commands can be used to compare a configuration file called test62.cdb to the default configuration provided with DSP/BIOS:

```
cdbprint ..../include/bios62.cdb > original.txt
cdbprint test62.cdb > test62.txt
diff original.txt test62.txt
```
3.2 gconfgen

Reads a .cdb file created with the Configuration Tool

Syntax

gconfgen cdb-file

Description

This command line utility reads a .cdb file (e.g. program.cdb) created with the Configuration Tool, where program is the name of your project, or program. The utility generates the target configuration files that are linked with the rest of the application code.

When you save a configuration file, the following files are created.

- **program.cdb.** Stores configuration settings for use by the Configuration Tool
- **programcfg.cmd.** Linker command file
- **programcfg.h62.** Assembly language header file included by hellocfg.s55
- **programcfg.s62.** Assembly language source file
- **programcfg_c.c.** Source file to define Chip Support Library (CSL) structures and properties. See the CSL documentation for more information.
- **programcfg.h.** Header file to include CSL header files and declare external variables for CSL objects. See the CSL documentation for more information.

The .h62 and .s62 extensions are generated for C62, C64, and C67 devices.

This utility is useful when the build process is controlled by a scripted mechanism, such as a make file, to generate the configuration source files from the configuration database file (.cdb file). Caution should be used, however, following product upgrades, since gconfgen does not detect revision changes. After a product update, use the graphical Configuration Tool to update your .cdb files to the new version. Once updated, gconfgen can be used again to generate the target configuration files.
Example

You can use gconfgen, as shown in the following example, from the makefiles provided with the DSP/BIOS examples in the product distribution. To use gconfgen from the command line or makefiles, use its full path (TI_DIR\plugins\bios\gconfgen) or add its folder (TI_DIR\plugins\bios) to your PATH environment variable. (Note that TI_DIR is the root directory of the product distribution).

```
/*
 * Makefile for creation of program named by the
 * PROG variable. The following naming conventions
 * are used by this makefile:
 *
 * <prog>.asm - C62 assembly language source file
 * <prog>.obj - C62 object file (compiled/assembled)
 * <prog>.out - C62 executable (fully linked program)
 * <prog>cfg.s62 - configuration assembly source file
 *               generated by Configuration Tool
 * <prog>cfg.h62 - configuration assembly header file
 *               generated by Configuration Tool
 * <prog>cfg.cmd - configuration linker command file
 *               generated by Configuration Tool
 *

TI_DIR := $(subst \,/,$(TI_DIR))
include $(TI_DIR)/c6000/bios/include/c62rules.mak

* Compiler, assembler, and linker options.
* -g enable symbolic debugging
CC62OPTS = -g
AS62OPTS =
  * -q quiet run
LD62OPTS = -g
  * -q quiet run
* Every BIOS program must be linked with:
* $(PROG)cfg.o62 - from assembling $(PROG)cfg.s62
* $(PROG)cfg.cmd - linker command file generated by
* Configuration Tool. If additional linker command
* files exist, $(PROG)cfg.cmd must appear first.
*
PROG   = tsktest
OBJS   = $(PROG)cfg.obj
LIBS   =
CMDS   = $(PROG)cfg.cmd
*
  * Targets:
* */
```
all:: $(PROG).out
$(PROG).out: $(OBS) $(CMDS)
$(PROG)cfg.obj: $(PROG)cfg.h62
$(PROG).obj:
$(PROG)cfg.s62 $(PROG)cfg.h62 $(PROG)cfg.cmd ::
$(PROG).cdb $(TI_DIR)/plugins/bios/gconfgen $(PROG).cdb
.clean clean::
  @ echo removing generated configuration files ...
  @$(REMOVE) -f $(PROG)cfg.s62 $(PROG)cfg.h62
$(PROG)cfg.cmd
  @ echo removing object files and binaries ...
  @$(REMOVE) -f *.obj *.out *.lst *.map
Display symbols and values in a TI COFF file

Syntax

nmti [file1 file2 ...]

Description

nmti prints the symbol table (name list) for each TI executable file listed on the command line. Executable files must be stored as COFF (Common Object File Format) files.

If no files are listed, the file a.out is searched. The output is sent to stdout. Note that both linked (executable) and unlinked (object) files can be examined with nmti.

Each symbol name is preceded by its value (blanks if undefined) and one of the following letters:

- A absolute symbol
- B bss segment symbol
- D data segment symbol
- E external symbol
- S section name symbol
- T text segment symbol
- U undefined symbol

The letter is upper case if the symbol is external, and lower case if it is local.
3.4 sectti

*Display information about sections in TI COFF files*

**Syntax**

sectti [-a] [file1 file2 ...]

**Description**

sectti displays location and size information for all the sections in a TI executable file. Executable files must be stored as COFF (Common Object File Format) files.

All values are in hexadecimal. If no file names are given, a.out is assumed. Note that both linked (executable) and unlinked (object) files can be examined with sectti.

Using the -a flag causes sectti to display all program sections, including sections used only on the target by the DSP/BIOS plug-ins. If you omit the -a flag, sectti displays only the program sections that are loaded on the target.
3.5 sizeti

Display the section sizes of an object file

Syntax

sizeti[file1 file2 ...]

Description

This utility prints the decimal number of MADUs required by all code sections, all data sections, and the .bss and .stack sections for each COFF file argument. If no file is specified, a.out is used. Note that both linked (executable) and unlinked (object) files can be examined with this utility.

All sections that are located in program memory are included as part of the value reported by the sizeti utility.
3.6 vers

Display version information for a DSP/BIOS source or library file

Syntax

vers [file1 file2 ...]

Description

The vers utility displays the version number of DSP/BIOS files installed in your system. For example, the following command checks the version number of the bios.a62 file in the lib sub-directory.

```bash
..\bin\vers bios.a62
bios.a62:
  *** library
  *** "date and time"
  *** bios-c06
  *** "version number"
```

The actual output from vers may contain additional lines of information. To identify your software version number to Technical Support, use the version number shown.

Note that both libraries and source files can be examined with vers.
Function Callability and Error Tables

This appendix provides tables describing TMS320C6000 errors and function callability.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 Function Callability by Thread Type</td>
<td>A-2</td>
</tr>
<tr>
<td>A.2 DSP/BIOS Error Codes</td>
<td>A-8</td>
</tr>
</tbody>
</table>
## A.1 Function Callability by Thread Type

<table>
<thead>
<tr>
<th>Function</th>
<th>Interface (C and/or Assembly)</th>
<th>Callable by Tasks?</th>
<th>Callable by SWI Handlers?</th>
<th>Callable by Hardware ISRs?</th>
<th>Possible Context Switch?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM_andi</td>
<td>C</td>
<td>Yes</td>
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<td>C62_enableIER</td>
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<td>No</td>
</tr>
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<td>C62_plug</td>
<td>C</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
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<td>C64_disableIER</td>
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<td>Yes</td>
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<td>No</td>
</tr>
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<td>C64_enableIER</td>
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<td>Yes</td>
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<td>Yes</td>
<td>No</td>
</tr>
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<td>No</td>
</tr>
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<td>CLK_countspms</td>
<td>C, assembly</td>
<td>Yes</td>
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<td>No</td>
</tr>
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<td>CLK_gettime</td>
<td>C, assembly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CLK_gettime</td>
<td>C, assembly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CLK_getprd</td>
<td>C, assembly</td>
<td>Yes</td>
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<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>DEV_match</td>
<td>C</td>
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<td>Yes</td>
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</tr>
<tr>
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<td>C</td>
<td>Yes</td>
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<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HOOK_setenv</td>
<td>C</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HST_getpipe</td>
<td>C, assembly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HWI_disable</td>
<td>C, assembly</td>
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<td>No</td>
</tr>
<tr>
<td>HWI_dispatchPlug</td>
<td>none</td>
<td>Yes</td>
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<td>Yes</td>
<td>No</td>
</tr>
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<td>HWI_enable</td>
<td>C, assembly</td>
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<td>Yes‡</td>
</tr>
<tr>
<td>Function</td>
<td>Interface (C and/or Assembly)</td>
<td>Callable by Tasks?</td>
<td>Callable by SWI Handlers?</td>
<td>Callable by Hardware ISRs?</td>
<td>Possible Context Switch?</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------</td>
<td>--------------------</td>
<td>---------------------------</td>
<td>-----------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>HWI_enter</td>
<td>assembly</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HWI_exit</td>
<td>assembly</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HWI_restore</td>
<td>C, assembly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes†</td>
</tr>
<tr>
<td>IDL_run</td>
<td>C</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LCK_create</td>
<td>C</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes†</td>
</tr>
<tr>
<td>LCK_delete</td>
<td>C</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes†</td>
</tr>
<tr>
<td>LCK_pend</td>
<td>C</td>
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## Function Callability by Thread Type

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</tr>
<tr>
<td>SYS_vsprintf</td>
<td>C</td>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>TRC_query</td>
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<td>Yes</td>
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<td>Yes</td>
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</tr>
<tr>
<td>TSK_checkstacks</td>
<td>C</td>
<td>Yes</td>
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</tr>
<tr>
<td>TSK_create</td>
<td>C</td>
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<td>No</td>
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</tr>
<tr>
<td>TSK_delete</td>
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<td>Yes</td>
<td>No</td>
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</tr>
<tr>
<td>TSK_deltatime</td>
<td>C</td>
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</tr>
<tr>
<td>TSK_disable</td>
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<td>TSK_enable</td>
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<td>C</td>
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<tr>
<td>TSK_getenv</td>
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</tr>
<tr>
<td>TSK_geterr</td>
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</tr>
<tr>
<td>TSK_getname</td>
<td>C</td>
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</tr>
<tr>
<td>TSK_getpri</td>
<td>C</td>
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</tr>
<tr>
<td>TSK_getsts</td>
<td>C</td>
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<td>No</td>
</tr>
<tr>
<td>TSK_itick</td>
<td>C</td>
<td>No</td>
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<td>Yes</td>
<td>Yes†</td>
</tr>
<tr>
<td>TSK_self</td>
<td>C</td>
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</tr>
<tr>
<td>TSK_setenv</td>
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<td>Yes</td>
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<tr>
<td>TSK_settime</td>
<td>C</td>
<td>Yes</td>
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</tr>
<tr>
<td>TSK_sleep</td>
<td>C</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes†</td>
</tr>
<tr>
<td>TSK_stat</td>
<td>C</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes†</td>
</tr>
<tr>
<td>TSK_tick</td>
<td>C</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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</tr>
<tr>
<td>TSK_time</td>
<td>C</td>
<td>Yes</td>
<td>Yes</td>
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</tr>
<tr>
<td>TSK_yield</td>
<td>C</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes†</td>
</tr>
</tbody>
</table>

† See the appropriate API reference page for more information.
A.2 DSP/BIOS Error Codes

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>SYS_Errors[Value]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS_OK</td>
<td>0</td>
<td>&quot;(SYS_OK)&quot;</td>
</tr>
<tr>
<td>SYS_EALLOC</td>
<td>1</td>
<td>&quot;(SYS_EALLOC): segid = %d, size = %u, align = %u&quot; Memory allocation error.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;(SYS_EFREE): segid = %d, ptr = ox%x, size = %u&quot; The memory free function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>associated with the indicated memory segment was unable to free the indicated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>size of memory at the address indicated by ptr.</td>
</tr>
<tr>
<td>SYS_ENODEV</td>
<td>3</td>
<td>&quot;(SYS_ENODEV): device not found&quot; The device being opened is not configured into</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the system.</td>
</tr>
<tr>
<td>SYS_EBUSY</td>
<td>4</td>
<td>&quot;(SYS_EBUSY): device in use&quot; The device is already opened by the maximum number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of users.</td>
</tr>
<tr>
<td>SYS_EINVAL</td>
<td>5</td>
<td>&quot;(SYS_EINVAL): invalid parameter&quot; An invalid parameter was passed to the device.</td>
</tr>
<tr>
<td>SYS_EBADIO</td>
<td>6</td>
<td>&quot;(SYS_EBADIO): device failure&quot; The device was unable to support the I/O operation.</td>
</tr>
<tr>
<td>SYS_EMODE</td>
<td>7</td>
<td>&quot;(SYS_EMODE): invalid mode&quot; An attempt was made to open a device in an improper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mode; e.g., an attempt to open an input device for output.</td>
</tr>
<tr>
<td>SYS_EDOMAIN</td>
<td>8</td>
<td>&quot;(SYS_EDOMAIN): domain error&quot; Used by SPOX-MATH when type of operation does not</td>
</tr>
<tr>
<td></td>
<td></td>
<td>match vector or filter type.</td>
</tr>
<tr>
<td>SYS_ETIMEOUT</td>
<td>9</td>
<td>&quot;(SYS_ETIMEOUT): timeout error&quot; Used by device drivers to indicate that reclaim</td>
</tr>
<tr>
<td></td>
<td></td>
<td>timed out.</td>
</tr>
<tr>
<td>SYS_EEOF</td>
<td>10</td>
<td>&quot;(SYS_EEOF): end-of-file error&quot; Used by device drivers to indicate the end of a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>file.</td>
</tr>
<tr>
<td>SYS_EDEAD</td>
<td>11</td>
<td>&quot;(SYS_EDEAD): previously deleted object&quot; An attempt was made to use an object that</td>
</tr>
<tr>
<td></td>
<td></td>
<td>has been deleted.</td>
</tr>
<tr>
<td>SYS_EBADOBJ</td>
<td>12</td>
<td>&quot;(SYS_EBADOBJ): invalid object&quot; An attempt was made to use an object that does not</td>
</tr>
<tr>
<td></td>
<td></td>
<td>exist.</td>
</tr>
<tr>
<td>SYS_EUSER</td>
<td>&gt;=256</td>
<td>&quot;(SYS_EUSER): &lt;user-defined string&gt;&quot; User-defined error.</td>
</tr>
</tbody>
</table>
# Index

## A
- **arg**: 2-51, 2-57
- **assembly**: 2-2
- **assembly language**: 2-2
- **atexit**: 2-344
- **ATM_andi**: 2-5
- **ATM_andu**: 2-6
- **ATM_cleari**: 2-7
- **ATM_clearu**: 2-8
- **ATM_deci**: 2-9
- **ATM_decu**: 2-10
- **ATM_ori**: 2-13
- **ATM_oru**: 2-14
- **ATM_seti**: 2-15
- **ATM_setu**: 2-16
- **atomic operations**: 2-179
- **atomic queue**: 2-179
- **average**: 2-241

## B
- **background loop**: 2-103
- **bind**: 2-50
- **boards**: 2-72
- **setting**: 2-72
- **buffered pipe manager**: 2-148

## C
- **C functions**: 2-2
- **call C functions from assembly language**: 2-2
- **calloc**: 2-344
- **cdb files**: 3-3
- **CDB path relative to .out**: 2-73
- **cdbprint utility**: 3-2
- **channels**: 2-80
- **Chip Support Library**: 2-72
- **Chip Support Library name**: 2-72
- **CLK - Code Composer Studio Interface**: 2-29
- **CLK module**: 2-26
- **global properties**: 2-27
- **trace types**: 2-302
- **CLK Object Properties**: 2-28
- **CLK_countspms**: 2-30
- **CLK_F_isr function**: 2-27
- **CLK_gethtime**: 2-31, 2-33
- **CLK_gettime**: 2-33
- **CLK_getprd**: 2-27, 2-35
- **Clock Manager Properties**: 2-27
- **clocks**: 2-3
- **clocks real time vs. data-driven**: 2-170
- **configuration files**: 3-3
- **printing**: 3-3
- **Configuration Tool**: 2-3
- **Configure L2 Cache Control (c6x11 support)**: 2-73
- **Configure Priority Queues**: 2-74
- **context switch**: 2-3
- **conversion specifications**: 2-299
- **count**: 2-241
- **counts per millisecond**: 2-295
- **CPU Interrupt create function**: 2-56
- **ctrl**: 2-51

## D
- **data channels**: 2-80
- **data transfer**: 2-148
- **DAX**: 2-37
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAX driver 2-50</td>
</tr>
<tr>
<td>dax.h 2-50</td>
</tr>
<tr>
<td>delete function 2-57</td>
</tr>
<tr>
<td>den 2-57</td>
</tr>
<tr>
<td>DEV Manager Properties 2-37</td>
</tr>
<tr>
<td>DEV module 2-36</td>
</tr>
<tr>
<td>DEV Object Properties 2-38</td>
</tr>
<tr>
<td>DEV_Fxns 2-37</td>
</tr>
<tr>
<td>DEV_FXNS table 2-50, 2-56, 2-61, 2-62, 2-68, 2-70</td>
</tr>
<tr>
<td>DEV_Fxns table 2-38</td>
</tr>
<tr>
<td>DEV_match 2-39</td>
</tr>
<tr>
<td>device driver interface 2-36</td>
</tr>
<tr>
<td>Device ID 2-38, 2-50, 2-56, 2-61, 2-62, 2-68, 2-70</td>
</tr>
<tr>
<td>device object</td>
</tr>
<tr>
<td>user-defined 2-37</td>
</tr>
<tr>
<td>device table 2-39</td>
</tr>
<tr>
<td>devices</td>
</tr>
<tr>
<td>empty 2-61</td>
</tr>
<tr>
<td>DGN 2-37</td>
</tr>
<tr>
<td>DGN driver 2-53</td>
</tr>
<tr>
<td>DGS 2-37</td>
</tr>
<tr>
<td>DGS driver 2-56</td>
</tr>
<tr>
<td>dgs.h 2-56</td>
</tr>
<tr>
<td>DHL 2-37</td>
</tr>
<tr>
<td>DHL driver 2-59</td>
</tr>
<tr>
<td>DHL Driver Properties 2-60</td>
</tr>
<tr>
<td>DHL Object Properties 2-60</td>
</tr>
<tr>
<td>Directly configure on-device timer registers 2-28</td>
</tr>
<tr>
<td>disable</td>
</tr>
<tr>
<td>HWI 2-91, 2-92, 2-102</td>
</tr>
<tr>
<td>LOG 2-115</td>
</tr>
<tr>
<td>SWI 2-266</td>
</tr>
<tr>
<td>TRC 2-305</td>
</tr>
<tr>
<td>disabling</td>
</tr>
<tr>
<td>hardware interrupts 2-91, 2-92, 2-102</td>
</tr>
<tr>
<td>DMA channel 2-24</td>
</tr>
<tr>
<td>dmachan 2-24, 2-25</td>
</tr>
<tr>
<td>DNL 2-37</td>
</tr>
<tr>
<td>DNL driver 2-61</td>
</tr>
<tr>
<td>DOV 2-38</td>
</tr>
<tr>
<td>DOV driver 2-62</td>
</tr>
<tr>
<td>DPI 2-37</td>
</tr>
<tr>
<td>DPI driver 2-65</td>
</tr>
<tr>
<td>DPI Driver Properties 2-67</td>
</tr>
<tr>
<td>DPI Object Properties 2-67</td>
</tr>
<tr>
<td>drivers</td>
</tr>
<tr>
<td>DAX 2-50</td>
</tr>
<tr>
<td>DGN 2-53</td>
</tr>
<tr>
<td>DGS 2-56</td>
</tr>
<tr>
<td>DHL 2-59</td>
</tr>
<tr>
<td>DNL 2-61</td>
</tr>
<tr>
<td>DOV 2-62</td>
</tr>
<tr>
<td>DPI 2-65</td>
</tr>
<tr>
<td>DST 2-68</td>
</tr>
<tr>
<td>DTR 2-70</td>
</tr>
<tr>
<td>DSP Endian Mode 2-72</td>
</tr>
<tr>
<td>DSP Speed In MHz (CLKOUT) 2-72</td>
</tr>
<tr>
<td>DSP Type 2-72</td>
</tr>
<tr>
<td>DST 2-38</td>
</tr>
<tr>
<td>DST driver 2-68</td>
</tr>
<tr>
<td>DTR 2-38</td>
</tr>
<tr>
<td>DTR driver 2-70</td>
</tr>
<tr>
<td>dtr.h 2-70</td>
</tr>
<tr>
<td>Dxx 2-37</td>
</tr>
<tr>
<td>Dxx_close 2-40</td>
</tr>
<tr>
<td>Dxx_ctrl 2-41</td>
</tr>
<tr>
<td>error handling 2-41</td>
</tr>
<tr>
<td>Dxx_idle 2-42</td>
</tr>
<tr>
<td>error handling 2-42</td>
</tr>
<tr>
<td>Dxx_init 2-43</td>
</tr>
<tr>
<td>Dxx_issue 2-44</td>
</tr>
<tr>
<td>Dxx_open 2-46</td>
</tr>
<tr>
<td>Dxx_ready 2-47</td>
</tr>
<tr>
<td>Dxx_reclaim 2-48</td>
</tr>
<tr>
<td>error handling 2-48</td>
</tr>
</tbody>
</table>

**E**

<table>
<thead>
<tr>
<th>enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWI 2-94</td>
</tr>
<tr>
<td>LOG 2-116</td>
</tr>
<tr>
<td>SWI 2-268</td>
</tr>
<tr>
<td>TRC 2-306</td>
</tr>
<tr>
<td>Enable All TRC Trace Event Classes 2-73</td>
</tr>
<tr>
<td>Enable CLK Manager 2-28</td>
</tr>
<tr>
<td>Enable Real Time Analysis 2-73</td>
</tr>
<tr>
<td>enabling</td>
</tr>
<tr>
<td>hardware interrupts 2-94</td>
</tr>
<tr>
<td>endian mode 2-72</td>
</tr>
<tr>
<td>environ 2-344</td>
</tr>
<tr>
<td>Error Codes A-8</td>
</tr>
<tr>
<td>error handling</td>
</tr>
<tr>
<td>by Dxx_close 2-40</td>
</tr>
<tr>
<td>by Dxx_ctrl 2-41</td>
</tr>
<tr>
<td>by Dxx_idle 2-42</td>
</tr>
<tr>
<td>by Dxx_reclaim 2-48</td>
</tr>
<tr>
<td>Execution Graph 2-29</td>
</tr>
<tr>
<td>exit 2-344</td>
</tr>
</tbody>
</table>

**F**

<table>
<thead>
<tr>
<th>files</th>
</tr>
</thead>
<tbody>
<tr>
<td>.h 2-17</td>
</tr>
<tr>
<td>flush 2-42</td>
</tr>
<tr>
<td>free 2-344</td>
</tr>
<tr>
<td>function list of 1-4</td>
</tr>
</tbody>
</table>
G

gconfgen utility 3-3

generators 2-53

getenv 2-344

global settings 2-72

Global Settings Properties 2-72

H

hardware interrupts 2-85

disabling 2-91, 2-92, 2-102

enabling 2-94

hardware timer counter register ticks 2-27

high-resolution time 2-26, 2-31

hook functions 2-75

HOOK module 2-75

HOOK getenv 2-75

HOOK_setenv 2-79

host data interface 2-80

HST module 2-80

HST object

adding a new 2-59

HST_getpipe 2-83

HWI dispatcher 2-27

HWI module 2-85

statistics units 2-242

trace types 2-302

HWI_disable 2-91, 2-92, 2-102

vs. instruction 2-2

HWI_enable 2-94

HWI_enter 2-96

HWI_exit 2-99

I

i16tof32/f32toi16 2-58

i16toI32/i32toi16 2-57

IDL module 2-103

IDL_run 2-106

IDRAM0 memory segment 2-140

IDRAM1 memory segment 2-140

IER 2-18, 2-19, 2-20

Init Fxn 2-38, 2-50, 2-56, 2-61, 2-62, 2-68, 2-70

initialization 2-75

Instructions/Init 2-28

Interrupt Enable Register 2-18, 2-19, 2-20

Interrupt Service Fetch Packet 2-24, 2-25

interrupt service routines 2-85

Interrupt Service Table 2-24, 2-25

IPRAM memory segment 2-140

ISPF 2-24

ISRs 2-85

IST 2-24

L

L2 MAR 0-15 - bitmask used to initialize MARs 2-73

L2 Mode - CCFG(L2MODE) 2-73

L2 Requestor Priority - CCFG(P) 2-74

L2ALLOC queues 2-74

LCK module 2-107

LCK_create 2-108

LCK_delete 2-109

LCK_release 2-111

LCK_seiz 2-110

LgInt type 2-294, 2-296, 2-298, 2-300

LgUns type 2-294, 2-296, 2-298, 2-300

localcopy 2-58

LOG module 2-112

LOG_disable 2-115

LOG_enable 2-116

LOG_error 2-117, 2-119

LOG_event 2-121

LOG_printf 2-123

LOG_reset 2-123

logged events 2-302

low-resolution clock 2-26

low-resolution time 2-26, 2-31, 2-33

M

mailbox

clear bits 2-257, 2-259

decrement 2-283, 2-269, 2-285

get value 2-271

increment 2-274

set bits 2-276, 2-278

malloc 2-344

maskable 2-19

Max L2 Transfer Requests 2-74

maximum 2-241

MBX module 2-127

MBX_create 2-129

MBX_delete 2-130

MBX_pend 2-131

MBX_post 2-132

MEM module 2-133

MEM_alloc 2-141, 2-142, 2-143

MEM_free 2-144

MEM_NULL 2-136, 2-313

MEM_redefine 2-148
MEM_stat 2-146
MEM_valloc 2-141, 2-142, 2-147
MHz 2-72
Microseconds/Int 2-28
Mode 2-60
Modifies definition of 1-3
modifies 2-2
modules list of 1-2
multiprocessor application 2-66

N
naming conventions 1-3
ntmti utility 3-6
notifyReader function use of HWI enter num 2-57

O
Object Memory 2-27
Object memory 2-60
on-chip timer 2-26
on-device timer 2-26
operations list of 1-4
outputdelay 2-51

P
packing/unpacking 2-56
Parameters 2-36, 2-50, 2-56, 2-61, 2-62, 2-68, 2-70
parameters listing 3-2
vs. registers 2-2
period register 2-35
period register property 2-35
PIP module 2-148
statistics units 2-242
PIP_alloc 2-152
PIP_free 2-154
PIP_get 2-156
PIP_getReaderAddr 2-158
PIP_getReaderNumFrames 2-160
PIP_getReaderSize 2-161
PIP_getWriterAddr 2-162
PIP_getWriterNumFrames 2-163
PIP_getWriterSize 2-164
PIP_put 2-165, 2-166, 2-168
PIP_setWriterSize 2-169
pipe object 2-83
pipes 2-148
postconditions 2-2
posting software interrupts 2-254, 2-280
PRD module 2-170
statistics units 2-242
trace types 2-302
PRD_register 2-28
PRD_getticks 2-173
PRD_start 2-174
PRD_stop 2-176
PRD_tick 2-177
Preconditions definition of 1-3
preconditions 2-2
printing configuration file 3-2
priorities 2-255
Program Cache Control 2-73

Q
QUE module 2-178
QUE_create 2-180
QUE_delete 2-182
QUE_dequeue 2-183
QUE_empty 2-184
QUE_enqueue 2-185
QUE_get 2-186
QUE_head 2-187
QUE_insert 2-188
QUE_new 2-189
QUE_next 2-190
QUE_prev 2-191
QUE_put 2-192
QUE_remove 2-193
read data 2-149
realloc 2-344
registers in Assembly Interface 1-3
modified 2-2
vs. parameters 2-2
RTA Control Panel 2-29
RTDX Mode 2-195
RTDX_bytesRead 2-209
RTDX_channelBusy 2-197
RTDX_CreateInputChannel 2-198, 2-199
RTDX_CreateOutputChannel 2-198, 2-199
RTDX_disableInput 2-200, 2-201, 2-202, 2-203
RTDX_disableOutput 2-200, 2-201, 2-202, 2-203
RTDX_enableInput 2-200, 2-201, 2-202, 2-203

Index 4
### RTDX_enableOutput
2-200, 2-201, 2-202, 2-203

### RTDX_isInputEnabled
2-204, 2-205

### RTDX_isOutputEnabled
2-204, 2-205

### RTDX_read
2-206

### RTDX_readNB
2-208

### RTDX_write
2-210

### S

- **SBSRAM memory segment**: 2-140
- **SDRAM0 memory segment**: 2-140
- **SDRAM1 memory segment**: 2-140

  - **sections in executable file**: 3-7
  - **sectti utility**: 3-7
  - **SEM module**: 2-211
  - **SEM_count**: 2-213
  - **SEM_create**: 2-214
  - **SEM_delete**: 2-215
  - **SEM_ipost**: 2-216
  - **SEM_new**: 2-217
  - **SEM_pend**: 2-218
  - **SEM_post**: 2-219
  - **SEM_reset**: 2-220
  - **signed integer**:
    - **maximum**: 2-11
    - **minimum**: 2-11
  - **single-processor application**: 2-66

### SIO

- **SIO module**: 2-221
- **SIO_bufsize**: 2-222
- **SIO_create**: 2-224
- **SIO_ctl**: 2-226
- **SIO_delete**: 2-227
- **SIO_flush**: 2-230
- **SIO_get**: 2-231
- **SIO_idle**: 2-232
- **SIO_issue**: 2-233
- **SIO_ISSUERECLAIM streaming model and DPI**: 2-66
- **SIO_put**: 2-235
- **SIO_reclaim**: 2-236
- **SIO_segid**: 2-238
- **SIO_select**: 2-239
- **sizeti utility**: 3-8
  - **software interrupts**: 2-253
  - **stack overflow check**: 2-316
  - **stack, execution**: 2-255
  - **Stacking Device**: 2-38, 2-49, 2-50, 2-56, 2-61, 2-62, 2-68, 2-70
  - **start**: 2-51
  - **statistics units**: 2-242
  - **std.h**: 2-344
  - **stdlib.h**: 2-344
- **stop**: 2-51

### STS

- **STS manager**: 2-195, 2-241
- **STS_add**: 2-247
- **STS_delta**: 2-248
- **STS_reset**: 2-250
- **STS_set**: 2-251
- **SWI module**: 2-253
  - **statistics units**: 2-242
  - **trace types**: 2-302
- **SWI_and**: 2-257, 2-259
- **SWI_dec**: 2-261, 2-263, 2-265
- **SWI_disable**: 2-266
- **SWI_enable**: 2-268
- **SWI_getmbox**: 2-271
- **SWI_getpri**: 2-273
- **SWI_inc**: 2-274
- **SWI_or**: 2-276, 2-278
- **SWI_post**: 2-280
- **SWI_raisepri**: 2-281
- **SWI_restorepri**: 2-283
- **SWI_self**: 2-284
- **symbol table**: 3-6
- **SYS module**: 2-287
- **SYS_abort**: 2-289
- **SYS_atexit**: 2-290
- **SYS_EALLOC**: A-8
- **SYS_EBADIO**: A-8
- **SYS_EBADOBJ**: A-8
- **SYS_EBUSY**: A-8
- **SYS_EDEAD**: A-8
- **SYS_EEOF**: A-8
- **SYS_EFREE**: A-8
- **SYS_EINVAL**: A-8
- **SYS_EMODE**: A-8
- **SYS_ERROR**: A-8
- **SYS_ERROR_TIMEOUT**: A-8
- **SYS_EUSER**: A-8
- **SYS_OK**: A-8
- **SYS_printf**: 2-293, 2-295, 2-299
- **SYS_putchar**: 2-301
- **system clock manager**: 2-26

### T

- **target board**: 2-72
- **task switch**: 2-21, 2-23
- **tasks on demand**: 2-53
- **TDDR register**: 2-28
- **templates**: 2-37