OPTO32

Optically Isolated I/O, 24 Input, 8 Output

PMC-OPTO32A

Software Development Kit SDK 5.0.0 Reference Manual

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Preface

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1. Introduction

This reference manual applies to SDK release version 5.0.0.

1.1. Purpose

The purpose of this document is to describe the Application Programming Interface to the OPTO32 Software Development Kit. This software provides the interface between "Application Software" and the OPTO32 board. The interface provided by the SDK is based on the board's functionality.

1.2. Acronyms

The following is a list of commonly occurring acronyms used throughout this document.

Acronyms	Description
API	Application Programming Interface
GSC	General Standards Corporation
PCI	Peripheral Component Interconnect
PMC	PCI Mezzanine Card
SDK	Software Development Kit (This is sometimes used synonymously with API or API Library.)

1.3. Definitions

The following is a list of commonly occurring terms used throughout this document.

Term	Definition
API Library	This refers to the library implementing the application level OPTO32 interface. (This is sometimes used synonymously with SDK or API.)
Application	This refers to user mode processes.
Driver	This refers to the device driver, which runs under control of the operating system.
Library	This refers to the library module specific to the OS in use.

1.4. Installation

Installation instructions for the SDK are provided in separate, operating system specific setup guides.

1.5. Application Programming Interface

The SDK API is defined in the three header files listed below. These C language headers are C++ compatible. The only header that need be included by OPTO32 applications is `opto32_api.h`. The API consists of macros, data types, function calls and parameter definitions. These are described in other sections of this document. The headers define numerous items in addition to those described in this document. These additional items are provided without documentation. All software components of the API begin with a prefix of `OPTO32` or `GSC` (both appear with upper and lower case letters). The table below indicates where to look for any particular item's definition.

File Name	Description
`gsc_common.h`	This header contains status definitions, a few data type definitions and a variety of macros. All items defined here have a prefix of "`GSC`" or "`gsc`".
`gsc_pci9080.h`	This header contains register definitions for the PCI9080, which is the PCI interface chip used on OPTO32s. All items defined here have a prefix of "`GSC`" or "`gsc`" and include "`9080`".
`opto32_api.h`	This header contains the bulk of the API, including function calls, data types and numerous macros. All items defined here include the prefix "`OPTO32`" or "`opto32`".

1.6. Software Overview

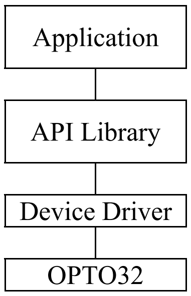
The software interface to the OPTO32 consists of a Device Driver and an API Library; the primary components of the SDK. The Device Driver operates under control of the operating system and must be loaded and running in order to access any installed OPTO32 devices. The interface provided by the API Library is based on the board's functionality and is organized around the OPTO32's set of main hardware features. The general categories are as follows and permit access to and manipulation of virtually every feature available on the board.

- General Access Services (API Status, Version Numbers, Board Count, Open, Close, …)
- Change of State Configuration
- Other Miscellaneous Configuration
- Interrupt Notification and Configuration

All OPTO32 features are individually accessible via a generalized configuration service. For each parameter, as appropriate, the API includes a set of support macros. These include setting options (i.e. defaults and acceptable values), quick access retrieval macros, and quick access manipulation macros. All are described later in this document.

1.6.1. Software Architecture

An application communicates with an OPTO32 using the driver and library described briefly above. Any number of applications may make simultaneous use of the library and each use is totally independent, unless specifically designed to do otherwise. Each instance provides access to at most 32 different OPTO32 devices. The diagram below describes the components and how they fit together.



This is any application written to communicate with one or more OPTO32 devices using the driver and library provided in the SDK.

This library presents an OPTO32 feature based interface to applications wishing to communicate with OPTO32 devices.

The driver provides access to OPTO32 devices.

This refers to any number of installed OPTO32 devices.

NOTE: While multiple applications can gain access to the same device, this is discouraged since the driver maintains resources and settings per device rather than per application or device handle.

1.7. Hardware Overview

The OPTO32 is a high performance optically isolated I/O board with Change Of State (COS) detection on all inputs. The board includes 24 optically isolated inputs and eight optically isolated outs. All inputs are controlled by a global debounce timer. The debounce period consists of three sampling intervals, where the interval is configurable in 100ns increments from 200ns to just under 215 seconds. The debounced input can be read at any time. Also, each COS input can be independently configured to generate an interrupt on either a rising or falling state transition. The D23 input has the added capability of generating an interrupt after receipt of from 1 to 64K low-to-high state changes. The eight outputs include four with normal output capability and four with high output capability.

1.8. Code Samples

All of the code samples in this manual are included in the `opto32_dsl` library along with their C source files. The examples given are notably simplistic, but are provided to illustrate use rather than accomplishment of broader tasks.

1.9. Reference Material

The following reference material may be of particular benefit in using the OPTO32 and this SDK. The specifications provide the information necessary for an in-depth understanding of the specialized features implemented on this board.

- The applicable *OPTO32 User Manual* from General Standards Corporation.
- The *PCI9080 PCI Bus Master Interface Chip* data handbook from PLX Technology, Inc. *
- The PLX PCI SDK, version 4.0.0 from PLX Technology, Inc. *

* PLX material is available from PLX at the following location.

PLX Technology Inc.
870 Maude Avenue
Sunnyvale, California 94085 USA
Phone: 1-800-759-3735
WEB: http://www.plxtech.com

2. Macros

The OPTO32 API includes the following macros. The headers also contain various other utility type macros, which are provided without documentation. Parameter support macros are not presented in this subsection. These macros are described in section 5 beginning on page 34.

2.1. API Version Number

This macro defines the version number of the API's executable interface. It does not refer to the SDK version number, the API Library version number or the Device Driver version number. Applications pass this value to the function `opto32_api_status()` (page 19), which is used to verify that the application and the library are compatible.

Macros	Description
`OPTO32_API_VERSION`	This is the API's executable interface version number.

2.2. Common Parameter Assignment Values

The below macros define universal values understood by all parameters to have special meanings, as given below. Any time a parameter assignment request is being carried out, use of these macros as the assignment value will produce the results given here.

Macros	Description
`GSC_DEFAULT`	Set the parameter to its default state/value. This is equivalent to using the explicitly defined default macro for the respective parameter.
`GSC_NO_CHANGE`	Do not change the parameter's state/value. Since parameter access follows a set-then-get model, this value can be used to achieve a get only operation.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_led_reset(void* handle, int verbose)
{
    U32 get;
    U32 status;

    // Reset the LED on/off state to its default.
    status  = opto32_config(    handle,
                                OPTO32_MISC_LED,
                                0,
                                GSC_DEFAULT,
                                &get);

    if (!verbose)
    {
    }
    else if (status == GSC_SUCCESS)
    {
        printf("opto32_config() failure: %ld\n", (long) status);
    }
    else
```

```
        {
            printf("LED State: ");

            if (get == OPTO32_MISC_LED_OFF)
                printf("Off\n");
            else
                printf("On\n");
        }

        return(status);
    }
```

Example

```
    #include <stdio.h>

    #include "opto32_api.h"
    #include "opto32_dsl.h"

    U32 opto32_dsl_led_get(void* handle, int verbose, U32* get)
    {
        U32 status;

        // Reset the LED on/off state to its default.
        status  = opto32_config(    handle,
                                    OPTO32_MISC_LED,
                                    0,
                                    GSC_NO_CHANGE,
                                    get);

        if (!verbose)
        {
        }
        else if (status == GSC_SUCCESS)
        {
            printf("opto32_config() failure: %ld\n", (long) status);
        }
        else
        {
            printf("LED State: ");

            if (get[0] == OPTO32_MISC_LED_OFF)
                printf("Off\n");
            else
                printf("On\n");
        }

        return(status);
    }
```

2.3. Discrete Data Type Options

The below macros are defined by application code as needed to enable or disable declarations for and size validation for the data types `S8`, `U8`, `S16`, `U16`, `S32` and `U32` (see page 17).

Macros	Description
`GSC_DATA_TYPES_CHECK`	If the API declares the data types and the application defines this macro, then the data type sizes will be validated during the application's build process. This macro should only be defined if the compiler in use supports the `sizeof()` macro during preprocessing.
`GSC_DATA_TYPES_NOT_NEEDED`	Applications should define this macro before including `opto32_api.h` to disable the declarations for these data types.

2.4. Maximum Number of Open Handles

This macro defines the maximum number of device handles that can be opened at any one time. All open handles are unique even if they refer to the same device, though handles are reused once closed.

Macros	Description
`GSC_PROCESS_OPEN_MAX`	This defines the maximum number of open handles.

2.5. Parameter Access "Which" Bits

The table below lists the set of selection bits that may be set when a configuration parameter is modified or accessed. They are referred to as "which" bits in that they specify the objects which the parameter is to access. For example, to enable or disable the COS 0 interrupt the which value passed with the `OPTO32_IRQ_ENABLE` parameter must be `OPTO32_WHICH_COS_00`. When appropriate, bits within the same category may be bitwise or'd in order to apply the action to multiple objects. For retrieval purposes, the retrieved setting may reflect the setting of the first item accessed, the last item accessed, or all items collectively. The bits' use is explained along with the parameters that each is associated with, and appears in subsequent portions of this document.

Macros	Description
`OPTO32_WHICH_COS_00`	This identifies Change Of State input number 0.
`OPTO32_WHICH_COS_01`	This identifies Change Of State input number 1.
`OPTO32_WHICH_COS_02`	This identifies Change Of State input number 2.
`OPTO32_WHICH_COS_03`	This identifies Change Of State input number 3.
`OPTO32_WHICH_COS_04`	This identifies Change Of State input number 4.
`OPTO32_WHICH_COS_05`	This identifies Change Of State input number 5.
`OPTO32_WHICH_COS_06`	This identifies Change Of State input number 6.
`OPTO32_WHICH_COS_07`	This identifies Change Of State input number 7.
`OPTO32_WHICH_COS_08`	This identifies Change Of State input number 8.
`OPTO32_WHICH_COS_09`	This identifies Change Of State input number 9.
`OPTO32_WHICH_COS_10`	This identifies Change Of State input number 10.
`OPTO32_WHICH_COS_11`	This identifies Change Of State input number 11.
`OPTO32_WHICH_COS_12`	This identifies Change Of State input number 12.
`OPTO32_WHICH_COS_13`	This identifies Change Of State input number 13.
`OPTO32_WHICH_COS_14`	This identifies Change Of State input number 14.
`OPTO32_WHICH_COS_15`	This identifies Change Of State input number 15.
`OPTO32_WHICH_COS_16`	This identifies Change Of State input number 16.
`OPTO32_WHICH_COS_17`	This identifies Change Of State input number 17.
`OPTO32_WHICH_COS_18`	This identifies Change Of State input number 18.
`OPTO32_WHICH_COS_19`	This identifies Change Of State input number 19.
`OPTO32_WHICH_COS_20`	This identifies Change Of State input number 20.
`OPTO32_WHICH_COS_21`	This identifies Change Of State input number 21.
`OPTO32_WHICH_COS_22`	This identifies Change Of State input number 22.
`OPTO32_WHICH_COS_23`	This identifies Change Of State input number 23.
`OPTO32_WHICH_COS_ALL`	This identifies all of the Change Of State inputs.
`OPTO32_WHICH_IRQ_ALL`	This identifies off interrupts sources.

`OPTO32_WHICH_RECO`	This identifies the Receive Event Counter interrupt source.

2.6. Registers

The following tables give the complete set of OPTO32 registers. The tables are divided by register categories. There are PCI registers, PLX feature set registers, and there are GSC firmware based registers. The PCI registers and the PLX registers are provided by the PCI interface chips used on the OPTO32. Applications have read access to all registers, but write access only to the GSC firmware registers.

2.6.1. GSC Registers

The following table gives the complete set of GSC specific OPTO32 registers. For detailed definitions of these registers refer to the applicable *OPTO32 User Manual*.

Macros	Description
`OPTO32_BCR`	Board Control Register (BCR)
`OPTO32_BSR`	Board Status Register (BSR)
`OPTO32_CDR`	Clock Divider Register (CDR)
`OPTO32_COSIER`	Change Of State Interrupt Enable Register (COSIER)
`OPTO32_COSPR`	Change Of State Polarity Register (COSPR)
`OPTO32_COSR`	Change Of State Register (COSR)
`OPTO32_ODR`	Output Data Register (ODR)
`OPTO32_RDR`	Receive Data Register (RDR)
`OPTO32_RECR`	Receive Event Counter Register (RECR)

2.6.2. PLX PCI9080 PCI Configuration Registers

The following table gives the set of PCI Configuration Registers. For detailed definitions of these registers refer to the *PCI9080 Data Book*.

Macros	Description
`GSC_PCI_9080_BAR0`	PCI Base Address Register for Memory Accesses to Local, Runtime, and DMA Registers (PCIBAR0)
`GSC_PCI_9080_BAR1`	PCI Base Address Register for I/O Accesses to Local, Runtime, and DMA Registers (PCIBAR1)
`GSC_PCI_9080_BAR2`	PCI Base Address Register for Memory Accesses to Local Address Space 0 (PCIBAR2)
`GSC_PCI_9080_BAR3`	PCI Base Address Register for Memory Accesses to Local Address Space 1 (PCIBAR3)
`GSC_PCI_9080_BAR4`	Unused Base Address Register (PCIBAR4)
`GSC_PCI_9080_BAR5`	Unused Base Address Register (PCIBAR5)
`GSC_PCI_9080_BISTR`	PCI Built-In Self Test Register (PCIBISTR)
`GSC_PCI_9080_CCR`	PCI Class Code Register (PCICCR)
`GSC_PCI_9080_CIS`	PCI Cardbus CIS Pointer Register (PCICIS)
`GSC_PCI_9080_CLSR`	PCI Cache Line Size Register (PCICLSR)
`GSC_PCI_9080_CR`	PCI Command Register (PCICR)
`GSC_PCI_9080_DIDR`	PCI Device ID Register (PCIDIDR)
`GSC_PCI_9080_ERBAR`	PCI Expansion ROM Base Address (PCIERBAR)
`GSC_PCI_9080_HTR`	PCI Header Type Register (PCIHTR)
`GSC_PCI_9080_ILR`	PCI Interrupt Line Register (PCIILR)
`GSC_PCI_9080_IPR`	PCI Interrupt Pin Register (PCIIPR)
`GSC_PCI_9080_LTR`	PCI Latency Timer Register (PCILTR)
`GSC_PCI_9080_MGR`	PCI Min_Gnt Register (PCIMGR)
`GSC_PCI_9080_MLR`	PCI Max_Lat Register (PCIMLR)

GSC_PCI_9080_REV	PCI Revision ID Register (PCIREV)
GSC_PCI_9080_SID	PCI Subsystem ID Register (PCISID)
GSC_PCI_9080_SR	PCI Status Register (PCISR)
GSC_PCI_9080_SVID	PCI Subsystem Vendor ID Register (PCISVID)
GSC_PCI_9080_VIDR	PCI Vendor ID Register (PCIVIDR)

NOTE: The following table gives those registers and values that uniquely identify OPTO32 boards.

Register	Value	Description
GSC_PCI_9080_VIDR	0x10B5	The PCI interface chip as a PLX device.
GSC_PCI_9080_DIDR	0x906E	The PCI interface chip is reported as a PLX PCI9060E, though it is actually a PLX PCI9080.
GSC_PCI_9080_SVID	0x10B5	The PCI interface chip as a PLX device.
GSC_PCI_9080_SID	0x9080	The PCI interface chip is a PLX PCI9080.

2.6.3. PLX PCI9080 Feature Set Registers

The following tables give the set of PLX feature set registers.

Local Configuration Registers

The following table gives the set of PLX Local Configuration Registers. For detailed definitions of these registers refer to the *PCI9080 Data Book*.

Macros	Description
GSC_PLX_9080_BIGEND	Big/Little Endian Descriptor Register (BIGEND)
GSC_PLX_9080_DMCFGA	PCI Configuration Address Register for Direct Master to PCI IO/CFG (DMCFGA)
GSC_PLX_9080_DMLBAM	Local Bus Base Address Register for Direct Master to PCI Memory (DMLBAM)
GSC_PLX_9080_DMLBAI	Local Bus Base Address Register for Direct Master to PCI IO/CFG (DMLBAI)
GSC_PLX_9080_DMPBAM	PCI Base Address Register for Direct Master to PCI Memory (DMPBAM)
GSC_PLX_9080_DMRR	Local Range Register for Direct Master to PCI (DMRR)
GSC_PLX_9080_EROMBA	Expansion ROM Local Base Address Register (EROMBA)
GSC_PLX_9080_EROMRR	Expansion ROM Range Register (EROMRR)
GSC_PLX_9080_LAS0BA	Local Address Space 0 Local Base Address Register (LASOBA)
GSC_PLX_9080_LAS0RR	Local Address Space 0 Range Register for PCI-to-Local Bus (LASORR)
GSC_PLX_9080_LAS1BA	Local Address Space 1 Local Base Address Register (LAS1BA)
GSC_PLX_9080_LAS1RR	Local Address Space 1 Range Register for PCI-to-Local Bus (LAS1RR)
GSC_PLX_9080_LBRD0	Local Address Space 0/Expansion ROM Bus Region Descriptor Register (LBRD0)
GSC_PLX_9080_LBRD1	Local Address Space 1 Bus Region Descriptor Register (LBRD1)
GSC_PLX_9080_MARBR	Mode Arbitration Register (MARBR)

Runtime Registers

The following table gives the set of PLX Runtime Registers. For detailed definitions of these registers refer to the *PCI9080 Data Book*.

Macros	Description
GSC_PLX_9080_CNTRL	Serial EEPROM Control, CPI Command Codes, User I/O, Init Control Register (CNTRL)
GSC_PLX_9080_INTCSR	Interrupt Control/Status Register (INTCSR)
GSC_PLX_9080_L2PDBELL	Local-to-PCI Doorbell Register (L2PDBELL)
GSC_PLX_9080_MBOX0	Mailbox Register 0 (MBOX0)
GSC_PLX_9080_MBOX1	Mailbox Register 1 (MBOX1)

`GSC_PLX_9080_MBOX2`	Mailbox Register 2 (MBOX2)
`GSC_PLX_9080_MBOX3`	Mailbox Register 3 (MBOX3)
`GSC_PLX_9080_MBOX4`	Mailbox Register 4 (MBOX4)
`GSC_PLX_9080_MBOX5`	Mailbox Register 5 (MBOX5)
`GSC_PLX_9080_MBOX6`	Mailbox Register 6 (MBOX6)
`GSC_PLX_9080_MBOX7`	Mailbox Register 7 (MBOX7)
`GSC_PLX_9080_P2LDBELL`	PCI-to-Local Doorbell Register (P2LDBELL)
`GSC_PLX_9080_PCIHIDR`	PCI Permanent Configuration ID Register (PCIHIDR)
`GSC_PLX_9080_PCIHREV`	PCI Permanent Revision ID Register (PCIHREV)

DMA Registers

The following table gives the set of PLX DMA Registers. For detailed definitions of these registers refer to the *PCI9080 Data Book*. These register definitions are provided for informational purposes only as the OPTO32 implements no features that might use DMA.

Macros	**Description**
`GSC_PLX_9080_DMAARB`	DMA Arbitration Register (DMAARB)
`GSC_PLX_9080_DMACSR0`	DMA Channel 0 Command/Status Register (DMACSR0)
`GSC_PLX_9080_DMACSR1`	DMA Channel 1 Command/Status Register (DMACSR1)
`GSC_PLX_9080_DMADPR0`	DMA Channel 0 Descriptor Pointer Register (DMADPR0)
`GSC_PLX_9080_DMADPR1`	DMA Channel 1 Descriptor Pointer Register (DMADPR1)
`GSC_PLX_9080_DMALADR0`	DMA Channel 0 Local Address Register (DMALADR0)
`GSC_PLX_9080_DMALADR1`	DMA Channel 1 Local Address Register (DMALADR1)
`GSC_PLX_9080_DMAMODE0`	DMA Channel 0 Mode Register (DMAMODE0)
`GSC_PLX_9080_DMAMODE1`	DMA Channel 1 Mode Register (DMAMODE1)
`GSC_PLX_9080_DMAPADR0`	DMA Channel 0 PCI Address Register (DMAPADR0)
`GSC_PLX_9080_DMAPADR1`	DMA Channel 1 PCI Address Register (DMAPADR1)
`GSC_PLX_9080_DMASIZ0`	DMA Channel 0 Transfer Size Register (DMASIZ0)
`GSC_PLX_9080_DMASIZ1`	DMA Channel 1 Transfer Size Register (DMASIZ1)
`GSC_PLX_9080_DMATHR`	DMA Threshold Register (DMATHR)

Message Queue Registers

The following table gives the set of PLX Messaging Queue Registers. For detailed definitions of these registers refer to the *PCI9080 Data Book*.

Macros	**Description**
`GSC_PLX_9080_IFHPR`	Inbound Free Head Pointer Register (IFHPR)
`GSC_PLX_9080_IFTPR`	Inbound Free Tail Pointer Register (IFTPR)
`GSC_PLX_9080_IPHPR`	Inbound Post Head Pointer Register (IPHPR)
`GSC_PLX_9080_IPTPR`	Inbound Post Tail Pointer Register (IPTPR)
`GSC_PLX_9080_IQP`	Inbound Queue Port Register (IQP)
`GSC_PLX_9080_MQCR`	Messaging Queue Configuration Register (MQCR)
`GSC_PLX_9080_OFHPR`	Outbound Free Head Pointer Register (OFHPR)
`GSC_PLX_9080_OFTPR`	Outbound Free Tail Pointer Register (OFTPR)
`GSC_PLX_9080_OPHPR`	Outbound Post Head Pointer Register (OPHPR)
`GSC_PLX_9080_OPLFIM`	Outbound Post List FIFO Interrupt Mask Register (OPLFIM)
`GSC_PLX_9080_OPLFIS`	Outbound Post List FIFO Interrupt Status Register (OPLFIS)
`GSC_PLX_9080_OPTPR`	Outbound Post Tail Pointer Register (OPTPR)
`GSC_PLX_9080_OQP`	Outbound Queue Port Register (OQP)
`GSC_PLX_9080_QBAR`	Queue Base Address Register (QBAR)
`GSC_PLX_9080_QSR`	Queue Status/Control Register (QSR)

2.7. Version Data Selectors

This set of macros is used when requesting a version number and indicates which version number is desired. The macros are passed as the `id` argument to the `opto32_version_get()` function (see page 32). The second table below lists utility macros used to retrieve each of the respective version numbers. In the second table, the argument `h` refers to the handle used to access the device, the `b` refers to an application buffer where the version string is recorded, and the `s` is the size of that buffer.

Macros (Values)	**Description**
`GSC_VERSION_LIBRARY`	This requests the library's version number.
`GSC_VERSION_DRIVER`	This requests the driver's version number.

Macro (Services)	**Description**
`OPTO32_VERSION_GET_LIBRARY(h,b,s)`	This requests the version number for the API Library.
`OPTO32_VERSION_GET_DRIVER(h,b,s)`	This requests the version number for the Device Driver.

3. Data Types

The interface includes the following data types.

3.1. Discrete Data Types

The following discrete data types are defined and used by the API. If an OPTO32 application includes other headers which also define these types, then the API can be directed to omit these definitions. This is done by defining the macro `GSC_DATA_TYPES_NOT_NEEDED` before including the API header. The alternate definitions must however define these types as listed in the below table.

Data Type	Description
`S8`	This is an 8-bit signed integer.
`U8`	This is an 8-bit unsigned integer.
`S16`	This is a 16-bit signed integer.
`U16`	This is a 16-bit unsigned integer.
`S32`	This is a 32-bit signed integer.
`U32`	This is a 32-bit unsigned integer.

3.2. opto32_callback_func_t

This is the data type required for all event notification callback functions. This applies to Interrupt Notification callbacks.

Definition

```
typedef void (*opto32_callback_func_t)(U32 arg1, U32 arg2, U32 arg3);
```

Arguments	Description
`arg1`	This is the device handle cast to a `U32` data type.
`arg2`	For Interrupt Notification this is the `OPTO32_WHICH_XXX` bit for the respective interrupt.
`arg3`	This is any arbitrary application supplied data value.

3.3. Status Values

This unnamed enumerated data type lists all possible status values returnable from API service calls. The enumerated values represent common definitions used by this and other GSC SDKs. Many values will never be encountered when using the OPTO32 SDK. The table below gives brief descriptions for many values and omits those that should never be seen. The most common value encountered is `GSC_SUCCESS` and indicates that the request was completed successfully.

Definition

```
typedef enum
{
    …
};
```

Values	Description
`GSC_ABORTED`	An I/O operation was aborted due to a user's explicit or implicit request.
`GSC_ACCESS_DENIED`	The operation failed because access to a device, service

	or system resource or service was denied.
`GSC_FAILED`	An operation failed in a non-specific manner.
`GSC_INIT_FAILURE`	API Library initialization failed.
`GSC_INSUFFICIENT_RESOURCES`	An operation failed because insufficient OS resources were available.
`GSC_INVALID_API_HANDLE`	An operation failed because the application supplied an invalid device handle. API device handles are API specific resources and are of no meaning to the OS.
`GSC_INVALID_DATA`	An operation failed because invalid data was provided.
`GSC_INVALID_VERSION_API`	API Library initialization failed because the API Library version was incompatible. This refers either to the API's version number or the GSC revision level. The version data can still be retrieved when this status is seen.
`GSC_INVALID_VERSION_DIL`	API Library initialization failed because the Driver Interface Library version was incompatible. This refers either to the library's version number or the GSC revision level. The version data can still be retrieved when this status is seen.
`GSC_INVALID_VERSION_DRIVER`	API Library initialization failed because the Device Driver version was incompatible. This refers either to the driver's version number or the GSC revision level. The version data can still be retrieved when this status is seen.
`GSC_LIB_FUNCTION_ACCESS_FAILURE`	API Library initialization failed because the API could not access a Driver Interface Library function.
`GSC_NULL_PARAM`	An operation failed because an argument was NULL.
`GSC_SUCCESS`	An operation completed successfully.
`GSC_THREAD_FAILURE`	An operation (`opto32_open()`) failed because a support thread could not be started.
`GSC_TOO_MANY_OPEN_HANDLES`	An operation (`opto32_open()`) failed because the application attempted too many simultaneous device accesses.
`GSC_WAIT_TIMEOUT`	An operation completed because a timeout period lapsed.
`GSC_WAIT_CANCELED`	An operation waiting for an event ended prematurely. This usually means the application was terminated while waiting for the event.

4. Functions

The OPTO32 API includes the following functions. The SDK interface also includes a number of function style macro definitions. These macros are described in section 5 beginning on page 34.

4.1. opto32_api_status()

This function is the entry point to determine the status of the API Library. This must be the very first call into the API and determines the usability of the API Library and the Device Driver. If the initial status obtained is other than `GSC_SUCCESS`, then only a limited portion of the API is functional. If not fully usable, then both values returned may be useful in resolving the situation. Thereafter, the status obtained might vary if the API encounters irregular circumstances. The table below lists the utility macros available for this service.

Macro (Services)	Description
`OPTO32_API_STATUS(s,a)`	Retrieve the status information without having to explicitly enter the macro for the current API version.

Prototype

```
U32 opto32_api_status(U32* stat, U32* arg, U32 api_ver);
```

Argument	Description
`stat`	The API records the current API status here, which can change during use. The pointer must not be NULL.
`arg`	The API records auxiliary status information here, which can change during use. This value should be related to the above reported status. The pointer must not be NULL.
`api_ver`	This must be the version number of the API the application was written for. If this number does not match, then the API is unusable by the application.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded (the status was retrieved).
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_api_status(int verbose)
{
    U32 arg;
    U32 stat;
    U32 status;

    status  = opto32_api_status(&stat, &arg, OPTO32_API_VERSION);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_api_status() failure: 0x%lX\n", (long) status);
    }
```

```
        else
        {
            status  = stat;
            printf("API Status:\n");
            printf("  Status:   0x%lX\n", (long) stat);
            printf("  Argument: 0x%lX\n", (long) arg);
        }

        return(status);
    }
```

4.2. opto32_board_count()

This function is the entry point to determine the number of OPTO32 boards installed in the system and accessible to the API. This service can be called without requiring access to any particular device.

Prototype

```
U32 opto32_board_count(U8* count);
```

Argument	Description
`count`	The API records the number of boards at this location. This pointer must not be NULL.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_board_count(U8* count, int verbose)
{
    U32 status;

    status  = opto32_board_count(count);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_board_count() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("OPTO32 Board Count: %d\n", (int) count[0]);
    }

    return(status);
}
```

4.3. opto32_close()

This function is the entry point to close a connection to an open OPTO32 board. The function should only be called after a successful open of the respective device via `opto32_open()` and must not be used after being closed. Before returning, the API returns the device to the same state produced when originally opened.

Prototype

```
U32 opto32_close(void* handle);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_close(void* handle, int verbose)
{
    U32 status;

    status  = opto32_close(handle);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_close() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("Device Closed: 0x%lX\n", (long) handle);
    }

    return(status);
}
```

4.4. opto32_config()

This function is the entry point to accessing an individual parameter where all pertinent data is given as separate arguments. The function should only be called after a successful open of the respective device via `opto32_open()`.

Prototype

```
U32 opto32_config(
    void*   handle,
    U32     parm,
    U32     which,
    U32     set,
    U32*    get);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`parm`	This is the Parameter Identifier for the parameter to be accessed.
`which`	This is any number or combination of parameter specific `OPTO32_WHICH_XXX` bits that specify the object(s) the parameter is applied to. Many parameters ignore this argument. When it is used, a value of zero is acceptable, and merely specifies to access none of the corresponding objects.
`set`	This is the value to apply to the parameter being accessed. The universal value `GSC_NO_CHANGE` specifies that the parameter not be altered and must be used when the purpose of the access is to get the current setting. Some parameters are read-only, in which case this argument is ignored.
`get`	After applying any changes to the parameter, its current setting is recorded here. When the “`which`” argument specifies multiple objects, the value recorded here may be from the first object accessed, the last or a collective result. This argument may be NULL, in which case the current setting is not retrieved.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_led_set(void* handle, U32 set, int verbose)
{
    U32 get;
    U32 status;

    // Reset the LED on/off state to its default.
    status  = opto32_config(    handle,
                                OPTO32_MISC_LED,
                                0,
                                set,
                                &get);

    if (!verbose)
    {
    }
    else if (status == GSC_SUCCESS)
    {
        printf("opto32_config() failure: %ld\n", (long) status);
    }
    else
    {
        printf("LED State: ");
```

```
            if (get == OPTO32_MISC_LED_OFF)
                printf("Off\n");
            else
                printf("On\n");
        }

        return(status);
    }
```

4.5. opto32_cos_read()

This function is the entry point to reading the current debounced input from the cable. The function should only be called after a successful open of the respective device via `opto32_open()`.

Prototype

```
U32 opto32_cos_read(void* handle, U32* value);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`value`	The value read is recorded here. The upper eight bits will always be zero.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_cos_read(void* handle, U32* value, int verbose)
{
    U32 status;

    status  = opto32_cos_read(handle, value);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_cos_read() failure: %ld\n", (long) status);
    }
    else
    {
        printf("COS Read: 0x%06lX\n", (long) value[0]);
    }

    return(status);
}
```

4.6. opto32_cos_write()

This function is the entry point to writing to the cable's output signals. The function should only be called after a successful open of the respective device via `opto32_open()`.

Prototype

```
U32 opto32_cos_write(void* handle, U8 value);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`value`	This is the value to write.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_cos_write(void* handle, U8 value, int verbose)
{
    U32 status;

    status  = opto32_cos_write(handle, value);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_cos_write() failure: %ld\n", (long) status);
    }
    else
    {
        printf("COS Write: 0x%02lX\n", (long) value);
    }

    return(status);
}
```

4.7. opto32_init()

This function is the entry point to return a device and all parameters to the state produced when the device was first opened. This function should only be called after a successful open of the respective device via `opto32_open()`.

Prototype

```
U32 opto32_init(void* handle);
```

Argument	Description
handle	This is an API device handle obtained via `opto32_open()`.

Return Value	Description
GSC_SUCCESS	The operation succeeded.
Otherwise …	A GSC_XXX error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_init(void* handle, int verbose)
{
    U32 status;

    status  = opto32_init(handle);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_init() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("Device Initialized: 0x%lX\n", (long) handle);
    }

    return(status);
}
```

4.8. opto32_irq_wait()

This function is the entry point to pause thread execution until an interrupt occurs. The function should only be called after a successful open of the respective device via `opto32_open()`. When called, the current thread will block until any one of a specified set of interrupts occurs. The call will return as soon as the time period expires, or when the first referenced interrupt occurs, whichever occurs first. There is no limit to the number of threads that may simultaneously utilize this service or on the combination of interrupts that may be referenced. Applications can use the utility macros `OPTO32_IRQ_WAIT__XXX(h)` to perform waits on individual interrupts without having to explicitly enter the macro for the respective interrupt. In these macros, the `XXX` may be `COS_00` through `COS_23` for COS inputs zero through 23, respectively, or `RECO` for the COS 23 Rx Event Counter Overflow. See the table below.

Macro (Services)	Description
OPTO32_IRQ_WAIT__COS_XX(h,to)	Wait for COS interrupt *XX*. *
OPTO32_IRQ_WAIT__RECO(h,to)	Wait for the Receive Event Count interrupt.

* The *XX* portion of these macros refers individually to COS interrupts 00 through 23.

Prototype

```
U32 opto32_irq_wait(void* handle, U32 which, U32 timeout_ms);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`which`	This is any bitwise or'd combination of `OPTO32_WHICH_XXX` bits applicable to interrupts. Set the bits according to the interrupts of interest. Unreferenced interrupts will have no impact. If none are set the function returns immediately with `GSC_SUCCESS`.
`timeout_ms`	This is the timeout limit is milliseconds. If an interrupt does not occur within this time period, then the call returns at the end of the period. The timeout period will be at least the amount of time specified, but may be longer depending on the OS.

Return Value	Description
`GSC_SUCCESS`	Either no interrupts were referenced or one of the referenced interrupts occurred. No indication is given to indicate which interrupt, if any, caused the call to return.
`GSC_WAIT_TIMEOUT`	The timeout period expired before a referenced interrupt occurred.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_event_count_wait(
    void*   handle,
    long    timeout_ms,
    int     verbose)
{
    U32 status;

    status  = opto32_irq_wait(handle, OPTO32_WHICH_RECO, timeout_ms);

    if (!verbose)
    {
    }
    else if (status == GSC_SUCCESS)
    {
        printf("IRQ COS 23 Event Count: interrupt occurred.\n");
    }
    else if (status == GSC_WAIT_TIMEOUT)
    {
        printf( "IRQ COS 23 Event Count:"
                " timeout after %ld milliseconds\n",
                (long) timeout_ms);
    }
    else
    {
        printf("opto32_irq_wait() failure: %ld\n", (long) status);
    }
    return(status);
}
```

4.9. opto32_open()

This function is the entry point to open a connection to an OPTO32 board. This function must be called before any other device access functions may be called. If successful, the device and all parameters are initialized to default settings. Multiple requests can be made to access the same device, and each can succeed. However, care must be taken when doing this as device access via one handle is likely to interfere with the device state maintained by the other. Additionally, one handle may configure the device in a way that conflicts with the configuration established by the other.

Prototype

```
U32 opto32_open(U8 index, void** handle);
```

Argument	**Description**
`index`	This is the zero based index of the board to access.
`handle`	If the request succeeds, the API records at this address the handle to be used for subsequent access to the respective device. This pointer must not be NULL. The pointer returned will be NULL if the request fails and non-NULL otherwise.

Return Value	**Description**
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_open(U8 index, void** handle, int verbose)
{
    U32 status;

    status  = opto32_open(index, handle);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_open() failure: %ld\n", (long) status);
    }
    else
    {
        printf("Device Opened:\n");
        printf("  Index:  0x%lX\n", (long) index);
        printf("  Handle: 0x%lX\n", (long) handle);
    }

    return(status);
}
```

4.10. opto32_reg_mod()

This function is the entry point to performing a read-modify-write operation on an OPTO32 register. The function should only be called after a successful open of the respective device via `opto32_open()`. Only GSC firmware register may be modified. The PCI and PLX feature set registers are read-only.

Prototype

```
U32 opto32_reg_mod(void* handle, U32 reg, U32 value, U32 mask);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`reg`	This is the register to access.
`value`	This is the value for the bits to be modified.
`mask`	This is the set of register bit to be modified. All others are unchanged.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_cosier_mod(
    void*   handle,
    U32     value,
    U32     mask,
    int     verbose)
{
    U32 status;

    status  = opto32_reg_mod(handle, OPTO32_COSIER, value, mask);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_reg_mod() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("COSIER Modify:\n");
        printf("  Value: 0x%lX\n", (long) value);
        printf("  Mask:  0x%lX\n", (long) mask);
    }

    return(status);
}
```

4.11. opto32_reg_read()

This function is the entry point to reading the value from an OPTO32 register. The function should only be called after a successful open of the respective device via `opto32_open()`. All OPTO32 registers may be read.

Prototype

```
U32 opto32_reg_read(void* handle, U32 reg, U32* value);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`reg`	This is the register to access.
`value`	The value read is recorded here. If this is NULL then no action is taken.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_cosier_read(void* handle, U32* value, int verbose)
{
    U32 status;

    status  = opto32_reg_read(handle, OPTO32_COSIER, value);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_reg_read() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("COSIER Read: 0x%lX\n", (long) value[0]);
    }

    return(status);
}
```

4.12. opto32_reg_write()

This function is the entry point to writing to an OPTO32 register. The function should only be called after a successful open of the respective device via `opto32_open()`. Only the OPTO32 firmware registers (those defined inside `opto32_api.h`) may be modified. All PCI and PLX registers are read-only.

Prototype

```
U32 opto32_reg_write(void* handle, U32 reg, U32 value);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`reg`	This is the register to access.
`value`	This is the value to write to the specified register.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_cosier_write(void* handle, U32 value, int verbose)
{
    U32 status;

    status  = opto32_reg_write(handle, OPTO32_COSIER, value);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_reg_write() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("COSIER Write: 0x%lX\n", (long) value);
    }

    return(status);
}
```

4.13. opto32_reset()

This function is the entry point to perform a device hardware reset. The function should only be called after a successful open of the respective device via `opto32_open()`.

> **WARNING:** The API performs a variety of actions during this call that are in addition to resetting the hardware. This is necessary for proper API operation. If an application initiates a hardware reset by writing to the various registers the results may not be identical.

Prototype

```
U32 opto32_reset(void* handle);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.

Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_reset(void* handle, int verbose)
{
    U32 status;

    status  = opto32_reset(handle);

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_reset() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("Device Reset: 0x%lX\n", (long) handle);
    }

    return(status);
}
```

4.14. opto32_status_text()

This function is the entry point to retrieving a text based description of the status values supported by the SDK.

Prototype

```
U32 opto32_status_text(U32 status, char* text, size_t size);
```

Argument	Description
`status`	This is the status value whose description is desired.
`text`	The descriptive text is recorded here.
`size`	This gives the size of the above buffer.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_status_text(U32 stat, int verbose)
```

```
{
    char    buf[128];
    U32     status;

    status  = opto32_status_text(stat, buf, sizeof(buf));

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_status_text() failure: 0x%lX\n", (long) status);
    }
    else
    {
        printf("Status: 0x%lX: %s\n", (long) stat, buf);
    }

    return(status);
}
```

4.15. opto32_version_get()

This function is the entry point to retrieving version number strings. Without a valid device handle, only the API Library version number is accessible. Access to the Device Driver's version number requires a valid device handle.

Prototype

```
U32 opto32_version_get(
    void*   handle,
    U8      index,
    char*   version,
    size_t  size);
```

Argument	Description
`handle`	This is an API device handle obtained via `opto32_open()`.
`index`	This identifies the version number desired. It must be one of the `GSC_VERSION_XXX` macros.
`version`	The requested version string is recorded here.
`size`	This is the size of the above buffer.

Return Value	Description
`GSC_SUCCESS`	The operation succeeded.
Otherwise …	A `GSC_XXX` error status reflecting the problem encountered.

Example

```
#include <stdio.h>

#include "opto32_api.h"
#include "opto32_dsl.h"

U32 opto32_dsl_version_get(void* handle, U8 id, int verbose)
{
    U32     status;
    char    version[32];

    status      = opto32_version_get(   handle,
                                        id,
                                        version,
                                        sizeof(version));

    if (!verbose)
    {
    }
    else if (status != GSC_SUCCESS)
    {
        printf("opto32_version_get() failure: 0x%lX\n", (long) status);
    }
    else if (id == GSC_VERSION_LIBRARY)
    {
        printf("Library Version: %s\n", version);
    }
    else
    {
        printf("Driver Version: %s\n", version);
    }

    return(status);
}
```

5. Configuration Parameters

5.1. Parameter Macros

The Configuration Parameters are grouped according to their functional categories. Within each category each parameter is described (in this section) along with the set of utility macros designed to facilitate configuration of and access to the respective parameters. Parameter macros fall into three groups, which are described the following paragraphs. All macros are described in the following pages in association with their respective parameters. The parameter categories are as given in the below table.

Parameter Categories	Description
`OPTO32_COS_XXX`	These refer to the Change Of State Parameters.
`OPTO32_IRQ_XXX`	These refer to the Interrupt Parameters.
`OPTO32_MISC_XXX`	These refer to the Miscellaneous Parameters.

5.1.1. Parameter Definitions

The first group of macros includes the parameter definitions. These are used to identify the specific parameter to be accessed. These macros begin with "`OPTO32_`" and are followed immediately by upper case letters identifying the parameter category. For example "`OPTO32_MISC_`" prefaces all Miscellaneous Parameter identifiers. These macros end with upper case letters indicating the name of the specific parameter. For example "`OPTO32_MISC_STRICT_ARGUMENTS`" identifies the Miscellaneous Strict Arguments parameter.

5.1.2. Value Definitions

The second group of macros identifies predefined values associated with the respective parameters. These macros begin with the Parameter Definition and are followed by a single underscore ("_") then upper case letters that reflect the meaning of the respective values. For example the macro "`OPTO32_MISC_STRICT_ARGUMENTS_DISABLE`" is the value that represents the parameter's *disabled* setting.

5.1.3. Service Definitions

The third group of macros performs operations on parameters. These are utility macros that retrieve parameter settings and states or assign parameter values. These macros include the Parameter Definition followed by a double underscore ("__") then upper case letters that reflect the action to perform. For example "`OPTO32_MISC_STRICT_ARGUMENTS__GET()`" retrieves the current setting of the Miscellaneous Strict Arguments parameter. These macros include arguments, which are described as follows.

5.1.3.1. Device Handle: h

In the service macros, the argument `h` refers to the device handle used to access the respective device. This handle is obtained by calling `opto32_open()`. This argument must not be NULL.

5.1.3.2. Which Bits: w

In the service macros, the argument `w` refers to any combination of the `OPTO32_WHICH_XXX` bits. Refer to paragraph 2.5 on page 12. With some parameters this argument is unused or is specified inside the macro's replacement text. In those cases the `w` is not included as a macro argument.

5.1.3.3. Set Value: s

In the service macros, the argument `s` refers to the value to be applied to the referenced parameter. With some parameters the value can be arbitrarily assigned by the application. With most parameters this argument should be one of the predefined value definitions. The `s` is not included as a macro argument for those cases where either a value is not being applied or the value applied is specified inside the macro replacement text.

5.1.3.4. Get Value: g

In the service macros, the argument `g` refers to the address of the variable to receive the parameter's current setting. In cases where the current setting is not being read, this argument has been omitted from the service macro. In all cases, this argument can be NULL, in which case the current value is not retrieved.

5.2. Change Of State Parameters

The purpose of the Change Of State (COS) Parameters is to permit access to and control of the board's COS feature. All COS Parameters are put in a default state when the device is opened and are returned to that state via the `opto32_init()` and `opto32_reset()` services. Applications are free to manipulate the configuration either via the API's register access services or via the COS Parameter services. The following table summaries the COS Parameters.

Parameter Identifier	**Description**
`OPTO32_COS_DEBOUNCE_DIVISOR`	This gives direct access to the Clock Divider Register.
`OPTO32_COS_DEBOUNCE_PERIOD_MS`	This refers to the overall debounce period in milliseconds.
`OPTO32_COS_DEBOUNCE_PERIOD_US`	This refers to the overall debounce period in microseconds.

5.2.1. COS Parameter: Debounce Divisor

The purpose of this parameter is to control and report the board's debounce Clock Divider. Accessing this service is equivalent to accessing the Clock Divider Register (CDR) directly. Setting this parameter updates the Clock Divider. Reading this parameter returns the current Clock Divider value. The following tables describe the macros associated with this parameter.

NOTE: All OPTO32 interrupts are temporarily disabled while the Debounce Divisor is being set.

Macro (Parameter)	**Description**
`OPTO32_COS_DEBOUNCE_DIVISOR`	This is the identifier for this parameter.

Macro (Values)	**Description**
`OPTO32_COS_DEBOUNCE_DIVISOR_DEFAULT`	This is the divider's default value, which is zero.

Macro (Services)	**Description**
`OPTO32_COS_DEBOUNCE_DIVISOR__GET(h,g)`	This retrieves the current divider.
`OPTO32_COS_DEBOUNCE_DIVISOR__RESET(h)`	This sets the counter to its default value.
`OPTO32_COS_DEBOUNCE_DIVISOR__SET(h,s)`	This applies a specified counter value.

5.2.2. COS Parameter: Debounce Period In Milliseconds

The purpose of this parameter is to control and report the board's debounce period in milliseconds. This refers to the overall debounce period, which consists of three individual sampling intervals. When a value is applied it is converted from milliseconds to the closest corresponding Clock Divider value. When the period is retrieved the Clock Divider is rounded to the nearest millisecond. The following tables describe the macros associated with this parameter.

NOTE: All OPTO32 interrupts are temporarily disabled while the Debounce Divisor is being set.

Macro (Parameter)	**Description**
`OPTO32_COS_DEBOUNCE_PERIOD_MS`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_COS_DEBOUNCE_PERIOD_MS_DEFAULT`	This is the default period. The minimum is the default.
`OPTO32_COS_DEBOUNCE_PERIOD_MS_MAX`	This is the maximum period that may be requested, which is two minutes.
`OPTO32_COS_DEBOUNCE_PERIOD_MS_MIN`	This is the minimum period that may be requested, which is zero. (Zero corresponds to a period of 600 nanoseconds.)

Macro (Services)	Description
`OPTO32_COS_DEBOUNCE_PERIOD_MS__GET(h,g)`	This retrieves the current period.
`OPTO32_COS_DEBOUNCE_PERIOD_MS__RESET(h)`	This requests the default period.
`OPTO32_COS_DEBOUNCE_PERIOD_MS__SET(h,s)`	This requests a specified period.

5.2.3. COS Parameter: Debounce Period In Microseconds

The purpose of this parameter is to control and report the board's debounce period in microseconds. This refers to the overall debounce period, which consists of three individual sampling intervals. When a value is applied it is converted from microseconds to the closest corresponding Clock Divider value. When the period is retrieved the Clock Divider is rounded to the nearest microsecond. The following tables describe the macros associated with this parameter.

NOTE: All OPTO32 interrupts are temporarily disabled while the Debounce Divisor is being set.

Macro (Parameter)	Description
`OPTO32_COS_DEBOUNCE_PERIOD_US`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_COS_DEBOUNCE_PERIOD_US_DEFAULT`	This is the default period. The minimum is the default.
`OPTO32_COS_DEBOUNCE_PERIOD_US_MAX`	This is the maximum period that may be requested, which is two minutes.
`OPTO32_COS_DEBOUNCE_PERIOD_US_MIN`	This is the minimum period that may be requested, which is zero. (Zero corresponds to a period of 600 nanoseconds.)

Macro (Services)	Description
`OPTO32_COS_DEBOUNCE_PERIOD_US__GET(h,g)`	This retrieves the current period.
`OPTO32_COS_DEBOUNCE_PERIOD_US__RESET(h)`	This requests the default period.
`OPTO32_COS_DEBOUNCE_PERIOD_US__SET(h,s)`	This requests a specified period.

5.3. Interrupt Parameters

The purpose of the Interrupt Parameters is to permit access to and control of the OPTO32 hardware based interrupts. All Interrupt Parameters are put in a default state when the device is opened and are returned to that state via the `opto32_init()` service. The hardware based interrupt configuration is returned to its default state via the `opto32_reset()` service. The configuration of the Interrupt Parameters is retained mostly within the OPTO32 firmware registers. Applications have access to the OPTO32 interrupt registers but it is advised that they be accessed only through the parameter access service. When using the service `opto32_config()` any number or combination of `OPTO32_WHICH_XXX` bits may be used, even none. An interrupt is accessed only if it's respective "which" bit is set. If none is set, then no action will be taken. The following table summaries the Interrupt Parameters.

Parameter Identifier	Description
`OPTO32_IRQ_CALLBACK_ARG`	This gives direct access to the application specific argument for

	the callback form of interrupt notification.
OPTO32_IRQ_CALLBACK_FUNC	This gives direct access to the application specific callback function for the callback form of interrupt notification.
OPTO32_IRQ_COS_23_EVENT_COUNTER	This deals with the COS 23 input Event Counter.
OPTO32_IRQ_COS_POLARITY	This gives direct access to the COS state change polarity used to generate interrupts.
OPTO32_IRQ_ENABLE	This gives direct access to the interrupt enable/disable option.
OPTO32_IRQ_STATE	This reports the interrupt triggered state of the board's interrupt sources.

5.3.1. Interrupt Parameter: Callback Argument

The purpose of this parameter is to modify and report the application provided argument that the application receives as "arg2" during an interrupt callback event. In the opto32_config() service interrupt selections are made using individual OPTO32_WHICH__XXX bits. (Here "XXX" is any of the predefined interrupt selection options.) The following tables describe the macros associated with this parameter.

> **NOTE:** Applications must remember that the macros GSC_NO_CHANGE and GSC_DEFAULT have special meaning when applying parameter modifications. If the application specific value being supplied for this parameter happens to equal either of these values, then the results will be according to the API's use of these special values rather than the applications intent.

> **NOTE:** This parameter can be accessed and altered during the callback, but the callback must return before subsequent callbacks can be made on the same interrupt.

Macro (Parameter)	Description
OPTO32_IRQ_CALLBACK_ARG	This is the identifier for this parameter.

Macro (Values)	Description
OPTO32_IRQ_CALLBACK_ARG_DEFAULT	This is the default, which is zero.

Macro (Services)	Description
OPTO32_IRQ_CALLBACK_ARG__GET(h,w,g)	This retrieves a current setting.
OPTO32_IRQ_CALLBACK_ARG__RESET(h,w)	This requests that the setting for the referenced interrupts be set to the default value.
OPTO32_IRQ_CALLBACK_ARG__SET(h,w,s)	This requests a setting change to the referenced interrupts.
OPTO32_IRQ_CALLBACK_ARG__XXX_GET(h,g)	This retrieves the current interrupt *XXX* setting. *
OPTO32_IRQ_CALLBACK_ARG__XXX_RESET(h)	This requests an interrupt *XXX* setting change to its default. *
OPTO32_IRQ_CALLBACK_ARG__XXX_SET(h,s)	This requests an interrupt *XXX* setting change. *

* The *XXX* portion of these macros refers individually to COS_00 through COS_23, and RECO.

5.3.2. Interrupt Parameter: Callback Function

The purpose of this parameter is to modify and report the application provided callback function pointer for an interrupt callback event. This parameter tells the API which application supplied function to call when an interrupt occurs. In the opto32_config() service he interrupt selections are made using individual OPTO32_WHICH_XXX bits. (Here "XXX" is any of the predefined interrupt selection options.) The following tables describe the macros associated with this parameter.

> **NOTE:** This parameter can be accessed and altered during the callback, but the callback must return before subsequent callbacks can be made on the same interrupt.

Macro (Parameter)	Description
`OPTO32_IRQ_CALLBACK_FUNC`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_IRQ_CALLBACK_FUNC_DEFAULT`	This is the default, which is NULL. This effectively disables the callback feature since the API has no function to call.

Macro (Services)	Description
`OPTO32_IRQ_CALLBACK_FUNC__GET(h,w,g)`	This retrieves a current function pointer.
`OPTO32_IRQ_CALLBACK_FUNC__RESET(h,w)`	This requests that the function pointer for the referenced interrupts be set to the default value.
`OPTO32_IRQ_CALLBACK_FUNC__SET(h,w,s)`	This requests a function pointer change.
`OPTO32_IRQ_CALLBACK_FUNC__XXX_GET(h,g)`	This retrieves the current interrupt *XXX* function pointer. *
`OPTO32_IRQ_CALLBACK_FUNC__XXX_RESET(h)`	This requests an interrupt *XXX* function pointer change to its default. *
`OPTO32_IRQ_CALLBACK_FUNC__XXX_SET(h,s)`	This requests an interrupt *XXX* function pointer change. *

* The *XXX* portion of these macros refers individually to `COS_00` through `COS_23`, and `RECO`.

5.3.3. Interrupt Parameter: COS 23 Event Counter

The purpose of this parameter is to control and report the COS 23 Receive Event Counter value. This feature counts low-to-high state changes on the COS 23 input. If the interrupt is enabled, an interrupt is generated when the count rolls over from 0xFFFF to 0x0. Applying a setting updates the current count, and reporting the setting retrieves the current count. The setting refers to the current count, not the number of additional events needed to generate an interrupt. The number of additional events needed to generate an interrupt is defined as `(0xFFFF - X + 1)`, where `X` is the current reading. The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
`OPTO32_IRQ_COS_23_EVENT_COUNTER`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_IRQ_COS_23_EVENT_COUNTER_DEFAULT`	This refers to the default, which is zero.

Macro (Services)	Description
`OPTO32_IRQ_COS_23_EVENT_COUNTER__GET(h,g)`	This requests the current setting.
`OPTO32_IRQ_COS_23_EVENT_COUNTER__RESET(h)`	This sets the counter to its default value.
`OPTO32_IRQ_COS_23_EVENT_COUNTER__SET(h,s)`	This requests a setting change.

5.3.4. Interrupt Parameter: COS Polarity

The purpose of this parameter is to control and report the COS polarity used for generating interrupts. This parameter controls whether a COS interrupt is generated on a rising edge or a falling edge. If a setting is High-to-Low, then generation of an interrupt is tied to detection of a high-to-low state transition. This similarly applies for a Low-to-High setting. The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
`OPTO32_IRQ_COS_POLARITY`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_IRQ_COS_POLARITY_HI_LOW`	This refers to a High-to-Low state change.
`OPTO32_IRQ_COS_POLARITY_LOW_HI`	This refers to a Low-to-High state change.

OPTO32_IRQ_COS_POLARITY_DEFAULT	This refers to the default, which is High-to-Low.

Macro (Services)	Description
OPTO32_IRQ_COS_POLARITY__GET(h,w,g)	This requests the current setting for the specified input(s).
OPTO32_IRQ_COS_POLARITY__RESET(h,w)	This requests a setting change for the specified input(s) to the default value.
OPTO32_IRQ_COS_POLARITY__SET(h,w,s)	This requests a setting change for the specified input(s).
OPTO32_IRQ_COS_POLARITY__XX_GET(h,g)	This requests the current setting for the input number "XX". *
OPTO32_IRQ_COS_POLARITY__XX_H2L(h)	This requests a setting change for the input number "XX". *
OPTO32_IRQ_COS_POLARITY__XX_L2H(h)	This requests a setting change for the input number "XX". *
OPTO32_IRQ_COS_POLARITY__XX_RESET(h)	This requests a setting change for the input number "XX" to its default. *
OPTO32_IRQ_COS_POLARITY__XX_SET(h,s)	This requests a setting change for the input number "XX". *

* The *XX* portion of these macros refers individually to 00 through 23.

5.3.5. Interrupt Parameter: Enable

The purpose of this parameter is to modify and report the enabled state of the respective interrupt. This parameter enables and disables individual interrupts. In the opto32_config() service interrupt selections are made using individual OPTO32_WHICH_XXX bits. (Here "XXX" is any of the predefined interrupt selection options.) The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
OPTO32_IRQ_ENABLE	This is the identifier for this parameter.

Macro (Values)	Description
OPTO32_IRQ_ENABLE_DEFAULT	This is the default which is disabled.
OPTO32_IRQ_ENABLE_NO	This option disables the interrupt.
OPTO32_IRQ_ENABLE_YES	This option enables the interrupt.

Macro (Services)	Description
OPTO32_IRQ_ENABLE__GET(h,w,g)	This retrieves a current setting.
OPTO32_IRQ_ENABLE__NO(h,w)	This requests that the referenced interrupts be disabled.
OPTO32_IRQ_ENABLE__RESET(h,w)	This requests a setting change for the referenced interrupts to the default.
OPTO32_IRQ_ENABLE__SET(h,w,s)	This requests a setting change.
OPTO32_IRQ_ENABLE__XXX_GET(h,g)	This retrieves the current interrupt *XXX* setting. *
OPTO32_IRQ_ENABLE__XXX_NO(h)	This requests that interrupt *XXX* be disabled. *
OPTO32_IRQ_ENABLE__XXX_RESET(h)	This requests an interrupt *XXX* setting change to its default. *
OPTO32_IRQ_ENABLE__XXX_SET(h,s)	This requests an interrupt *XXX* setting change. *
OPTO32_IRQ_ENABLE__XXX_YES(h)	This requests that interrupt *XXX* be enabled. *

* The *XXX* portion of these macros refers individually to COS_00 through COS_23, and RECO.

5.3.6. Interrupt Parameter: State

The purpose of this read-only parameter is to report the state of the respective interrupt source. This parameter tells whether an interrupt source is active or inactive. In the `opto32_config()` service interrupt selections are made using individual `OPTO32_WHICH_XXX` bits. (Here "`XXX`" is any of the predefined interrupt selection options.) The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
`OPTO32_IRQ_STATE`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_IRQ_STATE_ACTIVE`	This reflects that the source was active.
`OPTO32_IRQ_STATE_INACTIVE`	This reflects that the source was inactive.

Macro (Services)	Description
`OPTO32_IRQ_STATE__GET(h,w,g)`	This retrieves a current state.
`OPTO32_IRQ_STATE__XXX_GET(h,g)`	This retrieves the current interrupt *XXX* state. *

* The *XXX* portion of these macros refers individually to `COS_00` through `COS_23`, and `RECO`.

5.4. Miscellaneous Parameters

The purpose of the Miscellaneous Parameters is to permit access to and control of OPTO32 parameters which do not readily fit into the other parameter categories. All Miscellaneous Parameters are put in a default state when the device is opened and are returned to that state via the `opto32_init()` service. The hardware based Miscellaneous Parameters are returned to their default states via the `opto32_reset()` service. Applications have access to these OPTO32 registers but it is advised that these parameters be accessed only through the Miscellaneous Parameter services. When using the service `opto32_config()` the "which" bits argument is ignored. The following table summaries the Miscellaneous Parameters.

Parameter Identifier	Description
`OPTO32_MISC_LED`	This gives direct access to the LED on the OPTO32 panel.
`OPTO32_MISC_MAP_GSC_REGS`	This refers to direct access to the firmware registers.
`OPTO32_MISC_MAP_GSC_REGS_PTR`	This refers to an application's direct access to the firmware registers.
`OPTO32_MISC_MAP_PLX_REGS`	This gives direct access to how the API accesses the PLX registers.
`OPTO32_MISC_STRICT_ARGUMENTS`	This gives direct access to how the API responds to unrecognized parameter values.
`OPTO32_MISC_STRICT_CONFIG`	This refers to how the library responds to invalid configuration requests.

5.4.1. Miscellaneous Parameter: LED

The purpose of this parameter is to control and report the state of the LED located near the cable interface. This parameter turns the LED on and off. The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
`OPTO32_MISC_LED`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_MISC_LED_DEFAULT`	This is the default, which is *on*.
`OPTO32_MISC_LED_OFF`	This refers to the *off* state.
`OPTO32_MISC_LED_ON`	This refers to the *on* state.

Macro (Services)	Description
`OPTO32_MISC_LED__GET(h,g)`	This requests the current setting.
`OPTO32_MISC_LED__OFF(h)`	This requests that the LED be turned off.
`OPTO32_MISC_LED__ON(h)`	This requests that the LED be turned on.
`OPTO32_MISC_LED__RESET(h)`	This requests that the LED be set to its default state.
`OPTO32_MISC_LED__SET(h,s)`	This requests a change to the current setting.

5.4.2. Miscellaneous Parameter: GSC Register Mapping

The purpose of this parameter is to control and report the mapping of GSC registers into application and API memory space. This parameter should always be enabled, even if unused by applications. If it is disabled, the API's access to OPTO32 firmware registers operates with reduced efficiency. The following tables describe the macros associated with this parameter.

> **NOTE:** There are circumstances where this feature cannot be enabled and utilized. This is usually limited to embedded hosts here the BIOS doesn't place all PCI memory access regions on CPU Page Size boundaries. If the BIOS cannot be configured to utilize such boundaries, then API performance is degraded.

> **NOTE:** This parameter should only be disabled for testing purposes.

Macro (Parameter)	Description
`OPTO32_MISC_MAP_GSC_REGS`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_MISC_MAP_GSC_REGS_DEFAULT`	This is the default, which is *enabled*.
`OPTO32_MISC_MAP_GSC_REGS_DISABLE`	This refers to the *disabled* state. When disabled access to firmware registers must go through the Device Driver, which reduces efficiency.
`OPTO32_MISC_MAP_GSC_REGS_ENABLE`	This refers to the *enabled* state. When enabled access to firmware registers is done entirely within the API, which increases efficiency.

Macro (Services, See section 5.1.3, page 34.)	Description
`OPTO32_MISC_MAP_GSC_REGS__DISABLE(h)`	This requests that the option be disabled.
`OPTO32_MISC_MAP_GSC_REGS__ENABLE(h)`	This requests that the option be enabled.
`OPTO32_MISC_MAP_GSC_REGS__GET(h,g)`	This requests the current setting.
`OPTO32_MISC_MAP_GSC_REGS__RESET(h)`	This requests that the default be selected.
`OPTO32_MISC_MAP_GSC_REGS__SET(h,s)`	This requests a change to the current setting.

5.4.3. Miscellaneous Parameter: GSC Register Mapping Pointer

The purpose of this read-only parameter is to retrieve the pointer the API uses for direct access to OPTO32 firmware registers. If the GSC Register Mapping feature is enabled the application can use the pointer to directly access OPTO32 firmware registers. If disabled, the pointer returned is NULL. The following tables describe the macros associated with this parameter.

> **NOTE:** There are circumstances where this feature cannot be utilized. This is usually limited to embedded hosts here the BIOS doesn't place all PCI memory access regions on CPU Page Size boundaries. If the BIOS cannot be configured to utilize such boundaries, then API performance is degraded.

Macro (Parameter)	Description
`OPTO32_MISC_MAP_GSC_REGS_PTR`	This is the identifier for this parameter.

Macro (Services, See section 5.1.3, page 34.)	Description
`OPTO32_MISC_MAP_GSC_REGS_PTR__GET(h,g)`	This requests the current pointer.

5.4.4. Miscellaneous Parameter: PLX Register Mapping

The purpose of this parameter is to control and report the mapping of PLX registers into API memory space. This parameter is used to give the API direct access to PLX feature set registers. When mapping is enabled the API reads these registers itself, contributing to improved performance. When mapping is disabled the API passes read requests for these registers to the driver, which takes more work to complete. This parameter should always be enabled, even though it is not directly usable by applications. The following tables describe the macros associated with this parameter.

> **NOTE:** There are circumstances where this feature cannot be enabled and utilized. This is usually limited to embedded hosts here the BIOS doesn't place all PCI memory access regions on CPU Page Size boundaries. If the BIOS cannot be configured to utilize such boundaries, then API performance is degraded.

Macro (Parameter)	Description
`OPTO32_MISC_MAP_PLX_REGS`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_MISC_MAP_PLX_REGS_DEFAULT`	This is the default, which is *enabled*.
`OPTO32_MISC_MAP_PLX_REGS_DISABLE`	This refers to the *disabled* state. When disabled access to PLX registers must go through the Device Driver, which reduces efficiency.
`OPTO32_MISC_MAP_PLX_REGS_ENABLE`	This refers to the *enabled* state. When enabled access to PLX registers is done entirely within the API, which increases efficiency.

Macro (Services)	Description
`OPTO32_MISC_MAP_PLX_REGS__ENABLE(h)`	This request that the option be enabled.
`OPTO32_MISC_MAP_PLX_REGS__GET(h,g)`	This requests the current setting.
`OPTO32_MISC_MAP_PLX_REGS__SET(h,s)`	This request a change to the current setting.

5.4.5. Miscellaneous Parameter: Strict Arguments

The purpose of this parameter is to control and retrieve the setting that governs the API's handling of certain unrecognized values. For example, if the setting supplied when adjusting this parameter is not listed in the appropriate table below, then the API can either respond with an error condition or infer the application's intent per the value that was received. If Strict Argument processing is enabled, then processing is terminated with an error status. Otherwise the API is lenient and will try to proceed gracefully. This policy is applicable to parameter processing only, and applies to most parameters. The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
`OPTO32_MISC_STRICT_ARGUMENTS`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_MISC_STRICT_ARGUMENTS_DEFAULT`	This is the default, which is lenient processing.
`OPTO32_MISC_STRICT_ARGUMENTS_DISABLE`	This refers to lenient processing.
`OPTO32_MISC_STRICT_ARGUMENTS_ENABLE`	This refers to strict processing.

Macro (Services)	Description
`OPTO32_MISC_STRICT_ARGUMENTS__GET(h,g)`	This requests the current setting.
`OPTO32_MISC_STRICT_ARGUMENTS__NO(h)`	This requests lenient processing.
`OPTO32_MISC_STRICT_ARGUMENTS__RESET(h)`	This requests that the setting be changed to its default value.
`OPTO32_MISC_STRICT_ARGUMENTS__SET(h,s)`	This requests a setting change.
`OPTO32_MISC_STRICT_ARGUMENTS__YES(h)`	This requests strict processing.

5.4.6. Miscellaneous Parameter: Strict Configuration

The purpose of this parameter is to control and retrieve the setting that governs the API's handling of certain invalid configurations. For example, if the setting supplied when adjusting a parameter is inconsistent with the board's current configuration, then the API can either respond with an error condition or try to proceed gracefully. If Strict Configuration processing is enabled, then processing is terminated with an error status. Otherwise the API is lenient and will try to proceed gracefully. This policy is applicable to parameter processing only, but is NOT applicable to the OPTO32 at this time. The following tables describe the macros associated with this parameter.

Macro (Parameter)	Description
`OPTO32_MISC_STRICT_CONFIG`	This is the identifier for this parameter.

Macro (Values)	Description
`OPTO32_MISC_STRICT_CONFIG_DEFAULT`	This is the default, which is lenient processing.
`OPTO32_MISC_STRICT_CONFIG_DISABLE`	This refers to lenient processing.
`OPTO32_MISC_STRICT_CONFIG_ENABLE`	This refers to strict processing.

Macro (Services)	Description
`OPTO32_MISC_STRICT_CONFIG__GET(h,g)`	This requests the current setting.
`OPTO32_MISC_STRICT_CONFIG__NO(h)`	This requests lenient processing.
`OPTO32_MISC_STRICT_CONFIG__RESET(h)`	This requests that the default be selected.
`OPTO32_MISC_STRICT_CONFIG__SET(h,s)`	This requests a setting change.
`OPTO32_MISC_STRICT_CONFIG__YES(h)`	This requests strict processing.

6. Operation

This section explains some operational procedures using the OPTO32 with the SDK. This is in no way intended to be a comprehensive guide on using the OPTO32. This is simply to address a very few issues relating to the board's use.

6.1. Overview

Before accessing any OPTO32, applications first verify the state of the API (by calling `opto32_api_status()`). Once done, access is permissible to any and all installed boards (by calling `opto32_open()`). An open request returns a handle to the device which is specific to and usable only by the API. (The API prevents access to the device other than by this handle.) Using this handle, applications have full access to and control over the OPTO32 and its features. Applications can configure all available device and API settings, perform discrete I/O operations and when done release access to the device (by calling `opto32_close()`).

6.2. Direct Register Access

Application can gain direct access to the OPTO32 firmware registers via the Miscellaneous Parameters `OPTO32_MISC_MAP_GSC_REGS` and `OPTO32_MISC_MAP_GSC_REGS_PTR`. This feature permits applications to read and write the registers using 32-bit pointers, such as `U32*`. While direct access to the OPTO32 firmware registers can contribute to a performance gain, there may be virtually no gain to an application using this feature. The reason is because the API uses direct register access at all times, when possible. This is done automatically for performance reasons and occurs unless the Miscellaneous GSC Register Mapping parameter is disabled. If this is done, then direct access is available to neither the API nor the application.

6.3. Data Input

Very little is required in terms of configuring and using the OPTO32's data input feature. The steps needed are as follows.

1. Configure the Debounce Clock Divisor for the desired debounce period. For this refer to the utility macros for the following parameters. Refer to `OPTO32_COS_DEBOUNCE_DIVISOR` to set the divisor explicitly. Refer to `OPTO32_COS_DEBOUNCE_PERIOD_MS` to set the debounce period in millisecond increments. Refer to `OPTO32_COS_DEBOUNCE_PERIOD_US` to set the debounce period in microsecond increments.

2. If the input is to be read in response to an interrupt then perform the following additional steps.

    a. If the input is to be read in response to a COS state change interrupt then configure the polarity of the state change desired. For this refer to the utility macros for parameter `OPTO32_IRQ_COS_POLARITY`.

    b. If the input is to be read in response to a specific number of low-to-high state changes on the COS 23 input, then configure the COS 23 Event Counter for the desired number of events. For this refer to the utility macros for parameter `OPTO32_IRQ_COS_23_EVENT_COUNTER`.

    c. If the input is to be read using the interrupt notification feature's callback option, then configure the callback argument and the callback function parameters for the interrupts of interest. For these refer respectively to the utility macros for parameters `OPTO32_IRQ_CALLBACK_ARG` and `OPTO32_IRQ_CALLBACK_FUNC`. When the callback occurs proceed to the steps below.

    d. If the input is to be read using the interrupt notification feature's wait option, then perform the wait for the interrupts of interest. For this refer to the API function `opto32_irq_wait()` or the utility macros `OPTO32_IRQ_WAIT__XXX(h)`. In these macros `XXX` refers collectively to the set of macros available (COS_00 through COS_23, and RECO). When the function returns and the status reflects than an interrupt did occur, then proceed to the steps below.

3. Read debounced input from the OPTO32. For this refer to API function `opto32_cos_read()`.

That's all there is to it. Reading the input can be done at any time. The value returned will always reflect the current debounced input. Applications can read the input in a polling fashion or make use of the API's interrupt notification feature as described in subsequent paragraphs.

6.4. Data Output

The OPTO32 requires no configuration or setup in order to post output to the cable. All output is asynchronous to the write request. When writing data to the OPTO32 the data immediately appears at the output (or at least as soon as the hardware is able to respond). A minimum hold time feature is not supported by either the hardware or the API. Applications needing a minimum hold time on the output must implement support in application code.

6.5. Event Notification

The API Library supports event notification in the form of Interrupt Notification. Notification includes both a callback mechanism and a wait mechanism. Both are described below. Interrupt Notification is driven by interrupts generated by the OPTO32 from any of its interrupt sources.

> **NOTE:** When interrupt notification is used it is the application's responsibility to enable all applicable interrupts. This applies to both the wait mechanism and the callback mechanism. To receive continuous interrupt notification applications must re-enable each interrupt source after each notification. To terminate notification applications should disable the respective interrupts.
>
> **NOTE:** Once an interrupt is enabled it will remain so until it is disabled by the application or until it is disabled by the API in the normal course of servicing the interrupt.

6.5.1. Event Callback

The callback feature permits an application supplied function to be called in response to OPTO32 interrupts. Each interrupt source can independently be assigned its own callback function along with a different application defined callback argument. Callbacks can be assigned to any source and in any combination desired. If a given callback is associated with multiple sources, then multiple callbacks will be made as the different events occur. So, for example, if a single callback is assigned to two different interrupts, then the callback function will be called separately for each interrupt, as often as each occurs. Since each source is associated with its own callback context, a thread context, such callbacks must support multithreaded operation. Applications are free to reconfigure callbacks during a callback context, but the callback for a given event must return before subsequent callback notification can occur for that same source. The prototype required for all callbacks is the data type `opto32_callback_func_t`. The three arguments to the callback are each `U32` data types. Applications must cast the values given to their respective types, which are described below.

6.5.1.1. Interrupt Notification Callback

The callback function arguments are described in the following table. The values received during the callback must be cast according to the data types specified.

Argument	Cast	Description
arg1	void*	This is the device handle received from `opto32_open()`.
arg2	U32	This is the specific "which" bit for the interrupt that produced the callback. Refer to the OPTO32_WHICH_XXX macros.
arg3	U32	This is an application specific argument. This is the Interrupt Callback Argument

		parameter.

6.5.2. Event Waiting

The waiting mechanism operates by blocking the calling thread until any one of a number of referenced events occurs. The calling thread is resumed when the first of the referenced events occurs, or when a timeout limit expires, whichever occurs first. The time limit is passed as an argument to the wait service. Threads can wait on any number or combinations of interrupts. Also, any number of threads can wait on identical or different events. All are resumed when a referenced event occurs.

Document History

Revision	Description
August 18, 2005	Initial release.