Software Interface
CCRTAICC (WC-ADS6418)

PCIe 64-Channel Analog Input Card (AICC)

Driver	ccrtaicc (WC-ADS6418)	
OS	RedHawk (CentOS/Rocky or Ubuntu based)	
Vendor	Concurrent Real-Time	
Hardware	PCIe 64-Channel Analog Input Card (CP-ADS6418)	
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1. Introduction

This document provides the software interface to the ***ccrtaicc*** driver which communicates with the Concurrent Real-Time PCI Express 64-Channel Analog Input Card (AICC). For additional information for low-level programming is contained in the *Concurrent Real-Time PCIe 64-Channel Analog Input Card (AICC) Design Specification* (No. *0610108*) document.

The software package that accompanies this board provides the ability for advanced users to communicate directly with the board via the driver *ioctl(2)* and *mmap(2)* system calls. When programming in this mode, the user needs to be intimately familiar with both the hardware and the register programming interface to the board. Failure to adhere to correct programming will result in unpredictable behavior.

Additionally, the software package is accompanied with an extensive set of application programming interface (API) calls that allow the user to access all capabilities of the board. The API library also allows the user the ability to communicate directly with the board through the *ioctl(2)* and *mmap(2)* system calls. In this case, there is a risk of this direct access conflicting with API calls and therefore should only be used by advanced users who are intimately familiar with the hardware, board registers and the driver code.

Various example tests have been provided in the *test* and *test/lib* directories to assist the user in developing their applications.

Though API calls exist for the following, the board does not support them:

- SDRAM
- SPROM

1.1 Related Documents

- PCIe 64-Channel Analog Input Card Driver Installation on RedHawk Release Notes by Concurrent Real-Time.
- PCIe 64-Channel Analog Input Driver Technical Guide by Concurrent Real-Time.
- PCIe 64-Channel Analog Input Card (AICC) Design Specification (No. *0610108*) by Concurrent Real-Time.

2. Software Support

Software support is provided for users to communicate directly with the board using the kernel system calls *(Direct Driver Access)* or the supplied *API.* Both approaches are identified below to assist the user in software development.

2.1 Direct Driver Access

2.1.1 open(2) system call

In order to access the board, the user first needs to open the device using the standard system call *open(2).*

```
int    fp;
fp = open("/dev/ccrtaicc0", O_RDWR);
```

The file pointer '*fp'* is then used as an argument to other system calls. The user can also supply the O_NONBLOCK flag if the user does not wish to block waiting for reads to complete. In that case, if the read is not satisfied, the call will fail. The device name specified is of the format "/dev/ccrtaicc<num>" where *num* is a digit 0..9 which represents the board number that is to be accessed. Basically, the driver only allows one application to open a board at a time. The reason for this is that the application can have full access to the card, even at the board and API level. If another application were to communicate with the same card

concurrently, the results would be unpredictable unless proper synchronization between applications is performed external to the driver API.

This driver allows multiple applications to open the same board by specifying an additional *oflag O_APPEND*. It is then the responsibility of the user to ensure that the various applications communicating with the same cards are properly synchronized. Various tests supplied in this package has the *O_APPEND* flags enabled, however, it is strongly recommended that only one application be run with a single card at a time, unless the user is well aware of how the applications are going to interact with each other and accept any unpredictable results.

2.1.2 ioctl(2) system call

This system call provides the ability to control and get responses from the board. The nature of the control/response will depend on the specific *ioctl* command.

```
int   status;
int   arg;
status = ioctl(fp, <IOCTL_COMMAND>, &arg);
```

where, '*fp'* is the file pointer that is returned from the *open(2)* system call. <*IOCTL_COMMAND*> is one of the *ioctl* commands below and *arg* is a pointer to an argument that could be anything and is dependent on the command being invoked. If no argument is required for a specific command, then set to *NULL*.

Driver IOCTL command:

```
IOCTL_CCRTAICC_ABORT_DMA
IOCTL_CCRTAICC_ADD_IRQ
IOCTL_CCRTAICC_DISABLE_PCI_INTERRUPTS
IOCTL_CCRTAICC_ENABLE_PCI_INTERRUPTS
IOCTL_CCRTAICC_GET_DRIVER_ERROR
IOCTL_CCRTAICC_GET_DRIVER_INFO
IOCTL_CCRTAICC_GET_PHYSICAL_MEMORY
IOCTL_CCRTAICC_GET_ADC_READ_MODE
IOCTL_CCRTAICC_INIT_BOARD
IOCTL_CCRTAICC_INTERRUPT_TIMEOUT_SECONDS
IOCTL_CCRTAICC_MMAP_SELECT
IOCTL_CCRTAICC_NO_COMMAND
IOCTL_CCRTAICC_PCI_CONFIG_REGISTERS
IOCTL_CCRTAICC_REMOVE_IRQ
IOCTL_CCRTAICC_RESET_BOARD
IOCTL_CCRTAICC_SELECT_ADC_READ_MODE
IOCTL_CCRTAICC_WAIT_FOR_INTERRUPT
IOCTL_CCRTAICC_RELOAD_FIRMWARE
IOCTL_CCRTAICC_GET_ALL_BOARDS_DRIVER_INFO
```

IOCTL_CCRTAICC_ABORT_DMA: This *ioctl* does not have any arguments. Its purpose is to abort any DMA already in progress..

IOCTL_CCRTAICC_ADD_IRQ: This *ioctl* does not have any arguments. Its purpose is to setup the driver *interrupt handler* to handle interrupts. If support for MSI interrupts are configured, they will be enabled. Normally, there is no need to call this *ioctl* as the interrupt handler is already added when the driver is loaded. This *ioctl* should only be invoked if the user has issued the *IOCTL_CCRTAICC_REMOVE_IRQ* call earlier to remove the interrupt handler.

IOCTL_CCRTAICC_DISABLE_PCI_INTERRUPTS: This *ioctl* does not have any arguments. Its purpose is to disable PCI interrupts. This call shouldn't be used during normal reads or writes, as calls could time out. The driver handles enabling and disabling interrupts during its normal course of operation.

IOCTL_CCRTAICC_ENABLE_PCI_INTERRUPTS: This *ioctl* does not have any arguments. Its purpose is to enable PCI interrupts. This call shouldn't be used during normal reads or writes as calls could time out. The driver handles enabling and disabling interrupts during its normal course of operation.

IOCTL_CCRTAICC_GET_DRIVER_ERROR: The argument supplied to this *ioctl* is a pointer to the *ccrtaicc_user_error_t* structure. Information on the structure is located in the *ccrtaicc_user.h* include file. The error returned is the last reported error by the driver. If the argument pointer is *NULL*, the current error is reset to *CCRTAICC_SUCCESS.*

IOCTL_CCRTAICC_GET_DRIVER_INFO: The argument supplied to this *ioctl* is a pointer to the *ccrtaicc_driver_info_t* structure. Information on the structure is located in the *ccrtaicc_user.h* include file. This *ioctl* provides useful driver information.

IOCTL_CCRTAICC_GET_PHYSICAL_MEMORY: The argument supplied to this *ioctl* is a pointer to the *ccrtaicc_user_phys_mem_t* structure. Information on the structure is located in the *ccrtaicc_user.h* include file. If physical memory is not allocated, the call will fail; otherwise the call will return the physical memory address and size in bytes. The only reason to request and get physical memory from the driver is to allow the user to perform DMA operations and bypass the driver and library. Care must be taken when performing user level DMA, as incorrect programming could lead to unpredictable results, including but not limited to corrupting the kernel and any device connected to the system.

IOCTL_CCRTAICC_GET_ADC_READ_MODE: The argument supplied to this *ioctl* is a pointer to an *unsigned long int*. The value returned will be one of the ADC read modes as defined by the *enum _ccrtaicc_driver_ADC_read_mode_t* located in the *ccrtaicc_user.h* include file.

IOCTL_CCRTAICC_INIT_BOARD: This *ioctl* does not have any arguments. This call resets the board to a known initial default state. This call is currently identical to the *IOCTL_CCRTAICC_RESET_BOARD* call.

IOCTL_CCRTAICC_INTERRUPT_TIMEOUT_SECONDS: The argument supplied to this *ioctl* is a pointer to an *int*. It allows the user to change the default time out from 30 seconds to user supplied time out. This is the time that the read call will wait before it times out. The call could time out if a DMA fails to complete. The device should have been opened in the block mode (*O_NONBLOCK* not set) for reads to wait for an operation to complete.

IOCTL_CCRTAICC_MMAP_SELECT: The argument to this *ioctl* is a pointer to the *ccrtaicc_mmap_select_t* structure. Information on the structure is located in the *ccrtaicc_user.h* include file. This call needs to be made prior to the *mmap(2)* system call so as to direct the *mmap(2)* call to perform the requested mapping specified by this *ioctl*. The four possible mappings that are performed by the driver are to *mmap* the local register space *(CCRTAICC_SELECT_LOCAL_MMAP)*, the configuration register space *(CCRTAICC_SELECT_CONFIG_MMAP)* the physical memory *(CCRTAICC_SELECT_PHYS_MEM_MMAP)* that is created by the *mmap(2)* system call and the driver/library mapping *(CCRTAICC_SELECT_DRIVER_LIBRARY_MMAP)*.

IOCTL_CCRTAICC_NO_COMMAND: This *ioctl* does not have any arguments. It is only provided for debugging purpose and should not be used as it serves no purpose for the application.

IOCTL_CCRTAICC_PCI_CONFIG_REGISTERS: The argument supplied to this *ioctl* is a pointer to the *ccrtaicc_pci_config_reg_addr_mapping_*t structure whose definition is located in the *ccrtaicc_user.h* include file.

IOCTL_CCRTAICC_REMOVE_IRQ: This *ioctl* does not have any arguments. Its purpose is to remove the interrupt handler that was previously setup. The interrupt handler is managed internally by the driver and the library. The user should not issue this call, otherwise reads will time out.

IOCTL_CCRTAICC_RESET_BOARD: This *ioctl* does not have any arguments. This call resets the board to a known initial default state. This call is currently identical to the *IOCTL_CCRTAICC_INIT_BOARD* call.

IOCTL_CCRTAICC_SELECT_ADC_READ_MODE: The argument supplied to this *ioctl* is a pointer to an *unsigned long int*. The value set will be one of the ADC read modes as defined by the *enum _ccrtaicc_driver_ADC_read_mode_t* located in the *ccrtaicc_user.h* include file.

IOCTL_CCRTAICC_WAIT_FOR_INTERRUPT: The argument to this *ioctl* is a pointer to the *ccrtaicc_driver_int_t* structure. Information on the structure is located in the *ccrtaicc_user.h* include file. The user can wait for a DMA or Analog signal complete interrupt. If a time out value greater than zero is specified, the call will time out after the specified seconds, otherwise it will not time out.

IOCTL_CCRTAICC_RELOAD_FIRMWARE: This *ioctl* does not have any arguments. This call performs a reload of the latest firmware that was loaded into the board. Typically, this is used after a new firmware has been installed. It eliminates the need to reboot the kernel after a firmware update.

IOCTL_CCRTAICC_GET_ALL_BOARDS_DRIVER_INFO: The argument to this *ioctl* is a pointer to *ccrtaicc_all_boards_driver_info*. It provides the ability to supply all driver information for all the *ccrtaicc* cards in the system to the user.

2.1.3 mmap(2) system call

This system call provides the ability to map either the local board registers, the configuration board registers, create and map a physical memory that can be used for user DMA or driver/library structure mapping. Prior to making this system call, the user needs to issue the *ioctl(2)* system call with the *IOCTL_CCRTAICC_MMAP_SELECT* command. When mapping either the local board registers or the configuration board registers, the *ioctl* call returns the size of the register mapping which needs to be specified in the *mmap(2)* call. In the case of mapping a physical memory, the size of physical memory to be created is supplied to the *mmap(2)* call.

```
int *munmap_local_ptr;
ccrtaicc_local_ctrl_data_t  *local_ptr;
ccrtaicc_mmap_select_t  mmap_select;
unsigned long mmap_local_size;

mmap_select.select = CCRTAICC_SELECT_LOCAL_MMAP;
mmap_select.offset=0;
mmap_select.size=0;
ioctl(fp, IOCTL_CCRTAICC_MMAP_SELECT,(void *)&mmap_select);
mmap_local_size = mmap_select.size;

munmap_local_ptr = (int *) mmap((caddr_t)0, map_local_size,
                   (PROT_READ|PROT_WRITE), MAP_SHARED, fp, 0);

local_ptr = (ccrtaicc_local_ctrl_data_t *)munmap_local_ptr;
local_ptr = (ccrtaicc_local_ctrl_data_t *)((char *)local_ptr +
                                           mmap_select.offset);
.
.
.

if(munmap_local_ptr != NULL)
```

```
munmap((void *)munmap_local_ptr, mmap_local_size);
```

2.1.4 read(2) system call

This system call currently supports ADC programmed I/O reads of channel registers and FIFO. The option selected is determined by the *ccrtAICC_ADC_Set_Driver_Read_Mode()* call.

CCRTAICC_ADC_PIO_CHANNEL: Perform .channel registers programmed I/O reads.
CCRTAICC_ADC_PIO_FIFO: Perform FIFO reads using programmed I/O.

2.1.5 write(2) system call

This card does not support this call.

2.2 Application Program Interface (API) Access

The following APIs are the recommended method of communicating with the board for most users:

```
ccrtAICC_Abort_DMA()
ccrtAICC_ADC_Activate()
ccrtAICC_ADC_Get_CSR()
ccrtAICC_ADC_Get_Driver_Read_Mode()
ccrtAICC_ADC_Get_Fifo_Channel_Select()
ccrtAICC_ADC_Get_Fifo_Info()
ccrtAICC_ADC_Get_Fifo_Status()
ccrtAICC_ADC_Get_Fifo_Threshold()
ccrtAICC_ADC_Get_Input_Control()
ccrtAICC_ADC_Get_Negative_Cal()
ccrtAICC_ADC_Get_Offset_Cal()
ccrtAICC_ADC_Get_Positive_Cal()
ccrtAICC_ADC_Perform_Auto_Calibration()
ccrtAICC_ADC_Perform_External_Negative_Calibration()
ccrtAICC_ADC_Perform_External_Offset_Calibration()
ccrtAICC_ADC_Perform_External_Positive_Calibration()
ccrtAICC_ADC_Perform_Negative_Calibration()
ccrtAICC_ADC_Perform_Offset_Calibration()
ccrtAICC_ADC_Perform_Positive_Calibration()
ccrtAICC_ADC_Read_Channels()
ccrtAICC_ADC_Read_Channels_Calibration()
ccrtAICC_ADC_Reset_Calibration()
ccrtAICC_ADC_Reset_Fifo()
ccrtAICC_ADC_Set_CSR()
ccrtAICC_ADC_Set_Driver_Read_Mode()
ccrtAICC_ADC_Set_Fifo_Channel_Select()
ccrtAICC_ADC_Set_Fifo_Threshold()
ccrtAICC_ADC_Set_Input_Control()
ccrtAICC_ADC_Set_Negative_Cal()
ccrtAICC_ADC_Set_Offset_Cal()
ccrtAICC_ADC_Set_Positive_Cal()
ccrtAICC_ADC_Write_Channels_Calibration()
ccrtAICC_Add_Irq()
ccrtAICC_BoardExpirationTimeRemaining()
ccrtAICC_Clear_Cable_Fault()
ccrtAICC_Clear_Driver_Error()
ccrtAICC_Clear_Lib_Error()
ccrtAICC_Clock_Generator_Disable_Outputs()
ccrtAICC_Clock_Generator_Enable_Outputs()
ccrtAICC_Clock_Generator_Soft_Reset()
ccrtAICC_Clock_Get_Generator_CSR()
ccrtAICC_Clock_Get_Generator_Info()
ccrtAICC_Clock_Get_Generator_Input_Clock_Enable()
ccrtAICC_Clock_Get_Generator_Input_Clock_Select()
ccrtAICC_Clock_Get_Generator_Input_Clock_Status()
ccrtAICC_Clock_Get_Generator_M_Divider()
ccrtAICC_Clock_Get_Generator_N_Divider()
ccrtAICC_Clock_Get_Generator_Output_Config()
ccrtAICC_Clock_Get_Generator_Output_Format()
ccrtAICC_Clock_Get_Generator_Output_Mode()
ccrtAICC_Clock_Get_Generator_Output_Mux()
ccrtAICC_Clock_Get_Generator_P_Divider()
```

```
ccrtAICC_Clock_Get_Generator_P_Divider_Enable()
ccrtAICC_Clock_Get_Generator_R_Divider()
ccrtAICC_Clock_Get_Generator_Revision()
ccrtAICC_Clock_Get_Generator_Value()
ccrtAICC_Clock_Get_Generator_Voltage_Select()
ccrtAICC_Clock_Get_Generator_Zero_Delay()
ccrtAICC_Clock_ReturnOutputFrequency()
ccrtAICC_Clock_Set_Generator_CSR()
ccrtAICC_Clock_Set_Generator_Input_Clock_Enable()
ccrtAICC_Clock_Set_Generator_Input_Clock_Select()
ccrtAICC_Clock_Set_Generator_M_Divider()
ccrtAICC_Clock_Set_Generator_N_Divider()
ccrtAICC_Clock_Set_Generator_Output_Config()
ccrtAICC_Clock_Set_Generator_Output_Format()
ccrtAICC_Clock_Set_Generator_Output_Mode()
ccrtAICC_Clock_Set_Generator_Output_Mux()
ccrtAICC_Clock_Set_Generator_P_Divider()
ccrtAICC_Clock_Set_Generator_P_Divider_Enable()
ccrtAICC_Clock_Set_Generator_R_Divider()
ccrtAICC_Clock_Set_Generator_Value()
ccrtAICC_Clock_Set_Generator_Voltage_Select()
ccrtAICC_Clock_Set_Generator_Zero_Delay()
ccrtAICC_Close()
ccrtAICC_Compute_All_Output_Clocks()
ccrtAICC_Convert_Physmem2avmm_Address()
ccrtAICC_Create_UserProcess()
ccrtAICC_DataToVolts()
ccrtAICC_Destroy_AllUserProcess()
ccrtAICC_Destroy_UserProcess()
ccrtAICC_Disable_Pci_Interrupts()
ccrtAICC_DMA_Configure()
ccrtAICC_DMA_Fire()
ccrtAICC_Enable_Pci_Interrupts()
ccrtAICC_Fast_Memcpy()
ccrtAICC_Fast_Memcpy_Unlocked()
ccrtAICC_Fast_Memcpy_Unlocked_FIFO()
ccrtAICC_Fraction_To_Hex()
ccrtAICC_Get_All_Boards_Driver_Info()
ccrtAICC_Get_Board_CSR()
ccrtAICC_Get_Board_Info()
ccrtAICC_Get_Cable_Fault_CSR()
ccrtAICC_Get_Calibration_CSR()
ccrtAICC_Get_Driver_Error()
ccrtAICC_Get_Driver_Info()
ccrtAICC_Get_External_Clock_CSR()
ccrtAICC_Get_Interrupt_Status()
ccrtAICC_Get_Interrupt_Timeout_Seconds()
ccrtAICC_Get_Lib_Error_Description()
ccrtAICC_Get_Lib_Error()
ccrtAICC_Get_Library_Info()
ccrtAICC_Get_Mapped_Config_Ptr()
ccrtAICC_Get_Mapped_Driver_Library_Ptr()
ccrtAICC_Get_Mapped_Local_Ptr()
ccrtAICC_Get_Open_File_Descriptor()
ccrtAICC_Get_Physical_Memory()
```

ccrtAICC_Get_RunCount_UserProcess()
ccrtAICC_Get_TestBus_Control()
ccrtAICC_Get_Value()
ccrtAICC_Hex_To_Fraction()
ccrtAICC_Identify_Board()
ccrtAICC_Initialize_Board()
ccrtAICC_MMap_Physical_Memory()
ccrtAICC_MsgDma_Clone()
ccrtAICC_MsgDma_Configure_ADC_Fifo()
ccrtAICC_MsgDma_Configure_Descriptor()
ccrtAICC_MsgDma_Configure_Single()
ccrtAICC_MsgDma_Fire()
ccrtAICC_MsgDma_Fire_ADC_Fifo()
ccrtAICC_MsgDma_Fire_Single()
ccrtAICC_MsgDma_Free_Descriptor()
ccrtAICC_MsgDma_Get_Descriptor()
ccrtAICC_MsgDma_Get_Dispatcher_CSR()
ccrtAICC_MsgDma_Get_Prefetcher_CSR()
ccrtAICC_MsgDma_Release()
ccrtAICC_MsgDma_Seize()
ccrtAICC_MsgDma_Setup()
ccrtAICC_Munmap_Physical_Memory()
ccrtAICC_NanoDelay()
ccrtAICC_Open()
ccrtAICC_Pause_UserProcess()
ccrtAICC_Program_All_Output_Clocks()
ccrtAICC_Read()
ccrtAICC_Reload_Firmware()
ccrtAICC_Remove_Irq()
ccrtAICC_Reset_Board()
ccrtAICC_Reset_Clock()
ccrtAICC_Resume_UserProcess()
ccrtAICC_Return_Board_Info_Description()
ccrtAICC_SDRAM_Activate() **
ccrtAICC_SDRAM_Get_CSR() **
ccrtAICC_SDRAM_Read() **
ccrtAICC_SDRAM_Set_CSR() **
ccrtAICC_SDRAM_Write() **
ccrtAICC_Set_Board_CSR()
ccrtAICC_Set_Calibration_CSR()
ccrtAICC_Set_External_Clock_CSR()
ccrtAICC_Set_Interrupt_Status()
ccrtAICC_Set_Interrupt_Timeout_Seconds()
ccrtAICC_Set_TestBus_Control()
ccrtAICC_Set_Value()
ccrtAICC_SPROM_Read() **
ccrtAICC_SPROM_Read_Item() **
ccrtAICC_SPROM_Write() **
ccrtAICC_SPROM_Write_Item() **
ccrtAICC_SPROM_Write_Override() **
ccrtAICC_Transfer_Data()
ccrtAICC_Update_Clock_Generator_Divider()
ccrtAICC_UserProcess_Command()
ccrtAICC_VoltsToData()
ccrtAICC_Wait_For_Interrupt()

ccrtAICC_Write()

2.2.1 ccrtAICC_Abort_DMA()

This call will abort any DMA operation that is in progress. Normally, the user should not use this call unless they are providing their own DMA handling.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Abort_DMA(void *Handle)

   Description: Abort any DMA in progress

   Input:   void *Handle                        (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
               # CCRTAICC_LIB_IOCTL_FAILED      (driver ioctl call failed)
*************************************************************************/
```

2.2.2 ccrtAICC_ADC_Activate()

This call must be the first call to activate the ADC. Without activation, all other calls to the ADC will fail. The user can also use this call to return the current state of the ADC without any change by specifying a pointer to current_state and setting activate to CCRTAICC_ADC_ALL_ENABLE_DO_NOT_CHANGE. If the ADC is already active and the user issues a CCRTAICC_ADC_ALL_ENABLE, no additional activation will be performed. To cause the ADC to go through a full reset, the user needs to issue the CCRTAICC_ADC_ALL_RESET which will cause the ADC to disable and then re-enable, setting all its ADC values to a default state. ADC calibration data will *not* be reset.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Activate (void                       *Handle,
                          _ccrtaicc_adc_all_enable_t  activate,
                          _ccrtaicc_adc_all_enable_t  *current_state)

   Description: Activate/DeActivate ADC module

   Input:   void                              *Handle         (Handle pointer)
            _ccrtaicc_adc_all_enable_t        activate        (activate/deactivate)
               # CCRTAICC_ADC_ALL_DISABLE
               # CCRTAICC_ADC_ALL_ENABLE
               # CCRTAICC_ADC_ALL_RESET
               # CCRTAICC_ADC_ALL_ENABLE_DO_NOT_CHANGE
   Output:  _ccrtaicc_adc_all_enable_t        *current_state  (active/deactive)
               # CCRTAICC_ADC_ALL_DISABLE
               # CCRTAICC_ADC_ALL_ENABLE
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                 (successful)
               # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                 (device not open)
               # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION          (local region not present)
*************************************************************************/
```

2.2.3 ccrtAICC_ADC_Get_CSR()

This call returns information from the ADC registers for the selected channel group.

```
/*************************************************************************
```

```
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_CSR (void                  *Handle,
                         _ccrtaicc_adc_mask_t  adc_mask,
                         ccrtaicc_adc_csr_t    *adc_csr)

   Description: Get ADC Control and Status information

   Input:   void                                    *Handle  (Handle pointer)
            _ccrtaicc_adc_mask_t                    adc_mask (selected ADC mask)
               # CCRTAICC_ADC_MASK_0_15
               # CCRTAICC_ADC_MASK_16_31
               # CCRTAICC_ADC_MASK_32_47
               # CCRTAICC_ADC_MASK_48_63
               # CCRTAICC_ALL_ADC_MASK
   Output:  _ccrtaicc_adc_csr_t                     *adc_csr (pointer to ADC csr)
               _ccrtaicc_adccsr_update_clock_t      adc_update_clock
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_0:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_1:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_2:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_3:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_0:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_1:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_2:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_3:
                  # CCRTAICC_ADC_UPDATE_NORMAL_EXTERNAL_CLOCK:
                  # CCRTAICC_ADC_UPDATE_INVERTED_EXTERNAL_CLOCK:
                  # CCRTAICC_ADC_UPDATE_CLOCK_NONE:
               _ccrtaicc_adccsr_speed_select_t      adc_speed_select;
                  # CCRTAICC_ADC_NORMAL_SPEED:
                  # CCRTAICC_ADC_HIGH_SPEED:
                  # CCRTAICC_ADC_SPEED_SELECT_DO_NOT_CHANGE:
               _ccrtaicc_adccsr_data_format_t       adc_data_format
                  # CCRTAICC_ADC_OFFSET_BINARY:
                  # CCRTAICC_ADC_TWOS_COMPLEMENT:
                  # CCRTAICC_ADC_DATA_FORMAT_DO_NOT_CHANGE:
               _ccrtaicc_adccsr_input_range_t       adc_input_range
                  # CCRTAICC_ADC_BIPOLAR_5V:
                  # CCRTAICC_ADC_BIPOLAR_10V:
                  # CCRTAICC_ADC_UNIPOLAR_5V:
                  # CCRTAICC_ADC_UNIPOLAR_10V:
                  # CCRTAICC_ADC_INPUT_RANGE_DO_NOT_CHANGE:
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE       (ADC is not active)
*************************************************************************/
```

2.2.4 ccrtAICC_ADC_Get_Driver_Read_Mode()

This call returns the current driver ADC read mode. When a *read(2)* system call is issued, it is this mode that determines the type of read being performed by the driver.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Driver_Read_Mode (void                                *Handle,
                                      _ccrtaicc_driver_ADC_read_mode_t   *mode)

   Description: Get current ADC read mode that will be selected by the 'read()'
```

```
                                                                    call

   Input:   void                                *Handle (Handle pointer)
   Output:  _ccrtaicc_driver_ADC_read_mode_t   *mode   (select ADC read mode)
               # CCRTAICC_ADC_PIO_CHANNEL
               # CCRTAICC_ADC_PIO_FIFO
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_IOCTL_FAILED           (driver ioctl call failed)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
 ***************************************************************************/
```

2.2.5 ccrtAICC_ADC_Get_Fifo_Channel_Select()

This call returns the current Fifo Channel selection mask. Only samples for these selected channels are placed in the fifo during sample collection.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Fifo_Channel_Select(void       *Handle,
                    _ccrtaicc_adc_channel_mask_t  *adc_fifo_channel_select_mask)

   Description: ADC Get Fifo Channel Selection

   Input:   void                          *Handle            (handle pointer)
   Output:  _ccrtaicc_adc_channel_mask_t *adc_fifo_channel_select_mask
                                                             (channel select mask)
               # CCRTAICC_ADC_CHANNEL_MASK_0
               # CCRTAICC_ADC_CHANNEL_MASK_1
               # CCRTAICC_ADC_CHANNEL_MASK_2
               # CCRTAICC_ADC_CHANNEL_MASK_3
               # CCRTAICC_ADC_CHANNEL_MASK_4
               # CCRTAICC_ADC_CHANNEL_MASK_5
               # CCRTAICC_ADC_CHANNEL_MASK_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_MASK_58
               # CCRTAICC_ADC_CHANNEL_MASK_59
               # CCRTAICC_ADC_CHANNEL_MASK_60
               # CCRTAICC_ADC_CHANNEL_MASK_61
               # CCRTAICC_ADC_CHANNEL_MASK_62
               # CCRTAICC_ADC_CHANNEL_MASK_63
               # CCRTAICC_ALL_ADC_CHANNELS_MASK
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE (ADC is not active)
 ***************************************************************************/
```

2.2.6 ccrtAICC_ADC_Get_Fifo_Info()

This call returns ADC FIFO information to the user.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Fifo_Info (void                    *Handle,
```

```
                                ccrtaicc_adc_fifo_info_t *adc_fifo)

   Description: Get ADC FIFO control and Status information

   Input:   void                              *Handle   (Handle pointer)
   Output:  ccrtaicc_adc_fifo_info_t       *adc_fifo (pointer to ADC fifo struct)
               _ccrtaicc_adc_fifo_reset_t      reset;
                  # CCRTAICC_ADC_FIFO_ACTIVE
                  # CCRTAICC_ADC_FIFO_RESET
               _ccrtaicc_adc_fifo_overflow_t   overflow;
                  # CCRTAICC_ADC_FIFO_NO_OVERFLOW
                  # CCRTAICC_ADC_FIFO_OVERFLOW
               _ccrtaicc_adc_fifo_underflow_t  underflow;
                  # CCRTAICC_ADC_FIFO_NO_UNDERFLOW
                  # CCRTAICC_ADC_FIFO_UNDERFLOW
               _ccrtaicc_adc_fifo_full_t       full;
                  # CCRTAICC_ADC_FIFO_NOT_FULL
                  # CCRTAICC_ADC_FIFO_FULL
               _ccrtaicc_adc_fifo_threshold_t  threshold_exceeded;
                  # CCRTAICC_ADC_FIFO_THRESHOLD_NOT_EXCEEDED
                  # CCRTAICC_ADC_FIFO_THRESHOLD_EXCEEDED
               _ccrtaicc_adc_fifo_empty_t      empty;
                  # CCRTAICC_ADC_FIFO_NOT_EMPTY
                  # CCRTAICC_ADC_FIFO_EMPTY
               uint                             data_counter;
               uint                             threshold;
               uint                             max_threshold;
               uint                             driver_threshold;
               _ccrtaicc_adc_channel_mask_t     channel_select_mask;
                  # CCRTAICC_ADC_CHANNEL_MASK_0
                  # CCRTAICC_ADC_CHANNEL_MASK_1
                  # CCRTAICC_ADC_CHANNEL_MASK_2
                  # CCRTAICC_ADC_CHANNEL_MASK_3
                  # CCRTAICC_ADC_CHANNEL_MASK_4
                  # CCRTAICC_ADC_CHANNEL_MASK_5
                  # CCRTAICC_ADC_CHANNEL_MASK_6
                  # "   "   "
                  # CCRTAICC_ADC_CHANNEL_MASK_58
                  # CCRTAICC_ADC_CHANNEL_MASK_59
                  # CCRTAICC_ADC_CHANNEL_MASK_60
                  # CCRTAICC_ADC_CHANNEL_MASK_61
                  # CCRTAICC_ADC_CHANNEL_MASK_62
                  # CCRTAICC_ADC_CHANNEL_MASK_63
                  # CCRTAICC_ALL_ADC_CHANNELS_MASK
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE (ADC is not active)
 ***************************************************************************/
```

2.2.7 ccrtAICC_ADC_Get_Fifo_Status()

This call returns the ADC Fifo status information.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Fifo_Status (void                       *Handle,
                                 ccrtaicc_adc_fifo_status_t *adc_fifo_status)
```

```
   Description: Get ADC FIFO Status information

   Input:   void                                *Handle   (Handle pointer)
   Output:  ccrtaicc_adc_fifo_status_t          *adc_fifo_status (pointer to ADC
                                                 fifo status struct)
               _ccrtaicc_adc_fifo_reset_t       reset;
                  # CCRTAICC_ADC_FIFO_ACTIVE
                  # CCRTAICC_ADC_FIFO_RESET
               _ccrtaicc_adc_fifo_overflow_t    overflow;
                  # CCRTAICC_ADC_FIFO_NO_OVERFLOW
                  # CCRTAICC_ADC_FIFO_OVERFLOW
               _ccrtaicc_adc_fifo_underflow_t   underflow;
                  # CCRTAICC_ADC_FIFO_NO_UNDERFLOW
                  # CCRTAICC_ADC_FIFO_UNDERFLOW
               _ccrtaicc_adc_fifo_full_t        full;
                  # CCRTAICC_ADC_FIFO_NOT_FULL
                  # CCRTAICC_ADC_FIFO_FULL
               _ccrtaicc_adc_fifo_threshold_t   threshold_exceeded;
                  # CCRTAICC_ADC_FIFO_THRESHOLD_NOT_EXCEEDED
                  # CCRTAICC_ADC_FIFO_THRESHOLD_EXCEEDED
               _ccrtaicc_adc_fifo_empty_t       empty;
                  # CCRTAICC_ADC_FIFO_NOT_EMPTY
                  # CCRTAICC_ADC_FIFO_EMPTY
               uint                              data_counter;
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE (ADC is not active)
*************************************************************************/
```

2.2.8 ccrtAICC_ADC_Get_Fifo_Threshold()

This call returns the ADC Fifo threshold information.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Fifo_Threshold(void *Handle,
                                   uint *adc_threshold)

   Description: ADC Get Fifo Threshold

   Input:   void                    *Handle        (handle pointer)
   Output:  uint                    *adc_threshold (ADC fifo threshold)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
 *************************************************************************/
```

2.2.9 ccrtAICC_ADC_Get_Input_Control()

This call returns the ADC input control information.

```
/*************************************************************************
```

```
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Input_Control (void                        *Handle,
                                   _ccrtaicc_adc_input_control_t *adc_input_control)

   Description: Return Input Control information for all the ADCs

   Input:   void                   *Handle       (handle pointer)
   Output:  _ccrtaicc_adc_input_control_t
                                   *adc_input_control (pointer to control select)
               # CCRTAICC_ADC_INPUT_CONTROL_EXTERNAL_SIGNAL
               # CCRTAICC_ADC_INPUT_CONTROL_CALIBRATION_BUS
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
*************************************************************************/
```

2.2.10 ccrtAICC_ADC_Get_Negative_Cal()

This call returns the ADC negative calibration information for all the channels.

```
/*************************************************************************
  _ccrtaicc_lib_error_number_t
  ccrtAICC_ADC_Get_Negative_Cal(void               *Handle,
                                ccrtaicc_adc_cal_t *cal)

   Description: Get the ADC Negative Calibration data.

   Input:   void                       *Handle  (handle pointer)
   Output:  ccrtaicc_adc_cal_t         *cal     (pointer to board cal)
               uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
               double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
 *************************************************************************/
```

2.2.11 ccrtAICC_ADC_Get_Offset_Cal()

This call returns the ADC offset calibration information for all the channels.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Offset_Cal(void               *Handle,
                               ccrtaicc_adc_cal_t *cal)

   Description: Get the ADC Offset Calibration data.

   Input:   void                       *Handle  (handle pointer)
   Output:  ccrtaicc_adc_cal_t         *cal     (pointer to board cal)
               uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
               double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
```

```
 ****************************************************************************/
```

2.2.12 ccrtAICC_ADC_Get_Positive_Cal()

This call returns the ADC positive calibration information for all the channels.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Get_Positive_Cal(void               *Handle,
                                 ccrtaicc_adc_cal_t *cal)

   Description: Get the ADC Positive Calibration data.

   Input:   void                       *Handle  (handle pointer)
   Output:  ccrtaicc_adc_cal_t         *cal     (pointer to board cal)
               uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
               double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
 ****************************************************************************/
```

2.2.13 ccrtAICC_ADC_Perform_Auto_Calibration()

This single call performs a full ADC calibration of all the selected channels using the internal reference voltages. Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/****************************************************************************

   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Perform_Auto_Calibration (void                     *Handle,
                                      _ccrtaicc_adc_channel_t chan_start,
                                      _ccrtaicc_adc_channel_t chan_end)

   Description: Perform ADC Auto Calibration

   Input:    void                    *Handle        (handle pointer)
             _ccrtaicc_adc_channel_t chan_start     (start channel number)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "  "  "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
             _ccrtaicc_adc_channel_t chan_end       (end channel number)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
```

```
            # CCRTAICC_ADC_CHANNEL_2
            # CCRTAICC_ADC_CHANNEL_3
            # CCRTAICC_ADC_CHANNEL_4
            # CCRTAICC_ADC_CHANNEL_5
            # CCRTAICC_ADC_CHANNEL_6
            # "  "  "
            # CCRTAICC_ADC_CHANNEL_58
            # CCRTAICC_ADC_CHANNEL_59
            # CCRTAICC_ADC_CHANNEL_60
            # CCRTAICC_ADC_CHANNEL_61
            # CCRTAICC_ADC_CHANNEL_62
            # CCRTAICC_ADC_CHANNEL_63
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
            # CCRTAICC_LIB_NO_ERROR             (successful)
            # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN             (library not open)
            # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
            # CCRTAICC_LIB_NO_RESOURCE          (no free PLL available)
            # CCRTAICC_LIB_IO_ERROR             (read error)
            # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
            # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
            # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                (clock not assigned to ADC)
 ****************************************************************************/
```

2.2.14 ccrtAICC_ADC_Perform_External_Negative_Calibration()

Use this call to perform an external negative calibration. Prior to calling this function, the ADC inputs must be provided with a negative signal close to -10 Volts, otherwise this call will fail. Additionally, the user can specify a range of channels.

Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Perform_External_Negative_Calibration(void      *Handle,
                                     _ccrtaicc_adc_channel_t chan_start,
                                     _ccrtaicc_adc_channel_t chan_end,
                                     double                  ReferenceVoltage)

   Description: Perform ADC External Negative Calibration

   Input:   void                    *Handle          (handle pointer)
            _ccrtaicc_adc_channel_t chan_start       (start channel)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "  "  "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
```

```
            _ccrtaicc_adc_channel_t chan_end         (end channel)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "  "  "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
            double                  ReferenceVoltage (Reference Voltage)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
              # CCRTAICC_LIB_NO_ERROR               (successful)
              # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
              # CCRTAICC_LIB_NOT_OPEN               (library not open)
              # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
              # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
              # CCRTAICC_LIB_NO_RESOURCE            (no free PLL available)
              # CCRTAICC_LIB_IO_ERROR               (read error)
              # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE      (ADC is not active)
              # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
              # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                    (clock not assigned to ADC)
*****************************************************************************/
```

2.2.15 ccrtAICC_ADC_Perform_External_Offset_Calibration()

Use this call to perform an external offset calibration. Prior to calling this function, the ADC inputs must be provided with a offset signal close to 0 Volts, otherwise this call will fail. Additionally, the user can specify a range of channels. Once this call is executed, the user will need to perform external negative and external positive calibrations as this call resets these gains to 1.0 prior to calibration.

Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Perform_External_Offset_Calibration(void          *Handle,
                                       _ccrtaicc_adc_channel_t chan_start,
                                       _ccrtaicc_adc_channel_t chan_end)

   Description: Perform ADC External Offset Calibration

   Input:   void                   *Handle         (handle pointer)
            _ccrtaicc_adc_channel_t chan_start      (start channel)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "  "  "
               # CCRTAICC_ADC_CHANNEL_58
```

```
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
            _ccrtaicc_adc_channel_t chan_end        (end channel)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (library not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_NO_RESOURCE          (no free PLL available)
               # CCRTAICC_LIB_IO_ERROR             (read error)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
               # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                   (clock not assigned to ADC)
 ***************************************************************************/
```

2.2.16 ccrtAICC_ADC_Perform_External_Positive_Calibration()

Use this call to perform an external positive calibration. Prior to calling this function, the ADC inputs must be provided with a positive signal close to +10 Volts, otherwise this call will fail. Additionally, the user can specify a range of channels.

Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
  ccrtAICC_ADC_Perform_External_Positive_Calibration(void       *Handle,
                                     _ccrtaicc_adc_channel_t chan_start,
                                     _ccrtaicc_adc_channel_t chan_end,
                                     double                  ReferenceVoltage)

   Description: Perform ADC External Positive Calibration

   Input:   void                   *Handle          (handle pointer)
            _ccrtaicc_adc_channel_t chan_start       (start channel)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
```

```
            # CCRTAICC_ADC_CHANNEL_5
            # CCRTAICC_ADC_CHANNEL_6
            # "  "  "
            # CCRTAICC_ADC_CHANNEL_58
            # CCRTAICC_ADC_CHANNEL_59
            # CCRTAICC_ADC_CHANNEL_60
            # CCRTAICC_ADC_CHANNEL_61
            # CCRTAICC_ADC_CHANNEL_62
            # CCRTAICC_ADC_CHANNEL_63
          _ccrtaicc_adc_channel_t chan_end         (end channel)
            # CCRTAICC_ADC_CHANNEL_0
            # CCRTAICC_ADC_CHANNEL_1
            # CCRTAICC_ADC_CHANNEL_2
            # CCRTAICC_ADC_CHANNEL_3
            # CCRTAICC_ADC_CHANNEL_4
            # CCRTAICC_ADC_CHANNEL_5
            # CCRTAICC_ADC_CHANNEL_6
            # "  "  "
            # CCRTAICC_ADC_CHANNEL_58
            # CCRTAICC_ADC_CHANNEL_59
            # CCRTAICC_ADC_CHANNEL_60
            # CCRTAICC_ADC_CHANNEL_61
            # CCRTAICC_ADC_CHANNEL_62
            # CCRTAICC_ADC_CHANNEL_63
          double                 ReferenceVoltage (Reference Voltage)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
            # CCRTAICC_LIB_NO_ERROR              (successful)
            # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN              (library not open)
            # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
            # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
            # CCRTAICC_LIB_NO_RESOURCE           (no free PLL available)
            # CCRTAICC_LIB_IO_ERROR              (read error)
            # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE     (ADC is not active)
            # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE   (Clock is not active)
            # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                 (clock not assigned to ADC)
 ****************************************************************************/
```

2.2.17 ccrtAICC_ADC_Perform_Negative_Calibration()

This call performs a negative calibration using the internal reference voltage for the selected channels.

Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Perform_Negative_Calibration (void                   *Handle,
                                              _ccrtaicc_adc_channel_t chan_start,
                                              _ccrtaicc_adc_channel_t chan_end)

   Description: Perform ADC Negative Calibration

   Input:    void                   *Handle        (handle pointer)
             _ccrtaicc_adc_channel_t chan_start     (start channel number)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
```

```
              # CCRTAICC_ADC_CHANNEL_3
              # CCRTAICC_ADC_CHANNEL_4
              # CCRTAICC_ADC_CHANNEL_5
              # CCRTAICC_ADC_CHANNEL_6
              # "  "  "
              # CCRTAICC_ADC_CHANNEL_58
              # CCRTAICC_ADC_CHANNEL_59
              # CCRTAICC_ADC_CHANNEL_60
              # CCRTAICC_ADC_CHANNEL_61
              # CCRTAICC_ADC_CHANNEL_62
              # CCRTAICC_ADC_CHANNEL_63
            _ccrtaicc_adc_channel_t chan_end       (end channel number)
              # CCRTAICC_ADC_CHANNEL_0
              # CCRTAICC_ADC_CHANNEL_1
              # CCRTAICC_ADC_CHANNEL_2
              # CCRTAICC_ADC_CHANNEL_3
              # CCRTAICC_ADC_CHANNEL_4
              # CCRTAICC_ADC_CHANNEL_5
              # CCRTAICC_ADC_CHANNEL_6
              # "  "  "
              # CCRTAICC_ADC_CHANNEL_58
              # CCRTAICC_ADC_CHANNEL_59
              # CCRTAICC_ADC_CHANNEL_60
              # CCRTAICC_ADC_CHANNEL_61
              # CCRTAICC_ADC_CHANNEL_62
              # CCRTAICC_ADC_CHANNEL_63
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
              # CCRTAICC_LIB_NO_ERROR             (successful)
              # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
              # CCRTAICC_LIB_NOT_OPEN             (library not open)
              # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
              # CCRTAICC_LIB_NO_RESOURCE          (no free PLL available)
              # CCRTAICC_LIB_IO_ERROR             (read error)
              # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
              # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
              # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                  (clock not assigned to ADC)
 ****************************************************************************/
```

2.2.18 ccrtAICC_ADC_Perform_Offset_Calibration()

This call performs an offset calibration using the internal reference voltage for the selected channels. Once this call is executed, the user will need to perform negative and positive calibrations as this call resets these gains to 1.0 prior to calibration.

Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Perform_Offset_Calibration (void                    *Handle,
                                           _ccrtaicc_adc_channel_t chan_start,
                                           _ccrtaicc_adc_channel_t chan_end)

   Description: Perform ADC Offset Calibration

   Input:    void                    *Handle        (handle pointer)
             _ccrtaicc_adc_channel_t chan_start     (start channel number)
               # CCRTAICC_ADC_CHANNEL_0
```

```
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
            _ccrtaicc_adc_channel_t chan_end       (end channel number)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_NO_RESOURCE          (no free PLL available)
               # CCRTAICC_LIB_IO_ERROR             (read error)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
               # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                   (clock not assigned to ADC)
 ***************************************************************************/
```

2.2.19 ccrtAICC_ADC_Perform_Positive_Calibration()

This call performs a positive calibration using the internal reference voltage for the selected channels.

Users need to perform this calibration after they have configured the channels with the appropriate clocks and frequencies, voltage references and channel speed selection. The reason for this is that these selections will have a direct bearing on the calibrated values. Failure to do so will result in inaccurate ADC readings.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Perform_Positive_Calibration (void                    *Handle,
                                              _ccrtaicc_adc_channel_t chan_start,
                                              _ccrtaicc_adc_channel_t chan_end)

   Description: Perform ADC Positive Calibration

   Input:   void                    *Handle         (handle pointer)
            _ccrtaicc_adc_channel_t chan_start      (start channel number)
               # CCRTAICC_ADC_CHANNEL_0
```

```
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
            _ccrtaicc_adc_channel_t chan_end        (end channel number)
               # CCRTAICC_ADC_CHANNEL_0
               # CCRTAICC_ADC_CHANNEL_1
               # CCRTAICC_ADC_CHANNEL_2
               # CCRTAICC_ADC_CHANNEL_3
               # CCRTAICC_ADC_CHANNEL_4
               # CCRTAICC_ADC_CHANNEL_5
               # CCRTAICC_ADC_CHANNEL_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_58
               # CCRTAICC_ADC_CHANNEL_59
               # CCRTAICC_ADC_CHANNEL_60
               # CCRTAICC_ADC_CHANNEL_61
               # CCRTAICC_ADC_CHANNEL_62
               # CCRTAICC_ADC_CHANNEL_63
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_NO_RESOURCE          (no free PLL available)
               # CCRTAICC_LIB_IO_ERROR             (read error)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
               # CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC
                                                   (clock not assigned to ADC)
 ***************************************************************************/
```

2.2.20 ccrtAICC_ADC_Read_Channels()

This call provides the user an easy method of reading the ADC channels. User can supply a channel mask. If pointer to *adc_csr* is NULL, then the routine itself computes the current ADC configuration. For performance, the user should get the current ADC configuration using the *ccrtAICC_ADC_Get_CSR()* call to get the current settings and pass it to this routine. Hence, if the configuration is not changed, the user can continuously invoke *ccrtAICC_ADC_Read_Channels()* routine without incurring the additional overhead of routine calling the *ccrtAICC_ADC_Get_CSR()* call.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Read_Channels(void                          *Handle,
                              _ccrtaicc_adc_channel_mask_t ChanMask,
                              _ccrtaicc_adc_csr_t          *adc_csr,
                              ccrtaicc_adc_volts_t         *adc_volts)

   Description: Read ADC Channels

   Input:   void                              *Handle       (Handle pointer)
```

```
            _ccrtaicc_adc_channel_mask_t    ChanMask      (specify channel mask)
               # CCRTAICC_ADC_CHANNEL_MASK_0
               # CCRTAICC_ADC_CHANNEL_MASK_1
               # CCRTAICC_ADC_CHANNEL_MASK_2
               # CCRTAICC_ADC_CHANNEL_MASK_3
               # CCRTAICC_ADC_CHANNEL_MASK_4
               # CCRTAICC_ADC_CHANNEL_MASK_5
               # CCRTAICC_ADC_CHANNEL_MASK_6
               # "  "  "
               # CCRTAICC_ADC_CHANNEL_MASK_58
               # CCRTAICC_ADC_CHANNEL_MASK_59
               # CCRTAICC_ADC_CHANNEL_MASK_60
               # CCRTAICC_ADC_CHANNEL_MASK_61
               # CCRTAICC_ADC_CHANNEL_MASK_62
               # CCRTAICC_ADC_CHANNEL_MASK_63
               # CCRTAICC_ALL_ADC_CHANNELS_MASK
            _ccrtaicc_adc_csr_t                    *adc_csr (pointer to ADC csr)
               _ccrtaicc_adccsr_update_clock_t     adc_update_clock
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_0:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_1:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_2:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_3:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_0:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_1:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_2:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_3:
                  # CCRTAICC_ADC_UPDATE_NORMAL_EXTERNAL_CLOCK:
                  # CCRTAICC_ADC_UPDATE_INVERTED_EXTERNAL_CLOCK:
                  # CCRTAICC_ADC_UPDATE_CLOCK_NONE:
               _ccrtaicc_adccsr_speed_select_t     adc_speed_select;
                  # CCRTAICC_ADC_NORMAL_SPEED:
                  # CCRTAICC_ADC_HIGH_SPEED:
                  # CCRTAICC_ADC_SPEED_SELECT_DO_NOT_CHANGE:
               _ccrtaicc_adccsr_data_format_t      adc_data_format
                  # CCRTAICC_ADC_OFFSET_BINARY:
                  # CCRTAICC_ADC_TWOS_COMPLEMENT:
                  # CCRTAICC_ADC_DATA_FORMAT_DO_NOT_CHANGE:
               _ccrtaicc_adccsr_input_range_t      adc_input_range
                  # CCRTAICC_ADC_BIPOLAR_5V:
                  # CCRTAICC_ADC_BIPOLAR_10V:
                  # CCRTAICC_ADC_UNIPOLAR_5V:
                  # CCRTAICC_ADC_UNIPOLAR_10V:
                  # CCRTAICC_ADC_INPUT_RANGE_DO_NOT_CHANGE:
   Output:  ccrtaicc_adc_volts_t           *adc_volts (pointer to ADC volts)
                  uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
                  double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (library not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE    (ADC is not active)
 ***************************************************************************/
```

2.2.21 ccrtAICC_ADC_Read_Channels_Calibration()

This routine reads the ADC channel calibration registers and dumps all of them to the user specified file. If the file name specified is NULL, then information is written to *stdout.*

```
/***************************************************************************
```

```
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Read_Channels_Calibration(void *Handle,
                                          char *filename)

   Description: Read ADC Channels Calibration

   Input:    void   *Handle                      (handle pointer)
   Output:   char   *filename                    (pointer to filename)
   Return:   _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_BAD_HANDLE         (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN           (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION    (local region not present)
               # CCRTAICC_LIB_CANNOT_OPEN_FILE   (cannot open calib. file)
 ***************************************************************************/
```

e.g.

```
#Date          : Fri Dec 14 11:30:00 2018

#Chan   Negative                       Offset                 Positive
#====   ========                       ======                 ========
 ch00:  1.000178198330104351043701172 -0.00022888183593750000  1.000139905605465173721313477
 ch01:  0.999954220838844776153564453 -0.00007629394531250000  0.999967454932630062103271484
 ch02:  1.000127669423818588256835938 -0.00015258789062500000  1.000118218362331390380859375
 ch03:  0.999876655638217926025390625  0.00000000000000000000  0.999875877983868122100830078
 . . .
 ch61:  1.000136931426823139190673828 -0.00007629394531250000  1.000138226430863142013549805
 ch62:  1.000080410391092300415039062 -0.00007629394531250000  1.000093937385827302932739258
 ch63:  1.000272549688816070556640625 -0.00007629394531250000  1.000277046114206314086914062
```

2.2.22 ccrtAICC_ADC_Reset_Calibration()

This call resets the gain and offset information for all channels to default, i.e. both the positive and negative *gains* are set to 1 and the *offset* is set to 0.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Reset_Calibration (void *Handle)

   Description: Reset Calibration Data

   Input:    void                       *Handle       (handle pointer)
   Output:   none
   Return:   _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (library not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
               # CCRTAICC_LIB_NO_RESOURCE           (no free PLL available)
               # CCRTAICC_LIB_IO_ERROR              (read error)
***************************************************************************/
```

2.2.23 ccrtAICC_ADC_Reset_Fifo()

This call provides the ability to reset the ADC Fifo to the power-on state. User can elect to activate the FIFO after a reset in order for data collection to resume immediately.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Reset_Fifo(void                        *Handle,
                           _ccrtaicc_adc_fifo_reset_t  activate)
```

```
   Description: ADC Reset Fifo

   Input:   void                        *Handle  (handle pointer)
            _ccrtaicc_adc_fifo_reset_t  activate (activate converter)
               # CCRTAICC_ADC_FIFO_ACTIVATE
               # CCRTAICC_ADC_FIFO_RESET
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE (ADC is not active)
 ***************************************************************************/
```

2.2.24 ccrtAICC_ADC_Set_CSR()

This call sets the ADC control registers for the selected channel group. For accurate results during data collection, the user needs to perform a calibration of the channels once are configured and the associated clocks started.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_CSR (void                  *Handle,
                         _ccrtaicc_adc_mask_t  adc_mask,
                         ccrtaicc_adc_csr_t    *adc_csr)

   Description: Set ADC Control and Status information

   Input:   void                                    *Handle  (Handle pointer)
            _ccrtaicc_adc_mask_t                    adc_mask (selected ADC mask)
               # CCRTAICC_ADC_MASK_0_15
               # CCRTAICC_ADC_MASK_16_31
               # CCRTAICC_ADC_MASK_32_47
               # CCRTAICC_ADC_MASK_48_63
               # CCRTAICC_ALL_ADC_MASK
            _ccrtaicc_adc_csr_t                     *adc_csr (pointer to ADC csr)
               _ccrtaicc_adccsr_update_clock_t      adc_update_clock
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_0:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_1:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_2:
                  # CCRTAICC_ADC_UPDATE_NORMAL_CLOCK_3:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_0:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_1:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_2:
                  # CCRTAICC_ADC_UPDATE_INVERTED_CLOCK_3:
                  # CCRTAICC_ADC_UPDATE_NORMAL_EXTERNAL_CLOCK:
                  # CCRTAICC_ADC_UPDATE_INVERTED_EXTERNAL_CLOCK:
                  # CCRTAICC_ADC_UPDATE_CLOCK_NONE:
               _ccrtaicc_adccsr_speed_select_t      adc_speed_select;
                  # CCRTAICC_ADC_NORMAL_SPEED:
                  # CCRTAICC_ADC_HIGH_SPEED:
                  # CCRTAICC_ADC_SPEED_SELECT_DO_NOT_CHANGE:
               _ccrtaicc_adccsr_data_format_t       adc_data_format
                  # CCRTAICC_ADC_OFFSET_BINARY:
                  # CCRTAICC_ADC_TWOS_COMPLEMENT:
                  # CCRTAICC_ADC_DATA_FORMAT_DO_NOT_CHANGE:
               _ccrtaicc_adccsr_input_range_t       adc_input_range
                  # CCRTAICC_ADC_BIPOLAR_5V:
                  # CCRTAICC_ADC_BIPOLAR_10V:
```

```
                # CCRTAICC_ADC_UNIPOLAR_5V:
                # CCRTAICC_ADC_UNIPOLAR_10V:
                # CCRTAICC_ADC_INPUT_RANGE_DO_NOT_CHANGE:
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (library not open)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE      (ADC is not active)
*************************************************************************/
```

2.2.25 ccrtAICC_ADC_Set_Driver_Read_Mode()

This call sets the current driver ADC read mode. When a *read(2)* system call is issued, it is this mode that determines the type of read being performed by the driver. Refer to the *read(2)* system call under *Direct Driver Access* section for more information on the various modes. If the *read(2)* call fails with the *ENOBUFS* error, an overflow condition has occurred. User will need to reduce the clock speed and/or the number of selected channels until an overflow condition is no longer triggered.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Driver_Read_Mode (void                                *Handle,
                                      _ccrtaicc_driver_ADC_read_mode_t   mode)

   Description: Select Driver ADC Read Mode

   Input:   void                              *Handle (Handle pointer)
            _ccrtaicc_driver_ADC_read_mode_t mode    (select ADC read mode)
               # CCRTAICC_ADC_PIO_CHANNEL
               # CCRTAICC_ADC_PIO_FIFO
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
 *************************************************************************/
```

2.2.26 ccrtAICC_ADC_Set_Fifo_Channel_Select()

This call allows the user to select a set of channels that need to be captured in the ADC Fifo. For ADCs that have the high speed option *CCRTAICC_ADC_HIGH_SPEED* selected, the odd *(unused)* channels for the ADC will *not* be included in the Fifo, even if the odd channels are specified in the channel selection mask.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Fifo_Channel_Select(void       *Handle,
                                        _ccrtaicc_adc_channel_mask_t
                                                   adc_fifo_channel_select_mask)

   Description: ADC Set Fifo Channel Selection

   Input:   void                         *Handle           (handle pointer)
            _ccrtaicc_adc_channel_mask_t adc_fifo_channel_select_mask
                                                          (channel select mask)
               # CCRTAICC_ADC_CHANNEL_MASK_0
```

```
               # CCRTAICC_ADC_CHANNEL_MASK_1
               # CCRTAICC_ADC_CHANNEL_MASK_2
               # CCRTAICC_ADC_CHANNEL_MASK_3
               # CCRTAICC_ADC_CHANNEL_MASK_4
               # CCRTAICC_ADC_CHANNEL_MASK_5
               # CCRTAICC_ADC_CHANNEL_MASK_6
               # "   "   "
               # CCRTAICC_ADC_CHANNEL_MASK_58
               # CCRTAICC_ADC_CHANNEL_MASK_59
               # CCRTAICC_ADC_CHANNEL_MASK_60
               # CCRTAICC_ADC_CHANNEL_MASK_61
               # CCRTAICC_ADC_CHANNEL_MASK_62
               # CCRTAICC_ADC_CHANNEL_MASK_63
               # CCRTAICC_ALL_ADC_CHANNELS_MASK
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE   (ADC is not active)
*************************************************************************/
```

2.2.27 ccrtAICC_ADC_Set_Fifo_Threshold()

This call allows the user to set the ADC Fifo Threshold.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Fifo_Threshold(void *Handle,
                                   uint adc_threshold)

   Description: ADC Set Fifo Threshold

   Input:   void                    *Handle        (handle pointer)
            uint                    adc_threshold  (ADC fifo threshold)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_ADC_IS_NOT_ACTIVE   (ADC is not active)
 *************************************************************************/
```

2.2.28 ccrtAICC_ADC_Set_Input_Control()

This call allows the user to select whether the inputs to all the ADCs are from an *external* supply or the *calibration* bus. If calibration bus is selected, then the user can select one of several reference voltages or ground reference using the *ccrtAICC_Set_Calibration_CSR()* to direct it as an input to the all the active ADCs.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Input_Control (void                        *Handle,
                                   _ccrtaicc_adc_input_control_t adc_input_control)

   Description: Set Input Control information for all the ADCs
```

```
   Input:   void                *Handle           (handle pointer)
            _ccrtaicc_adc_input_control_t
                                 adc_input_control (control select)
               # CCRTAICC_ADC_INPUT_CONTROL_EXTERNAL_SIGNAL
               # CCRTAICC_ADC_INPUT_CONTROL_CALIBRATION_BUS
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
 ***************************************************************************/
```

2.2.29 ccrtAICC_ADC_Set_Negative_Cal()

This call allows the user to set the negative calibration data for all the channels by supplying floating point *Float* gains to the call. Users can supply CCRTAICC_DO_NOT_CHANGE as a gain for any channel that should not be changed. Additionally, this call will return the *RAW* value of the gain supplied that is written to the board.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Negative_Cal(void               *Handle,
                                 ccrtaicc_adc_cal_t *cal)

   Description: Set the ADC Negative Calibration data.

   Input:    void                       *Handle       (handle pointer)
             ccrtaicc_adc_cal_t         *cal          (pointer to board cal)
               uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
               double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Output:   none
   Return:   _ccrtaicc_lib_error_number_t
                # CCRTAICC_LIB_NO_ERROR              (successful)
                # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
                # CCRTAICC_LIB_NOT_OPEN              (library not open)
                # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
                # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
                # CCRTAICC_LIB_NO_RESOURCE           (no free PLL available)
                # CCRTAICC_LIB_IO_ERROR              (read error)
 ***************************************************************************/
```

2.2.30 ccrtAICC_ADC_Set_Offset_Cal()

This call allows the user to set the offset calibration data for all the channels by supplying floating point *Float* offset to the call. Users can supply CCRTAICC_DO_NOT_CHANGE as a gain for any channel that should not be changed. Additionally, this call will return the *Raw* value of the offset supplied that is written to the board.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Offset_Cal(void               *Handle,
                               ccrtaicc_adc_cal_t *cal)

   Description: Set the ADC Offset Calibration data.

   Input:    void                       *Handle       (handle pointer)
             ccrtaicc_adc_cal_t         *cal          (pointer to board cal)
               uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
               double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Output:   none
```

```
   Return:   _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (library not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
               # CCRTAICC_LIB_NO_RESOURCE           (no free PLL available)
               # CCRTAICC_LIB_IO_ERROR              (read error)
 ***************************************************************************/
```

2.2.31 ccrtAICC_ADC_Set_Positive_Cal()

This call allows the user to set the positive calibration data for all the channels by supplying floating point *Float* gains to the call. Users can supply CCRTAICC_DO_NOT_CHANGE as a gain for any channel that should not be changed. Additionally, this call will return the *Raw* value of the gain supplied that is written to the board.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Set_Positive_Cal(void              *Handle,
                                 ccrtaicc_adc_cal_t *cal)

   Description: Set the ADC Positive Calibration data.

   Input:    void                      *Handle       (handle pointer)
             ccrtaicc_adc_cal_t        *cal          (pointer to board cal)
               uint    Raw[CCRTAICC_MAX_ADC_CHANNELS];
               double  Float[CCRTAICC_MAX_ADC_CHANNELS];
   Output:   none
   Return:   _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (library not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
               # CCRTAICC_LIB_NO_RESOURCE           (no free PLL available)
               # CCRTAICC_LIB_IO_ERROR              (read error)
 ***************************************************************************/
```

2.2.32 ccrtAICC_ADC_Write_Channels_Calibration()

This call allows the user to write the calibration registers from a user supplied calibration file. The format of the file is similar to that generated by the *ccrtAICC_ADC_Read_Channels_Calibration()* call. File can contain comments if they start with '#', '*', or empty lines. Additionally, users need only specify those channels that they wish to calibrate and the order of specifying channels in not important, however, the format of each channel entry needs to be adhered to. E.g. <chxx:> <negative> <offset> <positive>

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_ADC_Write_Channels_Calibration(void *Handle,
                                          char *filename)

   Description: Write Channels Calibration

   Input:    void   *Handle                     (handle pointer)
   Output:   char   *filename                   (pointer to filename)
   Return:   _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
```

```
                # CCRTAICC_LIB_CANNOT_OPEN_FILE   (cannot open calib. file)
                # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
 ************************************************************************/
```

e.g.

```
#Date          : Fri Dec 14 11:30:00 2018

#Chan   Negative                       Offset                 Positive
#====   ========                       ======                 ========
 ch00:  1.000178198330104351043701172 -0.00022888183593750000  1.000139905605465173721313477
 ch01:  0.999954220838844776153564453 -0.00007629394531250000  0.999967454932630062103271484
 ch02:  1.000127669423818588256835938 -0.00015258789062500000  1.000118218362331390380859375
 ch03:  0.999876655638217926025390625  0.00000000000000000000  0.999875877983868122100830078
 . . .
 ch61:  1.000136931426823139190673828 -0.00007629394531250000  1.000138226430863142013549805
 ch62:  1.000080410391092300415039062 -0.00007629394531250000  1.000093937385827302932739258
 ch63:  1.000272549688816070556640625 -0.00007629394531250000  1.000277046114206314086914062
```

2.2.33 ccrtAICC_Add_Irq()

This call will add the driver interrupt handler if it has not been added. Normally, the user should not use this call unless they want to disable the interrupt handler and then re-enable it.

```
/************************************************************************
   int ccrtAICC_Add_Irq(void *Handle)

   Description: By default, the driver assigns an interrupt handler to handle
                device interrupts. If the interrupt handler was removed using
                the ccrtAICC_Remove_Irq(), then this call adds it back.

   Input:   void *Handle                        (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (library not open)
               # CCRTAICC_LIB_IOCTL_FAILED      (driver ioctl call failed)
************************************************************************/
```

2.2.34 ccrtAICC_BoardExpirationTimeRemaining()

This call provides useful information about the expiration date of the card if it has restricted licensing.

```
/************************************************************************
_ccrtaicc_lib_error_number_t
ccrtAICC_BoardExpirationTimeRemaining(void                  *Handle,
                                      time_t                *SecondsToExpire,
                                      ccrtaicc_date_string_t  *GmtDateTimeString,
                                      ccrtaicc_date_string_t  *LocalDateTimeString,
                                      _ccrtaicc_firmware_state  *FirmwareState)

   Description: Number of seconds to expire on a restricted card

   Input:   void                        *Handle             (Handle pointer)
   Output:  time_t                      *SecondsToExpire    (seconds to expire)
            ccrtaicc_date_string_t      *GmtDateTimeString  (GMT date/time
                                                             string)
               char  date[CCRTAICC_DATE_TIME_STRING_SIZE]
            ccrtaicc_date_string_t      *LocalDateTimeString (Local date/time
                                                             string)
               char  date[CCRTAICC_DATE_TIME_STRING_SIZE]
            _ccrtaicc_firmware_state    *FirmwareState      (Firmware State)
               # CCRTAICC_FIRMWARE_STATE_UNRESTRICTED
```

```
            # CCRTAICC_FIRMWARE_STATE_RESTRICTED
            # CCRTAICC_FIRMWARE_STATE_EXPIRED
   Return:  _ccrtaicc_lib_error_number_t
            # CCRTAICC_LIB_NO_ERROR                (successful)
            # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN                (library not open)
 ************************************************************************/
```

Mandatory arguments to the call are **Handle* and **SecondsToExpire*. Rest of the arguments are optional and be set to *NULL*.

*SecondsToExpire – If the board has an expiration date, this call will return the number of seconds this card can be used before it expires. ***Once the card has expired, this call will not be reached as the device open will fail with an authorization error.***

It the board has no expiration date, this call will return zero as the number of seconds.

*GmtDateTimeString – If the board has an expiration date, this ascii GMT date representation of the expiration date is available in this variable if it is not NULL

*LocalDateTimeString – If the board has an expiration date, this ascii Local date representation of the expiration date is available in this variable if it is not NULL

*FirmwareState – This returns the current state of the installed firmware. I can be one of:

- CCRTAICC_FIRMWARE_STATE_UNRESTRICTED. This firmware has no restrictions.
- CCRTAICC_FIRMWARE_STATE_RESTRICTED. This firmware has restrictions. It is possible that and expiration date restriction is not present.
- CCRTAICC_FIRMWARE_STATE_EXPIRED. This firmware has restrictions. One of the restrictions is the expiration date which has expired. Typically, you may not see this state as the utility will fail during the open with an authentication error.

2.2.35 ccrtAICC_Clear_Cable_Fault()

This call clears any latched fault conditions that were created due to overvoltage

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clear_Cable_Fault (void                       *Handle,
                               ccrtaicc_cable_fault_csr_t *CableFaultCSR)

   Description: Clear Cable Fault

   Input:   void                            *Handle     (handle pointer)
            ccrtaicc_cable_fault_csr_t      *CableFaultCSR   (pointer to cable fault CSR)
              _ccrtaicc_cable_fault_group_mask_t    LatchedFaultStatus
                 # CCRTAICC_CABLE_FAULT_GROUP_00_03_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_04_07_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_08_11_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_12_15_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_16_19_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_20_23_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_24_27_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_28_31_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_32_35_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_36_39_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_40_43_MASK
```

```
                # CCRTAICC_CABLE_FAULT_GROUP_44_47_MASK
                # CCRTAICC_CABLE_FAULT_GROUP_48_51_MASK
                # CCRTAICC_CABLE_FAULT_GROUP_52_55_MASK
                # CCRTAICC_CABLE_FAULT_GROUP_56_59_MASK
                # CCRTAICC_CABLE_FAULT_GROUP_60_63_MASK
                # CCRTAICC_ALL_CABLE_FAULT_GROUPS_MASK
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
 ***************************************************************************/
```

2.2.36 ccrtAICC_Clear_Driver_Error()

This call resets the last driver error that was maintained internally by the driver to *CCRTAICC_SUCCESS*.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Clear_Driver_Error(void *Handle)

   Description: Clear any previously generated driver related error.

   Input:   void *Handle                       (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED      (driver ioctl call failed)
****************************************************************************/
```

2.2.37 ccrtAICC_Clear_Lib_Error()

This call resets the last library error that was maintained internally by the API.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Clear_Lib_Error(void *Handle)

   Description: Clear any previously generated library related error.

   Input:   void *Handle                       (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
****************************************************************************
```

2.2.38 ccrtAICC_Clock_Generator_Disable_Outputs()

This call is used to disable the clock generator outputs. No data collection can occur until the clock outputs are re-enabled.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Generator_Disable_Outputs (void *Handle)

   Description: Disable Clock Generator Outputs
```

```
   Input:   void *Handle                          (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
              # CCRTAICC_LIB_NO_ERROR            (successful)
              # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
              # CCRTAICC_LIB_NOT_OPEN            (device not open)
              # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
*****************************************************************************/
```

2.2.39 ccrtAICC_Clock_Generator_Enable_Outputs()

This call is used to enable the clock generator outputs if they have been previously disabled by the *ccrtAICC_Clock_Generator_Disable_Outputs()* call.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Generator_Enable_Outputs (void *Handle)

   Description: Enable Clock Generator Outputs

   Input:   void *Handle                          (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
              # CCRTAICC_LIB_NO_ERROR            (successful)
              # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
              # CCRTAICC_LIB_NOT_OPEN            (device not open)
              # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
*****************************************************************************/
```

2.2.40 ccrtAICC_Clock_Generator_Soft_Reset()

Perform a soft clock reset on all the output clocks.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Clock_Generator_Soft_Reset(void *Handle)

   Description: Perform Soft Reset to Clock Generator

   Input:   void *Handle                          (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
              # CCRTAICC_LIB_NO_ERROR            (successful)
              # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
              # CCRTAICC_LIB_NOT_OPEN            (device not open)
              # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
  *****************************************************************************/
```

2.2.41 ccrtAICC_Clock_Get_Generator_CSR()

Return the clock generator control and status register.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_CSR (void                  *Handle,
                                     ccrtaicc_clkgen_csr_t *CgCsr)

   Description: Get Generator Control and Status information

   Input:   void                                   *Handle     (Handle pointer)
   Output:  ccrtaicc_clkgen_csr_t                  *CgCsr      (pointer to clock
                                                                generator csr)
               _ccrtaicc_clkgen_interface_t             interface
```

```
                  # CCRTAICC_CLOCK_GENERATOR_INTERFACE_IDLE
                  # CCRTAICC_CLOCK_GENERATOR_INTERFACE_BUSY
               _ccrtaicc_clkgen_output_t               output
                  # CCRTAICC_CLOCK_GENERATOR_OUTPUT_DISABLE
                  # CCRTAICC_CLOCK_GENERATOR_OUTPUT_ENABLE
               _ccrtaicc_clkgen_state_t                 state
                  # CCRTAICC_CLOCK_GENERATOR_ACTIVE
                  # CCRTAICC_CLOCK_GENERATOR_RESET
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                        (successful)
               # CCRTAICC_LIB_BAD_HANDLE                      (no/bad handler
                                                               supplied)
               # CCRTAICC_LIB_NOT_OPEN                        (device not open)
               # CCRTAICC_LIB_INVALID_ARG                     (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION                 (local region not
                                                               present)
 ****************************************************************************/
```

2.2.42 ccrtAICC_Clock_Get_Generator_Info()

This call returns the clock generator information for the selected output.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Info (void                          *Handle,
                              _ccrtaicc_clock_generator_output_t   WhichOutput,
                              ccrtaicc_clock_generator_info_t      *CgInfo)

   Description: Get Clock Generator Information

   Input:   void                                    *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t      WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
   Output:  ccrtaicc_clock_generator_info_t   *CgInfo  (pointer to clock
                                                       generator info)
               __u64                                      M_divider_num
               __u32                                      M_divider_den
               __u64                                      N_divider_num
               __u32                                      N_divider_den
               __u32                                      R_divider_value
               __u32                                      R_divider
               _ccrtaicc_cg_zero_delay_t                  ZeroDelay
                  # CCRTAICC_CG_ZERO_DELAY_MODE
                  # CCRTAICC_CG_NORMAL_MODE
               _ccrtaicc_cg_stat_ctrl_voltsel_t           Voltage_select
                  # CCRTAICC_CG_VOLTAGE_SELECT_1_8V
                  # CCRTAICC_CG_VOLTAGE_SELECT_3_3V
               _ccrtaicc_cg_input_xaxb_extclk_sel_t     Input_xaxb_selection
                  # CCRTAICC_CG_INPUT_XAXB_USE_CRYSTAL
                  # CCRTAICC_CG_INPUT_XAXB_USE_EXTCLK_SOURCE
               _ccrtaicc_cg_xaxb_power_down_t             Input_xaxb_power
                  # CCRTAICC_CG_XAXB_POWER_DOWN
```

```
   # CCRTAICC_CG_XAXB_DO_NOT_POWER_DOWN
ccrtaicc_clkgen_csr_t                          Clkcsr
   _ccrtaicc_clkgen_interface_t                interface
      # CCRTAICC_CLOCK_GENERATOR_INTERFACE_IDLE
      # CCRTAICC_CLOCK_GENERATOR_INTERFACE_BUSY
   _ccrtaicc_clkgen_output_t                   output
      # CCRTAICC_CLOCK_GENERATOR_OUTPUT_DISABLE
      # CCRTAICC_CLOCK_GENERATOR_OUTPUT_ENABLE
   _ccrtaicc_clkgen_state_t                    state
      # CCRTAICC_CLOCK_GENERATOR_ACTIVE
      # CCRTAICC_CLOCK_GENERATOR_RESET
ccrtaicc_clkgen_output_config_t                Config
   _ccrtaicc_cg_outcfg_force_rdiv2_t           force_rdiv2
      # CCRTAICC_CG_OUTPUT_CONFIG_DONT_FORCE_RDIV2
      # CCRTAICC_CG_OUTPUT_CONFIG_FORCE_RDIV2
   _ccrtaicc_cg_outcfg_enable_t                enable
      # CCRTAICC_CG_OUTPUT_CONFIG_DISABLE
      # CCRTAICC_CG_OUTPUT_CONFIG_ENABLE
   _ccrtaicc_cg_outcfg_shutdown_t              shutdown
      # CCRTAICC_CG_OUTPUT_CONFIG_POWER_UP
      # CCRTAICC_CG_OUTPUT_CONFIG_SHUTDOWN
ccrtaicc_clkgen_output_format_t                Format
   _ccrtaicc_cg_outfmt_cmos_drive_t            cmos_drive
      # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_LVDS
      # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_CMOS
   _ccrtaicc_cg_outfmt_disable_state_t         disable_state
      # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_LOW
      # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_HIGH
   _ccrtaicc_cg_outfmt_sync_t                  sync
      # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_DISABLE
      # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_ENABLE
   _ccrtaicc_cg_outfmt_format_t                format
      # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_LVDS
      # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_CMOS
ccrtaicc_clkgen_output_mode_t                  Mode
   _ccrtaicc_cg_outmode_amplitude_t            amplitude
      # CCRTAICC_CG_OUTPUT_AMPLITUDE_CMOS
      # CCRTAICC_CG_OUTPUT_AMPLITUDE_LVDS
   _ccrtaicc_cg_outmode_common_t               common
      # CCRTAICC_CG_OUTPUT_COMMON_CMOS
      # CCRTAICC_CG_OUTPUT_COMMON_LVDS
      # CCRTAICC_CG_OUTPUT_COMMON_LVPECL
ccrtaicc_clkgen_output_mux_t                   Mux
   _ccrtaicc_cg_outmux_inversion_t             inversion
      # CCRTAICC_CG_OUTPUT_MUX_COMPLEMENTARY
      # CCRTAICC_CG_OUTPUT_MUX_IN_PHASE
      # CCRTAICC_CG_OUTPUT_MUX_INVERTED
      # CCRTAICC_CG_OUTPUT_MUX_OUT_OF_PHASE
   _ccrtaicc_cg_outmux_ndiv_select_t           ndiv_mux
      # CCRTAICC_CG_OUTPUT_MUX_NDIV_0
      # CCRTAICC_CG_OUTPUT_MUX_NDIV_1
      # CCRTAICC_CG_OUTPUT_MUX_NDIV_2
      # CCRTAICC_CG_OUTPUT_MUX_NDIV_3
      # CCRTAICC_CG_OUTPUT_MUX_NDIV_4
ccrtaicc_clkgen_input_clock_enable_t           Input_clock_enable
   _ccrtaicc_cg_input_clock_enable_t           input_0_clock
      # CCRTAICC_CG_INPUT_CLOCK_DISABLE
      # CCRTAICC_CG_INPUT_CLOCK_ENABLE
   _ccrtaicc_cg_input_clock_enable_t           input_1_clock
      # CCRTAICC_CG_INPUT_CLOCK_DISABLE
      # CCRTAICC_CG_INPUT_CLOCK_ENABLE
```

```
   _ccrtaicc_cg_input_clock_enable_t            input_2_clock
      # CCRTAICC_CG_INPUT_CLOCK_DISABLE
      # CCRTAICC_CG_INPUT_CLOCK_ENABLE
   _ccrtaicc_cg_input_clock_enable_t            input_fb_clock
      # CCRTAICC_CG_INPUT_CLOCK_DISABLE
      # CCRTAICC_CG_INPUT_CLOCK_ENABLE
ccrtaicc_clkgen_input_clock_select_t            Input_clock_select
   _ccrtaicc_cg_input_clock_select_control_t    control
      # CCRTAICC_CG_INPUT_CLOCK_SELECT_PIN_CONTROL
      # CCRTAICC_CG_INPUT_CLOCK_SELECT_REG_CONTROL
   _ccrtaicc_cg_input_clock_select_register_t   select
      # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0
      # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1
      # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2
      # CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB
ccrtaicc_pdiv_all_info_t                        Pdiv_info
   __u64                                        Pfb_divider
   ccrtaicc_pdiv_info_t                         P0
      __u64                                     Divider
      _ccrtaicc_cg_pdiv_enable_t                Enable
         # CCRTAICC_CG_PDIV_DISABLE
         # CCRTAICC_CG_PDIV_ENABLE
      _ccrtaicc_cg_pdiv_input_state_t           State
         # CCRTAICC_CG_PDIV_INPUT_UNUSED
         # CCRTAICC_CG_PDIV_INPUT_DISABLED
         # CCRTAICC_CG_PDIV_INPUT_SELECTED
   ccrtaicc_pdiv_info_t                         P1
      __u64                                     Divider
      _ccrtaicc_cg_pdiv_enable_t                Enable
         # CCRTAICC_CG_PDIV_DISABLE
         # CCRTAICC_CG_PDIV_ENABLE
      _ccrtaicc_cg_pdiv_input_state_t           State
         # CCRTAICC_CG_PDIV_INPUT_UNUSED
         # CCRTAICC_CG_PDIV_INPUT_DISABLED
         # CCRTAICC_CG_PDIV_INPUT_SELECTED
   ccrtaicc_pdiv_info_t                         P2
      __u64                                     Divider
      _ccrtaicc_cg_pdiv_enable_t                Enable
         # CCRTAICC_CG_PDIV_DISABLE
         # CCRTAICC_CG_PDIV_ENABLE
      _ccrtaicc_cg_pdiv_input_state_t           State
         # CCRTAICC_CG_PDIV_INPUT_UNUSED
         # CCRTAICC_CG_PDIV_INPUT_DISABLED
         # CCRTAICC_CG_PDIV_INPUT_SELECTED
   ccrtaicc_pdiv_info_t                         Pxaxb
      __u64                                     Divider
      _ccrtaicc_cg_pdiv_enable_t                Enable
         # CCRTAICC_CG_PDIV_DISABLE
         # CCRTAICC_CG_PDIV_ENABLE
      _ccrtaicc_cg_pdiv_input_state_t           State
         # CCRTAICC_CG_PDIV_INPUT_UNUSED
         # CCRTAICC_CG_PDIV_INPUT_DISABLED
         # CCRTAICC_CG_PDIV_INPUT_SELECTED
   int                                  Which_Pdiv_Selected
   int                                  P_Divider
   long double                          OutputClockFrequency;
      # <valid positive output clock frequency>
      # CCRTAICC_CLOCK_ERROR_INVALID_P_DIVIDER
      # CCRTAICC_CLOCK_ERROR_VCO_CLOCK_NOT_IN_RANGE
      # CCRTAICC_CLOCK_ERROR_N_DIVIDER_NOT_IN_RANGE
      # CCRTAICC_CLOCK_ERROR_P_DIVIDER_NOT_IN_RANGE
```

```
                  # CCRTAICC_CLOCK_ERROR_R_DIVIDER_NOT_IN_RANGE
                  # CCRTAICC_CLOCK_ERROR_INVALID_CLOCK_FREQUENCY
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 ***************************************************************************/
```

2.2.43 ccrtAICC_Clock_Get_Generator_Input_Clock_Enable()

This call returns the status of all the input clocks.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Input_Clock_Enable (void *Handle,
                  ccrtaicc_clkgen_input_clock_enable_t   *InputClockEnable)

   Description: Return the Clock Generator Input Clock Enable

   Input:   void                                  *Handle        (Handle pointer)
   Output:  ccrtaicc_clkgen_input_clock_enable_t  *InputClockEnable (pointer to
                                                             input clock enable)
               _ccrtaicc_cg_input_clock_enable_t  input_0_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
               _ccrtaicc_cg_input_clock_enable_t  input_1_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
               _ccrtaicc_cg_input_clock_enable_t  input_2_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
               _ccrtaicc_cg_input_clock_enable_t  input_fb_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
   Return: _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
 ***************************************************************************/
```

2.2.44 ccrtAICC_Clock_Get_Generator_Input_Clock_Select()

This call returns the input clock selection.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Input_Clock_Select (void *Handle,
                             ccrtaicc_clkgen_input_clock_select_t   *ClkSel)

   Description: Get Input Clock Selection

   Input:   void                                      *Handle  (Handle pointer)
   Output:  ccrtaicc_clkgen_input_clock_select_t      *ClkSel  (pointer to
                                                        input clock selection)
               _ccrtaicc_cg_input_clock_select_control_t    control;
```

```
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_PIN_CONTROL
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_REG_CONTROL
            _ccrtaicc_cg_input_clock_select_register_t   select;
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                 (successful)
               # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                 (device not open)
               # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION          (local region error)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE      (Clock is not active)
 ************************************************************************/
```

2.2.45 ccrtAICC_Clock_Get_Generator_Input_Clock_Status()

The call returns the input clock status.

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Input_Clock_Status (void *Handle,
                            ccrtaicc_clkgen_input_clock_status_t   *ClkStatus)

   Description: Get Input Clock Status

   Input:   void                                  *Handle    (Handle pointer)
   Output:  ccrtaicc_clkgen_input_clock_status_t  *ClkSatus  (pointer to input
                                                             clock status)
               _ccrtaicc_cg_calibration_status_t            calstat
                  # CCRTAICC_CG_STATUS_DEVICE_IS_NOT_CALIBRATING
                  # CCRTAICC_CG_STATUS_DEVICE_IS_CALIBRATING
               _ccrtaicc_cg_lol_pll_locked_t               PLL_locked
                  # CCRTAICC_CG_STATUS_LOL_PLL_LOCKED
                  # CCRTAICC_CG_STATUS_LOL_PLL_NOT_LOCKED
               _ccrtaicc_cg_smbus_timeout_error_t          SMBUS_timeout
                  # CCRTAICC_CG_STATUS_LOL_SMBUS_NOT_TIMEDOUT
                  # CCRTAICC_CG_STATUS_LOL_SMBUS_TIMEDOUT
               _ccrtaicc_cg_los_signal_present_t           input_signal
                  # CCRTAICC_CG_STATUS_LOS_SIGNAL_PRESENT
                  # CCRTAICC_CG_STATUS_LOS_SIGNAL_NOT_PRESENT
               _ccrtaicc_cg_los_alarm_t                    input_0_clock
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_PRESENT
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_NOT_PRESENT
               _ccrtaicc_cg_los_alarm_t                    input_1_clock
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_PRESENT
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_NOT_PRESENT
               _ccrtaicc_cg_los_alarm_t                    input_2_clock
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_PRESENT
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_NOT_PRESENT
               _ccrtaicc_cg_los_alarm_t                    input_fb_clock
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_PRESENT
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_NOT_PRESENT
               _ccrtaicc_cg_losxaxb_signal_present_t       input_xaxb_clock
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_PRESENT
                  # CCRTAICC_CG_LOS_INPUT_CLOCK_NOT_PRESENT
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
```

```
            # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
            # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
            # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 ***************************************************************************/
```

2.2.46 ccrtAICC_Clock_Get_Generator_M_Divider()

This call returns the M-Divider numerator, denominator and value.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_M_Divider (void        *Handle,
                                          __u64       *Numerator,
                                          __u32       *Denominator,
                                          long double *Value)

   Description: Return Clock Generator M-Divider Numerator and Denominator

   Input:   void              *Handle             (Handle pointer)
   Output:  __u64             *Numerator          (pointer to Numerator)
            __u32             *Denominator        (pointer to Denominator)
            long double       *Value              (pointer to Value)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 ***************************************************************************/
```

2.2.47 ccrtAICC_Clock_Get_Generator_N_Divider()

This call returns the N-Divider numerator, denominator and value for the selected divider.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_N_Divider (void                       *Handle,
                              _ccrtaicc_clock_generator_divider_t WhichDivider,
                              __u64                               *Numerator,
                              __u32                               *Denominator,
                              long double                         *Value)

   Description: Return Clock Generator N-Divider Numerator and Denominator

   Input:   void                                *Handle         (Handle pointer)
            _ccrtaicc_clock_generator_divider_t  WhichDivider    (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N3
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N4
   Output:  __u64                        *Numerator    (pointer to Numerator)
            __u32                        *Denominator  (pointer to Denominator)
            long double                  *Value        (pointer to Value)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
```

```
 ****************************************************************************/
```

2.2.48 ccrtAICC_Clock_Get_Generator_Output_Config()

Return the clock generator output configuration for the selected output.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Output_Config (void                *Handle,
                             _ccrtaicc_clock_generator_output_t  WhichOutput,
                             ccrtaicc_clkgen_output_config_t     *OutCfg)

   Description: Return Clock Generator Output Configuration

   Input:   void                                  *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t    WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
   Output:  ccrtaicc_clkgen_output_config_t   *OutCfg (pointer to output config)
               _ccrtaicc_cg_outcfg_force_rdiv2_t        force_rdiv2
                  # CCRTAICC_CG_OUTPUT_CONFIG_DONT_FORCE_RDIV2
                  # CCRTAICC_CG_OUTPUT_CONFIG_FORCE_RDIV2
               _ccrtaicc_cg_outcfg_enable_t             enable
                  # CCRTAICC_CG_OUTPUT_CONFIG_DISABLE
                  # CCRTAICC_CG_OUTPUT_CONFIG_ENABLE
               _ccrtaicc_cg_outcfg_shutdown_t           shutdown
                  # CCRTAICC_CG_OUTPUT_CONFIG_POWER_UP
                  # CCRTAICC_CG_OUTPUT_CONFIG_SHUTDOWN
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 ****************************************************************************/
```

2.2.49 ccrtAICC_Clock_Get_Generator_Output_Format()

Return the clock generator output format for the selected output.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Output_Format (void                *Handle,
                              _ccrtaicc_clock_generator_output_t  WhichOutput,
                              ccrtaicc_clkgen_output_format_t     *OutFmt)

   Description: Return Clock Generator Output Format

   Input:   void                                 *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t   WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
```

```
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
            # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
   Output:  ccrtaicc_clkgen_output_format_t    *OutFmt (pointer to output format)
            _ccrtaicc_cg_outfmt_cmos_drive_t         cmos_drive
               # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_LVDS
               # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_CMOS
            _ccrtaicc_cg_outfmt_disable_state_t      disable_state
               # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_LOW
               # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_HIGH
            _ccrtaicc_cg_outfmt_sync_t               sync
               # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_DISABLE
               # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_ENABLE
            _ccrtaicc_cg_outfmt_format_t             format
               # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_LVDS
               # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_CMOS
   Return:  _ccrtaicc_lib_error_number_t
            # CCRTAICC_LIB_NO_ERROR               (successful)
            # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN               (device not open)
            # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
            # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
            # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 ***************************************************************************/
```

2.2.50 ccrtAICC_Clock_Get_Generator_Output_Mode()

Return the clock generator output mode for the selected output.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Output_Mode (void               *Handle,
                        _ccrtaicc_clock_generator_output_t    WhichOutput,
                        ccrtaicc_clkgen_output_mode_t         *OutMode)

   Description: Return Clock Generator Output Mode

   Input:   void                                    *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t      WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
   Output:  ccrtaicc_clkgen_output_mode_t       *OutMode (pointer to output
                                                          amplitude/common mode)
               _ccrtaicc_cg_outmode_amplitude_t         amplitude
                  # CCRTAICC_CG_OUTPUT_AMPLITUDE_CMOS
                  # CCRTAICC_CG_OUTPUT_AMPLITUDE_LVDS
               _ccrtaicc_cg_outmode_common_t            common
                  # CCRTAICC_CG_OUTPUT_COMMON_CMOS
```

```
               # CCRTAICC_CG_OUTPUT_COMMON_LVDS
               # CCRTAICC_CG_OUTPUT_COMMON_LVPECL
   Return:  _ccrtaicc_lib_error_number_t
             # CCRTAICC_LIB_NO_ERROR                 (successful)
             # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
             # CCRTAICC_LIB_NOT_OPEN                 (device not open)
             # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
             # CCRTAICC_LIB_NO_LOCAL_REGION          (local region not present)
             # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE      (Clock is not active)
 ***************************************************************************/
```

2.2.51 ccrtAICC_Clock_Get_Generator_Output_Mux()

Return the clock generator output mux for the selected output.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Output_Mux (void                   *Handle,
                            _ccrtaicc_clock_generator_output_t WhichOutput,
                            ccrtaicc_clkgen_output_mux_t       *OutMux)

   Description: Return Clock Generator Output Mux

   Input:   void                                    *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t      WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
   Output:  ccrtaicc_clkgen_output_mux_t        *OutMux (pointer to output
                                                         inversion/N-divider mux)
             _ccrtaicc_cg_outmux_inversion_t       inversion
               # CCRTAICC_CG_OUTPUT_MUX_COMPLEMENTARY
               # CCRTAICC_CG_OUTPUT_MUX_IN_PHASE
               # CCRTAICC_CG_OUTPUT_MUX_INVERTED
               # CCRTAICC_CG_OUTPUT_MUX_OUT_OF_PHASE
             _ccrtaicc_cg_outmux_ndiv_select_t     ndiv_mux
               # CCRTAICC_CG_OUTPUT_MUX_NDIV_0
               # CCRTAICC_CG_OUTPUT_MUX_NDIV_1
               # CCRTAICC_CG_OUTPUT_MUX_NDIV_2
               # CCRTAICC_CG_OUTPUT_MUX_NDIV_3
               # CCRTAICC_CG_OUTPUT_MUX_NDIV_4
   Return:  _ccrtaicc_lib_error_number_t
             # CCRTAICC_LIB_NO_ERROR               (successful)
             # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
             # CCRTAICC_LIB_NOT_OPEN               (device not open)
             # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
             # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
             # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 ***************************************************************************/
```

2.2.52 ccrtAICC_Clock_Get_Generator_P_Divider()

Return the clock generator P-Divider.

```
/*****************************************************************************
  _ccrtaicc_lib_error_number_t
  ccrtAICC_Clock_Get_Generator_P_Divider (void                     *Handle,
                              _ccrtaicc_clock_generator_divider_t WhichDivider,
                              __u64                               *Divider)

   Description: Return Clock Generator P-Divider

   Input:   void                                  *Handle      (Handle pointer)
            _ccrtaicc_clock_generator_divider_t   WhichDivider (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PFB
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PXAXB
   Output:  __u64                                 *Divider    (pointer to
                                                               Divider)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 *****************************************************************************/
```

2.2.53 ccrtAICC_Clock_Get_Generator_P_Divider_Enable()

Return the clock generator P-Divider Enable state.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_P_Divider_Enable (void              *Handle,
                              _ccrtaicc_clock_generator_divider_t  WhichDivider,
                              _ccrtaicc_cg_pdiv_enable_t           *Pdiv_Enable)

   Description: Return Clock Generator P-Divider Enable

   Input:   void                                  *Handle      (Handle pointer)
            _ccrtaicc_clock_generator_divider_t   WhichDivider (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PXAXB
   Output:  _ccrtaicc_cg_pdiv_enable_t            *Pdiv_Enable (pointer to enable
                                                                flag)
               # CCRTAICC_CG_PDIV_DISABLE
               # CCRTAICC_CG_PDIV_ENABLE
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 *****************************************************************************/
```

2.2.54 ccrtAICC_Clock_Get_Generator_R_Divider()

Return the clock generator R-Divider for the selected divider.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_R_Divider (void                 *Handle,
                           _ccrtaicc_clock_generator_divider_t WhichDivider,
                           __u32                               *Divider)

   Description: Return Clock Generator R-Divider

   Input:   void                                  *Handle      (Handle pointer)
            _ccrtaicc_clock_generator_divider_t   WhichDivider (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R3
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R4
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R5
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R6
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R7
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R8
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R9
   Output:  __u32                                 *Divider   (pointer to Divider)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 *****************************************************************************/
```

2.2.55 ccrtAICC_Clock_Get_Generator_Revision()

Return the clock generator revision information.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Revision (void                      *Handle,
                                          ccrtaicc_clock_revision_t *Revision)

   Description: Return Clock Generator Revision

   Input:   void                                 *Handle      (Handle pointer)
   Output:  ccrtaicc_clock_revision_t            *Revision    (pointer to Divider)
             _ccrtaicc_cg_die_revision_t          DieRevision
                # CCRTAICC_CG_SILICON_REVISION_A0
                # CCRTAICC_CG_SILICON_REVISION_A1
             _convert_base_part_number_t          BasePartNumber;
                _convert_base_part_number_t
                   u_short BPN
                   u_char  NChar[2]
             _ccrtaicc_cg_clock_speed_grade_t   ClockSpeedGrade;
                # CCRTAICC_CG_CLOCK_SPEED_GRADE_A
                # CCRTAICC_CG_CLOCK_SPEED_GRADE_B
                # CCRTAICC_CG_CLOCK_SPEED_GRADE_C
                # CCRTAICC_CG_CLOCK_SPEED_GRADE_D
             _ccrtaicc_cg_clock_revision_t      ClockRevision;
                # CCRTAICC_CG_CLOCK_REVISION_A
                # CCRTAICC_CG_CLOCK_REVISION_B
                # CCRTAICC_CG_CLOCK_REVISION_C
                # CCRTAICC_CG_CLOCK_REVISION_D
   Return:  _ccrtaicc_lib_error_number_t
```

```
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
*************************************************************************/
```

2.2.56 ccrtAICC_Clock_Get_Generator_Value()

This is a generic call that can return the value of a valid clock generator address.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Value (void    *Handle,
                                       int     address,
                                       u_char  *value)

   Description: Return the value of the specified Clock Generator register.

   Input:   void              *Handle             (Handle pointer)
            int               address             (clock gen address to display)
   Output:  u_char            *value;             (pointer to value)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 *************************************************************************/
```

2.2.57 ccrtAICC_Clock_Get_Generator_Voltage_Select()

Return the clock generator Voltage Selection.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Get_Generator_Voltage_Select (void                  *Handle,
                                _ccrtaicc_cg_stat_ctrl_voltsel_t   *VoltSel)

   Description: Return the Clock Generator Voltage Selection

   Input:   void                            *Handle  (Handle pointer)
   Output:  _ccrtaicc_cg_stat_ctrl_voltsel_t *VoltSel (pointer to voltage select)
               # CCRTAICC_CG_VOLTAGE_SELECT_1_8V
               # CCRTAICC_CG_VOLTAGE_SELECT_3_3V
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 *************************************************************************/
```

2.2.58 ccrtAICC_Clock_Get_Generator_Zero_Delay()

Return the clock generator Zero Delay status.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
```

```
   ccrtAICC_Clock_Get_Generator_Zero_Delay (void                    *Handle,
                                           _ccrtaicc_cg_zero_delay_t  *ZeroDelay)

   Description: Return the Clock Generator Zero Delay setting.

   Input:   void                        *Handle     (Handle pointer)
   Output:  _ccrtaicc_cg_zero_delay_t   *ZeroDelay  (pointer to zero delay)
               # CCRTAICC_CG_ZERO_DELAY_MODE
               # CCRTAICC_CG_NORMAL_MODE
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE  (Clock is not active)
 ***************************************************************************/
```

2.2.59 ccrtAICC_Clock_ReturnOutputFrequency()

This call does not return the actual programmed frequency but instead returns the expected output frequency that would be generated if the specified user input parameters are supplied.

```
/***************************************************************************
   long double
   ccrtAICC_Clock_ReturnOutputFrequency(double       InputClock,
                                        long double  Mdiv_value,
                                        long double  Ndiv_value,
                                        double       Pdiv_value,
                                        double       Rdiv_value)

   Description: Return output frequency

   Input:   double             InputClock  (input clock frequency in Hz)
            long double        Mdiv_value  (M-Divider value)
            long double        Ndiv_value  (N-Divider value)
            double             Pdiv_value  (P-Divider value)
            double             Rdiv_value  (R-Divider value)
   Output:  none
   Return:  long double        returned frequency
 ***************************************************************************/
```

2.2.60 ccrtAICC_Clock_Set_Generator_CSR()

This call sets the clock generator control and status register.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_CSR (void                      *Handle,
                                     ccrtaicc_clkgen_csr_t     *CgCsr)

   Description: Set Clock Generator Control and Status information

   Input:   void                   *Handle      (Handle pointer)
            ccrtaicc_clkgen_csr_t  *CgCsr       (pointer to clock generator csr)
               _ccrtaicc_clkgen_output_t                    output
                  # CCRTAICC_CLOCK_GENERATOR_OUTPUT_DISABLE
                  # CCRTAICC_CLOCK_GENERATOR_OUTPUT_ENABLE
                  # CCRTAICC_CLOCK_GENERATOR_OUTPUT_DO_NOT_CHANGE
               _ccrtaicc_clkgen_state_t                     state
                  # CCRTAICC_CLOCK_GENERATOR_ACTIVE
```

```
                # CCRTAICC_CLOCK_GENERATOR_RESET
                # CCRTAICC_CLOCK_GENERATOR_STATE_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
 ***************************************************************************/
```

2.2.61 ccrtAICC_Clock_Set_Generator_Input_Clock_Enable()

This call sets the input clock status for the input clocks. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Input_Clock_Enable (void       *Handle,
                       ccrtaicc_clkgen_input_clock_enable_t   *InputClockEnable)

   Description: Set Clock Generator Input Clock Enable

   Input:   void                                  *Handle            (Handle
                                                                      pointer)
            ccrtaicc_clkgen_input_clock_enable_t *InputClockEnable  (pointer to
                                                                 input clock enable)
               _ccrtaicc_cg_input_clock_enable_t    input_0_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
               _ccrtaicc_cg_input_clock_enable_t    input_1_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
               _ccrtaicc_cg_input_clock_enable_t    input_2_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
               _ccrtaicc_cg_input_clock_enable_t    input_fb_clock
                  # CCRTAICC_CG_INPUT_CLOCK_DISABLE
                  # CCRTAICC_CG_INPUT_CLOCK_ENABLE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 ***************************************************************************/
```

2.2.62 ccrtAICC_Clock_Set_Generator_Input_Clock_Select()

This call sets the input clock selection. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Input_Clock_Select (void         *Handle,
                          ccrtaicc_clkgen_input_clock_select_t   *ClkSel)
```

```
   Description: Set Clock Generator Input Clock Selection

   Input:   void                                    *Handle (Handle pointer)
            ccrtaicc_clkgen_input_clock_select_t    *ClkSel (pointer to input
                                                             clock select)
               _ccrtaicc_cg_input_clock_select_control_t    control;
                  # CCRTAICC_CG_INPUT_CLOCK_SELECT_PIN_CONTROL
                  # CCRTAICC_CG_INPUT_CLOCK_SELECT_REG_CONTROL
               _ccrtaicc_cg_input_clock_select_register_t   select;
                  # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0
                  # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1
                  # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2
                  # CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 ************************************************************************/
```

2.2.63 ccrtAICC_Clock_Set_Generator_M_Divider()

This call sets the clock generator M-Divider to the user specified Numerator and Denominator. If the Update flag is set, then the change will take place after the divider has been written to. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_M_Divider (void    *Handle,
                                           __u64   Numerator,
                                           __u32   Denominator,
                                           int     Update)

   Description: Set Clock Generator M-Divider Numerator and Denominator

   Input:   void              *Handle             (Handle pointer)
            __u64             Numerator           (Numerator)
            __u32             Denominator         (Denominator)
            int               Update              (True=Update)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 ************************************************************************/
```

2.2.64 ccrtAICC_Clock_Set_Generator_N_Divider()

This call sets the clock generator selected N-Divider to the user specified Numerator and Denominator. If the Update flag is set, then the change will take place after the divider has been written to. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/************************************************************************
```

```
   ccrtAICC_Clock_Set_Generator_N_Divider()
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_N_Divider (void            *Handle,
                   _ccrtaicc_clock_generator_divider_t     WhichDivider,
                   __u64                                   Numerator,
                   __u32                                   Denominator,
                   int                                     Update)

   Description: Set Clock Generator N-Divider Numerator and Denominator

   Input:   void                                *Handle         (Handle pointer)
            _ccrtaicc_clock_generator_divider_t  WhichDivider    (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N3
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N4
            __u64                                Numerator       (Numerator)
            __u32                                Denominator     (Denominator)
            int                                  Update          (True=Update)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 ************************************************************************/
```

2.2.65 ccrtAICC_Clock_Set_Generator_Output_Config()

This call sets the clock generator Output Configuration for the selected output. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Output_Config (void              *Handle,
                           _ccrtaicc_clock_generator_output_t  WhichOutput,
                           ccrtaicc_clkgen_output_config_t     *OutCfg)

   Description: Set Clock Generator Output Configuration

   Input:   void                                *Handle         (Handle pointer)
            _ccrtaicc_clock_generator_output_t  WhichOutput     (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
            ccrtaicc_clkgen_output_config_t   *OutCfg  (pointer to output config)
               _ccrtaicc_cg_outcfg_force_rdiv2_t        force_rdiv2
                  # CCRTAICC_CG_OUTPUT_CONFIG_DONT_FORCE_RDIV2
                  # CCRTAICC_CG_OUTPUT_CONFIG_FORCE_RDIV2
                  # CCRTAICC_CG_OUTPUT_CONFIG_FORCE_DO_NOT_CHANGE
```

```
            _ccrtaicc_cg_outcfg_enable_t             enable
               # CCRTAICC_CG_OUTPUT_CONFIG_DISABLE
               # CCRTAICC_CG_OUTPUT_CONFIG_ENABLE
               # CCRTAICC_CG_OUTPUT_CONFIG_ENABLE_DO_NOT_CHANGE
            _ccrtaicc_cg_outcfg_shutdown_t           shutdown
               # CCRTAICC_CG_OUTPUT_CONFIG_POWER_UP
               # CCRTAICC_CG_OUTPUT_CONFIG_SHUTDOWN
               # CCRTAICC_CG_OUTPUT_CONFIG_SHUTDOWN_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 ***************************************************************************/
```

2.2.66 ccrtAICC_Clock_Set_Generator_Output_Format()

This call sets the clock generator Output Format for the selected output. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Output_Format (void                  *Handle,
                              _ccrtaicc_clock_generator_output_t  WhichOutput,
                              ccrtaicc_clkgen_output_format_t     *OutFmt)

   Description: Set Clock Generator Output Format

   Input:   void                                    *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t      WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
            ccrtaicc_clkgen_output_format_t         *OutFmt     (pointer to
                                                                 output format)
               _ccrtaicc_cg_outfmt_cmos_drive_t         cmos_drive
                  # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_LVDS
                  # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_CMOS
                  # CCRTAICC_CG_OUTPUT_FORMAT_CMOS_DRIVE_DO_NOT_CHANGE
               _ccrtaicc_cg_outfmt_disable_state_t      disable_state
                  # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_LOW
                  # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_HIGH
                  # CCRTAICC_CG_OUTPUT_FORMAT_DISABLE_DO_NOT_CHANGE
               _ccrtaicc_cg_outfmt_sync_t               sync
                  # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_DISABLE
                  # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_ENABLE
                  # CCRTAICC_CG_OUTPUT_FORMAT_SYNC_DO_NOT_CHANGE
               _ccrtaicc_cg_outfmt_format_t             format
                  # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_LVDS
                  # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_CMOS
```

```
                # CCRTAICC_CG_OUTPUT_FORMAT_FORMAT_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 ***************************************************************************/
```

2.2.67 ccrtAICC_Clock_Set_Generator_Output_Mode()

This call sets the clock generator Output Mode for the selected output. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Output_Mode (void                  *Handle,
                           _ccrtaicc_clock_generator_output_t     WhichOutput,
                           ccrtaicc_clkgen_output_mode_t          *OutMode)

   Description: Set Clock Generator Output Mode

   Input:   void                                   *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t     WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
            ccrtaicc_clkgen_output_mode_t          *OutMode    (pointer to
                                                                output mode)
               _ccrtaicc_cg_outmode_amplitude_t         amplitude
                  # CCRTAICC_CG_OUTPUT_AMPLITUDE_CMOS
                  # CCRTAICC_CG_OUTPUT_AMPLITUDE_LVDS
                  # CCRTAICC_CG_OUTPUT_AMPLITUDE_DO_NOT_CHANGE
               _ccrtaicc_cg_outmode_common_t            common
                  # CCRTAICC_CG_OUTPUT_COMMON_CMOS
                  # CCRTAICC_CG_OUTPUT_COMMON_LVDS
                  # CCRTAICC_CG_OUTPUT_COMMON_LVPECL
                  # CCRTAICC_CG_OUTPUT_COMMON_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 ***************************************************************************/
```

2.2.68 ccrtAICC_Clock_Set_Generator_Output_Mux()

This call sets the clock generator Output Mux for the selected output. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Output_Mux (void                  *Handle,
                           _ccrtaicc_clock_generator_output_t     WhichOutput,
                           ccrtaicc_clkgen_output_mux_t           *OutMux)

   Description: Set Clock Generator Output Mux

   Input:   void                                    *Handle     (Handle pointer)
            _ccrtaicc_clock_generator_output_t      WhichOutput (select output)
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
               # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
            ccrtaicc_clkgen_output_mux_t       *OutMux  (pointer to output
                                                         inversion/N-divider mux)
              _ccrtaicc_cg_outmux_inversion_t       inversion
                 # CCRTAICC_CG_OUTPUT_MUX_COMPLEMENTARY
                 # CCRTAICC_CG_OUTPUT_MUX_IN_PHASE
                 # CCRTAICC_CG_OUTPUT_MUX_INVERTED
                 # CCRTAICC_CG_OUTPUT_MUX_OUT_OF_PHASE
                 # CCRTAICC_CG_OUTPUT_MUX_INVERSION_DO_NOT_CHANGE
              _ccrtaicc_cg_outmux_ndiv_select_t     ndiv_mux
                 # CCRTAICC_CG_OUTPUT_MUX_NDIV_0
                 # CCRTAICC_CG_OUTPUT_MUX_NDIV_1
                 # CCRTAICC_CG_OUTPUT_MUX_NDIV_2
                 # CCRTAICC_CG_OUTPUT_MUX_NDIV_3
                 # CCRTAICC_CG_OUTPUT_MUX_NDIV_4
                 # CCRTAICC_CG_OUTPUT_MUX_NDIV_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 *************************************************************************/
```

2.2.69 ccrtAICC_Clock_Set_Generator_P_Divider()

This call sets the clock generator selected P-Divider to the user specified value. If the Update flag is set, then the change will take place after the divider has been written to. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_P_Divider (void                   *Handle,
```

```
                        _ccrtaicc_clock_generator_divider_t     WhichDivider,
                        __u64                                   Divider,
                        int                                     Update)

   Description: Set Clock Generator R-Divider

   Input:   void                                *Handle       (Handle pointer)
            _ccrtaicc_clock_generator_divider_t  WhichDivider  (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PFB
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PXAXB
            __u64                       Divider         (Divider)
            int                         Update          (True=Update)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                 (successful)
               # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                 (device not open)
               # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION          (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE      (Clock is not active)
 ***************************************************************************/
```

2.2.70 ccrtAICC_Clock_Set_Generator_P_Divider_Enable()

This call sets the state of the clock generator P-Divider. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_P_Divider_Enable (void            *Handle,
                           _ccrtaicc_clock_generator_divider_t   WhichDivider,
                           _ccrtaicc_cg_pdiv_enable_t            Pdiv_Enable)

   Description: Set Clock Generator P-Divider Enable

   Input:   void                                *Handle         (Handle pointer)
            _ccrtaicc_clock_generator_divider_t  WhichDivider    (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PXAXB
            _ccrtaicc_cg_pdiv_enable_t           Pdiv_Enable     (enable flag)
               # CCRTAICC_CG_PDIV_DISABLE
               # CCRTAICC_CG_PDIV_ENABLE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                 (successful)
               # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                 (device not open)
               # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION          (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE      (Clock is not active)
 ***************************************************************************/
```

2.2.71 ccrtAICC_Clock_Set_Generator_R_Divider()

This call sets the clock generator selected R-Divider to the user specified value. If the output clock is running, the new clock frequency will take affect immediately or on the next clock cycle depending on the output configuration. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_R_Divider (void                    *Handle,
                         _ccrtaicc_clock_generator_divider_t     WhichDivider,
                         __u32                                   Divider)

   Description: Set Clock Generator R-Divider

   Input:   void                                  *Handle        (Handle pointer)
            _ccrtaicc_clock_generator_divider_t   WhichDivider   (select divider)
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R3
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R4
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R5
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R6
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R7
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R8
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_R9
            __u32                                    Divider         (Divider)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
 *****************************************************************************/
```

2.2.72 ccrtAICC_Clock_Set_Generator_Value()

This is a generic call that can program a valid clock generator address to a desired value. User must be intimately familiar with the hardware before programming the values. In-correct programming could result in unpredictable results. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Value (void    *Handle,
                                       int     address,
                                       u_char  value)

   Description: Set the value of the specified Clock Generator register.

   Input:   void              *Handle             (Handle pointer)
            int               address             (clock gen address to set)
            u_char            value;              (value to write)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
```

```
            # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN            (device not open)
            # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
            # CCRTAICC_LIB_NO_LOCAL_REGION     (local region not present)
            # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE (Clock is not active)
 ***************************************************************************/
```

2.2.73 ccrtAICC_Clock_Set_Generator_Voltage_Select()

Program the clock generator voltage selection. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Voltage_Select (void              *Handle,
                               _ccrtaicc_cg_stat_ctrl_voltsel_t   VoltSel)

   Description: Set Clock Generator voltage selection

   Input:   void                              *Handle   (Handle pointer)
            _ccrtaicc_cg_stat_ctrl_voltsel_t VoltSel   (voltage selection)
               # CCRTAICC_CG_VOLTAGE_SELECT_1_8V
               # CCRTAICC_CG_VOLTAGE_SELECT_3_3V
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)

 ***************************************************************************/
```

2.2.74 ccrtAICC_Clock_Set_Generator_Zero_Delay()

Program the clock generator zero delay. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Clock_Set_Generator_Zero_Delay (void                    *Handle,
                                      _ccrtaicc_cg_zero_delay_t  ZeroDelay)

   Description: Set Clock Generator Zero Delay selection

   Input:   void                              *Handle    (Handle pointer)
            _ccrtaicc_cg_zero_delay_t         ZeroDelay  (zero delay selection)
               # CCRTAICC_CG_ZERO_DELAY_MODE
               # CCRTAICC_CG_NORMAL_MODE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE    (Clock is not active)
 ***************************************************************************/
```

2.2.75 ccrtAICC_Close()

This call is used to close an already opened device using the *ccrtAICC_Open()* call.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Close(void *Handle)

   Description: Close a previously opened device.

   Input:   void *Handle                    (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
 *****************************************************************************/
```

2.2.76 ccrtAICC_Compute_All_Output_Clocks()

This call does not program the clock outputs but instead returns to the user whether the board can be programmed with the user selected output clock frequencies. Additionally, useful information is returned to the user in a structure for each clock that was computed.

```
/*****************************************************************************

   ccrtAICC_Compute_All_Output_Clocks()

   Description: Compute All Output Clocks

   Input:   void                        *Handle             (Handle pointer)
            double                      InputClockFrequency (Input clock
                                                             frequency)
            ccrtaicc_compute_all_output_clocks_t *AllClocks (Pointer to all
                                                             output clocks info)
               ccrtaicc_compute_single_output_clock_t       *Clock
                  long double                               DesiredFrequency
                  double                                    DesiredTolerancePPT
   Output:  ccrtaicc_compute_all_output_clocks_t            *AllClocks
               (Pointer to returned output clocks info)
               __u32                                        NumberOfNdividers
               ccrtaicc_compute_single_output_clock_t       *Clock
                  _ccrtaicc_clock_generator_output_t        OutputClock
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
                     # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
                  double                                    InputClockFrequency
                  long double                               FrequencyDeviation
                  int                                       FrequencyFound
                  long double                               ActualFrequency
                  double                                    ActualTolerancePPT
                  __u64                                     Mdiv_Numerator
                  __u32                                     Mdiv_Denominator
                  __u64                                     Ndiv_Numerator
                  __u32                                     Ndiv_Denominator
```

```
                _ccrtaicc_cg_outmux_ndiv_select_t        Ndiv_ToUse
                   # CCRTAICC_CG_OUTPUT_MUX_NDIV_0
                   # CCRTAICC_CG_OUTPUT_MUX_NDIV_1
                   # CCRTAICC_CG_OUTPUT_MUX_NDIV_2
                   # CCRTAICC_CG_OUTPUT_MUX_NDIV_3
                   # CCRTAICC_CG_OUTPUT_MUX_NDIV_4
                __u32                                    Rdiv_value
                __u32                                    Rdivider
                __u32                                    Pdivider
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                  (successful)
               # CCRTAICC_LIB_BAD_HANDLE                (no/bad handler
                                                         supplied)
               # CCRTAICC_LIB_NOT_OPEN                  (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION           (local region error)
               # CCRTAICC_LIB_IO_ERROR                  (device not ready)
               # CCRTAICC_LIB_N_DIVIDERS_EXCEEDED       (number of N-Dividers
                                                         exceeded)
               # CCRTAICC_LIB_CANNOT_COMPUTE_OUTPUT_FREQ (cannot compute
                                                         output freq)
               # CCRTAICC_LIB_INVALID_ARG               (invalid argument)
 ***************************************************************************/
```

2.2.77 ccrtAICC_Convert_Physmem2avmm_Address()

This call is used to supply the user with an Avalon equivalent Address for the supplied Physical DMA memory. This Avalon equivalent address can then be supplied to the DMA engine to perform DMA operations.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Convert_Physmem2avmm_Address(void        *Handle,
                                         uint        *PhysDmaMemPtr,
                                         uint        *AvalonAddress)

   Description: Get the converted value of Physical DMA memory to Avalon address
                to be supplied as address for DMA operations.

   Input:   void                    *Handle           (Handle pointer)
            uint                    *PhysDmaMemPtr    (pointer to physical DMA
                                                       memory
   Output:  uint                    *AvalonAddress    (pointer to Avalon
                                                       Address).
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (library not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_AVALON_TRANSLATION_TABLE (avalon translation table
                                                       error)
               # CCRTAICC_LIB_ADDRESS_RANGE_ERROR     (address range error)
 ***************************************************************************/
```

2.2.78 ccrtAICC_Create_UserProcess()

Typically reads from h/w take a finite time to complete. If the user has a process that is time critical and needs to read the latest data faster, they may use a new approach called Hyper-Drive. In this case, the user defines a thread with this call, which continuously reads the data from the board and holds the latest values. The user process can then access this latest data at substantially faster rates. The two drawbacks to this approach is that the excessive bus assess is made and dedicated CPUs are required.

This call is used to create this User Process looping thread which can be controlled by the user via the returned handle. *(This is an experimental API for debugging and testing).*

```
/*****************************************************************************
  _ccrtaicc_lib_error_number_t
  ccrtAICC_Create_UserProcess(void                          *Handle,
                              _ccrtaicc_UserFunction_t      *UFunc,
                              _ccrtaicc_UserFunction_t      **UFuncHandle)

   Description: Create a User Process for user defined processing

   Input:   void                        *Handle         (Handle pointer)
            _ccrtaicc_UserFunction_t    *UFunc          (pointer to user
                                                         information structure)
   Output:  _ccrtaicc_UserFunction_t    **UFuncHandle   (pointer to user function
                                                         struct handle)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                 (successful)
               # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                 (device not open)
               # CCRTAICC_LIB_NO_RESOURCE              (cannot allocate memory)
               # CCRTAICC_LIB_INTERNAL_ERROR           (pthread attr failed)
               # CCRTAICC_LIB_THREAD_CREATE_FAILED     (failed to create thread)
*****************************************************************************/

typedef struct
{
    int Magic;
    void                            (*UserFunction) (void *hdl);
    pthread_t                       UserFunction_Thread_id;
    pid_t                           Pid;
    pthread_mutex_t                 lock;               /* lock this structure */
    pthread_cond_t                  wait;               /* wait for command */
    pthread_mutex_t                 cmd_lock;           /* lock this structure */
    pthread_cond_t                  cmd_wait;           /* wait for command */
    pthread_mutex_t                 user_lock;          /* lock this structure */
    pthread_cond_t                  user_wait;          /* wait for command */
    pthread_mutex_t                 user_mem_lock;      /* lock this structure */
    pthread_cond_t                  user_mem_wait;      /* wait for command */
    volatile int                    cpuAffinity;        /* CPU on which Thread
                                                           will run */
    volatile int                    cpuCount;           /* no. of cpus to run on
                                                           starting at base */
    volatile void                   *Handle;
    volatile void                   **Args;
    volatile int                    SchedulePolicy;
    volatile int                    SchedulePriority;
    volatile int                    ScheduleSelf;       /* 1=(Use
                                                           SchedulePriority-
                                                           1),0=no change */
    volatile ccrtaicc_uf_action_t   Action;
    volatile ccrtaicc_uf_state_t    State;
    volatile int                    CommandPending;
    volatile void                   *Next_UserFunction;
    volatile unsigned int long long RunCount;
    volatile int                    Pause;
} _ccrtaicc_UserFunction_t;
```

2.2.79 ccrtAICC_DataToVolts()

This routine takes a raw analog input data value and converts it to a floating point voltage based on the supplied format. Format can be *CCRTAICC_TWOS_COMPLEMENT* or *CCRTAICC_OFFSET_BINARY*. The data supplied in *us_data* must not be greater than the hardware resolution bits *CCRTAICC_ADC_RESOLUTION_BITS* supported by the board. Data greater than this will be masked out.

```
/*************************************************************************
   double ccrtAICC_DataToVolts(int us_data, ccrtaicc_volt_convert_t *conv)

   Description: Convert Data to volts

   Input:   int                                us_data       (data to convert)
            ccrtaicc_volt_convert_t            *conv         (pointer to
                                                              conversion struct)
               double                          VoltageRange  (maximum voltage
                                                              range)
               _ccrtaicc_csr_dataformat_t      Format        (format)
                  # CCRTAICC_OFFSET_BINARY
                  # CCRTAICC_TWOS_COMPLEMENT
               ccrtaicc_bool                   BiPolar       (bi-polar)
                  # CCRTAICC_TRUE
                  # CCRTAICC_FALSE
               int                             ResolutionBits (Number of
                                                               resolution bits)
   Output:  none
   Return:  double                             volts          (returned volts)
 *************************************************************************/
```

2.2.80 ccrtAICC_Destroy_AllUserProcess()

The purpose of this call is to destroy all User Processes that have been previously created by the *ccrtAICC_Create_UserProcess()* command. *(This is an experimental API for debugging and testing).*

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Destroy_AllUserProcess(void *Handle)

   Description: Destroy all created  user processes

   Input:   void                       *Handle      (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
 *************************************************************************/
```

2.2.81 ccrtAICC_Destroy_UserProcess()

The purpose of this call is to destroy the User Process that have been previously created by the *ccrtAICC_Create_UserProcess()* call. *(This is an experimental API for debugging and testing).*

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_Destroy_UserProcess(void *Handle,
                                  _ccrtaicc_UserFunction_t **UFuncHandle)

   Description: Destroy an already created  user process

   Input:   void                       *Handle          (Handle pointer)
            _ccrtaicc_UserFunction_t   **UFuncHandle    (pointer to user handle)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
```

```
            # CCRTAICC_LIB_NO_ERROR                (successful)
            # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
 ***************************************************************************/
```

2.2.82 ccrtAICC_Disable_Pci_Interrupts()

The purpose of this call is to disable PCI interrupts. This call shouldn't be used during normal reads as calls could time out. The driver handles enabling and disabling interrupts during its normal course of operation.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Disable_Pci_Interrupts (void                          *Handle,
                                    _ccrtaicc_all_interrupts_mask interrupt_mask)

   Description: Disable interrupts being generated by the board.

   Input:   void                          *Handle         (Handle pointer)
            _ccrtaicc_all_interrupts_mask  interrupt_mask  (interrupt mask)
               # CCRTAICC_DMA0_INTMASK
               # CCRTAICC_DMA1_INTMASK
               # CCRTAICC_MSGDMA_INTMASK
               # CCRTAICC_ADC_FIFO_INTMASK
               # CCRTAICC_ALL_DMA_INTMASK
               # CCRTAICC_ALL_ANALOG_INTMASK
               # CCRTAICC_DMA_ANALOG_INTMASK
               # CCRTAICC_ALL_INTMASK
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED            (driver ioctl call
                                                       failed)
 ***************************************************************************/
```

2.2.83 ccrtAICC_DMA_Configure()

The purpose of this call is configure a DMA engine to be ready for commencing DMA.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_DMA_Configure(void                    *Handle,
                          ccrtaicc_dma_engine_t    DMAEngineNo,
                          uint                     AvMM_FromAddr,
                          uint                     AvMM_ToAddr,
                          uint                     DMASize)

   Description: Configure DMA Engine

   Input:   void                  *Handle       (Handle pointer)
            ccrtaicc_dma_engine_t DMAEngineNo   (select DMA engine)
               # CCRTAICC_DMA0
               # CCRTAICC_DMA1
            uint                  AvMM_FromAddr (Avalon Memory Converted Source
                                                 Address)
            uint                  AvMM_ToAddr   (Avalon Memory Converted
                                                 Destination Address)
            uint                  DMASize       (DMA transfer size in bytes)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
```

```
            # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN          (library not open)
            # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
            # CCRTAICC_LIB_DMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                             (DMA access not allowed for
                                              selected address)
 ***************************************************************************/
```

2.2.84 ccrtAICC_DMA_Fire()

The purpose of this call is to initiate an already configured DMA engine.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_DMA_Fire(void                          *Handle,
                     ccrtaicc_dma_engine_t         DMAEngineNo,
                     ccrtaicc_bool                 UseInterrupts,
                     ccrtaicc_bool                 WaitForCompletion,
                     int                           DmaControl)

   Description: Start DMA Engine

   Input:   void            *Handle                (Handle pointer)
            ccrtaicc_dma_engine_t DMAEngineNo      (select DMA engine)
               # CCRTAICC_DMA0
               # CCRTAICC_DMA1
            ccrtaicc_bool       UseInterrupts      (Enable Interrupt flag)
               # CCRTAICC_TRUE
               # CCRTAICC_FALSE
            ccrtaicc_bool       WaitForCompletion  (Wait for Completion Flag)
               # CCRTAICC_TRUE
               # CCRTAICC_FALSE
            int                 DmaControl         (DMA control flags)
               # CCRTAICC_DMA_CONTROL_RCON         (read constant)
               # CCRTAICC_DMA_CONTROL_WCON         (write constant)
               # CCRTAICC_DMA_CONTROL_INCREMENT    (increment)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (no error)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (library not open)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_IOCTL_FAILED        (ioctl failed)
               # CCRTAICC_LIB_DMA_FAILED          (DMA failed)
 ***************************************************************************/
```

2.2.85 ccrtAICC_Enable_Pci_Interrupts()

The purpose of this call is to enable PCI interrupts. This call shouldn't be used during normal reads as calls could time out. The driver handles enabling and disabling interrupts during its normal course of operation.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Enable_Pci_Interrupts (void                          *Handle,
                                   _ccrtaicc_all_interrupts_mask interrupt_mask)

   Description: Enable interrupts being generated by the board.

   Input:   void                          *Handle         (Handle pointer)
            _ccrtaicc_all_interrupts_mask  interrupt_mask  (interrupt mask)
               # CCRTAICC_DMA0_INTMASK
```

```
               # CCRTAICC_DMA1_INTMASK
               # CCRTAICC_MSGDMA_INTMASK
               # CCRTAICC_ADC_FIFO_INTMASK
               # CCRTAICC_ALL_DMA_INTMASK
               # CCRTAICC_ALL_ANALOG_INTMASK
               # CCRTAICC_DMA_ANALOG_INTMASK
               # CCRTAICC_ALL_INTMASK
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED  (driver ioctl call failed)
 ************************************************************************/
```

2.2.86 ccrtAICC_Fast_Memcpy()

The purpose of this call is to provide a fast mechanism to copy between hardware and memory using programmed I/O. The library performs appropriate locking while the copying is taking place. If the board provides support for double word transfers, this call will utilize it.

```
/************************************************************************
   ccrtAICC_Fast_Memcpy(void           *Handle,
                        volatile void  *Destination,
                        volatile void  *Source,
                        int            SizeInBytes)

   Description: Perform fast copy to/from buffer using Programmed I/O
                (WITH LOCKING)

   Input:   void         *Handle            (Handle pointer)
            volatile void *Source           (pointer to source buffer)
            int            SizeInBytes      (transfer size in bytes)
   Oupput:  volatile void *Destination      (pointer to destination buffer)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
 ************************************************************************/
```

2.2.87 ccrtAICC_Fast_Memcpy_Unlocked()

The purpose of this call is to provide a fast mechanism to copy between hardware and memory using programmed I/O. The library does not perform any locking. User needs to provide external locking instead. If the board provides support for double word transfers, this call will utilize it. The *double_word_support* field in the driver information structure *ccrtaicc_driver_info_t* indicates whether the double word support is available in the hardware.

```
/************************************************************************
   void
   ccrtAICC_Fast_Memcpy_Unlocked(volatile void *Destination,
                                 volatile void *Source,
                                 int           SizeInBytes,
                                 int           DoubleWordSupport)

   Description: Perform fast copy to/from buffer using Programmed I/O
                (WITHOUT LOCKING)

   Input:   volatile void *Source               (pointer to source buffer)
            int            SizeInBytes          (transfer size in bytes)
            int            DoubleWordSupport    (double word support flag)
```

```
               # CCRTAICC_FALSE                (h/w double word transfers not
                                                supported)
               # CCRTAICC_TRUE                 (h/w double word transfers
                                                supported)
   Oupput:  volatile void *Destination         (pointer to destination buffer)
   Return:  none
*****************************************************************************/
```

2.2.88 ccrtAICC_Fast_Memcpy_Unlocked_FIFO()

The purpose of this call is to provide a simple mechanism to copy between hardware FIFO and memory using programmed I/O. The library does not perform any locking. User needs to provide external locking instead. If the board provides support for double word transfers, this call will utilize it. The *double_word_support* field in the driver information structure *ccrtaicc_driver_info_t* indicates whether the double word support is available in the hardware.

```
/*****************************************************************************
   void
   ccrtAICC_Fast_Memcpy_Unlocked_FIFO(volatile void *Destination,
                                      volatile void *Source,
                                      int           SizeInWords,
                                      int           PioControl,
                                      int           DoubleWordSupport)

   Description: Perform fast copy to/from FIFO buffer using Programmed I/O
                (WITHOUT LOCKING)

   Input:   volatile void *Source               (pointer to source buffer)
            int            SizeInWords          (transfer size in words)
            int            PioControl           (PIO Control)
               # CCRTAICC_PIO_CONTROL_RCON      (read constant)
               # CCRTAICC_PIO_CONTROL_WCON      (write constant)
               # CCRTAICC_PIO_CONTROL_INCREMENT (read/write increment)
            int            DoubleWordSupport    (double word support flag)
               # CCRTAICC_FALSE                (h/w double word transfers not
                                                supported)
               # CCRTAICC_TRUE                 (h/w double word transfers
                                                supported)
   Oupput:  volatile void *Destination          (pointer to destination buffer)
   Return:  none
 *****************************************************************************/
```

2.2.89 ccrtAICC_Fraction_To_Hex()

This converts a fractional decimal to a hexadecimal value.

```
/*****************************************************************************
   int
   ccrtAICC_Fraction_To_Hex (double Fraction,
                             uint   *value)

   Description: Convert Fractional Decimal to Hexadecimal

   Input:       double   Fraction       (fraction to convert)
   Output:      uint     *value;        (converted hexadecimal value)
   Return:      1                       (call failed)
                0                       (good return)
 *****************************************************************************/
```

2.2.90 ccrtAICC_Get_All_Boards_Driver_Info()

This call returns driver information for all the *ccrtaicc* cards that have been found in the system.

```
/*************************************************************************
   ccrtAICC_Get_All_Boards_Driver_Info()
   _ccrtaicc_lib_error_number_t ccrtAICC_Get_All_Boards_Driver_Info(
                            void                            *Handle,
                            ccrtaicc_all_boards_driver_info *all_boards_info)

   Description: Get device information from driver for all boards.

   Input:   void                           *Handle          (Handle pointer)
   Output:  ccrtaicc_driver_info_t         *all_boards_info (info struct pointer)
      char                                 version[12]
      char                                 built[32]
      char                                 module_name[16]
      int                                  board_index
      int                                  table_index
      char                                 board_desc[32]
      int                                  bus
      int                                  slot
      int                                  func
      int                                  vendor_id
      int                                  sub_vendor_id
      int                                  sub_device_id
      union {
          u_int BoardInfo
          ccrtaicc_boardinfo_t             BInfo
              u_char  Function
              u_char  Type
              u_short Id
      }
      union {
          u_int FirmwareDate
          ccrtaicc_firmware_date_t         FmDate
              u_short Year
              u_char  Day
              u_char  Month
      }
      union {
          u_int FirmwareRevision
          ccrtaicc_firmware_revision_t     FmRev
              u_short Minor
              u_short Major
      }
      int                                  msi_support
      int                                  irqlevel
      double                               calibration_10v_reference_voltage
      double                               calibration_5v_reference_voltage
      int                                  driver_dma_size

      // DMA
      ccrtaicc_driver_dma_info_t           dma_info
        short   num_trans_tbl_entries
        int     avalon_page_bits
        int     avalon_page_size
        int     tx_interface_base
        int     dma_max_engines
        int     dma_max_burst_size
        int     dma_max_transactions
        int     dma_max_size[CCRTAICC_DMA_MAX_ENGINES]
```

```
  int     dma_width_in_bytes[CCRTAICC_DMA_MAX_ENGINES]
  int     dma_fire_command[CCRTAICC_DMA_MAX_ENGINES]

// Interrupt
ccrtaicc_driver_int_t               interrupt
  uint    InterruptsOccurredMask
  uint    WakeupInterruptMask
  int     timeout_seconds
  int     DmaControl

  long long unsigned  count
  long long unsigned  dma_count[CCRTAICC_DMA_MAX_ENGINES]
  long long unsigned  MsgDma_count;           // Modular Scatter-Gather DMA

int                                 Ccrtaicc_Max_Region

// Memory Region
ccrtaicc_dev_region_t               mem_region[CCRTAICC_MAX_REGION]
    uint physical_address
    uint size
    uint flags
    uint *virtual_address

// ADC
ccrtaicc_driver_adc_info_t          adc_info
    double adc_max_voltage_range
    int    number_of_adcs
    int    number_of_adc_channels
    int    number_of_adc_resolutionbits
    _ccrtaicc_adc_channel_mask_t
           all_adc_channels_mask
    int    max_adc_fifo_threshold
    int    max_adc_high_speed_frequency
    int    max_adc_normal_speed_frequency

// SDRAM
ccrtaicc_driver_sdram_info_t        sdram_info
    int                                sdram_max_size_in_words
    _ccrtaicc_clock_generator_output_t sdram_output_clock
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
    double                             sdram_output_clock_frequency
// CLOCK
ccrtaicc_driver_clock_info_t        clock_info
    _ccrtaicc_cg_input_clock_select_register_t  default_input_clock
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB
    double                                  default_input_clock_frequency
    double                                  default_clock_tolerance_ppt

// SPROM
```

```
        ccrtaicc_sprom_header_t             sprom_header
            u_int32_t   board_serial_number
            u_short     sprom_revision

        // Chip Temperature  (this board does NOT return a chip temperature)
        char                                fpga_chip_temperature

        char                                double_word_support

        union {
            u_int                           FirmwareTime
            ccrtaicc_firmware_time_t        FmTime
                u_char  Second
                u_char  Minute
                u_char  Hour
                u_char  unused
        }
        union {
            u_int                           FirmwareFlavorCode
            ccrtaicc_firmware_option_code_t FmOptionCode
                u_char  C0
                u_char  C1
                u_char  C2
                u_char  C3
        }

        u_short                             RunLevelSectorNumber
        char                                FirmwareReloadFailed
        char                                MultiFirmwareSupport

        union {
            u_int                           Dummy_time_t[2]
            time_t                          DriverLoadCurrentTime
        }

        u_int32_t                           FirmwareBoardSerialNumber
        u_int32_t                           MaxMsgDmaDescriptors
        u_int32_t                           MaxMsgDmaSize
        u_int32_t                           MsgDmaWidthInBytes
        u_int32_t                           MaxMsgDmaFifoSize
        u_int32_t                           FpgawbRevision
        int                                 CloningSupport
        u_short                             MaximumLinkWidth
        u_short                             NegotiatedLinkWidth
    Return:  _ccrtaicc_lib_error_number_t
                # CCRTAICC_LIB_NO_ERROR      (successful)
                # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
                # CCRTAICC_LIB_NOT_OPEN      (device not open)
                # CCRTAICC_LIB_INVALID_ARG   (invalid argument)
                # CCRTAICC_LIB_IOCTL_FAILED  (driver ioctl call failed)
*****************************************************************************/
```

2.2.91 ccrtAICC_Get_Board_CSR()

This call returns information from the board status register.

```
/*****************************************************************************
  _ccrtaicc_lib_error_number_t
  ccrtAICC_Get_Board_CSR (void                    *Handle,
                          ccrtaicc_board_csr_t    *bcsr)
```

```
   Description: Get Board Control and Status information

   Input:   void                                *Handle    (Handle pointer)
   Output:  ccrtaicc_board_csr_t                *bcsr      (pointer to board csr)
               _ccrtaicc_bcsr_identify_board_t  identify_board
                  # CCRTAICC_BCSR_IDENTIFY_BOARD_DISABLE
                  # CCRTAICC_BCSR_IDENTIFY_BOARD_ENABLE
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
 ****************************************************************************/
```

2.2.92 ccrtAICC_Get_Board_Info()

This call returns the board id, the board type and the firmware revision level for the selected board. This board id is *0x9277* and board type is *0x1* or *0x9278* with a board type of *0x2*.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Board_Info (void                    *Handle,
                            ccrtaicc_board_info_t  *binfo)
   Description: Get Board Information

   Input:   void                    *Handle        (Handle pointer)
   Output:  ccrtaicc_board_info_t   *binfo  (pointer to board info)
               int                                 vendor_id
               int                                 sub_vendor_id
               int                                 sub_device_id
               ccrtaicc_boardinfo_t                BInfo
                  u_char  Function
                  u_char  Type
                  u_short Id
               ccrtaicc_firmware_date_t            FmDate
                  u_short Year
                  u_char  Day
                  u_char  Month
               ccrtaicc_firmware_revision_t        FmRev
                  u_short Minor
                  u_short Major
               ccrtaicc_sprom_header_t             sprom_header
                  u_int32_t   board_serial_number
                  u_short     sprom_revision
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
 ****************************************************************************/
```

2.2.93 ccrtAICC_Get_Cable_Fault_CSR()

This call returns the cable fault and the latched cable fault status.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Cable_Fault_CSR (void                      *Handle,
                                 ccrtaicc_cable_fault_csr_t *CableFaultCSR)
```

```
   Description: Get Cable Fault Control & Status information

   Input:   void                         *Handle          (handle pointer)
   Output:  ccrtaicc_cable_fault_csr_t   *CableFaultCSR   (pointer to cable fault
                                                          CSR)
              _ccrtaicc_cable_fault_group_mask_t    LatchedFaultStatus
                 # CCRTAICC_CABLE_FAULT_GROUP_00_03_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_04_07_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_08_11_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_12_15_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_16_19_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_20_23_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_24_27_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_28_31_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_32_35_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_36_39_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_40_43_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_44_47_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_48_51_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_52_55_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_56_59_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_60_63_MASK
                 # CCRTAICC_ALL_CABLE_FAULT_GROUPS_MASK
              _ccrtaicc_cable_fault_group_mask_t    FaultStatus
                 # CCRTAICC_CABLE_FAULT_GROUP_00_03_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_04_07_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_08_11_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_12_15_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_16_19_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_20_23_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_24_27_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_28_31_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_32_35_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_36_39_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_40_43_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_44_47_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_48_51_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_52_55_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_56_59_MASK
                 # CCRTAICC_CABLE_FAULT_GROUP_60_63_MASK
                 # CCRTAICC_ALL_CABLE_FAULT_GROUPS_MASK
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_BAD_HANDLE         (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN           (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION    (local region error)
               # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
 ***************************************************************************/
```

2.2.94 ccrtAICC_Get_Calibration_CSR()

This call returns the current calibration control and status register.

```
/***************************************************************************
   ccrtAICC_Get_Calibration_CSR()

   Description: Get Calibration Control and Status Register

   Input:   void                         *Handle     (Handle pointer)
   Output:  ccrtaicc_calibration_csr_t   *CalCSR     (pointer to calibration CSR)
```

```
              _ccrtaicc_calbus_control_t BusControl  (bus control)
                 # CCRTAICC_CB_GROUND
                 # CCRTAICC_CB_POSITIVE_10V_REFERENCE
                 # CCRTAICC_CB_NEGATIVE_10V_REFERENCE
                 # CCRTAICC_CB_POSITIVE_5V_REFERENCE
                 # CCRTAICC_CB_NEGATIVE_5V_REFERENCE
                 # CCRTAICC_CB_POSITIVE_2V_REFERENCE
                 # CCRTAICC_CB_BUS_OPEN
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR        (successful)
               # CCRTAICC_LIB_BAD_HANDLE      (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN        (device not open)
               # CCRTAICC_LIB_INVALID_ARG     (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION (local region not present)
 ***************************************************************************/
```

2.2.95 ccrtAICC_Get_Driver_Error()

This call returns the last error generated by the driver.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Driver_Error (void                     *Handle,
                              ccrtaicc_user_error_t    *ret_err)

   Description: Get the last error generated by the driver.

   Input:   void                  *Handle             (Handle pointer)
   Output:  ccrtaicc_user_error_t *ret_err            (error struct pointer)
               uint error;                           (error number)
               char name[CCRTAICC_ERROR_NAME_SIZE]   (error name used in driver)
               char desc[CCRTAICC_ERROR_DESC_SIZE]   (error description)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_IOCTL_FAILED           (driver ioctl call failed)
 ***************************************************************************/

#define CCRTAICC_ERROR_NAME_SIZE    64
#define CCRTAICC_ERROR_DESC_SIZE    128

typedef struct _ccrtaicc_user_error_t
{
    uint error;                                 /* error number */
    char name[CCRTAICC_ERROR_NAME_SIZE];    /* error name used in driver */
    char desc[CCRTAICC_ERROR_DESC_SIZE];    /* error description */
} ccrtaicc_user_error_t;

enum
{
    CCRTAICC_SUCCESS = 0,
    CCRTAICC_INVALID_PARAMETER,
    CCRTAICC_DMA_TIMEOUT,
    CCRTAICC_OPERATION_CANCELLED,
    CCRTAICC_RESOURCE_ALLOCATION_ERROR,
    CCRTAICC_INVALID_REQUEST,
    CCRTAICC_FAULT_ERROR,
    CCRTAICC_BUSY,
    CCRTAICC_ADDRESS_IN_USE,
```

```
    CCRTAICC_USER_INTERRUPT_TIMEOUT,
    CCRTAICC_DMA_INCOMPLETE,
    CCRTAICC_DATA_UNDERFLOW,
    CCRTAICC_DATA_OVERFLOW,
    CCRTAICC_IO_FAILURE,
    CCRTAICC_OPERATION_NOT_SUPPORTED,
    CCRTAICC_ADC_FIFO_THRESHOLD_TIMEOUT,
    CCRTAICC_INTERRUPT_HANDLER_NOT_ENABLED,
    CCRTAICC_FIRMWARE_RELOAD_FAILED,
    CCRTAICC_DEVICE_AUTHORIZATION_FAILED,
};
```

2.2.96 ccrtAICC_Get_Driver_Info()

This call returns internal information that is maintained by the driver.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Driver_Info (void                      *Handle,
                             ccrtaicc_driver_info_t    *info)

   Description: Get device information from driver.

   Input:   void                              *Handle     (Handle pointer)
   Output:  ccrtaicc_driver_info_t            *info       (info struct pointer)
      char                                  version[12]
      char                                  built[32]
      char                                  module_name[16]
      int                                   board_index
      int                                   table_index
      char                                  board_desc[32]
      int                                   bus
      int                                   slot
      int                                   func
      int                                   vendor_id
      int                                   sub_vendor_id
      int                                   sub_device_id
      union {
          u_int BoardInfo
          ccrtaicc_boardinfo_t              BInfo
              u_char  Function
              u_char  Type
              u_short Id
      }
      union {
          u_int FirmwareDate
          ccrtaicc_firmware_date_t          FmDate
              u_short Year
              u_char  Day
              u_char  Month
      }
      union {
          u_int FirmwareRevision
          ccrtaicc_firmware_revision_t      FmRev
              u_short Minor
              u_short Major
      }
      int                                   msi_support
      int                                   irqlevel
      double                                calibration_10v_reference_voltage
      double                                calibration_5v_reference_voltage
```

```
int                                 driver_dma_size

// DMA
ccrtaicc_driver_dma_info_t          dma_info
  short   num_trans_tbl_entries
  int     avalon_page_bits
  int     avalon_page_size
  int     tx_interface_base
  int     dma_max_engines
  int     dma_max_burst_size
  int     dma_max_transactions
  int     dma_max_size[CCRTAICC_DMA_MAX_ENGINES]
  int     dma_width_in_bytes[CCRTAICC_DMA_MAX_ENGINES]
  int     dma_fire_command[CCRTAICC_DMA_MAX_ENGINES]

// Interrupt
ccrtaicc_driver_int_t               interrupt
  uint    InterruptsOccurredMask
  uint    WakeupInterruptMask
  int     timeout_seconds
  int     DmaControl

  long long unsigned  count
  long long unsigned  dma_count[CCRTAICC_DMA_MAX_ENGINES]
  long long unsigned  MsgDma_count;           // Modular Scatter-Gather DMA

int                                 Ccrtaicc_Max_Region

// Memory Region
ccrtaicc_dev_region_t               mem_region[CCRTAICC_MAX_REGION]
    uint physical_address
    uint size
    uint flags
    uint *virtual_address

// ADC
ccrtaicc_driver_adc_info_t          adc_info
    double adc_max_voltage_range
    int    number_of_adcs
    int    number_of_adc_channels
    int    number_of_adc_resolutionbits
    _ccrtaicc_adc_channel_mask_t
           all_adc_channels_mask
    int    max_adc_fifo_threshold
    int    max_adc_high_speed_frequency
    int    max_adc_normal_speed_frequency

// SDRAM
ccrtaicc_driver_sdram_info_t        sdram_info
    int                                sdram_max_size_in_words
    _ccrtaicc_clock_generator_output_t sdram_output_clock
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
        - CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
```

```
    double                              sdram_output_clock_frequency
// CLOCK
ccrtaicc_driver_clock_info_t        clock_info
    _ccrtaicc_cg_input_clock_select_register_t  default_input_clock
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2
        - CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB
    double                                      default_input_clock_frequency
    double                                      default_clock_tolerance_ppt

// SPROM
ccrtaicc_sprom_header_t             sprom_header
    u_int32_t   board_serial_number
    u_short     sprom_revision

// Chip Temperature  (this board does NOT return a chip temperature)
char                                fpga_chip_temperature

char                                double_word_support

union {
    u_int                           FirmwareTime
    ccrtaicc_firmware_time_t        FmTime
        u_char  Second
        u_char  Minute
        u_char  Hour
        u_char  unused
}
union {
    u_int                           FirmwareFlavorCode
    ccrtaicc_firmware_option_code_t FmOptionCode
        u_char  C0
        u_char  C1
        u_char  C2
        u_char  C3
}

u_short                             RunLevelSectorNumber
char                                FirmwareReloadFailed
char                                MultiFirmwareSupport

union {
    u_int                           Dummy_time_t[2]
    time_t                          DriverLoadCurrentTime
}

u_int32_t                           FirmwareBoardSerialNumber
u_int32_t                           MaxMsgDmaDescriptors
u_int32_t                           MaxMsgDmaSize
u_int32_t                           MsgDmaWidthInBytes
u_int32_t                           MaxMsgDmaFifoSize
u_int32_t                           FpgawbRevision
int                                 CloningSupport
u_short                             MaximumLinkWidth
u_short                             NegotiatedLinkWidth
Return:  _ccrtaicc_lib_error_number_t
         # CCRTAICC_LIB_NO_ERROR      (successful)
         # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
         # CCRTAICC_LIB_NOT_OPEN      (device not open)
         # CCRTAICC_LIB_INVALID_ARG   (invalid argument)
```

```
              # CCRTAICC_LIB_IOCTL_FAILED  (driver ioctl call failed)
 ***************************************************************************/
```

2.2.97 ccrtAICC_Get_External_Clock_CSR()

This call returns the current external clock connections.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_External_Clock_CSR (void                          *Handle,
                                    ccrtaicc_external_clock_csr_t *ExtClkCSR)

   Description: Get External Clock Control & Status information

   Input:   void                           *Handle     (handle pointer)
   Output:  ccrtaicc_external_clock_csr_t  *ExtClkCSR  (pointer to external clock
                                                        CSR)
              ccrtaicc_bool                             InputClockPresent
              ccrtaicc_bool                             OutputClockPresent
              _ccrtaicc_external_clock_output_select_t ClockOutputSelect;
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_0
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_1
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_2
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_3
                 # CCRTAICC_EXCLOS_EXTERNAL_CLOCK_INPUT
                 # CCRTAICC_EXCLOS_NO_CLOCK
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
 ***************************************************************************/
```

2.2.98 ccrtAICC_Get_Interrupt_Status()

This call returns the current status of the various interrupts.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Interrupt_Status (void                *Handle,
                                  ccrtaicc_interrupt_t *intr)

   Description: Get Interrupt Status information

   Input:   void                    *Handle       (handle pointer)
   Output:  ccrtaicc_interrupt_t    *intr         (pointer to interrupt status)
               _ccrtaicc_intsta_adc_t
                  # CCRTAICC_INT_ADC_FIFO_THRESHOLD_NONE
                  # CCRTAICC_INT_ADC_FIFO_THRESHOLD_OCCURRED
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
 ***************************************************************************/
```

2.2.99 ccrtAICC_Get_Interrupt_Timeout_Seconds()

This call returns the read time out maintained by the driver. It is the time that the read call will wait before it times out. The call could time out because a DMA fails to complete. The device should have been opened in the block mode (*O_NONBLOCK* not set) for reads to wait for the operation to complete.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Interrupt_Timeout_Seconds (void    *Handle,
                                           int     *int_timeout_secs)

   Description: Get Interrupt Timeout Seconds

   Input:   void            *Handle              (Handle pointer)
   Output:  int             *int_timeout_secs    (pointer to int tout secs)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_BAD_HANDLE         (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN           (device not open)
               # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION    (local region not present)
               # CCRTAICC_LIB_IOCTL_FAILED       (ioctl error)
 *************************************************************************/
```

2.2.100 ccrtAICC_Get_Lib_Error_Description()

This call returns the library error name and description for the supplied error number.

```
/*************************************************************************

   ccrtAICC_Get_Lib_Error_Description()

   Description: Get Error Description of supplied error number.

   Input:   int                                ErrorNumber     (Library error number)
   Output:  ccrtaicc_lib_error_description_t   *lib_error_desc (error description struct pointer)
               -- int  found
               -- char name[CCURPMFC_LIB_ERROR_NAME_SIZE] (last library error name)
               -- char desc[CCURPMFC_LIB_ERROR_DESC_SIZE] (last library error description)
   Return:  none

 *************************************************************************/
```

2.2.101 ccrtAICC_Get_Lib_Error()

This call provides detailed information about the last library error that was maintained by the API. The call itself can fail with a return code if an invalid handle is provided, the device is not open or device authorization has failed. If the call succeeds *CCRTAICC_LIB_NO_ERROR*, the last library error information is supplied to the user in the *ccrtaicc_lib_error_t* structure.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Lib_Error (void                    *Handle,
                           ccrtaicc_lib_error_t    *lib_error)

   Description: Get last error generated by the library.

   Input:   void                *Handle                (Handle pointer)
   Output:  ccrtaicc_lib_error_t *lib_error            (error struct pointer)
               -- uint error                           (last library error number)
               -- char name[CCRTAICC_LIB_ERROR_NAME_SIZE] (last library error name)
               -- char desc[CCRTAICC_LIB_ERROR_DESC_SIZE] (last library error description)
               -- int  line_number                     (last library error line number in lib)
               -- char function[CCRTAICC_LIB_ERROR_FUNC_SIZE]
```

```
                                                    (library function in error)
             -- ccrtaicc_lib_error_backtrace_t BT[CCRTAICC_BACK_TRACE_DEPTH]
                                                    (backtrace of errors)
                -- int  line_number                  (line number in library)
                -- char function[CCRTAICC_LIB_ERROR_FUNC_SIZE]
                                                    (library function)
   Return:  _ccrtaicc_lib_error_number_t
             # CCRTAICC_LIB_NO_ERROR                (successful)
             # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
             # CCRTAICC_LIB_NOT_OPEN                (device not open)
             # CCRTAICC_LIB_AUTHORIZATION_FAILURE   (device authorization failure)
 ****************************************************************************/

typedef struct
{
    int  line_number;                           /* line number in library */
    char function[CCRTAICC_LIB_ERROR_FUNC_SIZE]; /* library function */
} ccrtaicc_lib_error_backtrace_t;

typedef struct
{
    uint error;                                 /* last library error number */
    char name[CCRTAICC_LIB_ERROR_NAME_SIZE];    /* last library error name */
    char desc[CCRTAICC_LIB_ERROR_DESC_SIZE];    /* last libarary error description */
    int  line_number;                           /* last library  error line number in
                                                   lib */
    char function[CCRTAICC_LIB_ERROR_FUNC_SIZE]; /* library function in error */
    ccrtaicc_lib_error_backtrace_t BT[CCRTAICC_BACK_TRACE_DEPTH];
                                                /* backtrace of errors */
} ccrtaicc_lib_error_t;
```

Possible library errors:

```
CCRTAICC_LIB_NO_ERROR                   =  0,  /* Successful */
CCRTAICC_LIB_INVALID_ARG                = -1,  /* Invalid argument */
CCRTAICC_LIB_ALREADY_OPEN               = -2,  /* Already open */
CCRTAICC_LIB_OPEN_FAILED                = -3,  /* Open failed */
CCRTAICC_LIB_BAD_HANDLE                 = -4,  /* Bad handle */
CCRTAICC_LIB_NOT_OPEN                   = -5,  /* Device not opened */
CCRTAICC_LIB_MMAP_SELECT_FAILED         = -6,  /* Mmap selection failed */
CCRTAICC_LIB_MMAP_FAILED                = -7,  /* Mmap failed */
CCRTAICC_LIB_MUNMAP_FAILED              = -8,  /* Munmap failed */
CCRTAICC_LIB_NOT_MAPPED                 = -9,  /* Not mapped */
CCRTAICC_LIB_ALREADY_MAPPED             = -10, /* Device already mapped */
CCRTAICC_LIB_IOCTL_FAILED               = -11, /* Device IOCTL failed */
CCRTAICC_LIB_IO_ERROR                   = -12, /* I/O error */
CCRTAICC_LIB_INTERNAL_ERROR             = -13, /* Internal library error */
CCRTAICC_LIB_NOT_IMPLEMENTED            = -14, /* Call not implemented */
CCRTAICC_LIB_LOCK_FAILED                = -15, /* Failed to get lib lock */
CCRTAICC_LIB_NO_LOCAL_REGION            = -16, /* Local region not present */
CCRTAICC_LIB_NO_CONFIG_REGION           = -17, /* Config region not present */
CCRTAICC_LIB_NO_SOLUTION_FOUND          = -18, /* No solution found */
CCRTAICC_LIB_NO_RESOURCE                = -19, /* Resource not available */
CCRTAICC_LIB_CANNOT_OPEN_FILE           = -20, /* Cannot open file */
CCRTAICC_LIB_DMA_BUSY                   = -21, /* DMA busy */
CCRTAICC_LIB_AVALON_TRANSLATION_TABLE   = -22, /* Avalon translation table error */
CCRTAICC_LIB_ADDRESS_RANGE_ERROR        = -23, /* Physical DMA address exceeds memory size */
CCRTAICC_LIB_NO_SPACE_IN_TABLE          = -24, /* No space available to allocate any more physical
                                                  memory */
CCRTAICC_LIB_CANNOT_ALLOCATE_PHYS_MEM   = -25, /* Cannot allocate physical memory */
CCRTAICC_LIB_DMA_FAILED                 = -26, /* DMA failed */
CCRTAICC_LIB_THREAD_CREATE_FAILED       = -27, /* Thread Creation failed */
CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE        = -28, /* Clock Generator is not active */
CCRTAICC_LIB_CANNOT_COMPUTE_OUTPUT_FREQ = -29, /* Cannot compute output frequency */
CCRTAICC_LIB_N_DIVIDERS_EXCEEDED        = -30, /* Number of N-Dividers exceeded */
CCRTAICC_LIB_CLOCK_GENERATION_FAILED    = -31, /* Clock generation failed */
```

```
CCRTAICC_LIB_CALIBRATION_RANGE_ERROR       = -32, /* Calibration voltage out of range */
CCRTAICC_LIB_BAD_DATA_IN_CAL_FILE          = -33, /* Bad data in calibration file */
CCRTAICC_LIB_VOLTAGE_NOT_IN_RANGE          = -34, /* Voltage not in range */
CCRTAICC_LIB_ADC_IS_NOT_ACTIVE             = -35, /* ADC is not active */
CCRTAICC_LIB_SDRAM_IS_NOT_ACTIVE           = -36, /* SDRAM is not active */
CCRTAICC_LIB_SDRAM_INITIALIZATION_FAILED   = -37, /* SDRAM initialization failed */
CCRTAICC_LIB_SERIAL_PROM_FAILURE           = -38, /* Serial PROM failure - malfunction or not
                                                     present */
CCRTAICC_LIB_SERIAL_PROM_BUSY              = -39, /* Serial PROM busy */
CCRTAICC_LIB_SERIAL_PROM_WRITE_PROTECTED   = -40, /* Serial PROM is write protected */
CCRTAICC_LIB_AUTHORIZATION_FAILURE         = -41, /* Failure to authorize opening of device */
CCRTAICC_LIB_INTHDLR_CREATE_FAILURE        = -42, /* Interrupt handler creation failure */
CCRTAICC_LIB_INTHDLR_ALREADY_RUNNING       = -43, /* Interrupt handler already running */
CCRTAICC_LIB_NO_FREE_DESCRIPTORS_AVAILABLE = -44, /* No free descriptors available */
CCRTAICC_LIB_ERROR_IN_DESCRIPTOR_LIST      = -45, /* Error in descriptor list */
CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED          = -46, /* Modular Scatter-Gather DMA not supported */
CCRTAICC_LIB_MSGDMA_ACCESS_NOT_ALLOWED_FOR_SELECTDRESS
                                           = -47, /* MSGDMA access not allowed for selected
                                                     address */
CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA           = -48, /* Not Owner of Modular Scatter-Gather DMA */
CCRTAICC_LIB_MSGDMA_IN_USE                 = -49, /* Modular Scatter-Gather DMA In Use */
CCRTAICC_LIB_CLOCK_NOT_ASSIGNED_TO_ADC     = -50, /* Clock generator is not assigned to an ADC */
CCRTAICC_LIB_SERIAL_PROM_NOT_PRESENT       = -51, /* Serial PROM not present */
CCRTAICC_LIB_DMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_SS
                                           = -52, /* DMA access not allowed for selected address */
CCRTAICC_LIB_SDRAM_NOT_SUPPORTED           = -53, /* SDRAM not supported */
CCRTAICC_LIB_MSGDMA_NOT_SETUP              = -54, /* Modular Scatter-Gather DMA not setup */
CCRTAICC_LIB_MSGDMA_FAILED                 = -55, /* Modular Scatter-Gather DMA failed */
CCRTAICC_LIB_REGION_ADDRESSING_NOT_SUPPORTED
                                           = -56, /* Region addressing not supported by driver */
CCRTAICC_LIB_CLONING_NOT_SUPPORTED         = -57, /* Cloning not supported by the card */
```

2.2.102 ccrtAICC_Get_Library_Info()

This call returns useful library information to the user.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Library_Info (void                      *Handle,
                              ccrtaicc_library_info_t  *info)

   Description: Get library information

   Input:   void                                *Handle     (Handle pointer)
   Output:  ccrtaicc_library_info_t             *info       (info struct pointer)
               int                                  fp;

               ccrtaicc_local_ctrl_data_t           *local_ptr;
                  -- structure in ccrtaicc_user.h
               void                                 *munmap_local_ptr;
               int                                  local_mmap_size;

               ccrtaicc_config_local_data_t         *config_ptr;
                  -- structure in ccrtaicc_user.h
               void                                 *munmap_config_ptr;
               int                                  config_mmap_size;

               ccrtaicc_user_phys_mem_t
                             PhysMem[CCRTAICC_MAX_AVALON_NUM_TRANS_TBL_ENTRIES];
                  -- structure in ccrtaicc_user.h

               ccrtaicc_driver_library_common_t     *driver_lib_ptr;
                  -- structure in ccrtaicc_user.h
               void                                 *munmap_driver_lib_ptr;
               int                                  driver_lib_mmap_size;
```

```
            uint                                UserPid;
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_BAD_HANDLE         (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN           (device not open)
               # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
 ***************************************************************************/
```

2.2.103 ccrtAICC_Get_Mapped_Config_Ptr()

If the user wishes to bypass the API and communicate directly with the board configuration registers, then they can use this call to acquire a pointer to these registers. Please note that any type of access (read or write) by bypassing the API could compromise the API and results could be unpredictable. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the hardware programming registers before attempting to access these registers. For information on the registers, refer to the *ccrtaicc_user.h* include file that is supplied with the driver.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Mapped_Config_Ptr (void                          *Handle,
                                   ccrtaicc_config_local_data_t  **config_ptr)

   Description: Get mapped configuration pointer.

   Input:   void                           *Handle         (Handle pointer)
   Output:  ccrtaicc_config_local_data_t   **config_ptr    (config struct ptr)
               -- structure in ccrtaicc_user.h
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_CONFIG_REGION     (config region not present)
***************************************************************************/
```

2.2.104 ccrtAICC_Get_Mapped_Driver_Library_Ptr()

The driver and library share a common structure. This call returns a pointer to the shared driver/library structure.

```
/***************************************************************************

   ccrtAICC_Get_Mapped_Driver_Library_Ptr()
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Mapped_Driver_Library_Ptr (void                 *Handle,
                           ccrtaicc_driver_library_common_t     **driver_lib_ptr)

   Description: Get mapped Driver/Library structure pointer.

   Input:   void                               *Handle           (Handle pointer)
   Output:  ccrtaicc_driver_library_common_t   **driver_lib_ptr  (driver_lib
                                                                  struct ptr)
               -- structure in ccrtaicc_user.h
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)

 ***************************************************************************/
```

2.2.105 ccrtAICC_Get_Mapped_Local_Ptr()

If the user wishes to bypass the API and communicate directly with the board control and data registers, then they can use this call to acquire a pointer to these registers. Please note that any type of access (read or write) by bypassing the API could compromise the API and results could be unpredictable. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the hardware programming registers before attempting to access these registers. For information on the registers, refer to the *ccrtaicc_user.h* include file that is supplied with the driver.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Mapped_Local_Ptr (void                        *Handle,
                                  ccrtaicc_local_ctrl_data_t  **local_ptr)

   Description: Get mapped local pointer.

   Input:   void                        *Handle     (Handle pointer)
   Output:  ccrtaicc_local_ctrl_data_t  **local_ptr (local struct ptr)
               -- structure in ccrtaicc_user.h
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
 *************************************************************************/
```

2.2.106 ccrtAICC_Get_Open_File_Descriptor()

When the library *ccrtAICC_Open()* call is successfully invoked, the board is opened using the system call *open(2)*. The file descriptor associated with this board is returned to the user with this call. This call allows advanced users to bypass the library and communicate directly with the driver with calls like *read(2)*, *ioctl(2)*, etc. Normally, this is not recommended as internal checking and locking is bypassed and the library calls can no longer maintain integrity of the functions. This is only provided for advanced users who want more control and are aware of the implications.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Open_File_Descriptor (void *Handle,
                                      int  *fd)

   Description: Get Open File Descriptor

   Input:   void                  *Handle  (Handle pointer)
   Output:  int                   *fd      (open file descriptor)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_INVALID_ARG   (invalid argument)
 *************************************************************************/
```

2.2.107 ccrtAICC_Get_Physical_Memory()

This call returns to the user the physical memory pointer and size that was previously allocated by the *ccrtAICC_Mmap_Physical_Memory()* call. The physical memory is allocated by the user when they wish to perform their own DMA and bypass the API. If user specified a mmaped user memory pointer, search for it,

otherwise, simply return the contents of the physical memory list specified by a valid entry_num_in_tran_table. Once again, this call is only useful for advanced users.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Physical_Memory (void                      *Handle,
                                 ccrtaicc_user_phys_mem_t  *phys_mem)

   Description: Get previously mmapped() physical memory address and size

   Input:   void                      *Handle                (Handle pointer)
            ccrtaicc_user_phys_mem_t *phys_mem              (mem struct pointer)
               void                  *mmaped_user_mem_ptr   (mmaped user virtual
                                                             memory)
               uint                  entry_num_in_tran_table
                                                (entry number in translation table)
   Output:  ccrtaicc_user_phys_mem_t *phys_mem              (mem struct pointer)
               uint                     user_pid
               void                     *phys_mem_ptr
               void                     *driver_virt_mem_ptr
               void                     *mmaped_user_mem_ptr
               uint                     phys_mem_size
               uint                     phys_mem_size_freed
               uint                     entry_num_in_tran_table
               uint                     num_of_entries_used
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_IOCTL_FAILED           (driver ioctl call failed)
 *************************************************************************/
```

2.2.108 ccrtAICC_Get_RunCount_UserProcess()

This call returns to the user a count of the number of times the User Process was entered.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_RunCount_UserProcess(void                  *UFuncHandle,
                                     unsigned int long long *RunCount)

   Description: Get run count in user process

   Input:   void                       *UFuncHandle (UF Handle pointer))
   Output:  unsigned int long long     *RunCount    (pointer to run count)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
 *************************************************************************/
```

2.2.109 ccrtAICC_Get_TestBus_Control()

This call is provided for internal use in testing the hardware.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_TestBus_Control (void                       *Handle,
                                 _ccrtaicc_testbus_control_t *test_control)
```

```
   Description: Return the value of the Test Bus control information

   Input:   void                    *Handle       (handle pointer)
   Output:  _ccrtaicc_testbus_control_t
                                    *test_control (pointer to control select)
               # CCRTAICC_TBUS_CONTROL_OPEN
               # CCRTAICC_TBUS_CONTROL_CAL_BUS
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
 ****************************************************************************/
```

2.2.110 ccrtAICC_Get_Value()

This call allows the user to read the board registers. The actual data returned will depend on the command register information that is requested. Refer to the hardware manual for more information on what is being returned. Most commands return a pointer to an unsigned integer.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Get_Value (void               *Handle,
                       CCRTAICC_CONTROL    cmd,
                       void               *value)

   Description: Return the value of the specified board register.

   Input:   void               *Handle         (Handle pointer)
            CCRTAICC_CONTROL    cmd            (register definition)
               -- structure in ccrtaicc_lib.h
   Output:  void               *value;         (pointer to value)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
 ****************************************************************************/
```

2.2.111 ccrtAICC_Hex_To_Fraction()

This call converts a hexadecimal value to a fractional decimal.

```
/****************************************************************************
   double
   ccrtAICC_Hex_To_Fraction (uint value)

   Description: Convert Hexadecimal to Fractional Decimal

   Input:       uint     value                 (hexadecimal to convert)
   Output:      none
   Return:      double   Fraction              (converted fractional value)
 ****************************************************************************/
```

2.2.112 ccrtAICC_Identify_Board()

This call is useful in identifying a physical board via software control. It causes the front LED to either flash or stay steady. Users can also specify the number of seconds they wish to flash the LED.

```
/****************************************************************************
```

```
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Identify_Board (void                  *Handle,
                            _ccrtaicc_identify_t  Identify)

   Description: Identify the board by setting the front LED

   Input:   void                 *Handle              (Handle pointer)
            _ccrtaicc_identify_t Identify             (Identify board settings)
               # CCRTAICC_IDENTIFY_OFF                (turn off flashing)
               # CCRTAICC_IDENTIFY_ON                 (turn on flashing)
               # Number of seconds to flash           (flash for number of
                                                       seconds)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
 ****************************************************************************/
```

2.2.113 ccrtAICC_Initialize_Board()

This call initializes the driver structures to a default state and then resets the hardware.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Initialize_Board (void *Handle)

   Description: Initialize the board.

   Input:   void            *Handle             (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED      (driver ioctl call failed)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
 ****************************************************************************/
```

2.2.114 ccrtAICC_MMap_Physical_Memory()

This call is provided for advanced users to create a physical memory of specified size that can be used for DMA or MsgDma. The allocated DMA memory is rounded to a page size. If a physical memory is not available, this call will fail, at which point the user will need to issue the *ccrtAICC_Munmap_Physical_Memory()* API call to remove any previously allocated physical memory.

When user wishes to allocate a physical memory, they must make sure that the ***phys_mem_ptr*** in the ***ccrtaicc_user_phys_mem_t*** structure is set to 0, otherwise, the call will fail.

Instead of creating a physical memory, this same call can be used to map a user specified region if ***region addressing*** support is enabled as part of the Cloning feature. In this case, the user will need to supply a valid physical address of a Cloning Region to the ***phys_mem_ptr*** argument in this call.

Additionally, it is meaningless to perform Cloning on a FIFO region for two reasons. Firstly, each data in a FIFO is synchronous, however, the Cloned region is accessed asynchronously. Secondly, when the FIFO runs empty *(underflow)* or cannot accept more data *(overflow)* the results are unpredictable.

<u>Caution</u>: Since physical addresses are supplied for the MsgDma operation, care must be taken to ensure that the supplied addresses are valid and that while DMA is in progress, the memory regions must not be freed or made inactive, otherwise, the results could be unpredictable and could lead to the possible corruption of the system.

If the user supplies a non-zero ***phys_mem_ptr*** argument, the driver will attempt to request access to the memory region supplied by the user. If access to the region is denied, the call will fail. Reasons for access being denied is because the region has been reserved by some other process and is possibly in use. In this case, if the user still wishes to get access to the region, they can do so *at their own risk* by supplying the *CCRTAICC_DISABLE_REGION_PROTECTION* flag to the *flags* argument. If the call still fails, there is no way for the user to access the memory region as the kernel controls this access. One such reason is that the user is trying to access an invalid region.

Whether a physical memory is acquired by the driver or supplied by the user, the driver by default *caches* the memory region and returns a mapped virtual address to the user. If the user does not wish the region to be *cached*, they can supply the *CCRTAICC_DISABLE_ADDRESS_CACHE* flag to the *flags* argument. This may be useful if the user is running into problems with the region being *cached*, however, a noticeable performance degredation will be observed when accessing the region.

The *CCRTAICC_DEVICE_ADDRESS_ENTRY* is used internally by the driver and is only available as information to the user.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MMap_Physical_Memory (void                        *Handle,
                                  int                         size,
                                  ccrtaicc_user_phys_mem_t    *phys_mem)

   Description: Allocate a physical DMA memory for size bytes.

   Input:   void                        *Handle          (Handle pointer)
            int                         size             (size in bytes)
   Output:  ccrtaicc_user_phys_mem_t *phys_mem           (mem struct pointer)
               uint                     user_pid
               void                     *phys_mem_ptr
               void                     *driver_virt_mem_ptr
               void                     *mmaped_user_mem_ptr
               uint                     phys_mem_size
               uint                     phys_mem_size_freed
               uint                     entry_num_in_tran_table
               ushort                   flags
                  # CCRTAICC_DEVICE_ADDRESS_ENTRY
                  # CCRTAICC_DISABLE_ADDRESS_CACHE
                  # CCRTAICC_DISABLE_REGION_PROTECTION
               ushort                   num_of_entries_used
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_BAD_HANDLE         (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN           (device not open)
               # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
               # CCRTAICC_LIB_MMAP_SELECT_FAILED (mmap selection failed)
               # CCRTAICC_LIB_MMAP_FAILED        (mmap failed)
               # CCRTAICC_LIB_NO_SPACE_IN_TABLE  (no space in phys memory table)
               # CCRTAICC_LIB_REGION_ADDRESSING_NOT_SUPPORTED
                                                 (region addressing not
                                                  supported by the card)
               # CCRTAICC_LIB_MSGDMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                                 (access not allowed for
```

```
                                                        selected address)
 ***************************************************************************/
```

2.2.115 ccrtAICC_MsgDma_Clone() *(Patent-Pending)*

This call allows the user to Clone a transfer so that the process is continuously performing MsgDma once it has started until the Cloning operation is stopped by the user. This approach is different from standard MsgDma where a user has to re-initiate a MsgDma transfer every time it completes.

The following are the operation modes for this call:

- CCRTAICC_MSGDMA_CLONE_INITIALIZE
- CCRTAICC_MSGDMA_CLONE_ONE_CYCLE_WAIT
- CCRTAICC_MSGDMA_CLONE_START
- CCRTAICC_MSGDMA_CLONE_STOP

In order to perform a Cloning operation, the user first performs the same functions of MsgDma to seize, configure descriptors and MsgDma setup using the *ccrtAICC_MsgDma_Seize(), ccrtAICC_MsgDma_Configure_Descriptor()* and *ccrtAICC_MsgDma_Setup()* calls. Once that is done, the user needs to stop any previous MsgDma operation and initialize the cloning operation using (*CCRTAICC_MSGDMA_CLONE_STOP* | *CCRTAICC_MSGDMA_CLONE_INITIALIZE*) modes.

Now, whenever the user is ready, they can commence cloning operation with the *CCRTAICC_MSGDMA_CLONE_START* mode. At this point, MsgDma transfers start occurring continuously at the hardware level. If a chained MsgDma is configured, the entire chain is completed before it is repeated. Once Cloning has commenced, it can me stopped with the help of the *CCRTAICC_MSGDMA_CLONE_STOP* mode.

Once the operation has started with the *CCRTAICC_MSGDMA_CLONE_START* mode, it will run continuously under hardware control until stopped. There is no way to determine precisely how long a single descriptor cycle takes to complete. If the *CCRTAICC_MSGDMA_CLONE_ONE_CYCLE_WAIT* mode is set along with the *CCRTAICC_MSGDMA_CLONE_START* mode, the call will be blocked for the first transfer until the full descriptor cycle has completed. This approximate duration is also saved internally in the driver and is available to the user in the *CloneArgs->MsgDmaExtDesOnlyCycleDelay* argument. Anytime the user wishes to block their application for a duration of approximately one cycle delay, they can invoke this call with the *CCRTAICC_MSGDMA_CLONE_ONE_CYCLE_WAIT* as the only mode. If the user wishes to block more or less than the one cycle delay whenever the call is issued, they can specify the number of additional nano-seconds to block in the *CloneArgs->AdditionalOneCycleDelay.* A negative value will reduce the delay while a positive value will increase it. This call will have no effect on the Cloning operation in progress.

This Cloning feature can prove very helpful to users who don't want to perform single MsgDma calls to transfer a region from a card to a physical memory that is continuously changing. They can basically Clone the two regions and simply read the physical memory while the hardware is continuously updating it with the latest data from the card region at MsgDma rate. There is no CPU overhead during Cloning, however, it will be utilizing the PCI bus during its operation.

Only one Cloning or MsgDma operation can be active at a given time. Additionally, it is meaningless to perform Cloning on a FIFO region for two reasons. Firstly, each data in a FIFO is synchronous, however, the Cloned region is accessed asynchronously. Secondly, when the FIFO runs empty *(underflow)* or cannot accept more data *(overflow)* the results are unpredictable.

<u>Caution</u>: Since physical addresses are supplied for the MsgDma operation, care must be taken to ensure that the supplied addresses are valid and that while Cloning is in progress, the memory regions must not be freed or made inactive, otherwise, the results could be unpredictable and could lead to the possible corruption of the system.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   _ccrtAICC_MsgDma_Clone(void                                    *Handle,
                          _ccrtaicc_msgdma_clone_mode_mask_t ModeMask)

   Description: Clone Modular Scatter-Gather DMA

   Input:   void                                *Handle  (Handle pointer)
            _ccrtaicc_msgdma_clone_mode_mask_t  ModeMask (Mode Mask)
               # CCRTAICC_MSGDMA_CLONE_STOP
               # CCRTAICC_MSGDMA_CLONE_INITIALIZE
               # CCRTAICC_MSGDMA_CLONE_START
               # CCRTAICC_MSGDMA_CLONE_START_BLOCK
            ccrtaicc_msgdma_clone_args_t          *CloneArgs
               - unsigned long long               AdditionalOneCycleDelay
                                                  (Additional blocking for
                                                  Once Cycle Delay (nanoseconds))
   Output:  ccrtaicc_msgdma_clone_args_t          *CloneArgs
               - unsigned long long               MsgDmaExtDesOneCycleDelay
                                                  (MsgDma Extended Descriptor One
                                                  Cycle Delay (nanoseconds))
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
               # CCRTAICC_LIB_DMA_FAILED        (MsgDma failed)
               # CCRTAICC_LIB_MSGDMA_IN_USE     (MsgDma in use)
               # CCRTAICC_LIB_MSGDMA_NOT_SETUP  (MsgDma not setup)
               # CCRTAICC_LIB_MSGDMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                                (MsgDma not allowed for
                                                 selected address)
               # CCRTAICC_LIB_CLONING_NOT_SUPPORTED
                                                (Cloning not supported by the
                                                 card)
 *****************************************************************************/
```

2.2.116 ccrtAICC_MsgDma_Configure_ADC_Fifo()

This call in conjunction with the *ccrtaicc_MsgDma_Fire_Adc_Fifo()* API provides a fast method to extract samples that are present in the ADC Fifo. Due to the capability of this card to support a large number of channels at a very high rate, it is recommended to use this modular scatter-gather DMA instead of the regular DMA engine to perform the sample extraction. This configuration API need only be called once with a destination address and number of samples to be collected. As long as the configuration has not changed, the user can continuously collect samples from the ADC with help of the *ccrtaicc_MsgDma_Fire_Adc_Fifo()* API at very high transfer rates. If the user wishes to change the number of samples extracted, they will need to reissue this configuration API with the understanding that the overhead to setup the modular scatter-gather DMA engine is significant. Although the ADC Fifo is 128K samples deep, the maximum number of samples *NumberOfSamples* that can be specified in this call is 62K *(2048*31=63,488)*. This is because the maximum single MsgDma transfer size is 2048 samples and there are 31 descriptors available in order to perform a single contiguous transfer with the *ccrtaicc_MsgDma_Fire_Adc_Fifo()* API.

```
/*****************************************************************************
_ccrtaicc_lib_error_number_t
ccrtAICC_MsgDma_Configure_ADC_Fifo (void    *Handle,
                                    void    *PciDmaMemory,
                                    uint    NumberOfSamples,
                                    _ccrtaicc_msgdma_descriptors_id_t
                                            *LastDescriptorId)

   Description: Configure Modular Scatter-Gather MSG DMA ADC Fifo descriptor
```

```
   Input:   void               *Handle           (Handle pointer)
            void               *PciDmaMemory     (Virtual PCI DMA Memory pointer)
            uint               NumberOfSamples   (number of FIFO samples to read)
   Output:  _ccrtaicc_msgdma_descriptors_id_t
                               *LastDescriptorId (pointer to last descriptor id)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_FREE_DESCRIPTORS_AVAILABLE
                                                   (no free descriptors
                                                    available)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED (modular scatter-gather DMA
                                                    not supported)
               # CCRTAICC_LIB_DMA_BUSY             (MsgDma Busy, cannot be
                                                    reset)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA  (not owner of modular
                                                    scatter-gather)
*****************************************************************************/
```

2.2.117 ccrtAICC_MsgDma_Configure_Descriptor()

This call assists the user in setting up modular scatter-gather DMA descriptors. It allows the user to specify a read and write address offset along with length of transfer. Additionally, the call also provides the option to attach to other previously created descriptor blocks for scatter-gather operation. To perform scatter-gather DMA operation, the user creates a chain of descriptors, each having its own read/write/length information along with a start and end of the chain. The DMA operation is started from the first descriptor block in the chain and sequentially processes the descriptor blocks until the last descriptor block in the chain is processed.

To distinguish between descriptors, they are labeled with descriptor ID's. They range from ID 1 to 31. Users can supply a valid specific ID to this call or let the call itself find a free descriptor ID available. It is entirely left up to the user to determine how to manage the various descriptors and their relative linkages.

If the user wishes to have a previously created descriptor to point to a newly created descriptor, they can supply the previously created descriptor ID to the *AttachToDescriptorID* argument in the newly created descriptor. The newly created descriptor will not point to any descriptor and will always be the last descriptor in the chain.

DMA transfers can occur from either of the following:

1. Physical PCIe memory to Physical PCIe memory
2. Physical PCIe memory to Avalon Memory
3. Avalon Memory to Physical PCIe memory
4. Avalon Memory to Avalon Memory

There are certain restrictions and limitations to this scatter-gather operation:

1. Scatter-gather DMA is only supported in certain FPGA cards
2. Reads from Avalon memory below DiagRam location are not allowed for MIOC FPGA cards.
3. Invalid memory address supplied could result in the scatter-gather IP to lock up and the only way to recover will be to reload the driver.
4. Read and write addresses must be at a minimum full-word aligned and for maximum performance, it is recommended to be quad-word aligned.
5. Lengths are in bytes and must be at a minimum a multiple of a full-word and for maximum performance, it is recommended to be quad-word multiple.
6. You cannot cause a chain of descriptors to loop on itself.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
```

```
ccrtAICC_MsgDma_Configure_Descriptor (void                *Handle,
                      _ccrtaicc_msgdma_descriptors_id_t *DescriptorID,
                      ccrtaicc_msgdma_descriptor_t      *Descriptor,
                      _ccrtaicc_msgdma_descriptors_id_t AttachToDescriptorID)

Description: Configure Modular Scatter-Gather DMA descriptor

Input:   void                          *Handle (Handle pointer)
         _ccrtaicc_msgdma_descriptors_id_t *DescriptorID
                                         (Set to NULL or valid ID)
            # 0                          (let function find a free ID)
            # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
              CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
         ccrtaicc_msgdma_descriptor_t *Descriptor (pointer to descriptor)
            __u64  ReadAddress
            __u64  WriteAddress
            __u32  Length
         _ccrtaicc_msgdma_descriptors_id_t AttachToDescriptorID
                                                  (Attach to descriptor ID)
            # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
              CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
Output:  _ccrtaicc_msgdma_descriptors_id_t *DescriptorID (returned ID)
            # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
              CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
Return:  _ccrtaicc_lib_error_number_t
            # CCRTAICC_LIB_NO_ERROR             (successful)
            # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN             (device not open)
            # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
            # CCRTAICC_LIB_NO_FREE_DESCRIPTORS_AVAILABLE
                                              (no free descriptors available)
            # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather
                                                  DMA not supported)
            # CCRTAICC_LIB_MSGDMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                              (MSG DMA Reads not allowed
                                               for selected address)
            # CCRTAICC_LIB_DMA_BUSY             (MsgDma Busy, cannot be
                                                  reset)
            # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA   (not owner of modular
                                                  scatter-gather)
*****************************************************************************/
```

2.2.118 ccrtAICC_MsgDma_Configure_Single()

This call performs a similar function to the *ccrtAICC_MsgDma_Configure()* call with the exception that no DMA chaining is performed and only the single descriptor ID-1 is used to perform the DMA operation. The user has the option to supply a valid descriptor block when using the *ccrtAICC_MsgDma_Configure_Single()* API or a *NULL* pointer to the descriptor as an argument when using the *ccrtAICC_Transfer_Data()* API to perform the transfer.

Normally this call needs to be issued once with a *NULL* pointer for the *Descriptor (i.e during initialization)* prior to using the *ccrtAICC_Transfer_Data()* call with the *LibMode* set to *CCRTAICC_LIBRARY_MSGDMA_MOD*. In this way, the descriptor ID-1 will be set up correctly prior to the transfer.

If instead, the user wishes to perform the DMA operation using the *ccrtAICC_MsgDma_Fire_Single()* call, they need to issue the *ccrtAICC_MsgDma_Configure_Single()* call with a valid descriptor block, otherwise, results will be unpredictable.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MsgDma_Configure_Single (void                              *Handle,
                                ccrtaicc_msgdma_descriptor_t           *Descriptor)

   Description: Configure Single Modular Scatter-Gather DMA descriptor

   Input:   void                          *Handle (Handle pointer)
            ccrtaicc_msgdma_descriptor_t *Descriptor (pointer to descriptor)
               __u64  ReadAddress
               __u64  WriteAddress
               __u32  Length
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_DMA_BUSY              (MsgDma Busy, cannot be
                                                     reset)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather DMA
                                                     not supported)
               # CCRTAICC_LIB_MSGDMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                                    (MSG DMA access not allowed
                                                     for selected address)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA   (not owner of modular
                                                     scatter-gather)
 *****************************************************************************/
```

2.2.119 ccrtAICC_MsgDma_Fire()

This call initiates a scatter-gather DMA operation that has been previously configured and setup by the *ccrtAICC_MsgDma_Configure()* and *ccrtAICC_MsgDma_Setup()* call.

The *StartDescriptorID* can be set to either '0' or a valid Descriptor ID. Normally, the user will set the *StartDescriptiorID* in the *ccrtAICC_MsgDma_Setup()* API during initialization and set it to '0' in this *ccrtAICC_MsgDma_Fire()* API. In this way, this call will not suffer the overhead of loading the *StartDescriptorID* in the internal prefetcher register when repeatedly calling the *ccrtAICC_MsgDma_Fire()* API. If the user specifies a valid *StartDescriptorID* that is already setup as a scatter-gather chain using the *ccrtAICC_MsgDma_Configure()* call, then this *ccrtAICC_MsgDma_Fire()* API will initiate the DMA starting with the user supplied start descriptor ID.
The *DescriptorIDMask* is a mask of all the valid descriptor ID's specified in the scatter-gather chain that was created earlier with the *ccrtAICC_MsgDma_Configure()* API. If this is incorrectly specified, the DMA operation will be unpredictable. This *ccrtAICC_MsgDma_Fire()* API call uses this mask to set the *ControlWord* for each of the IDs. Specifying this mask reduces the overhead in the call by not searching the scatter-gather chain to set the individual control words.

ControlWord for each descriptor is set based on the *DescriptorIDMask* mask. Normally, the following two flags are set:

- CCRTAICC_MSGD_DESC_CONTROL_GO
- CCRTAICC_MSGD_DESC_CONTROL_OWNED_BY_HW

LastIdForInterrupts is set to 0 if the DMA operation will use polling instead of using interrupts to detect completion of the operation. If interrupts are to be used, the ID of the last descriptor in the DMA chain is to be specified. This is the ID that will be interrupted when the entire chain is completed. Incorrect ID entered will result in unpredictable results. Normally, interrupt handling adds additional overhead and reduces performance, however, it reduces the overhead experienced by the CPU and PCIe bus during polling.

Once the scatter-gather DMA operation commences, it performs DMA operations starting with the *StartDescriptorID* and traversing through the chain sequentially until it reaches the last descriptor ID in the chain, at which point the DMA operation concludes.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   _ccrtAICC_MsgDma_Fire (void                                  *Handle,
                          _ccrtaicc_msgdma_descriptors_id_t     StartDescriptorID,
                          _ccrtaicc_msgdma_descriptors_id_mask_t DescriptorIDMask,
                          int                                   ControlWord,
                          _ccrtaicc_msgdma_descriptors_id_t
                                                              LastIdForInterrupts)

   Description: Fire Modular Scatter-Gather DMA descriptor

   Input:   void                                  *Handle (Handle pointer)
            _ccrtaicc_msgdma_descriptors_id_t      StartDescriptorID (Set to
                                                   valid ID)
               # 0                                 (don't set start descriptor ID
                                                    in prefetcher)
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
                 CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
            _ccrtaicc_msgdma_descriptors_id_mask_t DescriptorIDMask
                                                   (descriptor ID mask)
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1_MASK ...
                 CCRTAICC_MSGDMA_DESCRIPTOR_ID_31_MASK
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_ALL_MASK
            int                                    ControlWord
               # CCRTAICC_MSGD_DESC_CONTROL_GO
               # CCRTAICC_MSGD_DESC_CONTROL_OWNED_BY_HW
            _ccrtaicc_msgdma_descriptors_id_t      LastIdForInterrupts (Set 0 or
                                                   Last ID for interrupts)
               # 0
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
                 CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_DMA_FAILED           (MsgDma failed)
               # CCRTAICC_LIB_DMA_BUSY             (MsgDma busy)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED (modular scatter-gather DMA
                                                    not supported)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA  (not owner of modular scatter-
                                                    gather)
*****************************************************************************/
```

2.2.120 ccrtAICC_MsgDma_Fire_ADC_Fifo()

Once the user has configured the modular scatter-gather DMA engine for ADC Fifo extraction using the *ccrtAICC_MsgDma_Configure_ADC_Fifo()* API, the user will need to use this *ccrtAICC_MsgDma_Fire_ADC_Fifo()* API to extract the samples that have collected in the ADC. Prior to issuing this call, the user will need to ensure that sufficient samples have been collected in the FIFO, otherwise, the call will return an empty FIFO with *0xBAADBEEF* as its data. Once sufficient samples have collected in the FIFO, the user will need to immediately invoke the *ccrtAICC_MsgDma_Fire_ADC_Fifo()* API, otherwise it is possible that an overflow condition would occur and samples would be lost. At this point, the user will need to reset the FIFO (clear the samples) and resume data collection operation once again.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
```

```
   ccrtAICC_MsgDma_Fire_ADC_Fifo (void                          *Handle,
                                  _ccrtaicc_msgdma_descriptors_id_t
                                                                LastDescriptorId,
                                 int                            UseInterrupts)

   Description: Fire ADC Fifo Modular Scatter-Gather DMA descriptor

   Input:   void                                *Handle          (Handle pointer)
            _ccrtaicc_msgdma_descriptors_id_t LastDescriptorId  (Last Descriptor
                                                                 ID)
            int                                 UseInterrupts    (Use interrupts
                                                                 flag)
               # CCRTAICC_TRUE
               # CCRTAICC_FALSE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_DMA_FAILED           (MsgDma failed)
               # CCRTAICC_LIB_DMA_BUSY             (MsgDma busy)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED (modular scatter-gather DMA
                                                    not supported)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA  (not owner of modular scatter-
                                                    gather)
*************************************************************************/
```

2.2.121 ccrtAICC_MsgDma_Fire_Single()

This call is similar in functionality to the *ccrtAICC_MsgDma_Fire()* call with the exception that it operates on the single descriptor ID-1. It can be used when a single DMA rather than scatter-gather DMA operation needs to be performed. This call can be called once the *ccrtAICC_MsgDma_Config_Single()* call has been issued to set up the read/write address offset and length of transfer. Unless the read/write address offset or length of transfer is changed, the *ccrtAICC_MsgDma_Fire_Single()* call can be made repeatedly to perform the same DMA transfer.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   _ccrtAICC_MsgDma_Fire_Single (void *Handle,
                                 int  UseInterrupts)

   Description: Fire Single Modular Scatter-Gather DMA descriptor

   Input:   void  *Handle                   (Handle pointer)
            int   UseInterrupts             (Use interrupts flag)
               # CCRTAICC_TRUE
               # CCRTAICC_FALSE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_DMA_FAILED           (MsgDma failed)
               # CCRTAICC_LIB_DMA_BUSY             (MsgDma busy)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED (modular scatter-gather DMA
                                                    not supported)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA  (not owner of modular scatter-
                                                    gather)
 *************************************************************************/
```

UseInterrupts is a flag that can be set to specify if interrupt handling should be enabled.

2.2.122 ccrtAICC_MsgDma_Free_Descriptor()

This call can be used to free up already used descriptors.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MsgDma_Free_Descriptor (void                          *Handle,
                        _ccrtaicc_msgdma_descriptors_id_mask_t DescriptorIDMask)

   Description: Free Modular Scatter-Gather DMA descriptor

   Input:   void                                  *Handle (Handle pointer)
            _ccrtaicc_msgdma_descriptors_id_mask_t DescriptorIDMask
                                                  (descriptor ID mask)
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1_MASK ...
                 CCRTAICC_MSGDMA_DESCRIPTOR_ID_31_MASK
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_ALL_MASK
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather DMA
                                                     not supported)
               # CCRTAICC_LIB_DMA_BUSY              (MsgDma busy)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA   (not owner of modular
                                                     scatter-gather)
 *****************************************************************************/
```

2.2.123 ccrtAICC_MsgDma_Get_Descriptor()

This call returns information on the selected descriptor.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MsgDma_Get_Descriptor (void                       *Handle,
                           _ccrtaicc_msgdma_descriptors_id_t DescriptorID,
                           ccrtaicc_msgdma_descriptor_t      *Descriptor,
                           __u64                             *DescriptorAddress)

   Description: Get Modular Scatter-Gather DMA Descriptor

   Input:   void                                *Handle (Handle pointer)
            _ccrtaicc_msgdma_descriptors_id_t DescriptorID (descriptor ID)
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
                 CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
   Output:  ccrtaicc_msgdma_descriptor_t *Descriptor (pointer to descriptor)
               __u64  ReadAddress
               __u64  WriteAddress
               __u64  NextDescriptorPointer
               __u32  Length
               __u32  Control
               __u32  ReadBurstCount
               __u32  WriteBurstCount
               __u32  ReadStride
               __u32  WriteStride
               __u32  ActualBytesTransferred
               __u32  Status
               __u32  SequenceNumber
            __u64                          *DescriptorAddress (descriptor address)
   Return:  _ccrtaicc_lib_error_number_t
```

```
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather DMA
                                                     not supported)
*************************************************************************/
```

Pointer to *DescriptorAddress* can be specified to return its address offset within the configuration space. This argument can be set to *NULL* if address is not required.

2.2.124 ccrtAICC_MsgDma_Get_Dispatcher_CSR()

This call returns useful control and status register information on the dispatcher.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MsgDma_Get_Dispatcher_CSR (void                          *Handle,
                                       ccrtaicc_msgdma_dispatcher_t  *Dispatcher)

   Description: Get Modular Scatter-Gather DMA Dispatcher CSR

   Input:   void                              *Handle (Handle pointer)
   Output:  ccrtaicc_msgdma_dispatcher_t      *Dispatcher (pointer to dispatcher)
               __u32  Status
                  # CCRTAICC_MSGD_DISP_STATUS_IRQ            :IRQ
                  # CCRTAICC_MSGD_DISP_STATUS_STOPPED_ETERM  :Stopped on Early
                                                              Termination
                  # CCRTAICC_MSGD_DISP_STATUS_STOPPED_ERROR  :Stopped on Error
                  # CCRTAICC_MSGD_DISP_STATUS_RESETTING      :Resetting
                  # CCRTAICC_MSGD_DISP_STATUS_STOPPED        :Stopped
                  # CCRTAICC_MSGD_DISP_STATUS_RESP_BUF_FULL  :Response Buffer
                                                              Full
                  # CCRTAICC_MSGD_DISP_STATUS_RESP_BUF_EMPTY :Response Buffer
                                                              Empty
                  # CCRTAICC_MSGD_DISP_STATUS_DESC_BUF_FULL  :Descriptor Buffer
                                                              Full
                  # CCRTAICC_MSGD_DISP_STATUS_DESC_BUF_EMPTY :Descriptor Buffer
                                                              Empty
                  # CCRTAICC_MSGD_DISP_STATUS_BUSY           :Busy
               __u32  Control
                  # CCRTAICC_MSGD_DISP_CONTROL_STOP_DESC     :Stop Descriptors
                  # CCRTAICC_MSGD_DISP_CONTROL_INT_ENA_MASK  :Global Interrupt
                                                              Enable Mask
                  # CCRTAICC_MSGD_DISP_CONTROL_STOP_ETERM    :Stop on Early
                                                              Termination
                  # CCRTAICC_MSGD_DISP_CONTROL_STOP_ON_ERROR :Stop on Error
                  # CCRTAICC_MSGD_DISP_CONTROL_RESET_DISP    :Reset Dispatcher
                  # CCRTAICC_MSGD_DISP_CONTROL_STOP_DISP     :Stop Dispatcher
               __u32  ReadFillLevel
               __u32  WriteFillLevel
               __u32  ResponseFillLevel
               __u32  ReadSequenceNumber
               __u32  WriteSequenceNumber
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather DMA
                                                     not supported)
```

```
 ***************************************************************************/
```

2.2.125 ccrtAICC_MsgDma_Get_Prefetcher_CSR()

This call returns useful control and status register information on the prefetcher.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MsgDma_Get_Prefetcher_CSR (void                          *Handle,
                                       ccrtaicc_msgdma_prefetcher_t  *Prefetcher)

   Description: Get Modular Scatter-Gather DMA Prefetcher CSR

   Input:   void                              *Handle (Handle pointer)
   Output:  ccrtaicc_msgdma_prefetcher_t      *Prefetcher (pointer to prefetcher)
               __u32 Status
                  # CCRTAICC_MSGD_PREF_STATUS_IRQ           :IRQ Occurred
               __u32 Control
                  # CCRTAICC_MSGD_PREF_CONTROL_PARK_MODE    :Park Mode
                  # CCRTAICC_MSGD_PREF_CONTROL_INT_ENA_MASK :Global Interrupt
                                                             Enable Mask
                  # CCRTAICC_MSGD_PREF_CONTROL_RESET        :Reset Prefetcher
                                                             Core
                  # CCRTAICC_MSGD_PREF_CONTROL_DESC_POLL_EN :Descriptor Polling
                                                             Enable
                  # CCRTAICC_MSGD_PREF_CONTROL_RUN          :Start Descriptor
                                                             fetching operation
               __u64 NextDescriptorPointer
               __u32 DescriptorPollingFrequency
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather DMA
                                                     not supported)
***************************************************************************/
```

2.2.126 ccrtAICC_MsgDma_Release()

This *ccrtAICC_MsgDma_Release()* API call is used to free up the Modular Scatter-Gather DMA resource that has been reserved by the *ccrtAICC_MsgDma_Seize()* API. At this point, another user can take control of the MsgDMA operation by issuing the *ccrtAICCC_MsgDma_Seize()* call.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t   ccrtAICC_MsgDma_Release (void *Handle)

   Description: Release MsgDMA operation for others to use

   Input:   void                                 *Handle (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED  (modular scatter-gather DMA
                                                     not supported)
               # CCRTAICC_LIB_DMA_BUSY              (MsgDma Busy, cannot be
                                                     reset)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA   (not owner of modular
                                                     scatter-gather)
***************************************************************************/
```

2.2.127 ccrtAICC_MsgDma_Seize()

Modular Scatter-Gather DMA is a two part operation. The first part is to configure the Scatter-Gather DMA and the second part is to execute the DMA. Various MsgDma API calls have been provided for this. Since this two part operation is not atomic, it is necessary for the user of these calls to prevent other applications from configuring and using the MsgDMA resources while it is being actively used by another application. For this reason, the *ccrtAICC_MsgDma_Seize()* and *ccrtAICC_MsgDma_Release()* API calls have been introduced to assist the user in preventing other applications from accessing the Scatter-Gather DMA resource while it is reserved. Basically, before any MsgDma API call is issued that could modify the setting and execution of the MsgDma operation, the user needs to issue the *ccrtAICC_MsgDma_Seize()* API call once. In this way, on one else will have access to the MsgDma resource until the application has issued the *ccrtAICC_MsgDma_Release()* API call or has terminated.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t ccrtAICC_MsgDma_Seize (void *Handle)

   Description: Seize MsgDMA operation for private to use and become owner

   Input:   void                                        *Handle (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED (modular scatter-gather DMA
                                                    not supported)
               # CCRTAICC_LIB_MSGDMA_IN_USE        (modular scatter-gather DMA in
                                                    use)
*************************************************************************/
```

2.2.128 ccrtAICC_MsgDma_Setup()

This call is used in conjunction with the *ccrtAICC_MsgDma_Configure() and ccrtAICC_MsgDma_Fire()* calls. This call is made after all the descriptors are first configured with the help of the *ccrtAICC_MsgDma_Configure()* call. The purpose of this call is to specify the first descriptor in the chain. Additionally, the user can set the *ForceReset* flag to reset the dispatcher and prefetcher. Optionally, the user can request useful active descriptor information if *ActiveDescriptorsInfo* argument is specified *(i.e not NULL)*. In addition to returning useful active descriptor information, the descriptor chain and prefetcher settings are also validated for proper configuration.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_MsgDma_Setup (void                              *Handle,
                     _ccrtaicc_msgdma_descriptors_id_t      StartDescriptorID,
                     int                                    ForceReset,
                     ccrtaicc_msgdma_active_descriptors_info_t
                                                            *ActiveDescriptorsInfo)

   Description: Setup MsgDMA Dispatcher and Prefetcher

   Input:   void                                        *Handle (Handle pointer)
            _ccrtaicc_msgdma_descriptors_id_t           *StartDescriptorID (Set
                                                        to valid ID)
               # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
                 CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
            int                                         ForceReset
   Output:  ccrtaicc_msgdma_active_descriptors_info_t   *ActiveDescriptorsInfo;
               _ccrtaicc_msgdma_descriptors_id_t       ID
                   # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1 ...
                     CCRTAICC_MSGDMA_DESCRIPTOR_ID_31
```

```
                _ccrtaicc_msgdma_descriptors_id_mask_t  Mask
                    # CCRTAICC_MSGDMA_DESCRIPTOR_ID_1_MASK ...
                      CCRTAICC_MSGDMA_DESCRIPTOR_ID_31_MASK
                    # CCRTAICC_MSGDMA_DESCRIPTOR_ID_ALL_MASK
                __u32                                   NumberOfDescriptors
                __u32                                   TotalBytes
   Return:  _ccrtaicc_lib_error_number_t
                # CCRTAICC_LIB_NO_ERROR                 (successful)
                # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
                # CCRTAICC_LIB_NOT_OPEN                 (device not open)
                # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
                # CCRTAICC_LIB_DMA_BUSY                 (MsgDma Busy, cannot be
                                                         reset)
                # CCRTAICC_LIB_ERROR_IN_DESCRIPTOR_LIST (invalid descreptor list)
                # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED     (modular scatter-gather
                                                         DMA not supported)
                # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA      (not owner of modular
                                                         scatter-gather)
*****************************************************************************/
```

2.2.129 ccrtAICC_Munmap_Physical_Memory()

This call simply removes a physical memory that was previously allocated by the *ccrtAICC_MMap_Physical_Memory()* API call.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Munmap_Physical_Memory (void   *Handle,
                                    void   *mmaped_user_mem_ptr)

   Description: Unmap a previously mapped physical DMA memory.

   Input:   void            *Handle                (Handle pointer)
   Output:  void            *mmaped_user_mem_ptr   (virtual memory pointer)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_MUNMAP_FAILED        (failed to un-map memory)
               # CCRTAICC_LIB_NOT_MAPPED           (memory not mapped)
               # CCRTAICC_LIB_MSGDMA_IN_USE        (modular scatter-gather DMA
                                                    in use)
 *****************************************************************************/
```

2.2.130 ccrtAICC_NanoDelay()

This call goes into a tight loop spinning for the requested nano seconds specified by the user.

```
/*****************************************************************************
   void
   ccrtAICC_NanoDelay (unsigned long long NanoDelay)

   Description: Delay (loop) for user specified nano-seconds

   Input:   unsigned long long NanoDelay       (number of nano-secs to delay)
   Output:  none
   Return:  none
 *****************************************************************************/
```

2.2.131 ccrtAICC_Open()

This is the first call that needs to be issued by a user to open a device and access the board through the rest of the API calls. What is returned is a handle to a *void pointer* that is supplied as an argument to the other API calls. The *Board_Number* is a valid board number [0..9] that is associated with a physical card. There must exist a character special file */dev/ccrtaicc<Board_Number>* for the call to be successful. One character special file is created for each board found when the driver is successfully loaded.

The *oflag* is the flag supplied to the *open(2)* system call by this API. It is normally '0' *(zero)*, however the user may use the *O_NONBLOCK* option for *read(2)* calls which will change the default reading in block mode.

This driver allows multiple applications to open the same board by specifying an additional *oflag O_APPEND*. It is then the responsibility of the user to ensure that the various applications communicating with the same cards are properly synchronized. Various tests supplied in this package has the *O_APPEND* flags enabled, however, it is strongly recommended that only one application be run with a single card at a time, unless the user is well aware of how the applications are going to interact with each other and accept any unpredictable results.

In case of error, *errno* is also set for some non-system related errors encountered.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Open (void     **My_Handle,
                  int      Board_Number,
                  int      oflag)

   Description: Open a device.

   Input:   void            **Handle               (Handle pointer to pointer)
            int             Board_Number           (0-9 board number)
            int             oflag                  (open flags)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_ALREADY_OPEN         (device already opened)
               # CCRTAICC_LIB_OPEN_FAILED          (device open failed)
               # CCRTAICC_LIB_ALREADY_MAPPED       (memory already mmapped)
               # CCRTAICC_LIB_MMAP_SELECT_FAILED   (mmap selection failed)
               # CCRTAICC_LIB_MMAP_FAILED          (mmap failed)
 *****************************************************************************/
```

2.2.132 ccrtAICC_Pause_UserProcess()

This call causes a running User Process to sleep for user specified micro-seconds.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Pause_UserProcess(void *UFuncHandle,
                              int  usleep)

   Description: Pause running user process

   Input:   void                      *UFuncHandle (UF Handle pointer)
            int                       usleep       (micro-seconds sleep)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
```

```
*****************************************************************************/
```

2.2.133 ccrtAICC_Program_All_Output_Clocks()

This is the main call to program all the output clocks with a single call. All existing clock activity is stopped and replaced with the new clocks selection. Though the user can select the Input Clock Frequency with this call, it is expected that they will use the default CCRTAICC_DEFAULT_INPUT_CLOCK_FREQUENCY value.

The input clock can be one of:

```
CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0    → 10MHz TCXO (Temperature Compensated
                                        Oscillator Clock).
CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1    → External Input
CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2    → FPGA Supplied
CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB → Not used
```

When using this card, the default clock should be set to *CCRTAICC_CG_INPUT_CLOCK_SELECT_N0* i.e. the 10MHz internal clock.

If the desired output clock frequencies are unable to be computed due to hardware limitation, they may wish to increase the desired tolerance *DesiredTolerancePPT* for the particular clock. Note that this tolerance is only applicable to computing a clock value as close to the desired frequency *DesiredFrequency* and not a representation of the accuracy of the output clocks.

Additionally, the programming could fail if the number of N-Divider resource gets exhausted due to the user selecting several output clocks with widely different output clocks.

```
/*****************************************************************************
   ccrtAICC_Program_All_Output_Clocks()
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Program_All_Output_Clocks(void                    *Handle,
                                      double                  InputClockFrequency,
                _ccrtaicc_cg_input_clock_select_register_t    InputClockSel,
                ccrtaicc_compute_all_output_clocks_t          *AllClocks,
                int                                           ProgramClocks,
                int                                           ActivateClocks)

   Description: Program All Output Clocks

   Input:   void                                          *Handle
                                                          (Handle pointer)
            double                                        InputClockFrequency
                                                          (input clock frequency)
            _ccrtaicc_cg_input_clock_select_register_t    InputClockSel
                                                          (select input clock)
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN0
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN1
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_IN2
               # CCRTAICC_CG_INPUT_CLOCK_SELECT_INXAXB
            ccrtaicc_compute_all_output_clocks_t       *AllClocks    (pointer to
                                                                     all Clocks)
               ccrtaicc_compute_single_output_clock_t  *Clock        (Pointer to
                                                      returned output clock info)
                  long double                          DesiredFrequency
                  double                               DesiredTolerancePPT
             int                                       ProgramClocks  (program
                                                                       clocks)
             int                                       ActivateClocks (1=activate
```

```
                                                        clocks after program)
Output:   ccrtaicc_compute_all_output_clocks_t      *AllClocks     (Pointer to
                                                   returned output clocks info)
             ccrtaicc_compute_single_output_clock_t *Clock         (Pointer to
                                                   returned output clock info)
                _ccrtaicc_clock_generator_output_t  OutputClock
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_0
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_1
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_2
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_3
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_4
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_5
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_6
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_7
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_8
                   # CCRTAICC_CLOCK_GENERATOR_OUTPUT_9
                 double                                InputClockFrequency
                 long double                           FrequencyDeviation
                 int                                   FrequencyFound
                 long double                           ActualFrequency
                 double                                ActualTolerancePPT
                 __u64                                 Mdiv_Numerator
                 __u32                                 Mdiv_Denominator
                 __u64                                 Ndiv_Numerator
                 __u32                                 Ndiv_Denominator
                 _ccrtaicc_cg_outmux_ndiv_select_t     Ndiv_ToUse
                    # CCRTAICC_CG_OUTPUT_MUX_NDIV_0
                    # CCRTAICC_CG_OUTPUT_MUX_NDIV_1
                    # CCRTAICC_CG_OUTPUT_MUX_NDIV_2
                    # CCRTAICC_CG_OUTPUT_MUX_NDIV_3
                    # CCRTAICC_CG_OUTPUT_MUX_NDIV_4
                 __u32                                     Rdiv_value
                 __u32                                     Rdivider
                 __u32                                     Pdivider
Return:   _ccrtaicc_lib_error_number_t
             # CCRTAICC_LIB_NO_ERROR                (successful)
             # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
             # CCRTAICC_LIB_NOT_OPEN                (device not open)
             # CCRTAICC_LIB_NO_LOCAL_REGION         (local region error)
             # CCRTAICC_LIB_IO_ERROR                (device not ready)
             # CCRTAICC_LIB_N_DIVIDERS_EXCEEDED     (number of N-Dividers
                                                     exceeded)
             # CCRTAICC_LIB_CANNOT_COMPUTE_OUTPUT_FREQ (cannot compute
                                                        output freq)
             # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
             # CCRTAICC_LIB_CLOCK_GENERATION_FAILED  (clock generation
                                                     failed)
*****************************************************************************/
```

2.2.134 ccrtAICC_Read()

This call performs a programmed I/O driver read of either the ADC *channel registers* or the *FIFO*. Prior to issuing this call, the user needs to set up the desired read mode of operation using the *ccrtAICC_ADC_Set_Driver_Read_Mode()* with *CCRTAICC_ADC_PIO_CHANNEL* or *CCRTAICC_ADC_PIO_FIFO* argument. For *channel register* reads, the size is limited to *CCRTAICC_MAX_ADC_CHANNELS* words and for *FIFO* reads, it is limited to *CCRTAICC_ADC_FIFO_DATA_MAX* words.

It basically calls the *read(2)* system call with the exception that it performs necessary *locking* and returns the *errno* returned from the system call in the pointer to the *error* variable. An *errno* of *ENOBUFS* can occur for *FIFO* reads when it encounters an overflow condition.

For specific information about the data being returned for the various read modes, refer to the *read(2)* system call description the *Driver Direct Access* section.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Read (void     *Handle,
                  void     *buf,
                  int      size,
                  int      *bytes_read,
                  int      *error)

   Description: Perform a read operation.

   Input:   void     *Handle               (Handle pointer)
            int      size                  (size of buffer in bytes)
   Output:  void     *buf                  (pointer to buffer)
            int      *bytes_read           (bytes read)
            int      *error                (returned errno)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_IO_ERROR      (read failed)
 *************************************************************************/
```

2.2.135 ccrtAICC_Reload_Firmware()

The purpose of this call is to power cycle the board which in turn will reload the latest firmware on the board.

```
/*************************************************************************
   ccrtAICC_Reload_Firmware()

   Description: This call power-cycles the board which in turn forces it to
                reload its firmware. Typically, this is called after a new
                firmware has been installed in the board. This saves the need
                to perform a system reboot after a firmware installation.

   Input:   void *Handle                  (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED  (driver ioctl call failed)
 *************************************************************************/
```

2.2.136 ccrtAICC_Remove_Irq()

The purpose of this call is to remove the interrupt handler that was previously set up. The interrupt handler is managed internally by the driver and the library. The user should not issue this call, otherwise reads will time out.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Remove_Irq (void *Handle)

   Description: By default, the driver sets up a shared IRQ interrupt handler
                when the device is opened. Now if for any reason, another
                device is sharing the same IRQ as this driver, the interrupt
                handler will also be entered every time the other shared
```

```
                device generates an interrupt. There are times that a user,
                for performance reasons may wish to run the board without
                interrupts enabled. In that case, they can issue this ioctl
                to remove the interrupt handling capability from the driver.

   Input:   void *Handle                    (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED  (driver ioctl call failed)
 ****************************************************************************/
```

2.2.137 ccrtAICC_Reset_Board()

This call resets the board to a known hardware state. It may be a good idea to start an application by first resetting the board so that it is set to a known state.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Reset_Board (void *Handle)

   Description: Reset the board.

   Input:   void *Handle                      (Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR        (successful)
               # CCRTAICC_LIB_BAD_HANDLE      (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN        (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED    (driver ioctl call failed)
               # CCRTAICC_LIB_NO_LOCAL_REGION (local region not present)
 ****************************************************************************/
```

2.2.138 ccrtAICC_Reset_Clock()

This call performs a hardware reset of the clock. All active output clocks are stopped and set to default state. The user can activate clocks if they wish after a reset via the *activate* argument.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Reset_Clock (void  *Handle,
                         int   activate)

   Description: Perform Hardware Clock Reset

   Input:   void                    *Handle   (Handle pointer)
            int                     activate  (1=activate after reset)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR        (successful)
               # CCRTAICC_LIB_BAD_HANDLE      (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN        (device not open)
               # CCRTAICC_LIB_IOCTL_FAILED    (driver ioctl call failed)
               # CCRTAICC_LIB_NO_LOCAL_REGION (local region not present)
 ****************************************************************************/
```

2.2.139 ccrtAICC_Resume_UserProcess()

Use this call to resume an already paused User Process.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Resume_UserProcess(void *UFuncHandle)

   Description: Resume paused running user process

   Input:   void         *UFuncHandle           (UF Handle pointer)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
 *****************************************************************************/
```

2.2.140 ccrtAICC_Return_Board_Info_Description()

Return board information description

```
/*****************************************************************************
  char *
  ccrtAICC_Return_Board_Info_Description (_ccrtaicc_board_function_t
                                                              BoardFunction)

   Description: Return Board Information Description

   Input:   _ccrtaicc_board_function_t   BoardFunction          (board function)
               # CCRTAICC_BOARD_FUNCTION_AICC
               # CCRTAICC_BOARD_FUNCTION_BASE_LEVEL
               # CCRTAICC_BOARD_FUNCTION_UNDEFINED
   Output:  none
   Return:  char                         *BoardFuncDesc         (board function
                                                                   description)
 *****************************************************************************/
```

2.2.141 ccrtAICC_SDRAM_Activate() **

Currently, SDRAM is not supported by this hardware.

This call must be the first call to activate the SDRAM. Without activation, all other calls will fail. The user can also use this call to return the current state of the SDRAM without any change.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SDRAM_Activate (void                          *Handle,
                            _ccrtaicc_sdram_all_enable_t  activate,
                            _ccrtaicc_sdram_all_enable_t  *current_state)

   Description: Activate/DeActivate SDRAM module

   Input:   void                           *Handle         (Handle pointer)
            _ccrtaicc_sdram_all_enable_t   activate        (activate/deactivate)
               # CCRTAICC_SDRAM_ALL_DISABLE
               # CCRTAICC_SDRAM_ALL_ENABLE
               # CCRTAICC_SDRAM_ALL_ENABLE_DO_NOT_CHANGE
   Output:  _ccrtaicc_sdram_all_enable_t   *current_state  (active/deactive)
               # CCRTAICC_SDRAM_ALL_DISABLE
               # CCRTAICC_SDRAM_ALL_ENABLE
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
```

```
            # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
            # CCRTAICC_LIB_NO_LOCAL_REGION          (local region not present)
            # CCRTAICC_LIB_SDRAM_INITIALIZATION_FAILED (SDRAM init failed)
            # CCRTAICC_LIB_SDRAM_NOT_SUPPORTED      (SDRAM not supported)
 ************************************************************************/
```

2.2.142 ccrtAICC_SDRAM_Get_CSR() **

Currently, SDRAM is not supported by this hardware.

This call returns the SDRAM control and status register information.

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SDRAM_Get_CSR (void                    *Handle,
                           ccrtaicc_sdram_csr_t    *sdram_csr)

   Description: Get SDRAM Control and Status information

   Input:   void                                  *Handle    (Handle pointer)
   Output:  ccrtaicc_sdram_csr_t                  *sdram_csr (pointer to SDRAM csr)
               _ccrtaicc_sdram_read_auto_increment_t   read_auto_increment;
                  # CCRTAICC_SDRAM_READ_AUTO_INCREMENT_DISABLE
                  # CCRTAICC_SDRAM_READ_AUTO_INCREMENT_ENABLE
               _ccrtaicc_sdram_write_auto_increment_t  write_auto_increment;
                  # CCRTAICC_SDRAM_WRITE_AUTO_INCREMENT_DISABLE
                  # CCRTAICC_SDRAM_WRITE_AUTO_INCREMENT_ENABLE
               _ccrtaicc_sdram_read_timeout_t          read_timeout;
                  # CCRTAICC_SDRAM_READ_TIMEOUT_DID_NOT_OCCUR
                  # CCRTAICC_SDRAM_READ_TIMEOUT_OCCURRED
               _ccrtaicc_sdram_calibration_fail_t      calibration_failed;
                  # CCRTAICC_SDRAM_CALIBRATION_FAIL_RESET
                  # CCRTAICC_SDRAM_CALIBRATION_FAIL_SET
               _ccrtaicc_sdram_calibration_pass_t      calibration_passed;
                  # CCRTAICC_SDRAM_CALIBRATION_PASS_RESET
                  # CCRTAICC_SDRAM_CALIBRATION_PASS_SET
               _ccrtaicc_sdram_initilization_done_t    initialization_done;
                  # CCRTAICC_SDRAM_INITIALIZATION_NOT_COMPLETE
                  # CCRTAICC_SDRAM_INITIALIZATION_COMPLETE
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (successful)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (device not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION        (local region not present)
               # CCRTAICC_LIB_SDRAM_IS_NOT_ACTIVE    (SDRAM is not active)
 ************************************************************************/
```

2.2.143 ccrtAICC_SDRAM_Read() **

Currently, SDRAM is not supported by this hardware.

This call provided the user the ability to read any portion of the SDRAM. Its range is from 1 to 0x10000000 (256Mwords). Offset to this routine is only set if it is 0 or greater. Maximum offset is 0x0FFFFFFF. If offset is negative, then the read commences from the last read location.

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SDRAM_Read (void      *Handle,
                        u_int32_t *Buf,
                        int       Offset,
```

```
                        u_int32_t Size,
                        u_int32_t *Words_read)

   Description: Perform a SDRAM read operation.

   Input:   void                        *Handle     (Handle pointer)
            int                         Offset      (word offset into SDRAM)
            u_int32_t                   Size        (size of buffer in words)
   Output:  u_int32_t                   *Buf        (pointer to buffer)
            u_int32_t                   *Words_read (words read)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
               # CCRTAICC_LIB_SDRAM_IS_NOT_ACTIVE   (SDRAM is not active)

 ****************************************************************************/
```

2.2.144 ccrtAICC_SDRAM_Set_CSR() **

Currently, SDRAM is not supported by this hardware.

This call sets the SDRAM control and status register.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SDRAM_Set_CSR (void                    *Handle,
                           ccrtaicc_sdram_csr_t    *sdram_csr)

   Description: Set SDRAM Control and Status information

   Input:   void                                  *Handle    (Handle pointer)
               _ccrtaicc_sdram_read_auto_increment_t   read_auto_increment;
                  # CCRTAICC_SDRAM_READ_AUTO_INCREMENT_DISABLE
                  # CCRTAICC_SDRAM_READ_AUTO_INCREMENT_ENABLE
               _ccrtaicc_sdram_write_auto_increment_t  write_auto_increment;
                  # CCRTAICC_SDRAM_WRITE_AUTO_INCREMENT_DISABLE
                  # CCRTAICC_SDRAM_WRITE_AUTO_INCREMENT_ENABLE
               _ccrtaicc_sdram_read_timeout_t          read_timeout;
                  # CCRTAICC_SDRAM_READ_TIMEOUT_DID_NOT_OCCUR
                  # CCRTAICC_SDRAM_READ_TIMEOUT_OCCURRED
               _ccrtaicc_sdram_calibration_fail_t      calibration_failed;
                  # CCRTAICC_SDRAM_CALIBRATION_FAIL_RESET
                  # CCRTAICC_SDRAM_CALIBRATION_FAIL_SET
               _ccrtaicc_sdram_calibration_pass_t      calibration_passed;
                  # CCRTAICC_SDRAM_CALIBRATION_PASS_RESET
                  # CCRTAICC_SDRAM_CALIBRATION_PASS_SET
               _ccrtaicc_sdram_initilization_done_t    initialization_done;
                  # CCRTAICC_SDRAM_INITIALIZATION_NOT_COMPLETE
                  # CCRTAICC_SDRAM_INITIALIZATION_COMPLETE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                 (successful)
               # CCRTAICC_LIB_BAD_HANDLE               (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                 (device not open)
               # CCRTAICC_LIB_INVALID_ARG              (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION          (local region not present)
               # CCRTAICC_LIB_SDRAM_IS_NOT_ACTIVE      (SDRAM is not active)
 ****************************************************************************/
```

2.2.145 ccrtAICC_SDRAM_Write() **

Currently, SDRAM is not supported by this hardware.

This call provided the user the ability to write to any portion of the SDRAM. Its range is from 1 to 0x10000000 (256Mwords). Offset to this routine is only set if it is 0 or greater. Maximum offset is 0x0FFFFFFF. If offset is negative, then the write commences from the last written location.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SDRAM_Write (void         *Handle,
                         u_int32_t    *Buf,
                         int          Offset,
                         u_int32_t    Size,
                         u_int32_t    *Words_written)

   Description: Perform a SDRAM write operation.

   Input:   void                        *Handle        (Handle pointer)
            u_int32_t                   *Buf           (pointer to buffer)
            int                         Offset         (word offset into SDRAM)
            u_int32_t                   Size           (size of buffer in words)
   Output:  u_int32_t                   *Words_written (words written)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
               # CCRTAICC_LIB_SDRAM_IS_NOT_ACTIVE     (SDRAM is not active)
 *************************************************************************/
```

2.2.146 ccrtAICC_Set_Board_CSR()

This call is used to set the board control register.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Set_Board_CSR (void                    *Handle,
                           ccrtaicc_board_csr_t    *bcsr)

   Description: Set Board Control and Status information

   Input:   void                        *Handle         (Handle pointer)
            ccrtaicc_board_csr_t                *bcsr   (pointer to board csr)
               _ccrtaicc_bcsr_identify_board_t  identify_board
                  # CCRTAICC_BCSR_IDENTIFY_BOARD_DISABLE
                  # CCRTAICC_BCSR_IDENTIFY_BOARD_ENABLE
                  # CCRTAICC_BCSR_IDENTIFY_BOARD_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (device not open)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region not present)
 *************************************************************************/
```

2.2.147 ccrtAICC_Set_Calibration_CSR()

This call sets the current calibration control and status register.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
```

```
   ccrtAICC_Set_Calibration_CSR (void                       *Handle,
                                ccrtaicc_calibration_csr_t *CalCSR)

   Description: Set Calibration Control and Status Register

   Input:   void                          *Handle     (Handle pointer)
            ccrtaicc_calibration_csr_t    *CalCSR     (pointer to calibration CSR)
              _ccrtaicc_calbus_control_t BusControl  (bus control)
                 # CCRTAICC_CB_GROUND
                 # CCRTAICC_CB_POSITIVE_10V_REFERENCE
                 # CCRTAICC_CB_NEGATIVE_10V_REFERENCE
                 # CCRTAICC_CB_POSITIVE_5V_REFERENCE
                 # CCRTAICC_CB_NEGATIVE_5V_REFERENCE
                 # CCRTAICC_CB_POSITIVE_2V_REFERENCE
                 # CCRTAICC_CB_BUS_OPEN
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR              (successful)
               # CCRTAICC_LIB_BAD_HANDLE            (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN              (device not open)
               # CCRTAICC_LIB_INVALID_ARG           (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION       (local region not present)
 ***************************************************************************/
```

2.2.148 ccrtAICC_Set_External_Clock_CSR()

This call sets the External Clock Input.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Set_External_Clock_CSR (void                           *Handle,
                                    ccrtaicc_external_clock_csr_t *ExtClkCSR)

   Description: Set External Clock Control & Status

   Input:   void                             *Handle     (handle pointer)
            ccrtaicc_external_clock_csr_t  *ExtClkCSR  (pointer to external clock
                                                        CSR)
              _ccrtaicc_external_clock_output_select_t ClockOutputSelect;
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_0
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_1
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_2
                 # CCRTAICC_EXCLOS_CLOCK_GENERATOR_OUTPUT_3
                 # CCRTAICC_EXCLOS_EXTERNAL_CLOCK_INPUT
                 # CCRTAICC_EXCLOS_NO_CLOCK
                 # CCRTAICC_EXCLOS_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
 ***************************************************************************/
```

2.2.149 ccrtAICC_Set_Interrupt_Status()

This call sets/clears the various interrupts.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Set_Interrupt_Status (void                *Handle,
```

```
                                    ccrtaicc_interrupt_t *intr)

   Description: Set Interrupt Status

   Input:   void                    *Handle       (handle pointer)
            ccrtaicc_interrupt_t    *intr         (pointer to interrupt status)
               _ccrtaicc_intsta_adc_t
                  # CCRTAICC_INT_ADC_FIFO_THRESHOLD_NONE
                  # CCRTAICC_INT_ADC_FIFO_THRESHOLD_RESET
                  # CCRTAICC_INT_ADC_FIFO_THRESHOLD_DO_NOT_CHANGE
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_BAD_HANDLE          (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN            (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (local region error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)

 ****************************************************************************/
```

2.2.150 ccrtAICC_Set_Interrupt_Timeout_Seconds()

This call sets the read *timeout* maintained by the driver. It allows the user to change the default time out from 30 seconds to a user specified value. It is the time that the read call will wait before it times out. The call could time out if the DMA fails to complete. The device should have been opened in the blocking mode *(O_NONBLOCK not set)* for reads to wait for the operation to complete.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Set_Interrupt_Timeout_Seconds (void    *Handle,
                                           int     timeout_secs)

   Description: Set Interrupt Timeout Seconds

   Input:   void         *Handle           (Handle pointer)
            int          timeout_secs      (interrupt tout secs)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_INVALID_ARG   (invalid argument)
 ****************************************************************************/
```

2.2.151 ccrtAICC_Set_TestBus_Control()

This call is provided for internal use in testing the hardware.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Set_TestBus_Control (void                        *Handle,
                                 _ccrtaicc_testbus_control_t test_control)

   Description: Set the value of the Test Bus control information

   Input:   void                     *Handle       (handle pointer)
   Output:  _ccrtaicc_testbus_control_t
                                     test_control  (control select)
               # CCRTAICC_TBUS_CONTROL_OPEN
               # CCRTAICC_TBUS_CONTROL_CAL_BUS
   Return:  _ccrtaicc_lib_error_number_t
```

```
            # CCRTAICC_LIB_NO_ERROR           (successful)
            # CCRTAICC_LIB_NO_LOCAL_REGION    (local region error)
            # CCRTAICC_LIB_BAD_HANDLE         (no/bad handler supplied)
            # CCRTAICC_LIB_NOT_OPEN           (device not open)
 ************************************************************************/
```

2.2.152 ccrtAICC_Set_Value()

This call allows the advanced user to set the writable board registers. The actual data written will depend on the command register information that is requested. Refer to the hardware manual for more information on what can be written to.

Normally, users should not be changing these registers as it will bypass the API integrity and could result in an unpredictable outcome.

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Set_Value (void               *Handle,
                       CCRTAICC_CONTROL    cmd,
                       void               *value)

   Description: Set the value of the specified board register.

   Input:   void             *Handle        (Handle pointer)
            CCRTAICC_CONTROL cmd            (register definition)
               -- structure in ccrtaicc_lib.h
            void             *value         (pointer to value to be set)
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR      (successful)
               # CCRTAICC_LIB_BAD_HANDLE    (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN      (device not open)
               # CCRTAICC_LIB_INVALID_ARG   (invalid argument)
 ************************************************************************/
```

2.2.153 ccrtAICC_SPROM_Read() **

Currently, SPROM is not supported by this hardware.

This is a basic call to read short word entries from the serial prom. The user specifies a word offset within the serial prom and a word count, and the call returns the data read in a pointer to short words.

```
/************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SPROM_Read(void               *Handle,
                       ccrtaicc_sprom_rw_t *spr)

   Description: Read Serial Prom for specified number of words

   Input:       void                  *Handle    (handle pointer)
                ccrtaicc_sprom_rw_t    *spr       (pointer to struct)
                   u_short word_offset
                   u_short num_words
   Output:      ccrtaicc_sprom_rw_t    *spr       (pointer to struct)
                   u_short *data_ptr
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION    (error)
               # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
               # CCRTAICC_LIB_SERIAL_PROM_BUSY   (serial prom busy)
               # CCRTAICC_LIB_SERIAL_PROM_FAILURE (serial prom failure)
```

```
               # CCRTAICC_LIB_SERIAL_PROM_NOT_PRESENT (serial prom not present)
*****************************************************************************/
```

2.2.154 ccrtAICC_SPROM_Read_Item() **

Currently, SPROM is not supported by this hardware.

This call is used to read well defined sections in the serial prom. The user supplies the serial prom section that needs to be read and the data is returned in a section specific structure.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SPROM_Read_Item(void                      *Handle,
                            _ccrtaicc_sprom_access_t item,
                            void                      *item_ptr)

   Description: Read Serial Prom for specified item

   Input:       void                   *Handle    (handle pointer)
                _ccrtaicc_sprom_access_t item     (select item)
                   # CCRTAICC_SPROM_HEADER
   Output:      void                   *item_ptr  (pointer to item struct)
                   *ccrtaicc_sprom_header_t sprom_header
                      u_int32_t        board_serial_number
                      u_short          sprom_revision
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
               # CCRTAICC_LIB_SERIAL_PROM_BUSY    (serial prom busy)
               # CCRTAICC_LIB_SERIAL_PROM_FAILURE (serial prom failure)
               # CCRTAICC_LIB_SERIAL_PROM_NOT_PRESENT (serial prom not present)
*****************************************************************************/
```

2.2.155 ccrtAICC_SPROM_Write() **

Currently, SPROM is not supported by this hardware.

This is a basic call to write short word entries to the serial prom. The user specifies a word offset within the serial prom and a word count, and the call writes the data pointed to by the *spw* pointer, in short words.

Prior to using this call, the user will need to issue the *ccrtAICC_SPROM_Write_Override()* to allow writing to the serial prom.

```
/*****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SPROM_Write(void               *Handle,
                        ccrtaicc_sprom_rw_t *spw)

   Description: Write data to Serial Prom for specified number of words

   Input:       void                  *Handle    (handle pointer)
                ccrtaicc_sprom_rw_t    *spw       (pointer to struct)
                   u_short word_offset
                   u_short num_words
                   u_short *data_ptr
   Output:      none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR            (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION     (error)
               # CCRTAICC_LIB_INVALID_ARG         (invalid argument)
```

```
               # CCRTAICC_LIB_SERIAL_PROM_BUSY    (serial prom busy)
               # CCRTAICC_LIB_SERIAL_PROM_FAILURE (serial prom failure)
               # CCRTAICC_LIB_SERIAL_PROM_NOT_PRESENT (serial prom not present)
*************************************************************************/
```

2.2.156 ccrtAICC_SPROM_Write_Item() **

Currently, SPROM is not supported by this hardware.

This call is used to write well defined sections in the serial prom. The user supplies the serial prom section that needs to be written and the data points to the section specific structure. This call should normally not be used by the user.

Prior to using this call, the user will need to issue the *ccrtAICC_SPROM_Write_Override()* to allowing writing to the serial prom.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SPROM_Write_Item(void                    *Handle,
                             _ccrtaicc_sprom_access_t item,
                             void                    *item_ptr)

   Description: Write Serial Prom with specified item

   Input:       void                  *Handle    (handle pointer)
                _ccrtaicc_sprom_access_t item    (select item)
                   # CCRTAICC_SPROM_HEADER
                void                  *item_ptr  (pointer to item struct)
                   *ccrtaicc_sprom_header_t sprom_header
                      u_int32_t        board_serial_number
                      u_short          sprom_revision
   Output:      none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR           (successful)
               # CCRTAICC_LIB_NO_LOCAL_REGION    (error)
               # CCRTAICC_LIB_INVALID_ARG        (invalid argument)
               # CCRTAICC_LIB_SERIAL_PROM_BUSY   (serial prom busy)
               # CCRTAICC_LIB_SERIAL_PROM_FAILURE (serial prom failure)
               # CCRTAICC_LIB_SERIAL_PROM_NOT_PRESENT (serial prom not present)
 *************************************************************************/
```

2.2.157 ccrtAICC_SPROM_Write_Override() **

Currently, SPROM is not supported by this hardware.

The serial prom is non-volatile and its information is preserved during a power cycle. It contains useful information and settings that the customer could lose if they were to inadvertently overwrite. For this reason, all calls that write to the serial proms will fail with a write protect error, unless this write protect override API is invoked prior to writing to the serial proms. Once the Write Override is enabled, it will stay in effect until the user closes the device or re-issues this call to disable writes to the serial prom.
The calls that will fail unless the write protect is disabled are:

- ccrtAICC_Write_Serial_Prom()
- ccrtAICC_Write_Serial_Prom_Item()

When *action* is set to *CCRTAICC_TRUE*, the serial prom write protecting is disabled, otherwise, it is enabled.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_SPROM_Write_Override (void *Handle,
```

```
                                int action)

   Description: Set Serial Prom Write Override

   Input:       void            *Handle             (handle pointer)
                int             action              (override action)
                   # CCRTAICC_TRUE
                   # CCRTAICC_FALSE
   Output:      none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR             (successful)
               # CCRTAICC_LIB_BAD_HANDLE           (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN             (device not open)
               # CCRTAICC_LIB_INVALID_ARG          (invalid argument)
               # CCRTAICC_LIB_NO_LOCAL_REGION      (local region not present)
               # CCRTAICC_LIB_SERIAL_PROM_NOT_PRESENT (serial prom not present)
 ***************************************************************************/
```

2.2.158 ccrtAICC_Transfer_Data()

This is the main call that the user can use to transfer data from physical memory that the user has previously allocated to a region in the local register, and vice-versa. The operation can be performed via DMA or programmed I/O mode. In the case of DMA mode, the user can select whether interrupts are to be used to wait for DMA to complete instead of polling. User can also specify which DMA engine to use during this operation.

If the board supports modular scatter-gather DMA, then the user can specify that instead of the basic DMA engine. In this case, the user needs to first call the *ccrtAICC_MsgDma_Configure_Single()* with the *NULL* argument to setup descriptor ID-1 for scatter-gather DMA operation.

When scatter-gather DMA is selected, the *DmaEngineNo* argument is ignored and the *IoControl* argument must be set to *CCRTAICC_DMA_CONTROL_INCREMENT.*

There are certain limitations to modular scatter-gather feature:

1. Scatter-gather DMA is only supported in certain cards
2. Reads from Avalon memory below DiagRam location are not allowed for MIOC FPGA cards.
3. Invalid memory address supplied could result in the scatter-gather IP to lock up and the only way to recover will be to reload the driver or reboot the system.
4. Read and write addresses must be at a minimum full-word aligned and for maximum performance, it is recommended to be quad-word aligned.
5. Lengths are in bytes and must be at a minimum a multiple of a full-word and for maximum performance, it is recommended to be quad-word multiple.
6. Scatter-gather chaining cannot be performed with this call.

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Transfer_Data(void                             *Handle,
                          volatile void                    *PciDmaMemory,
                          volatile void                    *AvalonMem,
                          uint                             TransferSize,
                          _ccrtaicc_direction_t            XferDirection,
                          _ccrtaicc_library_rw_mode_t      LibMode,
                          ccrtaicc_dma_engine_t            DMAEngineNo,
                          ccrtaicc_bool                    UseInterrupts,
                          int                              IoControl)

   Description: Routine to transfer data from PCI memory to Avalon memory
                or vice-versa
```

```
   Input:   void                       *Handle         (Handle pointer)
            volatile void              *PciDmaMemory   (pointer to virtual memory)
            volatile void              *AvalonMem      (pointer to virtual Avalon
                                                        memory)
            uint                       TransferSize    (size of transfer in bytes)
            _ccrtaicc_direction_t      XferDirection   (direction of transfer)
               # CCRTAICC_AVALON_2_PCIMEM
               # CCRTAICC_PCIMEM_2_AVALON
            _ccrtaicc_library_rw_mode_t  LibMode       (Lib transfer mode)
               # CCRTAICC_LIBRARY_PIO_MODE
               # CCRTAICC_LIBRARY_DMA_MODE
               # CCRTAICC_LIBRARY_MSGDMA_MODE
            ccrtaicc_dma_engine_t      DMAEngineNo    (select DMA engine)
               # CCRTAICC_DMA0
               # CCRTAICC_DMA1
               # CCRTAICC_NONE
            ccrtaicc_bool              UseInterrupts  (enable interrupts)
               # CCRTAICC_TRUE
               # CCRTAICC_FALSE
            int                        IoControl      (DMA or PIO control flags)
               # CCRTAICC_DMA_CONTROL_RCON           (DMA: read constant)
               # CCRTAICC_DMA_CONTROL_WCON           (DMA: write constant)
               # CCRTAICC_DMA_CONTROL_INCREMENT      (DMA: increment)
               # CCRTAICC_PIO_CONTROL_RCON           (PIO: read constant)
               # CCRTAICC_PIO_CONTROL_WCON           (PIO: write constant)
               # CCRTAICC_PIO_CONTROL_INCREMENT      (PIO: increment)

   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR               (no error)
               # CCRTAICC_LIB_BAD_HANDLE             (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN               (library not open)
               # CCRTAICC_LIB_INVALID_ARG            (invalid argument)
               # CCRTAICC_LIB_IOCTL_FAILED           (driver ioctl call failed)
               # CCRTAICC_LIB_DMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                                     (DMA access not allowed for
                                                      selected address)
               # CCRTAICC_LIB_MSGDMA_NOT_SUPPORTED   (modular scatter-gather DMA
                                                      not supported)
               # CCRTAICC_LIB_MSGDMA_ACCESS_NOT_ALLOWED_FOR_SELECTED_ADDRESS
                                                     (MSG DMA Reads not allowed
                                                      for selected address)
               # CCRTAICC_LIB_NOT_OWNER_OF_MSGDMA    (not owner of modular
                                                      scatter-gather)
 ***************************************************************************/
```

2.2.159 ccrtAICC_Update_Clock_Generator_Divider()

Update the selected clock generator divider so that its changes take affect. *Normally, this call should not be used. It is recommended that only advanced users should use this call and with extreme care and intimate knowledge of the clock programming, otherwise results would be indeterminate.*

```
/***************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Update_Clock_Generator_Divider (void                      *Handle,
                           _ccrtaicc_clock_generator_divider_t    WhichDivider)

   Description: Update Clock Generator Divider

   Input:   void                                 *Handle         (Handle pointer)
            _ccrtaicc_clock_generator_divider_t  WhichDivider    (select divider)
```

```
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_M
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N3
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_N_ALL
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P0
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P1
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P2
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PFB
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_P_ALL
               # CCRTAICC_CLOCK_GENERATOR_DIVIDER_PXAXB
   Output:  none
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR                (successful)
               # CCRTAICC_LIB_BAD_HANDLE              (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN                (library not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION         (local region error)
               # CCRTAICC_LIB_INVALID_ARG             (invalid argument)
               # CCRTAICC_LIB_CLOCK_IS_NOT_ACTIVE     (Clock is not active)
*************************************************************************/
```

2.2.160 ccrtAICC_UserProcess_Command()

The user can control the execution of the created User Process with the help of this call.

```
/*************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_UserProcess_Command(void                  *Handle,
                                void                  *UFuncHandle,
                                ccrtaicc_uf_action_t  Action)

   Description: Command User process

   Input:   void                  *UFuncHandle  (User Process Handle pointer)
            ccrtaicc_uf_action_t  Action        (command action)
               # CCRTAICC_UF_ACTION_STOP
               # CCRTAICC_UF_ACTION_RUN
               # CCRTAICC_UF_ACTION_TERMINATE
   Output:  none
   Return:  none
 *************************************************************************/
```

2.2.161 ccrtAICC_VoltsToData()

This call returns to the user the raw converted value for the requested voltage in the specified format. Voltage supplied must be within the input range of the selected board type. If the voltage is out of range, the call sets the voltage to the appropriate limit value.

```
/*************************************************************************
   uint
   ccrtAICC_VoltsToData (double                  volts,
                         ccrtaicc_volt_convert_t *conv)

   Description: Convert Volts to data

   Input:   double                       volts        (volts to convert)
            ccrtaicc_volt_convert_t      *conv     (pointer to conversion struct)
              double                     VoltageRange (maximum voltage range)
              _ccrtaicc_csr_dataformat_t Format       (format)
                 # CCRTAICC_OFFSET_BINARY
```

```
               # CCRTAICC_TWOS_COMPLEMENT
             ccrtaicc_bool              BiPolar      (bi-polar)
               # CCRTAICC_TRUE
               # CCRTAICC_FALSE
             int                   ResolutionBits (Number of resolution bits)
   Output:  none
   Return:  uint                  data           (returned data)
 ****************************************************************************/
```

2.2.162 ccrtAICC_Wait_For_Interrupt()

This call is made available to advanced users to bypass the API and perform their own data collection. The user can wait for a DMA complete interrupt. If a time out value greater than zero is specified, the call will time out after the specified seconds, otherwise it will not time out.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Wait_For_Interrupt (void                  *Handle,
                               ccrtaicc_driver_int_t  *drv_int)

   Description: Wait For Interrupt

   Input:   void                  *Handle         (Handle pointer)
            ccrtaicc_driver_int_t  *drv_int        (pointer to drv_int struct)
               uint                WakeupInterruptMask
                  # CCRTAICC_DMA0_INTMASK
                  # CCRTAICC_DMA1_INTMASK
                  # CCRTAICC_MSGDMA_INTMASK
                  # CCRTAICC_ADC_FIFO_INTMASK
               int                 timeout_seconds
   Output:  ccrtaicc_driver_int_t   *drv_int       (pointer to drv_int struct)
               long long unsigned   count
               long long unsigned   dma_count[CCRTAICC_DMA_MAX_ENGINES]
               long long unsigned   MsgDma_count
               uint                 InterruptsOccurredMask
               uint                 WakeupInterruptMask
               int                  DmaControl     (DMA control flags)
                  # CCRTAICC_DMA_CONTROL_RCON      (read constant)
                  # CCRTAICC_DMA_CONTROL_WCON      (write constant)
                  # CCRTAICC_DMA_CONTROL_INCREMENT (increment)
   Return:  _ccrtaicc_lib_error_number_t
               # CCRTAICC_LIB_NO_ERROR          (successful)
               # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
               # CCRTAICC_LIB_NOT_OPEN          (device not open)
               # CCRTAICC_LIB_NO_LOCAL_REGION   (local region not present)
               # CCRTAICC_LIB_INVALID_ARG       (invalid argument)
 ****************************************************************************/
```

2.2.163 ccrtAICC_Write()

This call is currently not supported by the driver.

```
/****************************************************************************
   _ccrtaicc_lib_error_number_t
   ccrtAICC_Write (void    *Handle,
                   void    *buf,
                   int     size,
                   int     *bytes_written,
                   int     *error)

   Description: Perform a write operation.
```

```
  Input:   void     *Handle                   (Handle pointer)
           int      size                      (number of bytes to write)
  Output:  void     *buf                      (pointer to buffer)
           int      *bytes_written            (bytes written)
           int      *error                    (returned errno)
  Return:  _ccrtaicc_lib_error_number_t
              # CCRTAICC_LIB_NO_ERROR          (successful)
              # CCRTAICC_LIB_BAD_HANDLE        (no/bad handler supplied)
              # CCRTAICC_LIB_NOT_OPEN          (device not open)
              # CCRTAICC_LIB_IO_ERROR          (write failed)
              # CCRTAICC_LIB_NOT_IMPLEMENTED   (call not implemented)
*****************************************************************************/
```

3. Test Programs

This driver and API are accompanied with an extensive set of test examples. Examples under the *Direct Driver Access* do not use the API, while those under *Application Program Interface Access* use the API.

3.1 Direct Driver Access Example Tests

These set of tests are located in the *.../test* directory and do not use the API. They communicate directly with the driver. Users should be extremely familiar with both the driver and the hardware registers if they wish to communicate directly with the hardware.

3.1.1 ccrtaicc_disp

Useful program to display the local board registers. This program uses the *curses* library.

```
Usage: ./ccrtaicc_disp [-b BoardNo] [-d Delay] [-l LoopCnt] [-o Offset] [-s Size]
 -b BoardNo  (Board number -- default is 0)
 -d Delay    (Delay between screen refresh -- default is 0)
 -l LoopCnt  (Loop count -- default is 0)
 -o Offset   (Hex offset to read from -- default is 0x0)
 -s Size     (Number of bytes to read -- default is 0x400)
```

Example display:

./ccrtaicc_disp

```
 Board Number    [-b]: 0
 Delay           [-d]: 0 milli-seconds
 Loop Count      [-l]: ***Forever***
 Offset          [-o]: 0x00000000
 Size            [-s]: 1024 (bytes)

 ScanCount =    33783

         00       04       08       0C       10       14       18       1C
         ======== ======== ======== ======== ======== ======== ======== ========
000000   93500101 04032019 00020000 00000000 00000000 00000000 00000000 00000000
000020   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000040   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000060   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000080   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0000a0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0000c0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0000e0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000100   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000120   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000140   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000160   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000180   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0001a0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0001c0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0001e0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000200   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000220   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000240   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000260   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000280   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0002a0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0002c0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0002e0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000300   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000320   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000340   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000360   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000380   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

```
0003a0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0003c0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0003e0   00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

3.1.2 ccrtaicc_dump

This test is for debugging purpose. It dumps all the hardware registers.

Usage: ccrtaicc_dump [-b board]
 -b board: board number -- default board is 0

Example display:

./ccrtaicc_dump

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

     LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
    CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
    LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008

======= LOCAL BOARD REGISTERS =========
LBR: @0x000000 --> 0x93500101
LBR: @0x000004 --> 0x04032019
LBR: @0x000008 --> 0x00020000
LBR: @0x00000c --> 0x00000000
LBR: @0x000010 --> 0x00000000
LBR: @0x000014 --> 0x00000000
LBR: @0x000018 --> 0x00000000
LBR: @0x00001c --> 0x00000000
LBR: @0x000020 --> 0x00000000
LBR: @0x000024 --> 0x00000000
LBR: @0x000028 --> 0x00000000
LBR: @0x00002c --> 0x00000000
LBR: @0x000030 --> 0x00000000
.
.
.
LBR: @0x01ffcc --> 0x00000000
LBR: @0x01ffd0 --> 0x00000000
LBR: @0x01ffd4 --> 0x00000000
LBR: @0x01ffd8 --> 0x00000000
LBR: @0x01ffdc --> 0x00000000
LBR: @0x01ffe0 --> 0x00000000
LBR: @0x01ffe4 --> 0x00000000
LBR: @0x01ffe8 --> 0x00000000
LBR: @0x01ffec --> 0x00000000
LBR: @0x01fff0 --> 0x00000000
LBR: @0x01fff4 --> 0x00000000
LBR: @0x01fff8 --> 0x00000000
LBR: @0x01fffc --> 0x00000000

======= LOCAL CONFIG REGISTERS =========
#### CONFIG REGS (PCIeLinkPartnerRegs) ####
```

```
LCR: @0x0000 --> 0x00000000
LCR: @0x0004 --> 0x00000000
LCR: @0x0008 --> 0x00000000
LCR: @0x000c --> 0x00000000
LCR: @0x0010 --> 0x00000000
LCR: @0x0014 --> 0x00000000
LCR: @0x0018 --> 0x00000000
LCR: @0x001c --> 0x00000000
LCR: @0x0020 --> 0x00000000
LCR: @0x0024 --> 0x00000000
LCR: @0x0028 --> 0x00000000
LCR: @0x002c --> 0x00000000
LCR: @0x0030 --> 0x00000000
.
.
.
LCR: @0x0fc0 --> 0x00000000
LCR: @0x0fc4 --> 0x00000000
LCR: @0x0fc8 --> 0x00000000
LCR: @0x0fcc --> 0x00000000
LCR: @0x0fd0 --> 0x00000000
LCR: @0x0fd4 --> 0x00000000
LCR: @0x0fd8 --> 0x00000000
LCR: @0x0fdc --> 0x00000000
LCR: @0x0fe0 --> 0x00000000
LCR: @0x0fe4 --> 0x00000000
LCR: @0x0fe8 --> 0x00000000
LCR: @0x0fec --> 0x00000000
LCR: @0x0ff0 --> 0x00000000
LCR: @0x0ff4 --> 0x00000000
LCR: @0x0ff8 --> 0x00000000
LCR: @0x0ffc --> 0x00000000

#### CONFIG REGS (AvalonMM_2_PCIeAddrTrans) ####
LCR: @0x1000 --> 0x00000000
LCR: @0x1004 --> 0x00000000
LCR: @0x1008 --> 0x00000000
LCR: @0x100c --> 0x00000000
LCR: @0x1010 --> 0x00000000
LCR: @0x1014 --> 0x00000000
LCR: @0x1018 --> 0x00000000
LCR: @0x101c --> 0x00000000
LCR: @0x1020 --> 0x00000000
LCR: @0x1024 --> 0x00000000
LCR: @0x1028 --> 0x00000000
LCR: @0x102c --> 0x00000000
LCR: @0x1030 --> 0x00000000
.
.
.
LCR: @0x1fb0 --> 0x00000000
LCR: @0x1fb4 --> 0x00000000
LCR: @0x1fb8 --> 0x00000000
LCR: @0x1fbc --> 0x00000000
LCR: @0x1fc0 --> 0x00000000
```

```
LCR: @0x1fc4 --> 0x00000000
LCR: @0x1fc8 --> 0x00000000
LCR: @0x1fcc --> 0x00000000
LCR: @0x1fd0 --> 0x00000000
LCR: @0x1fd4 --> 0x00000000
LCR: @0x1fd8 --> 0x00000000
LCR: @0x1fdc --> 0x00000000
LCR: @0x1fe0 --> 0x00000000
LCR: @0x1fe4 --> 0x00000000
LCR: @0x1fe8 --> 0x00000000
LCR: @0x1fec --> 0x00000000
LCR: @0x1ff0 --> 0x00000000
LCR: @0x1ff4 --> 0x00000000
LCR: @0x1ff8 --> 0x00000000
LCR: @0x1ffc --> 0x00000000

#### CONFIG REGS (DMA Control Table) ####
LCR: @0x4000 --> 0x00000011
LCR: @0x4004 --> 0x0000700c
LCR: @0x4008 --> 0x008ac000
LCR: @0x400c --> 0x00000000
LCR: @0x4010 --> 0x00000000
LCR: @0x4014 --> 0x00000000
LCR: @0x4018 --> 0x00000000
LCR: @0x401c --> 0x00000000
LCR: @0x4020 --> 0x00000011
LCR: @0x4024 --> 0x0000fff0
LCR: @0x4028 --> 0x00827ff0
LCR: @0x402c --> 0x00000000
LCR: @0x4030 --> 0x00000000
LCR: @0x4034 --> 0x00000000
LCR: @0x4038 --> 0x00000000
LCR: @0x403c --> 0x00000000

======= PCI CONFIG REG ADDR MAPPING =========
PCR: @0x0000 --> 0x93501542
PCR: @0x0004 --> 0x00100406
PCR: @0x0008 --> 0x08800001
PCR: @0x000c --> 0x00000010
PCR: @0x0010 --> 0xbd520000
PCR: @0x0014 --> 0x00000000
PCR: @0x0018 --> 0xbd500000
PCR: @0x001c --> 0x00000000
PCR: @0x0020 --> 0x00000000
PCR: @0x0024 --> 0x00000000
PCR: @0x0028 --> 0x00000000
PCR: @0x002c --> 0x01001542
PCR: @0x0030 --> 0x00000000
PCR: @0x0034 --> 0x00000050
PCR: @0x0038 --> 0x00000000
PCR: @0x003c --> 0x0000010b
PCR: @0x0040 --> 0x00000000
PCR: @0x0044 --> 0x02006160
PCR: @0x0048 --> 0x00000000
PCR: @0x004c --> 0x00000000
```

```
PCR: @0x0050 --> 0x00857805
PCR: @0x0054 --> 0xfeeff00c
PCR: @0x0058 --> 0x00000000
PCR: @0x005c --> 0x00004165
PCR: @0x0060 --> 0x00000000
PCR: @0x0064 --> 0x00000000
PCR: @0x0068 --> 0x00007811
PCR: @0x006c --> 0x00000000
PCR: @0x0070 --> 0x00000000
PCR: @0x0074 --> 0x00000000
PCR: @0x0078 --> 0x00038001
PCR: @0x007c --> 0x00000000
PCR: @0x0080 --> 0x00020010
PCR: @0x0084 --> 0x00648001
PCR: @0x0088 --> 0x00002830
PCR: @0x008c --> 0x01406441
PCR: @0x0090 --> 0x10410040
PCR: @0x0094 --> 0x00000000
PCR: @0x0098 --> 0x00000000
PCR: @0x009c --> 0x00000000
PCR: @0x00a0 --> 0x00000000
PCR: @0x00a4 --> 0x0000001f
PCR: @0x00a8 --> 0x0000000d
PCR: @0x00ac --> 0x00000000
PCR: @0x00b0 --> 0x00010001
PCR: @0x00b4 --> 0x00000000
PCR: @0x00b8 --> 0x00000000
PCR: @0x00bc --> 0x00000000
PCR: @0x00c0 --> 0x00000000
PCR: @0x00c4 --> 0x00000000
PCR: @0x00c8 --> 0x00000000
PCR: @0x00cc --> 0x00000000
PCR: @0x00d0 --> 0x00000000
PCR: @0x00d4 --> 0x00000000
PCR: @0x00d8 --> 0x00000000
PCR: @0x00dc --> 0x00000000
PCR: @0x00e0 --> 0x00000000
PCR: @0x00e4 --> 0x00000000
PCR: @0x00e8 --> 0x00000000
PCR: @0x00ec --> 0x00000000
PCR: @0x00f0 --> 0x00000000
PCR: @0x00f4 --> 0x00000000
PCR: @0x00f8 --> 0x00000000
PCR: @0x00fc --> 0x00000000`
```

3.1.3 ccrtaicc_rdreg

This is a simple program that returns the local register value for a given offset.

```
Usage: ./ccrtaicc_rdreg [-b Board] [-C] [-f] [-o Offset] [-s Size]
 -b Board   : Board number -- default board is 0
 -C         : Select Config Registers instead of Local Registers
 -f         : Fast Memory Reads
 -o Offset  : Hex offset to read from -- default offset is 0x0
 -s Size    : Number of bytes to read in decimal -- default size is 0x4
```

Example display:
./ccrtaicc_rdreg –s64

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

        LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
       CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
       LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008

#### LOCAL REGS #### (length=64)
+LCL+        0   93500101  04032019  00020000  00000000 *.P.... .........*
+LCL+     0x10   00000000  00000000  00000000  00000000 *.................*
+LCL+     0x20   00000000  00000000  00000000  00000000 *.................*
+LCL+     0x30   00000000  00000000  00000000  00000000 *.................*
  18.167us (   3.52 MB/s)
```

./ccrtaicc_rdreg -C -o4020 -s20

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

        LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
       CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
       LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008

#### CONFIG REGS #### (length=20)
+CFG+   0x4020   00000011  0000fff0  00827ff0  00000000 *.................*
+CFG+   0x4030   00000000                               *....             *
   5.203us (   3.84 MB/s)
```

3.1.4 ccrtaicc_reg

This call displays all the boards local and configuration registers.

```
Usage: ./ccrtaicc_reg [-b board]
 -b board: Board number -- default board is 0
```

Example display:

./ccrtaicc_reg

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

     LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
    CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
    LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008
LOCAL Register 0x7ffff7fd7000 size=0x00020000

#### LOCAL REGS #### (length=131072)
+LCL+        0   93500101  04032019  00020000  00000000 *.P.... .........*
+LCL+     0x10   00000000  00000000  00000000  00000000 *.................*
+LCL+     0x20   00000000  00000000  00000000  00000000 *.................*
+LCL+     0x30   00000000  00000000  00000000  00000000 *.................*
```

```
+LCL+     0x40   00000000  00000000  00000000  00000000 *................*
+LCL+     0x50   00000000  00000000  00000000  00000000 *................*
+LCL+     0x60   00000000  00000000  00000000  00000000 *................*
+LCL+     0x70   00000000  00000000  00000000  00000000 *................*
+LCL+     0x80   00000000  00000000  00000000  00000000 *................*
+LCL+     0x90   00000000  00000000  00000000  00000000 *................*
+LCL+     0xa0   00000000  00000000  00000000  00000000 *................*
+LCL+     0xb0   00000000  00000000  00000000  00000000 *................*
+LCL+     0xc0   00000000  00000000  00000000  00000000 *................*
+LCL+     0xd0   00000000  00000000  00000000  00000000 *................*
+LCL+     0xe0   00000000  00000000  00000000  00000000 *................*
+LCL+     0xf0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x100   00000000  00000000  00000000  00000000 *................*
+LCL+    0x110   00000000  00000000  00000000  00000000 *................*
+LCL+    0x120   00000000  00000000  00000000  00000000 *................*
+LCL+    0x130   00000000  00000000  00000000  00000000 *................*
+LCL+    0x140   00000000  00000000  00000000  00000000 *................*
+LCL+    0x150   00000000  00000000  00000000  00000000 *................*
+LCL+    0x160   00000000  00000000  00000000  00000000 *................*
+LCL+    0x170   00000000  00000000  00000000  00000000 *................*
+LCL+    0x180   00000000  00000000  00000000  00000000 *................*
+LCL+    0x190   00000000  00000000  00000000  00000000 *................*
+LCL+    0x1a0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x1b0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x1c0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x1d0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x1e0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x1f0   00000000  00000000  00000000  00000000 *................*
+LCL+    0x200   00000000  00000000  00000000  00000000 *................*
.
.
.
+LCL+  0x1fed0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1fee0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1fef0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff00   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff10   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff20   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff30   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff40   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff50   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff60   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff70   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff80   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ff90   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ffa0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ffb0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ffc0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ffd0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1ffe0   00000000  00000000  00000000  00000000 *................*
+LCL+  0x1fff0   00000000  00000000  00000000  00000000 *................*

CONFIG Register 0x7ffff7fcf000 size=0x00008000

#### CONFIG REGS (PCIeLinkPartnerRegs) #### (length=4096)
+CFG+        0   00000000  00000000  00000000  00000000 *................*
+CFG+     0x10   00000000  00000000  00000000  00000000 *................*
+CFG+     0x20   00000000  00000000  00000000  00000000 *................*
+CFG+     0x30   00000000  00000000  00000000  00000000 *................*
+CFG+     0x40   00000000  00000000  00000000  00000000 *................*
+CFG+     0x50   00000000  00000000  00000000  00000000 *................*
```

```
+CFG+     0x60   00000004  00000004  00000008  00000008 *................*
+CFG+     0x70   00000000  00000000  00000000  00000000 *................*
+CFG+     0x80   00000000  00000000  00000000  00000000 *................*
+CFG+     0x90   00000000  00000000  00000000  00000000 *................*
+CFG+     0xa0   00000000  00000000  00000000  00000000 *................*
+CFG+     0xb0   00000000  00000000  00000000  00000000 *................*
+CFG+     0xc0   00000000  00000000  00000000  00000000 *................*
+CFG+     0xd0   00000000  00000000  00000000  00000000 *................*
+CFG+     0xe0   00000004  00000004  00000008  00000008 *................*
+CFG+     0xf0   00000000  00000000  00000000  00000000 *................*
+CFG+    0x100   00000000  00000000  00000000  00000000 *................*
+CFG+    0x110   00000000  00000000  00000000  00000000 *................*
+CFG+    0x120   00000000  00000000  00000000  00000000 *................*
+CFG+    0x130   00000000  00000000  00000000  00000000 *................*
+CFG+    0x140   00000000  00000000  00000000  00000000 *................*
+CFG+    0x150   00000000  00000000  00000000  00000000 *................*
+CFG+    0x160   00000000  00000000  00000000  00000000 *................*
+CFG+    0x170   00000000  00000000  00000000  00000000 *................*
+CFG+    0x180   00000000  00000000  00000000  00000000 *................*
+CFG+    0x190   00000000  00000000  00000000  00000000 *................*
+CFG+    0x1a0   00000000  00000000  00000000  00000000 *................*
+CFG+    0x1b0   00000000  00000000  00000000  00000000 *................*
+CFG+    0x1c0   00000000  00000000  00000000  00000000 *................*
.
.
.
+CFG+    0xf00   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf10   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf20   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf30   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf40   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf50   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf60   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf70   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf80   00000000  00000000  00000000  00000000 *................*
+CFG+    0xf90   00000000  00000000  00000000  00000000 *................*
+CFG+    0xfa0   00000000  00000000  00000000  00000000 *................*
+CFG+    0xfb0   00000000  00000000  00000000  00000000 *................*
+CFG+    0xfc0   00000000  00000000  00000000  00000000 *................*
+CFG+    0xfd0   00000000  00000000  00000000  00000000 *................*
+CFG+    0xfe0   00000000  00000000  00000000  00000000 *................*
+CFG+    0xff0   00000000  00000000  00000000  00000000 *................*

#### CONFIG REGS (AvalonMM_2_PCIeAddrTrans) #### (length=4096)
+CFG+   0x1000   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1010   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1020   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1030   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1040   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1050   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1060   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1070   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1080   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1090   00000000  00000000  00000000  00000000 *................*
+CFG+   0x10a0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x10b0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x10c0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x10d0   00000000  00000000  00000000  00000000 *................*
.
.
.
```

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+CFG+   0x1f50   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1f60   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1f70   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1f80   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1f90   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1fa0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1fb0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1fc0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1fd0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1fe0   00000000  00000000  00000000  00000000 *................*
+CFG+   0x1ff0   00000000  00000000  00000000  00000000 *................*


#### CONFIG REGS (DMA Control Table) #### (length=64)
+CFG+   0x4000   00000011  0000700c  008ac000  00000000 *......p.........*
+CFG+   0x4010   00000000  00000000  00000000  00000000 *................*
+CFG+   0x4020   00000011  0000fff0  00827ff0  00000000 *................*
+CFG+   0x4030   00000000  00000000  00000000  00000000 *................*


======= LOCAL REGISTERS =========
    BoardInfo                                           =0x93500101  @0x00000000
    FirmwareDate                                        =0x04032019  @0x00000004
    FirmwareRevision                                    =0x00020000  @0x00000008
    FirmwareTime                                        =0x00000000  @0x0000000c
    FirmwareFlavorCode                                  =0x00000000  @0x00000010
    NumberMsgDmaDescriptors                             =0x00000000  @0x00000018
    BoardCSR                                            =0x00000000  @0x00002000
    InterruptStatus                                     =0x00000000  @0x00002010
    SPI_CommandStatus                                   =0x03004000  @0x000020f0
    SPI_FirmwareAddress                                 =0x01ffff24  @0x000020f4
    SPI_Ram[0]                                          =0x80004000  @0x00002100
    FPGA_ChipIdentification[0]                          =0x00f14102  @0x00002400
    FPGA_ChipIdentification[1]                          =0x088a0904  @0x00002404
    FPGA_ChipTemperature                                =0x00000000  @0x00002410
    ClockGen_CSR                                        =0x00000003  @0x00002500
    ClockGen_access                                     =0x000d00f4  @0x00002504
    CalibrationCSR                                      =0x00000000  @0x00002600
    TestBusControl                                      =0x00000000  @0x00002604
    ADC_InputControl                                    =0x00000000  @0x00002608
    ExternalClockCSR                                    =0x00610000  @0x00002700
    ADC_Enable                                          =0x00000001  @0x00003000
    ADC_ControlStatus[CCRTAICC_ADC_0]                   =0x00000000  @0x00003010
    ADC_ControlStatus[CCRTAICC_ADC_1]                   =0x00000000  @0x00003014
    ADC_ControlStatus[CCRTAICC_ADC_2]                   =0x00000000  @0x00003018
    ADC_ControlStatus[CCRTAICC_ADC_3]                   =0x00000000  @0x0000301c
    ADC_FifoCSR                                         =0x2001fffb  @0x00003030
    ADC_FifoThreshold                                   =0x0001ffff  @0x00003034
    ADC_FifoChannelSelect[CCRTAICC_ADC_FIFO_CHANNEL_SELECT_0_31]
                                                        =0xffffffff  @0x00003038
    ADC_FifoChannelSelect[CCRTAICC_ADC_FIFO_CHANNEL_SELECT_32_63]
                                                        =0xffffffff  @0x0000303c
    ADC_Data[CCRTAICC_ADC_CHANNEL_0]                    =0x00020004  @0x00003200
    ADC_Data[CCRTAICC_ADC_CHANNEL_1]                    =0x0001ffff  @0x00003204
    ADC_Data[CCRTAICC_ADC_CHANNEL_2]                    =0x0001ffff  @0x00003208
    ADC_Data[CCRTAICC_ADC_CHANNEL_3]                    =0x0001fffe  @0x0000320c
    ADC_Data[CCRTAICC_ADC_CHANNEL_4]                    =0x0001fffb  @0x00003210
    ADC_Data[CCRTAICC_ADC_CHANNEL_5]                    =0x0001ffff  @0x00003214
    ADC_Data[CCRTAICC_ADC_CHANNEL_6]                    =0x00020007  @0x00003218
    ADC_Data[CCRTAICC_ADC_CHANNEL_7]                    =0x00020001  @0x0000321c
    ADC_Data[CCRTAICC_ADC_CHANNEL_8]                    =0x00020000  @0x00003220
```

```
ADC_Data[CCRTAICC_ADC_CHANNEL_9]                    =0x00020000  @0x00003224
ADC_Data[CCRTAICC_ADC_CHANNEL_10]                   =0x00020000  @0x00003228
ADC_Data[CCRTAICC_ADC_CHANNEL_11]                   =0x00020000  @0x0000322c
ADC_Data[CCRTAICC_ADC_CHANNEL_12]                   =0x0001ffff  @0x00003230
ADC_Data[CCRTAICC_ADC_CHANNEL_13]                   =0x00020001  @0x00003234
ADC_Data[CCRTAICC_ADC_CHANNEL_14]                   =0x0001fffe  @0x00003238
ADC_Data[CCRTAICC_ADC_CHANNEL_15]                   =0x0001fffd  @0x0000323c
ADC_Data[CCRTAICC_ADC_CHANNEL_16]                   =0x00020007  @0x00003240
ADC_Data[CCRTAICC_ADC_CHANNEL_17]                   =0x0001fffe  @0x00003244
ADC_Data[CCRTAICC_ADC_CHANNEL_18]                   =0x00020005  @0x00003248
ADC_Data[CCRTAICC_ADC_CHANNEL_19]                   =0x0001fffa  @0x0000324c
ADC_Data[CCRTAICC_ADC_CHANNEL_20]                   =0x0001fffc  @0x00003250
ADC_Data[CCRTAICC_ADC_CHANNEL_21]                   =0x0001ffff  @0x00003254
ADC_Data[CCRTAICC_ADC_CHANNEL_22]                   =0x00020002  @0x00003258
ADC_Data[CCRTAICC_ADC_CHANNEL_23]                   =0x0001ffff  @0x0000325c
ADC_Data[CCRTAICC_ADC_CHANNEL_24]                   =0x00020001  @0x00003260
ADC_Data[CCRTAICC_ADC_CHANNEL_25]                   =0x0001fffd  @0x00003264
ADC_Data[CCRTAICC_ADC_CHANNEL_26]                   =0x0001ffff  @0x00003268
ADC_Data[CCRTAICC_ADC_CHANNEL_27]                   =0x0001fffb  @0x0000326c
ADC_Data[CCRTAICC_ADC_CHANNEL_28]                   =0x0001fffd  @0x00003270
ADC_Data[CCRTAICC_ADC_CHANNEL_29]                   =0x00020003  @0x00003274
ADC_Data[CCRTAICC_ADC_CHANNEL_30]                   =0x00020000  @0x00003278
ADC_Data[CCRTAICC_ADC_CHANNEL_31]                   =0x0001fffa  @0x0000327c
ADC_Data[CCRTAICC_ADC_CHANNEL_32]                   =0x00020003  @0x00003280
ADC_Data[CCRTAICC_ADC_CHANNEL_33]                   =0x0001fffe  @0x00003284
ADC_Data[CCRTAICC_ADC_CHANNEL_34]                   =0x0001fffe  @0x00003288
ADC_Data[CCRTAICC_ADC_CHANNEL_35]                   =0x0001fffa  @0x0000328c
ADC_Data[CCRTAICC_ADC_CHANNEL_36]                   =0x00020000  @0x00003290
ADC_Data[CCRTAICC_ADC_CHANNEL_37]                   =0x0001ffff  @0x00003294
ADC_Data[CCRTAICC_ADC_CHANNEL_38]                   =0x00020002  @0x00003298
ADC_Data[CCRTAICC_ADC_CHANNEL_39]                   =0x00020000  @0x0000329c
ADC_Data[CCRTAICC_ADC_CHANNEL_40]                   =0x00020000  @0x000032a0
ADC_Data[CCRTAICC_ADC_CHANNEL_41]                   =0x00020001  @0x000032a4
ADC_Data[CCRTAICC_ADC_CHANNEL_42]                   =0x00020000  @0x000032a8
ADC_Data[CCRTAICC_ADC_CHANNEL_43]                   =0x00020004  @0x000032ac
ADC_Data[CCRTAICC_ADC_CHANNEL_44]                   =0x00020003  @0x000032b0
ADC_Data[CCRTAICC_ADC_CHANNEL_45]                   =0x00020005  @0x000032b4
ADC_Data[CCRTAICC_ADC_CHANNEL_46]                   =0x00020001  @0x000032b8
ADC_Data[CCRTAICC_ADC_CHANNEL_47]                   =0x00020003  @0x000032bc
ADC_Data[CCRTAICC_ADC_CHANNEL_48]                   =0x00020001  @0x000032c0
ADC_Data[CCRTAICC_ADC_CHANNEL_49]                   =0x00020000  @0x000032c4
ADC_Data[CCRTAICC_ADC_CHANNEL_50]                   =0x0001ffff  @0x000032c8
ADC_Data[CCRTAICC_ADC_CHANNEL_51]                   =0x00020001  @0x000032cc
ADC_Data[CCRTAICC_ADC_CHANNEL_52]                   =0x00020005  @0x000032d0
ADC_Data[CCRTAICC_ADC_CHANNEL_53]                   =0x00020001  @0x000032d4
ADC_Data[CCRTAICC_ADC_CHANNEL_54]                   =0x00020003  @0x000032d8
ADC_Data[CCRTAICC_ADC_CHANNEL_55]                   =0x00020000  @0x000032dc
ADC_Data[CCRTAICC_ADC_CHANNEL_56]                   =0x0001fffc  @0x000032e0
ADC_Data[CCRTAICC_ADC_CHANNEL_57]                   =0x00020003  @0x000032e4
ADC_Data[CCRTAICC_ADC_CHANNEL_58]                   =0x00020004  @0x000032e8
ADC_Data[CCRTAICC_ADC_CHANNEL_59]                   =0x0001fffe  @0x000032ec
ADC_Data[CCRTAICC_ADC_CHANNEL_60]                   =0x00020009  @0x000032f0
ADC_Data[CCRTAICC_ADC_CHANNEL_61]                   =0x00020001  @0x000032f4
ADC_Data[CCRTAICC_ADC_CHANNEL_62]                   =0x0001fffc  @0x000032f8
ADC_Data[CCRTAICC_ADC_CHANNEL_63]                   =0x00020000  @0x000032fc
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_0]     =0x8004959d  @0x00003500
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_1]     =0x7ffeeefe  @0x00003504
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_2]     =0x8003dfb0  @0x00003508
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_3]     =0x7ffbeeca  @0x0000350c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_4]     =0x8003aeae  @0x00003510
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_5]     =0x800344ac  @0x00003514
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```
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_6]    =0x800014f7  @0x00003518
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_7]    =0x8003cf21  @0x0000351c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_8]    =0x7ffe4793  @0x00003520
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_9]    =0x7ffe175d  @0x00003524
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_10]   =0x7ffcbc38  @0x00003528
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_11]   =0x7ffbda07  @0x0000352c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_12]   =0x80047fda  @0x00003530
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_13]   =0x7ffee98d  @0x00003534
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_14]   =0x8009981b  @0x00003538
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_15]   =0x800af6f4  @0x0000353c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_16]   =0x80011262  @0x00003540
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_17]   =0x80045ac7  @0x00003544
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_18]   =0x7ffe93b5  @0x00003548
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_19]   =0x8006d462  @0x0000354c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_20]   =0x80038314  @0x00003550
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_21]   =0x8006361d  @0x00003554
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_22]   =0x80056e8d  @0x00003558
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_23]   =0x80081733  @0x0000355c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_24]   =0x80039e55  @0x00003560
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_25]   =0x8001dd2e  @0x00003564
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_26]   =0x8001d279  @0x00003568
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_27]   =0x8005a9c4  @0x0000356c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_28]   =0x80012070  @0x00003570
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_29]   =0x7ffdbffc  @0x00003574
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_30]   =0x8008c961  @0x00003578
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_31]   =0x800789a5  @0x0000357c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_32]   =0x8002fc4a  @0x00003580
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_33]   =0x8006028d  @0x00003584
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_34]   =0x8004af63  @0x00003588
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_35]   =0x80087407  @0x0000358c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_36]   =0x800178d0  @0x00003590
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_37]   =0x80069cb9  @0x00003594
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_38]   =0x7fff77a0  @0x00003598
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_39]   =0x7fff8169  @0x0000359c
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_40]   =0x80031b3a  @0x000035a0
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_41]   =0x8001049e  @0x000035a4
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_42]   =0x8005dcd7  @0x000035a8
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_43]   =0x80032bf0  @0x000035ac
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_44]   =0x8008fc4c  @0x000035b0
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_45]   =0x8002dd6c  @0x000035b4
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_46]   =0x800547f7  @0x000035b8
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_47]   =0x8002ff43  @0x000035bc
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_48]   =0x8006bef4  @0x000035c0
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_49]   =0x8001ee93  @0x000035c4
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_50]   =0x8003d0f3  @0x000035c8
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_51]   =0x7ffe7bbe  @0x000035cc
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_52]   =0x8006c500  @0x000035d0
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_53]   =0x8006e672  @0x000035d4
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_54]   =0x800434e0  @0x000035d8
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_55]   =0x80014e4e  @0x000035dc
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_56]   =0x80070db7  @0x000035e0
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_57]   =0x8008bc6b  @0x000035e4
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_58]   =0x8007cef9  @0x000035e8
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_59]   =0x80098a6c  @0x000035ec
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_60]   =0x8002ae77  @0x000035f0
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_61]   =0x80048787  @0x000035f4
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_62]   =0x80031401  @0x000035f8
ADC_PositiveCalibration[CCRTAICC_ADC_CHANNEL_63]   =0x80091408  @0x000035fc
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_0]    =0x8005d6d6  @0x00003600
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_1]    =0x7ffe7ffa  @0x00003604
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_2]    =0x80042ef8  @0x00003608
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ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_3]    =0x7ffbf550  @0x0000360c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_4]    =0x8003ee19  @0x00003610
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_5]    =0x8002f701  @0x00003614
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_6]    =0x8001357a  @0x00003618
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_7]    =0x8004b664  @0x0000361c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_8]    =0x7ffeeca7  @0x00003620
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_9]    =0x7ffe5519  @0x00003624
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_10]   =0x7ffd6b9a  @0x00003628
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_11]   =0x7ffc2d8c  @0x0000362c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_12]   =0x8004eb9e  @0x00003630
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_13]   =0x7fff3d16  @0x00003634
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_14]   =0x800a5d9a  @0x00003638
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_15]   =0x800b7359  @0x0000363c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_16]   =0x80016de6  @0x00003640
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_17]   =0x800371a5  @0x00003644
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_18]   =0x7fff4e3e  @0x00003648
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_19]   =0x80063a52  @0x0000364c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_20]   =0x8003d183  @0x00003650
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_21]   =0x8005b749  @0x00003654
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_22]   =0x80066c72  @0x00003658
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_23]   =0x800832d3  @0x0000365c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_24]   =0x80037d87  @0x00003660
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_25]   =0x8001ab7c  @0x00003664
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_26]   =0x800186a7  @0x00003668
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_27]   =0x800574de  @0x0000366c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_28]   =0x8001431f  @0x00003670
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_29]   =0x7ffd9805  @0x00003674
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_30]   =0x800923ad  @0x00003678
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_31]   =0x80074d0d  @0x0000367c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_32]   =0x800348a5  @0x00003680
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_33]   =0x8005b1c8  @0x00003684
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_34]   =0x8004486c  @0x00003688
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_35]   =0x8007e53e  @0x0000368c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_36]   =0x800172a5  @0x00003690
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_37]   =0x80061e9d  @0x00003694
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_38]   =0x7fffdc94  @0x00003698
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_39]   =0x7ffee5b0  @0x0000369c
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_40]   =0x80027472  @0x000036a0
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_41]   =0x80009319  @0x000036a4
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_42]   =0x8005e276  @0x000036a8
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_43]   =0x800298cc  @0x000036ac
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_44]   =0x80097519  @0x000036b0
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_45]   =0x80027131  @0x000036b4
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_46]   =0x8005d3fd  @0x000036b8
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_47]   =0x8002de03  @0x000036bc
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_48]   =0x80062cc2  @0x000036c0
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_49]   =0x8000a24b  @0x000036c4
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_50]   =0x800401eb  @0x000036c8
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_51]   =0x7ffdeccf  @0x000036cc
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_52]   =0x80077663  @0x000036d0
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_53]   =0x8006d3ff  @0x000036d4
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_54]   =0x80041297  @0x000036d8
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_55]   =0x80010e93  @0x000036dc
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_56]   =0x800685c6  @0x000036e0
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_57]   =0x8007d1d9  @0x000036e4
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_58]   =0x80079571  @0x000036e8
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_59]   =0x8008e3c5  @0x000036ec
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_60]   =0x8002e763  @0x000036f0
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_61]   =0x80047caa  @0x000036f4
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_62]   =0x8002a288  @0x000036f8
ADC_NegativeCalibration[CCRTAICC_ADC_CHANNEL_63]   =0x8008ee50  @0x000036fc
```

```
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_0]      =0x0003fffd  @0x00003700
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_1]      =0x0003ffff  @0x00003704
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_2]      =0x0003fffe  @0x00003708
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_3]      =0x00000000  @0x0000370c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_4]      =0x0003fffd  @0x00003710
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_5]      =0x0003ffff  @0x00003714
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_6]      =0x0003fffd  @0x00003718
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_7]      =0x0003fffe  @0x0000371c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_8]      =0x0003fffe  @0x00003720
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_9]      =0x0003ffff  @0x00003724
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_10]     =0x0003fffd  @0x00003728
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_11]     =0x0003ffff  @0x0000372c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_12]     =0x0003fffd  @0x00003730
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_13]     =0x0003ffff  @0x00003734
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_14]     =0x0003fffd  @0x00003738
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_15]     =0x0003ffff  @0x0000373c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_16]     =0x0003ffff  @0x00003740
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_17]     =0x00000001  @0x00003744
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_18]     =0x0003fffe  @0x00003748
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_19]     =0x00000001  @0x0000374c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_20]     =0x0003fffe  @0x00003750
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_21]     =0x00000001  @0x00003754
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_22]     =0x0003fffe  @0x00003758
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_23]     =0x0003ffff  @0x0000375c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_24]     =0x0003ffff  @0x00003760
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_25]     =0x0003ffff  @0x00003764
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_26]     =0x0003ffff  @0x00003768
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_27]     =0x00000001  @0x0000376c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_28]     =0x0003fffe  @0x00003770
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_29]     =0x00000000  @0x00003774
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_30]     =0x0003ffff  @0x00003778
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_31]     =0x0003ffff  @0x0000377c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_32]     =0x0003ffff  @0x00003780
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_33]     =0x00000001  @0x00003784
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_34]     =0x0003ffff  @0x00003788
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_35]     =0x00000000  @0x0000378c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_36]     =0x00000000  @0x00003790
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_37]     =0x00000001  @0x00003794
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_38]     =0x0003ffff  @0x00003798
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_39]     =0x00000001  @0x0000379c
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_40]     =0x00000001  @0x000037a0
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_41]     =0x00000001  @0x000037a4
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_42]     =0x0003ffff  @0x000037a8
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_43]     =0x00000001  @0x000037ac
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_44]     =0x0003ffff  @0x000037b0
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_45]     =0x00000001  @0x000037b4
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_46]     =0x0003fffd  @0x000037b8
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_47]     =0x0003fffe  @0x000037bc
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_48]     =0x00000001  @0x000037c0
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_49]     =0x00000002  @0x000037c4
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_50]     =0x0003fffe  @0x000037c8
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_51]     =0x00000001  @0x000037cc
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_52]     =0x0003fffe  @0x000037d0
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_53]     =0x00000000  @0x000037d4
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_54]     =0x00000000  @0x000037d8
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_55]     =0x00000001  @0x000037dc
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_56]     =0x00000000  @0x000037e0
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_57]     =0x00000002  @0x000037e4
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_58]     =0x00000000  @0x000037e8
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_59]     =0x00000002  @0x000037ec
ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_60]     =0x0003fffe  @0x000037f0
```

```
    ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_61]     =0x0003ffff  @0x000037f4
    ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_62]     =0x0003ffff  @0x000037f8
    ADC_OffsetCalibration[CCRTAICC_ADC_CHANNEL_63]     =0x0003ffff  @0x000037fc
    ADC_FifoData                                       =0x0501fffb  @0x00003400
    SDRAM_Enable                                       =0x00000000  @0x00007000
    SDRAM_CSR                                          =0x00000000  @0x00007004
    SDRAM_Address                                      =0x00000000  @0x00007008
    SDRAM_Data                                         =0x00000000  @0x0000700c
    DiagRam[0]                                         =0xface0000  @0x00008000
    FpgawbRevision                                     =0x00000000  @0x0001f000

======= CONFIG REGISTERS =========
    PcieLinkPartners.a2p_interrupt_status              =0x00000000  @0x00000040
    PcieLinkPartners.a2p_interrupt_enable              =0x00000000  @0x00000050

#### PCIe Link Partners (p2a_mailbox) #### (length=32)
+P2A+    0x800   00000000  00000000  00000000  00000000 *................*
+P2A+    0x810   00000000  00000000  00000000  00000000 *................*

#### PCIe Link Partners (a2p_mailbox) #### (length=32)
+A2P+    0x900   00000000  00000000  00000000  00000000 *................*
+A2P+    0x910   00000000  00000000  00000000  00000000 *................*
    DMAengine[CCRTAICC_DMA0].dma_status                =0x00000011  @0x00004000
    DMAengine[CCRTAICC_DMA0].dma_readaddress           =0x0000700c  @0x00004004
    DMAengine[CCRTAICC_DMA0].dma_writeaddress          =0x008ac000  @0x00004008
    DMAengine[CCRTAICC_DMA0].dma_length                =0x00000000  @0x0000400c
    DMAengine[CCRTAICC_DMA0].dma_control               =0x00000000  @0x00004018

    DMAengine[CCRTAICC_DMA1].dma_status                =0x00000011  @0x00004020
    DMAengine[CCRTAICC_DMA1].dma_readaddress           =0x0000fff0  @0x00004024
    DMAengine[CCRTAICC_DMA1].dma_writeaddress          =0x00827ff0  @0x00004028
    DMAengine[CCRTAICC_DMA1].dma_length                =0x00000000  @0x0000402c
    DMAengine[CCRTAICC_DMA1].dma_control               =0x00000000  @0x00004038

    MsgDmaDispatcherCsr.Status                         =0x00000000  @0x00004200
    MsgDmaDispatcherCsr.Control                        =0x00000000  @0x00004204
    MsgDmaDispatcherCsr.ReadFillLevel                  =0x00000000  @0x00004208
    MsgDmaDispatcherCsr.WriteFillLevel                 =0x00000000  @0x0000420a
    MsgDmaDispatcherCsr.ResponseFillLevel              =0x00000000  @0x0000420c
    MsgDmaDispatcherCsr.ReadSequenceNumber             =0x00000000  @0x00004210
    MsgDmaDispatcherCsr.WriteSequenceNumber            =0x00000000  @0x00004212

    MsgDmaPrefetcherCsr.Control                        =0x00000000  @0x00004220
    MsgDmaPrefetcherCsr.NextDescriptorPointerLow       =0x00000000  @0x00004224
    MsgDmaPrefetcherCsr.NextDescriptorPointerHigh      =0x00000000  @0x00004228
    MsgDmaPrefetcherCsr.DescriptorPollingFrequency     =0x00000000  @0x0000422c
    MsgDmaPrefetcherCsr.Status                         =0x00000000  @0x00004230

    === Descriptor at offset 0 ===
    MsgDmaExtendedDescriptor[Id].ReadAddressLow        =0x00000000  @0x00004800
    MsgDmaExtendedDescriptor[Id].WriteAddressLow       =0x00000000  @0x00004804
    MsgDmaExtendedDescriptor[Id].Length                =0x00000000  @0x00004808
    MsgDmaExtendedDescriptor[Id].NextDescriptorPointerLow
                                                       =0x00000000  @0x0000480c
    MsgDmaExtendedDescriptor[Id].ActualBytesTransferred=0x00000000  @0x00004810
    MsgDmaExtendedDescriptor[Id].Status                =0x00000000  @0x00004814
    MsgDmaExtendedDescriptor[Id].SequenceNumber        =0x00000000  @0x0000481c
    MsgDmaExtendedDescriptor[Id].ReadBurstCount        =0x00000000  @0x0000481e
    MsgDmaExtendedDescriptor[Id].WriteBurstCount       =0x00000000  @0x0000481f
    MsgDmaExtendedDescriptor[Id].ReadStride            =0x00000000  @0x00004820
    MsgDmaExtendedDescriptor[Id].WriteStride           =0x00000000  @0x00004822
```

```
MsgDmaExtendedDescriptor[Id].ReadAddressHigh       =0x00000000  @0x00004824
MsgDmaExtendedDescriptor[Id].WriteAddressHigh      =0x00000000  @0x00004828
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerHigh
                                                   =0x00000000  @0x0000482c
MsgDmaExtendedDescriptor[Id].Control               =0x00000000  @0x0000483c
=== Descriptor at offset 1 ===
MsgDmaExtendedDescriptor[Id].ReadAddressLow        =0x00000000  @0x00004840
MsgDmaExtendedDescriptor[Id].WriteAddressLow       =0x00000000  @0x00004844
MsgDmaExtendedDescriptor[Id].Length                =0x00000000  @0x00004848
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerLow
                                                   =0x00000000  @0x0000484c
MsgDmaExtendedDescriptor[Id].ActualBytesTransferred=0x00000000  @0x00004850
MsgDmaExtendedDescriptor[Id].Status                =0x00000000  @0x00004854
MsgDmaExtendedDescriptor[Id].SequenceNumber        =0x00000000  @0x0000485c
MsgDmaExtendedDescriptor[Id].ReadBurstCount        =0x00000000  @0x0000485e
MsgDmaExtendedDescriptor[Id].WriteBurstCount       =0x00000000  @0x0000485f
MsgDmaExtendedDescriptor[Id].ReadStride            =0x00000000  @0x00004860
MsgDmaExtendedDescriptor[Id].WriteStride           =0x00000000  @0x00004862
MsgDmaExtendedDescriptor[Id].ReadAddressHigh       =0x00000000  @0x00004864
MsgDmaExtendedDescriptor[Id].WriteAddressHigh      =0x00000000  @0x00004868
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerHigh
                                                   =0x00000000  @0x0000486c
MsgDmaExtendedDescriptor[Id].Control               =0x00000000  @0x0000487c

=== Descriptor at offset 2 ===
MsgDmaExtendedDescriptor[Id].ReadAddressLow        =0x00000000  @0x00004880
MsgDmaExtendedDescriptor[Id].WriteAddressLow       =0x00000000  @0x00004884
MsgDmaExtendedDescriptor[Id].Length                =0x00000000  @0x00004888
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerLow
                                                   =0x00000000  @0x0000488c
MsgDmaExtendedDescriptor[Id].ActualBytesTransferred=0x00000000  @0x00004890
MsgDmaExtendedDescriptor[Id].Status                =0x00000000  @0x00004894
MsgDmaExtendedDescriptor[Id].SequenceNumber        =0x00000000  @0x0000489c
MsgDmaExtendedDescriptor[Id].ReadBurstCount        =0x00000000  @0x0000489e
MsgDmaExtendedDescriptor[Id].WriteBurstCount       =0x00000000  @0x0000489f
MsgDmaExtendedDescriptor[Id].ReadStride            =0x00000000  @0x000048a0
MsgDmaExtendedDescriptor[Id].WriteStride           =0x00000000  @0x000048a2
MsgDmaExtendedDescriptor[Id].ReadAddressHigh       =0x00000000  @0x000048a4
MsgDmaExtendedDescriptor[Id].WriteAddressHigh      =0x00000000  @0x000048a8
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerHigh
                                                   =0x00000000  @0x000048ac
MsgDmaExtendedDescriptor[Id].Control               =0x00000000  @0x000048bc

=== Descriptor at offset 3 ===
MsgDmaExtendedDescriptor[Id].ReadAddressLow        =0x00000000  @0x000048c0
MsgDmaExtendedDescriptor[Id].WriteAddressLow       =0x00000000  @0x000048c4
MsgDmaExtendedDescriptor[Id].Length                =0x00000000  @0x000048c8
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerLow
                                                   =0x00000000  @0x000048cc
MsgDmaExtendedDescriptor[Id].ActualBytesTransferred=0x00000000  @0x000048d0
MsgDmaExtendedDescriptor[Id].Status                =0x00000000  @0x000048d4
MsgDmaExtendedDescriptor[Id].SequenceNumber        =0x00000000  @0x000048dc
MsgDmaExtendedDescriptor[Id].ReadBurstCount        =0x00000000  @0x000048de
MsgDmaExtendedDescriptor[Id].WriteBurstCount       =0x00000000  @0x000048df
MsgDmaExtendedDescriptor[Id].ReadStride            =0x00000000  @0x000048e0
MsgDmaExtendedDescriptor[Id].WriteStride           =0x00000000  @0x000048e2
MsgDmaExtendedDescriptor[Id].ReadAddressHigh       =0x00000000  @0x000048e4
MsgDmaExtendedDescriptor[Id].WriteAddressHigh      =0x00000000  @0x000048e8
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerHigh
                                                   =0x00000000  @0x000048ec
MsgDmaExtendedDescriptor[Id].Control               =0x00000000  @0x000048fc
```

```
.
.
.
=== Descriptor at offset 29 ===
MsgDmaExtendedDescriptor[Id].ReadAddressLow        =0x00000000  @0x00004f40
MsgDmaExtendedDescriptor[Id].WriteAddressLow       =0x00000000  @0x00004f44
MsgDmaExtendedDescriptor[Id].Length                =0x00000000  @0x00004f48
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerLow
                                                   =0x00000000  @0x00004f4c
MsgDmaExtendedDescriptor[Id].ActualBytesTransferred=0x00000000  @0x00004f50
MsgDmaExtendedDescriptor[Id].Status                =0x00000000  @0x00004f54
MsgDmaExtendedDescriptor[Id].SequenceNumber        =0x00000000  @0x00004f5c
MsgDmaExtendedDescriptor[Id].ReadBurstCount        =0x00000000  @0x00004f5e
MsgDmaExtendedDescriptor[Id].WriteBurstCount       =0x00000000  @0x00004f5f
MsgDmaExtendedDescriptor[Id].ReadStride            =0x00000000  @0x00004f60
MsgDmaExtendedDescriptor[Id].WriteStride           =0x00000000  @0x00004f62
MsgDmaExtendedDescriptor[Id].ReadAddressHigh       =0x00000000  @0x00004f64
MsgDmaExtendedDescriptor[Id].WriteAddressHigh      =0x00000000  @0x00004f68
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerHigh
                                                   =0x00000000  @0x00004f6c
MsgDmaExtendedDescriptor[Id].Control               =0x00000000  @0x00004f7c

=== Descriptor at offset 30 ===
MsgDmaExtendedDescriptor[Id].ReadAddressLow        =0x00000000  @0x00004f80
MsgDmaExtendedDescriptor[Id].WriteAddressLow       =0x00000000  @0x00004f84
MsgDmaExtendedDescriptor[Id].Length                =0x00000000  @0x00004f88
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerLow
                                                   =0x00000000  @0x00004f8c
MsgDmaExtendedDescriptor[Id].ActualBytesTransferred=0x00000000  @0x00004f90
MsgDmaExtendedDescriptor[Id].Status                =0x00000000  @0x00004f94
MsgDmaExtendedDescriptor[Id].SequenceNumber        =0x00000000  @0x00004f9c
MsgDmaExtendedDescriptor[Id].ReadBurstCount        =0x00000000  @0x00004f9e
MsgDmaExtendedDescriptor[Id].WriteBurstCount       =0x00000000  @0x00004f9f
MsgDmaExtendedDescriptor[Id].ReadStride            =0x00000000  @0x00004fa0
MsgDmaExtendedDescriptor[Id].WriteStride           =0x00000000  @0x00004fa2
MsgDmaExtendedDescriptor[Id].ReadAddressHigh       =0x00000000  @0x00004fa4
MsgDmaExtendedDescriptor[Id].WriteAddressHigh      =0x00000000  @0x00004fa8
MsgDmaExtendedDescriptor[Id].NextDescriptorPointerHigh
                                                   =0x00000000  @0x00004fac
MsgDmaExtendedDescriptor[Id].Control               =0x00000000  @0x00004fbc

=== Terminating Descriptor at offset 31 ===
MsgDmaTerminatingDescriptor.ReadAddressLow         =0x00000000  @0x00004fc0
MsgDmaTerminatingDescriptor.WriteAddressLow        =0x00000000  @0x00004fc4
MsgDmaTerminatingDescriptor.Length                 =0x00000000  @0x00004fc8
MsgDmaTerminatingDescriptor.NextDescriptorPointerLow
                                                   =0x00000000  @0x00004fcc
MsgDmaTerminatingDescriptor.ActualBytesTransferred =0x00000000  @0x00004fd0
MsgDmaTerminatingDescriptor.Status                 =0x00000000  @0x00004fd4
MsgDmaTerminatingDescriptor.SequenceNumber         =0x00000000  @0x00004fdc
MsgDmaTerminatingDescriptor.ReadBurstCount         =0x00000000  @0x00004fde
MsgDmaTerminatingDescriptor.WriteBurstCount        =0x00000000  @0x00004fdf
MsgDmaTerminatingDescriptor.ReadStride             =0x00000000  @0x00004fe0
MsgDmaTerminatingDescriptor.WriteStride            =0x00000000  @0x00004fe2
MsgDmaTerminatingDescriptor.ReadAddressHigh        =0x00000000  @0x00004fe4
MsgDmaTerminatingDescriptor.WriteAddressHigh       =0x00000000  @0x00004fe8
MsgDmaTerminatingDescriptor.NextDescriptorPointerHigh
                                                   =0x00000000  @0x00004fec
MsgDmaTerminatingDescriptor.Control                =0x00000000  @0x00004ffc
```

3.1.5 ccrtaicc_regedit

This is an interactive test to display and write to local, configuration and physical memory.

Usage: ./ccrtaicc_regedit [-b board]
 -b board: Board number -- default board is 0

Example display:

./ccrtaicc_regedit

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

         LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
        CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
        LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008

Initialize_Board: Firmware Rev. 0x10000 successful

Virtual Address: 0x7ffff7fd7000
   1 = Create Physical Memory         2 = Destroy Physical memory
   3 = Display Channel Data           4 = Display Driver Information
   5 = Display Physical Memory Info   6 = Display Registers (CONFIG)
   7 = Display Registers (LOCAL)      8 = Dump Physical Memory
   9 = Reset Board                   10 = Write Register (LOCAL)
  11 = Write Register (CONFIG)       12 = Write Physical Memory

Main Selection ('h'=display menu, 'q'=quit)->
```

3.1.6 ccrtaicc_tst

This is an interactive test to exercise some of the driver features.

Usage: ./ccrtaicc_tst [-b board]
 -b board: Board number -- default board is 0

Example display:

./ccrtaicc_tst

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

         LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
        CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
        LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008
Initialize_Board: Firmware Rev. 0x10000 successful

  01 = add irq                       02 = disable pci interrupts
  03 = enable pci interrupts         04 = get device error
  05 = get driver info               06 = get physical memory
  07 = init board                    08 = mmap select
  09 = mmap(CONFIG registers)        10 = mmap(LOCAL registers)
  11 = mmap(physical memory)         12 = munmap(physical memory)
```

```
  13 = no command                    14 = read operation
  15 = remove irq                    16 = reset board
  17 = restore config registers      18 = write operation

Main Selection ('h'=display menu, 'q'=quit)->
```

3.1.7 ccrtaicc_wreg

This is a simple test to write to the local registers at the user specified offset.

```
Usage: ./ccrtaicc_wreg [-b Board] [-C] [-o Offset] [-s Size] [-v Value] [-x]
 -b Board   : Board selection --  default board is 0
 -C         : Select Config Registers instead of Local Registers
 -o Offset  : Hex offset to write to -- default offset is 0x0
 -s Size    : Number of bytes to write in decimal -- default size is 0x4
 -v Value   : Hex value to write at offset -- default value is 0x0
 -x         : Do not read back just written values -- default read back values
```

Example display:

./ccrtaicc_wreg -v12345678 -o0x8000 -s400

```
Device Name: /dev/ccrtaicc0

  LOCAL REGION: Physical Addr=0xbd500000 Size=131072 (0x00020000)
 CONFIG REGION: Physical Addr=0xbd520000 Size=32768 (0x00008000)

         LOCAL: Register 0x7ffff7fd7000 Offset=0x0 Size=0x00020000
        CONFIG: Register 0x7ffff7fcf000 Offset=0x0 Size=0x00008000
        LIBPTR: Register 0x7ffff7fcd000 Offset=0x0 Size=0x00001008

Writing 0x12345678 to offset 0x8000 for 400 bytes

#### LOCAL REGS #### (length=400)
+LCL+   0x8000   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8010   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8020   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8030   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8040   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8050   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8060   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8070   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8080   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8090   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x80a0   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x80b0   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x80c0   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x80d0   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x80e0   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x80f0   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8100   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8110   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8120   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8130   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8140   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8150   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8160   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8170   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
+LCL+   0x8180   12345678  12345678  12345678  12345678 *.4Vx.4Vx.4Vx.4Vx*
```

3.1.8 Flash/ccrtaicc_flash

This program is used to burn new firmware or update the license of an already installed firmware. It can also be used to reload the firmware on the card. This must only be done at the direction of Concurrent Real-Time support team, otherwise, they could render the board useless.

```
./ccrtaicc_flash -b[Board] -B -F[!] -i -L -q -Q -r[OutFile] -R -v -w[InFile] -X
-b [Board]        : Board number. Must be specified
-B                : Reload Base Level Firmware if MultiFirmware support present
-F                : Force Read Flash:  Overwrite output file if exists
-F                : Force Write Flash: Do not abort Flash burn for header label
                    mismatch
-F!               : Force Write Flash: Serious override required to continue
                    burning
-i                : Query chip, on-board flash and InFile if specified
-L                : Update License only. (default is to update entire firmware)
-q                : Quite (non-interactive) mode
-Q                : Quite (non-interactive) mode. Also dump FPGAWB message
-r                : Read Flash and write to output file created by
                    ./ccrtaicc_flash
-r [OutFile]      : Read Flash and write to output file 'OutFile'
-R                : Reload Firmware at sector address in Flash
-R [SectorNumber] : Reload Firmware at sector address 'SectorNumber'
-v                : Enable verbose mode
-w [InFile]       : Read input FPGA file and Flash the board
-X                : Use Full File. Do not truncate for firmware write

 ======================================= Notes ========================================
 Board must be specifed. Use '-b' option
 Query option '-i' not allowed with '-B', '-R#', '-L', 'r' or '-X' options
 Firmware reload '-B' or '-R' not allowed with '-i', '-L', '-r', '-w' or '-X' options
 Firmware read flash '-r' not allowed with '-B', '-i', '-L', '-R', '-w' or '-X' options
 Base Run Level '-B' or '-R#' option not allowed with '-i', '-L', 'r', '-w' or '-X' options
 Must specify write flash option '-w' when License only option '-L' is specified
 License only option '-L' not allowed with '-B', '-i', '-R', '-w' or '-X' options
 Don't truncate file option '-X' cannot be selected with the license only update '-L' option
 Don't truncate file option '-X' can only be used with the '-w' option
 Inquiry '-i' can be used '-w' options
 ======================================================================================

e.g. ./ccrtaicc_flash -b0                 (Query chip and on-board Flash)
     ./ccrtaicc_flash -b0 -i              (Query chip and on-board Flash)
     ./ccrtaicc_flash -b0 -i -w InFile    (Query chip, on-board Flash and InFile)
     ./ccrtaicc_flash -b0 -r OutFile      (On-board FPGA ===> OutFile)
     ./ccrtaicc_flash -b0 -w InFile       (InFile ===> On-board FPGA - use truncated file)
     ./ccrtaicc_flash -b0 -w InFile -v    (InFile ===> On-board FPGA - use truncated file –
                                           verbose)
     ./ccrtaicc_flash -b0 -w InFile -X    (InFile ===> On-board FPGA - use entire file)
     ./ccrtaicc_flash -b0 -w InFile -L    (InFile ===> On-board FPGA - only license updated
                                           - interactive)
     ./ccrtaicc_flash -b0 -w InFile -L -q (InFile ===> On-board FPGA - only license updated
                                           – non-interactive)
     ./ccrtaicc_flash -b0 -R              (Reload Firmware - i.e. power-cycle the card)
                                           - Run Level
     ./ccrtaicc_flash -b0 -B              (Reload Firmware - i.e. power-cycle the card)
                                           - Base Level
     ./ccrtaicc_flash -b0 -R 0            (Reload Firmware - i.e. power-cycle the card)
                                           - Base Level
     ./ccrtaicc_flash -b0 -R 200          (Reload Firmware - i.e. power-cycle the card)
                                           - at sector 200
```

*If the installed firmware is a Multi-Level firmware and you are running at Base Level, then the only utility that will be able to access the card will be this **ccrtaicc_flash** utility. You will need to switch to Run Level before un-restricted access is allowed to the card.*

3.1.9 Flash/ccrtaicc_label

This utility is only supplied for those customers that are creating their own firmware and need to install in a RedHawk system. In its simplest form, the customer will request a License file from Concurrent Real-Time for the option to burn their custom firmware. The license file (*.lic) supplied by Concurrent Real-Time, along with the customer firmware (*.rpd) file will be supplied to this utility to create a burnable FPGA file (*.cust), that will be supplied to the *ccrtaicc_flash* utility to burn the firmware on the card.

The user can also supply the '-x' option to additionally create a license only file (*.cust.liconly) file that is associated with the firmware (.rpd). This is useful if you only wish to update the license information of a card that already has the same firmware installed. This is similar to having a (*.cust) file and using the '-L' option when running the *ccrtaicc_flash* utility.

```
./ccrtaicc_label -d[OutputDirectory] -c[ChipName] -F -i[InputFile] -K[FpgawbKey]
                 -L[LicenseFile] -m[MemberCode] -o[OutputFile]
                 -S[RunLevelSectorAddress] -t[Tag] -x
-d [OutputDirectory]       : Directory to use for Output File
-c [ChipName]              : Chip Name. One of:
                             EPCQ16 EPCQ32 EPCQ64 EPCQ128 EPCQ256 EPCQ512
                             (This option is mandatory if not specified in license file)
-F                         : Force overwriting of output file if it exists
-i [InputFile]             : Raw input file. (.rpd extension)
-K [FpgawbKey]             : Fpgawb Key is required if license contains FPGA workbench
                             restriction
-L [LicenseFile]           : License file (.lic extension) to restrict firmware access (this
                             option is mandatory)
                             If '-i' option is not specified, the license file is dumped to
                             stderr
-m [MemberCode]            : Specify Member Code (C7)
                             (This option is mandatory if not specified in license file)
-o [OutputFile]            : Use output file instead of the default file created by the
                             program
-S [RunLevelSectorAddress] : Run Level Sector Address. (This option is mandatory if not
                             specified in license file)
                           : S0=Base Level, S#=Run Level Number
-t [Tag]                   : Insert this tag name in the default file created by the program
-x                         : Create an additional License only file (*.liconly)

==== Notes ====
- Options '-L' is required. If option '-i' is not specified, license file is dumped
- Options 'c', '-m' and '-S' are required if they have not already been defined in
  LicenseFile
- You cannot specify a Run Level Sector '-S' with Single Level Firmware '-1' option
- Run Level Sector address of zero '-S0' represents the Base Level Firmware in Multi-
  Firmware support
- If option '-o' is not specified, the created customer FPGA file name will be as follows:
  <OutputDirectory>/<InputFile>_<Tag>_<Function>_<ChipName><MemberCode><RunLevel>.cust
- If the license file contains an FPGAWB restrict key, then the '-K' FpgawbKey is required

e.g. ./ccrtaicc_label -iraw_file.rpd -L LicenseFile.lic (in its simplest form)
       (output file created is: 'raw_file_<Function>_<ChipName><MemberCode><RunLevel>.cust')
     ./ccrtaicc_label -L LicenseFile.lic (this will display licensing information)
     ./ccrtaicc_label -iraw_RUN_file.rpd -ooutput_file.cust -S150 -L LicenseFile.lic
     ./ccrtaicc_label -iraw_SINGLE_file.rpd -L LicenseFile.lic
     ./ccrtaicc_label -iraw_RUN_file.rpd -ooutput_file.cust -S200 -L LicenseFile.lic
     ./ccrtaicc_label -iraw_BASE_file.rpd -S0 -L LicenseFile.lic
       (Will cause firmware to be loaded at start offset Base Run Level)
```

3.1.10 Flash/ccrtaicc_dump_license

This utility allows the customer to dump the license information from a firmware *(*.cust)* file or the *(*.liconly)* file.

```
Format: ./ccrtaicc_dump_license <Firmware file>
```

```
This utility only dumps the license information from the *.cust file
and not the *.lic license file

e.g ./ccrtaicc_dump_license AICC_EPCQ256C7S150.cust
    ./ccrtaicc_dump_license AICC_EPCQ256C7S150.cust.liconly
```

3.2 Application Program Interface (API) Access Example Tests

These set of tests are in the *.../test/lib* directory and use the API.

3.2.1 lib/ccrtaicc_adc

This test performs validation of the Analog Input ADC card.

```
Usage: ./ccrtaicc_adc [-!][-A] [-a RollingAve] [-b BoardNo] [-c StartChan,EndChan]
                      [-C AdcUpdateClock] [-d Delay] [-D DMAEngine]
                      [-E ExpInpVolt] [-f DataFormat] [-F DebugFile] [-i]
                      [-j SpeedSelect] [-l LoopCnt] [-m XferMode] [-n NumChans]
                      [-N] [-p ClockTolerance] [-s InputSignal] [-t Compare]
                      [-T TestBus] [-V MaxBoardVolts] [-X ExtClock]
 -!                      (Don't display header information)
 -A                      (Perform Auto Calibration first using reference voltage)
 -a RollingAve           (Rolling average -- default "=== None ===")
 -b BoardNo              (Board number -- default is 0)
 -c StartChan,EndChan    (Select start and end channel numbers -- default 0,63
    -c 7,16              (select channels 7 through 16 for processing
    -c 32                (select channels 32 through 63 for processing
 -C AdcUpdateClock       (select ADC update clock, a,b,c,d,e,A,B,C,D,E or 'n|N')
    -C a                 (Ch0..63=Normal Clock 0 set to MAX SPS 500000)
    -C b@20000.0/n       (Ch0..15=Normal Clock 1 at 20000 SPS, Ch16..63=No Clock)
    -C a,b,A,B           (Ch0..15=Normal Clock 0, Ch16..31 Normal Clock 1,
                          Ch32..47 Inverted Clock 0, Ch48..63 Inverted Clock 1)
    -C c,d@350000,e      (Ch0..15=Normal Clock 2 at MAX SPS 500000, Ch16..31
                          Normal Clock 3 at 350000 SPS, Ch 32-63 Normal External
                          Signal
 -d Delay                (Delay between screen refresh -- default is 0 milli-
                          seconds)
 -D DMA Engine           (DMA Engine number -- default = 0)
 -E <ExpInpVolts>@<Tol>  (Expected Input Volts@Tolerance -- default Tol=0.005000)
    +@<Tol>              (Positive Calibration Ref Volt@Tolerance)
    -@<Tol>              (Negative Calibration Ref Volt@Tolerance)
    s@<Tol>              (Requires '-s' input signal option to specify voltage
                          Volt@Tolerance)
                         (valid '-s' arguments are 'g','+','-','f','n','t')
 -f DataFormat           (select data format, '2' or 'b')
    -f b,2               (Ch0..15=Offset binary, Ch16..63=Two's complement)
    -f 2,b/2,b           (Ch0..15 & Ch32..47=Two's complement, Ch16..31 &
                          Ch48..63=Offset binary)
    -f b                 (Ch0..63=Offset binary)
 -F DebugFile            (Debug file with menu display -- default "=== None ===")
    #DebugFile           (Debug file without display (only summary) -- default
                          "=== None ===")
    @DebugFile           (Debug file without display -- default "=== None ===")
    ~DebugFile           (For gnuplot, no header or summary -- default
                          "=== None ===")
    @, # or ~            (No debug file and no display -- default "=== None ===")
 -i                      (Enable Interrupts -- default = Disable)
 -j SpeedSelect          (select data speed, 'n' or 'h')
    -j n,h,n,h           (Ch0..15 & Ch32..47=normal speed, Ch16..31 &
                          Ch48..63=high speed)
    -j h/n               (Ch0..15=normal speed, Ch16..63=high speed)
    -j h                 (Ch0..63=high speed)
 -l LoopCnt              (Loop count -- default is 0)
 -m XferMode             (Transfer Mode -- default = 'DMA Channel' for old
                          firmware, and 'MSGDMA Channel' for new firmware)
    -mdp                 (Driver:  (Channel Registers) PIO mode)
    -mdP                 (Driver:  (FIFO) PIO mode)
```

```
   -mlc                (Library: (Channel Registers) program I/O Fast Memory
                        Copy)
   -mld                (Library: (Channel Registers) DMA mode)
   -mlD                (Library: (FIFO) DMA mode)
   -mlm                (Library: (Channel Registers) Modular scatter-gather DMA
                        mode)
   -mlx                (Library: (Channel Registers) Clone (ADC->MEM) Modular
                        scatter-gather DMA mode)
   -mlz                (Library: (Channel Registers) Clone (ADC->DIAG->MEM)
                        Modular scatter-gather DMA mode)
   -mlM                (Library: (FIFO) Modular scatter-gather DMA mode)
   -mlp                (Library: (Channel Registers) PIO
   -mlP                (Library: (FIFO) PIO mode)
-N                     (Open device with O_NONBLOCK flag)
-p ClockTolerance      (select clock tolerance in parts/trillion. default is
                        system default 0.0070)
-s InputSignal         (select input signal, 'e', 'g', '+', '-', 'f', '-n',
                        't', 'o')
   -s g                (All channels set to ground calibration)
   -s e                (All channels set to external input)
   -s +                (All channels set to positive 9.91V reference
                        calibration)
   -s -                (All channels set to negative 9.91V reference
                        calibration)
   -s f                (All channels set to positive 5V reference calibration)
   -s n                (All channels set to negative 5V reference calibration)
   -s t                (All channels set to positive 2V reference calibration)
   -s o                (Calibration Bus Open)
-t Compare             (Compare two channels for +/- -- default is
                        "=== None ===")
   -t0,15              (Compare channel 0 and 15 for being in sync)
   -t5/7               (Compare channel 5 and 7 for being in sync)
   -t12,4@0.500        (Compare channel 4 and 12 for being in sync with 0.5V
                        tolerance)
-T TestBus             (Test Bus Control 'b' or 'o'. Exit after programming
                        this option)
   -T b                (Calibration Bus Control)
   -T o                (Open Bus Control)
-V MaxBoardVolts       (Voltage range 'b5', 'u5', 'b10' or 'u10')
   -V b5,b10           (Ch0..15=+/-5V, Ch16..63=+/-10V)
   -V u5/u10/b5,b10    (Ch0..15=+5V, Ch16..31=+10V, Ch32..47=+/-5V,
                        Ch48..63=+/-10V)
   -V b10              (Ch0..63=+/-10V)
-X[0..3,e|E,n|N]       (Board External Clock Output Selection)
                          '0..3' - Clock Generator Output Number
                          'e|E'  - External clock input (redrive)
                          'n|N'  - No Clock

e.g. ./ccrtaicc_adc -A -Ca@470000.0/b@12345.0 -s+ (Autocal, ADC0=470000Hz, ADC1,
                                                   ADC2, ADC3=12345Hz Positive
                                                   9.91v Cal.)
     ./ccrtaicc_adc -A -Ca -s+ -E+                (Autocal, Max Clock for all 4
                                                   ADC, Positive cal. input,
                                                   validate result)
     ./ccrtaicc_adc -A -Ca -s- -t0,15 -a100       (Autocal, Max Clock for all 4
                                                   ADC, Negative cal. input,
                                                   compare ch0 and ch15, rolling
                                                   ave=100)
     ./ccrtaicc_adc -Ca,b,n -s+ -c15,21           (Max Clock for ADC0 & ADC1,
                                                   ADC2,ADC3 OFF, Positive cal.
                                                   input, display channels 15
```

```
                                                    through 21)
            ./ccrtaicc_adc -Ca -Vb10 -s- -Es        (Max Clock for all 4 ADC, -
                                                    9.91V input, validate against
                                                    -9.91V)
            ./ccrtaicc_adc -Ca -Vb10 -st -Es        (Max Clock for all 4 ADC, +2V
                                                    input, validate against +2V)
```

Example display:

./ccrtaicc_adc -A -Ca@470000,b@12345.0 -s+

```
local_ptr=0x7ffff7fbf000
           Physical Memory Information:
             UserPID         =13487
             PhysMemPtr      =0x2e218000
             DriverVirtMemPtr=0xffff917a2e218000
             MmapedUserMemPtr=0x7ffff7feb000
             PhysMemSize     =0x00001000
             PhysMemSizeFreed=0x00000000
             EntryInTxTbl    =0
             NumOfEntriesUsed=1
             Flags           =0x0000
Auto Calibration started...done. (2.576 seconds)

 Auto Calibration      [-A]: Performed
 Board Number          [-b]: 0
 Channel Selection     [-c]: Start=Ch0, End=Ch63 (Number of Active Channels=64)
                           : Active Channel Mask=0xffffffffffffffff
 Update Clock Selected [-C]: Ch00..15 [00]Normal Clock 0     (470000.000 SPS)
                           : Ch16..31 [01]Normal Clock 1     (12345.000 SPS)
                           : Ch32..47 [01]Normal Clock 1     (12345.000 SPS)
                           : Ch48..63 [01]Normal Clock 1     (12345.000 SPS)
 Delay                 [-d]: 0 milli-seconds
 DMA Engine            [-D]: 0
 Expected Input Volts  [-E]: === Not Specified ===
 Data Format           [-f]: Ch00..15 [0]Offset binary
                           : Ch16..31 [0]Offset binary
                           : Ch32..47 [0]Offset binary
                           : Ch48..63 [0]Offset binary
 Interrupts            [-i]: Disabled
 Speed Select          [-j]: Ch00..15 [0]Normal Speed
                           : Ch16..31 [0]Normal Speed
                           : Ch32..47 [0]Normal Speed
                           : Ch48..63 [0]Normal Speed
 Transfer Mode         [-m]: Library: (Channels Registers) MODULAR SCATTER-GATHER DMA I/O
 Clock Tolerance       [-p]: 0.0070 (parts/trillion)
 Input Signal          [-s]: [1]Calibration Bus (0x01: Positive 9.91)
 Voltage Range         [-V]: Ch00..15 [1]+/-10 Volts
                           : Ch16..31 [1]+/-10 Volts
                           : Ch32..47 [1]+/-10 Volts
                           : Ch48..63 [1]+/-10 Volts
 External Clock Output [-X]: 7 (No Clock)
 Scan Count                : 18459          (0:00:02:07)
 Read Duration (microsecs) : TotalDelta:     5.019 (min=   4.903/max=  13.026/ave=   4.998)

          ##### Raw Data #####
          [0]       [1]       [2]       [3]       [4]       [5]       [6]       [7]
          ======    ======    ======    ======    ======    ======    ======    ======
 [00 07]  03fb69    03fb66    03fb67    03fb66    03fb68    03fb67    03fb6c    03fb63
 [08 15]  03fb62    03fb60    03fb5f    03fb62    03fb61    03fb68    03fb64    03fb65
 [16 23]  03fb56    03fb58    03fb59    03fb58    03fb56    03fb59    03fb5a    03fb57
```

```
 [24 31]  03fb59    03fb5e    03fb58    03fb5c    03fb5e    03fb62    03fb5f    03fb5b
 [32 39]  03fb5f    03fb62    03fb60    03fb5e    03fb5f    03fb5e    03fb5f    03fb62
 [40 47]  03fb63    03fb66    03fb60    03fb60    03fb63    03fb63    03fb60    03fb68
 [48 55]  03fb61    03fb63    03fb61    03fb62    03fb69    03fb64    03fb64    03fb66
 [56 63]  03fb66    03fb63    03fb65    03fb65    03fb66    03fb67    03fb66    03fb64

          ##### Volts #####
          [0]       [1]       [2]       [3]       [4]       [5]       [6]       [7]
          =======   =======   =======   =======   =======   =======   =======   =======
 [00 07]  +9.9107   +9.9106   +9.9106   +9.9102   +9.9105   +9.9103   +9.9102   +9.9104
 [08 15]  +9.9104   +9.9103   +9.9104   +9.9105   +9.9102   +9.9104   +9.9105   +9.9102
 [16 23]  +9.9091   +9.9091   +9.9093   +9.9096   +9.9093   +9.9094   +9.9094   +9.9094
 [24 31]  +9.9095   +9.9099   +9.9093   +9.9098   +9.9100   +9.9098   +9.9096   +9.9093
 [32 39]  +9.9096   +9.9098   +9.9097   +9.9095   +9.9096   +9.9095   +9.9096   +9.9098
 [40 47]  +9.9099   +9.9101   +9.9097   +9.9097   +9.9099   +9.9099   +9.9097   +9.9103
 [48 55]  +9.9097   +9.9099   +9.9097   +9.9098   +9.9104   +9.9100   +9.9100   +9.9101
 [56 63]  +9.9101   +9.9099   +9.9100   +9.9100   +9.9101   +9.9102   +9.9101   +9.9100

=========================================================
                   Date: Thu Jan 20 09:47:01 2022
   Expected Input Volts: === Not Specified ===
           Scan Counter: 55965
   WorstMinChanVoltsHWM:   9.895782 (Ch06)
   WorstMaxChanVoltsHWM:   9.918900 (Ch16)
=========================================================
      <----------- (volts) ----------->   Tolerance
Chan  Min          Max          Ave          Exceeded Count
====  =========    =========    =========    ==============
 00    9.895782     9.915771     9.909987         -
 01    9.896393     9.915543     9.909997         -
 02    9.896774     9.915314     9.909991         -
 03    9.896698     9.915085     9.909970         -
 04    9.896164     9.915161     9.910016         -
 05    9.896393     9.915390     9.910015         -
 06    9.895782     9.915237     9.909967         -
 07    9.896317     9.915237     9.909908         -
 08    9.895782     9.915161     9.910003         -
 09    9.896164     9.915237     9.909959         -
 10    9.896088     9.915161     9.909943         -
 11    9.896088     9.915619     9.910010         -
 12    9.896240     9.915466     9.909952         -
 13    9.896317     9.915543     9.909954         -
 14    9.896088     9.916077     9.909937         -
 15    9.896317     9.915695     9.909937         -
 16    9.901276     9.918900     9.909981         -
 17    9.899597     9.918518     9.910027         -
 18    9.900284     9.918900     9.909955         -
 19    9.901657     9.918137     9.909983         -
 20    9.903107     9.913330     9.910011         -
 21    9.903641     9.913406     9.910003         -
 22    9.903336     9.913254     9.909988         -
 23    9.903488     9.913101     9.909962         -
 24    9.903030     9.913101     9.909992         -
 25    9.903717     9.913254     9.909982         -
 26    9.903259     9.913025     9.910018         -
 27    9.903336     9.913025     9.909963         -
 28    9.903259     9.912949     9.909983         -
 29    9.903717     9.913101     9.910005         -
 30    9.903488     9.913101     9.909963         -
 31    9.903336     9.913177     9.909955         -
 32    9.903564     9.912949     9.910012         -
```

```
 33    9.903946    9.912796    9.909997       -
 34    9.903641    9.913254    9.909971       -
 35    9.903641    9.912949    9.909987       -
 36    9.903336    9.913025    9.909987       -
 37    9.904099    9.912949    9.910007       -
 38    9.903946    9.912872    9.910023       -
 39    9.903946    9.913025    9.910024       -
 40    9.904022    9.912796    9.910010       -
 41    9.904251    9.913177    9.909980       -
 42    9.903946    9.912949    9.909962       -
 43    9.903717    9.912949    9.909952       -
 44    9.904099    9.912643    9.909999       -
 45    9.904099    9.912796    9.909987       -
 46    9.903946    9.912796    9.909954       -
 47    9.903717    9.912949    9.909981       -
 48    9.904022    9.912872    9.909993       -
 49    9.903946    9.912720    9.909958       -
 50    9.903717    9.913635    9.909989       -
 51    9.904099    9.913330    9.909939       -
 52    9.903946    9.912643    9.910003       -
 53    9.904251    9.912872    9.909996       -
 54    9.904022    9.913254    9.910019       -
 55    9.903488    9.913025    9.910024       -
 56    9.903641    9.912796    9.909969       -
 57    9.903946    9.913025    9.909982       -
 58    9.903793    9.912720    9.910011       -
 59    9.903870    9.912796    9.910001       -
 60    9.904022    9.912720    9.909960       -
 61    9.903641    9.912872    9.909961       -
 62    9.904022    9.912796    9.909946       -
 63    9.903793    9.913025    9.910001       -
=========================================================
```

./ccrtaicc_adc -mlz -Ca -s-

```
  local_ptr=0x7ffff7fbf000
            Physical Memory Information:
              UserPID         =13490
              PhysMemPtr      =0x2e218000
              DriverVirtMemPtr=0xffff917a2e218000
              MmapedUserMemPtr=0x7ffff7feb000
              PhysMemSize     =0x00001000
              PhysMemSizeFreed=0x00000000
              EntryInTxTbl    =0
              NumOfEntriesUsed=1
              Flags           =0x0000

   Auto Calibration      [-A]: Not Performed
   Board Number          [-b]: 0
   Channel Selection     [-c]: Start=Ch0, End=Ch63 (Number of Active Channels=64)
                             : Active Channel Mask=0xffffffffffffffff
   Update Clock Selected [-C]: Ch00..15 [00]Normal Clock 0     (500000.000 SPS)
                             : Ch16..31 [00]Normal Clock 0     (500000.000 SPS)
                             : Ch32..47 [00]Normal Clock 0     (500000.000 SPS)
                             : Ch48..63 [00]Normal Clock 0     (500000.000 SPS)
   Delay                 [-d]: 0 milli-seconds
   DMA Engine            [-D]: 0
   Expected Input Volts  [-E]: === Not Specified ===
   Data Format           [-f]: Ch00..15 [0]Offset binary
                             : Ch16..31 [0]Offset binary
                             : Ch32..47 [0]Offset binary
```

```
                          : Ch48..63 [0]Offset binary
 Interrupts            [-i]: Disabled
 Speed Select          [-j]: Ch00..15 [0]Normal Speed
                          : Ch16..31 [0]Normal Speed
                          : Ch32..47 [0]Normal Speed
                          : Ch48..63 [0]Normal Speed
 Transfer Mode         [-m]: Library: (Channels Registers) CLONE (ADC->DIAG->MEM) MODULAR
SCATTER-GATHER DMA I/O
 Clock Tolerance       [-p]: 0.0070 (parts/trillion)
 Input Signal          [-s]: [1]Calibration Bus (0x02: Negative 9.91)
 Voltage Range         [-V]: Ch00..15 [1]+/-10 Volts
                          : Ch16..31 [1]+/-10 Volts
                          : Ch32..47 [1]+/-10 Volts
                          : Ch48..63 [1]+/-10 Volts
 External Clock Output [-X]: 7 (No Clock)
 Scan Count                : 12846           (0:00:03:17)
 Read Duration (microsecs) : TotalDelta:     0.073 (min=   0.045/max=   0.198/ave=   0.062)

          ##### Raw Data #####
          [0]       [1]       [2]       [3]       [4]       [5]       [6]       [7]
          ======    ======    ======    ======    ======    ======    ======    ======
 [00 07]  000494    000493    00048a    000495    000493    000490    000494    00048f
 [08 15]  000494    00048d    000490    000490    000491    00048d    00048f    00048d
 [16 23]  00048c    000485    0004a0    0004a5    0004a4    0004a2    0004a2    0004a2
 [24 31]  0004a4    00049e    00049f    000499    0004a5    0004a3    0004a3    00049d
 [32 39]  0004a1    0004a1    000499    00049d    00049a    0004a0    00049a    00049c
 [40 47]  0004a4    0004a3    000495    000490    000498    000497    000496    000493
 [48 55]  000499    000495    000492    000491    000494    00048e    000494    000496
 [56 63]  000494    000494    000491    000496    000492    000490    000497    000496

          ##### Volts #####
          [0]       [1]       [2]       [3]       [4]       [5]       [6]       [7]
          =======   =======   =======   =======   =======   =======   =======   =======
 [00 07]  -9.9107   -9.9103   -9.9106   -9.9098   -9.9104   -9.9112   -9.9109   -9.9114
 [08 15]  -9.9109   -9.9112   -9.9105   -9.9107   -9.9109   -9.9107   -9.9109   -9.9101
 [16 23]  -9.9117   -9.9120   -9.9113   -9.9116   -9.9120   -9.9116   -9.9111   -9.9109
 [24 31]  -9.9116   -9.9113   -9.9114   -9.9120   -9.9110   -9.9113   -9.9114   -9.9114
 [32 39]  -9.9114   -9.9120   -9.9114   -9.9119   -9.9120   -9.9119   -9.9117   -9.9113
 [40 47]  -9.9113   -9.9108   -9.9113   -9.9113   -9.9116   -9.9109   -9.9115   -9.9111
 [48 55]  -9.9110   -9.9111   -9.9108   -9.9103   -9.9104   -9.9110   -9.9107   -9.9110
 [56 63]  -9.9106   -9.9105   -9.9100   -9.9100   -9.9104   -9.9107   -9.9100   -9.9102

=========================================================
                  Date: Thu Jan 20 09:51:08 2022
   Expected Input Volts: === Not Specified ===
           Scan Counter: 72140
   WorstMinChanVoltsHWM:  -9.913330 (Ch17)
   WorstMaxChanVoltsHWM:  -9.906998 (Ch00)
=========================================================
      <----------- (volts) ----------->   Tolerance
Chan  Min          Max          Ave          Exceeded Count
====  =========    =========    =========    ==============
 00   -9.912949    -9.906998    -9.909932        -
 01   -9.912567    -9.907303    -9.909889        -
 02   -9.912720    -9.907150    -9.909916        -
 03   -9.912796    -9.907303    -9.909836        -
 04   -9.912567    -9.907303    -9.909957        -
 05   -9.912643    -9.907532    -9.909936        -
 06   -9.912949    -9.907074    -9.909924        -
 07   -9.912720    -9.907379    -9.909959        -
 08   -9.912643    -9.907227    -9.909867        -
```

```
 09   -9.912720   -9.907379   -9.909928       -
 10   -9.912643   -9.907227   -9.909868       -
 11   -9.912567   -9.907303   -9.909837       -
 12   -9.912796   -9.907303   -9.909936       -
 13   -9.912720   -9.907303   -9.909946       -
 14   -9.912872   -9.907379   -9.909919       -
 15   -9.912720   -9.907227   -9.909870       -
 16   -9.912796   -9.907913   -9.910217       -
 17   -9.913330   -9.908142   -9.910563       -
 18   -9.912720   -9.907608   -9.910183       -
 19   -9.912949   -9.907684   -9.910139       -
 20   -9.912872   -9.908142   -9.910345       -
 21   -9.912872   -9.908066   -9.910319       -
 22   -9.912720   -9.907761   -9.910258       -
 23   -9.912872   -9.907990   -9.910303       -
 24   -9.912949   -9.907913   -9.910390       -
 25   -9.913025   -9.908218   -9.910434       -
 26   -9.913025   -9.907990   -9.910412       -
 27   -9.912796   -9.908066   -9.910390       -
 28   -9.912796   -9.908218   -9.910358       -
 29   -9.912796   -9.908295   -9.910382       -
 30   -9.912796   -9.907837   -9.910398       -
 31   -9.912796   -9.908142   -9.910387       -
 32   -9.912720   -9.908218   -9.910416       -
 33   -9.913101   -9.908295   -9.910428       -
 34   -9.912796   -9.908066   -9.910349       -
 35   -9.912720   -9.908218   -9.910366       -
 36   -9.912872   -9.908142   -9.910360       -
 37   -9.912643   -9.908371   -9.910451       -
 38   -9.912643   -9.908142   -9.910415       -
 39   -9.912643   -9.908218   -9.910495       -
 40   -9.912643   -9.908371   -9.910386       -
 41   -9.912567   -9.908142   -9.910442       -
 42   -9.912720   -9.908218   -9.910363       -
 43   -9.912567   -9.908295   -9.910357       -
 44   -9.912643   -9.908371   -9.910373       -
 45   -9.912567   -9.908295   -9.910385       -
 46   -9.912643   -9.908218   -9.910356       -
 47   -9.912491   -9.908142   -9.910365       -
 48   -9.912338   -9.908218   -9.910270       -
 49   -9.912415   -9.908447   -9.910383       -
 50   -9.912567   -9.907761   -9.910280       -
 51   -9.912643   -9.907837   -9.910264       -
 52   -9.912262   -9.908371   -9.910303       -
 53   -9.912415   -9.908371   -9.910343       -
 54   -9.912262   -9.907913   -9.910209       -
 55   -9.912567   -9.907913   -9.910195       -
 56   -9.912720   -9.908295   -9.910219       -
 57   -9.912415   -9.908371   -9.910254       -
 58   -9.912338   -9.908142   -9.910166       -
 59   -9.912872   -9.908295   -9.910184       -
 60   -9.912567   -9.908295   -9.910240       -
 61   -9.912720   -9.908295   -9.910243       -
 62   -9.912338   -9.908066   -9.910178       -
 63   -9.912567   -9.908218   -9.910193       -
=========================================================
```

3.2.2 lib/ccrtaicc_adc_calibrate

This test is useful for performing, saving and restoring ADC calibration. In order to calibrate, the clocks must be active and running for all the selected channels.

```
Usage: ./ccrtaicc_adc_calibrate [-A StartCh,EndCh] [-b board] [-i inCalFile]
                                [-o outCalFile] [-R]
 -A <StartCh,EndCh>    (perform Auto Calibration between start & end chans.
                        default = 0,63)
 -b <board>            (board #, default = 0)
 -i <In Cal File>      (input calibration file [input->board_reg])
 -o <Out Cal File>     (output calibration file [board_reg->output])
 -R                    (reset calibration data)

 e.g. ./ccrtaicc_adc_calibrate              (Dump calibration information to
                                             stdout)
      ./ccrtaicc_adc_calibrate -A -o Calfile (Perform Auto calibration and dump
                                             information to 'Calfile')
      ./ccrtaicc_adc_calibrate -i Calfile    (Update board calibration with
                                             supplied 'Calfile')
      ./ccrtaicc_adc_calibrate -A 16,31      (Perform Auto calibration on second
                                             ADC i.e. ch16..31)
      ./ccrtaicc_adc_calibrate -A ,12        (Perform Auto calibration on first
                                             ADC i.e. ch0..12)
      ./ccrtaicc_adc_calibrate -R            (Reset calibration data)
```

Example display:

./ccrtaicc_adc_calibrate -A

```
Device Name    : /dev/ccrtaicc0
Board Serial No: 687377 (0x000a7d11)
Start Channel  : 0
End Channel    : 63
Auto Calibration started...done. (0.826 seconds)

===> Dump to 'stdout'
#Date           : Tue Dec 18 11:53:26 2018

#Chan   Negative                       Offset                 Positive
#====   ========                       ======                 ========
 ch00:  1.000046280678361654281616211 -0.00022888183593750000  1.000050663948059082031250000
 ch01:  0.999962084926664829254150391  0.00000000000000000000  0.999961888883262872695922852
 ch02:  0.999896354041993618011474609 -0.00007629394531250000  0.999897750560194253921508789
 ch03:  1.000039299018681049346923828  0.00007629394531250000  1.000032507348805665969848633
 ch04:  1.000215303152799606323242188 -0.00015258789062500000  1.000227037351578474044799805
 ch05:  1.000232398509979248046875000  0.00000000000000000000  1.000233963597565889358520508
 ch06:  1.000174359418451786041259766 -0.00015258789062500000  1.000177062116563320159912109
 ch07:  0.999990142881870269775390625 -0.00007629394531250000  0.999986256472766399383544922
 ch08:  1.000093540642410516738891602 -0.00015258789062500000  1.000101460143923759460449219
 ch09:  0.999904607888311147689819336 -0.00007629394531250000  0.999918435700237751007080078
 ch10:  1.000021356157958507537841797 -0.00015258789062500000  1.000024581328034400939941406
 ch11:  0.999910922721028327941894531 -0.00007629394531250000  0.999915065709501504898071289
 ch12:  1.000108417589217424392700195 -0.00015258789062500000  1.000114621128886938095092773
 ch13:  1.000071702525019645690917969 -0.00007629394531250000  1.000082310289144515991210938
 ch14:  1.000154437962919473648071289 -0.00015258789062500000  1.000149235129356384277343750
 ch15:  1.000113883987069129943847656 -0.00015258789062500000  1.000124239362776279449462891
 ch16:  1.000155716668814420700073242 -0.00007629394531250000  1.000164224766194820404052734
 ch17:  1.000027132220566272735595703  0.00015258789062500000  1.000018282793462276458740234
 ch18:  0.999931633006781339645385742 -0.00007629394531250000  0.999930288176983594894409180
 ch19:  1.000115089118480682373046875  0.00015258789062500000  1.000108243897557258605957031
 ch20:  1.000110489781945943832397461 -0.00015258789062500000  1.000121916644275188446044922
 ch21:  1.000040223356336355209350586  0.00015258789062500000  1.000032895710319280624389648
 ch22:  1.000062614679336547851562500 -0.00015258789062500000  1.000066666398197412490844727
```

```
ch23:  1.000183795113116502761840820  0.0000000000000000000  1.000178982503712177276611328
ch24:  0.999957418534904718399047852  0.0000000000000000000  0.999956104904413223266601562
ch25:  0.999945123679935932159423828 -0.0000762939453125000  0.999955588020384311676025391
ch26:  0.999991035554558038711547852  0.0000000000000000000  0.999997129198163747787475586
ch27:  1.000172080937772989273071289  0.0000762939453125000  1.000174157321453094482421875
ch28:  1.000162992626428604125976562 -0.0000762939453125000  1.000165878795087337493896484
ch29:  1.000091203488409519195556641  0.0000762939453125000  1.000087699387222528457641602
ch30:  1.000282614957541227340698242 -0.0000762939453125000  1.000285412650555372238159180
ch31:  1.000113802030682563781738281 -0.0000762939453125000  1.000128523912280797958374023
ch32:  1.000043609645217657089233398 -0.0000762939453125000  1.000059755519032478332519531
ch33:  0.999953246209770441055297852  0.0000762939453125000  0.999960092362016439437866211
ch34:  1.000127836130559444427490234  0.0000000000000000000  1.000133277848362922668457031
ch35:  0.999941903166472911834716797  0.0000762939453125000  0.999943493865430355072021484
ch36:  0.999991669319570064544677734  0.0000762939453125000  0.999989827629178762435913086
ch37:  1.000043198000639677047729492  0.0000762939453125000  1.000050891656428575515747070
ch38:  0.999993903562426567077636719 -0.0000762939453125000  1.000003706663846969604492188
ch39:  0.999979448039084672927856445  0.0000762939453125000  0.999988916795700788497924805
ch40:  1.000092174392193555831909180  0.0000762939453125000  1.000099983066320419311523438
ch41:  1.000059309415519237518310547  0.0000762939453125000  1.000068699475377798080444336
ch42:  1.000167491380125284194946289 -0.0000762939453125000  1.000180571340024471282958984
ch43:  1.000253048259764909744262695  0.0000762939453125000  1.000258826185017824172973633
ch44:  1.000121331308037042617797852 -0.0000762939453125000  1.000130682252347469329833984
ch45:  1.000186069402843713760375977  0.0000762939453125000  1.000193846412003040313720703
ch46:  1.000097106676548719406127930 -0.0001525878906250000  1.000103554688394069671630859
ch47:  1.000041996128857135772705078 -0.0000762939453125000  1.000057924538850784301757812
ch48:  0.999975174665451049804687500  0.0000762939453125000  0.999979007523506879806518555
ch49:  1.000073832459747791290283203  0.0001525878906250000  1.000083983875811100006103516
ch50:  1.000060985330492258071899414 -0.0000762939453125000  1.000069220084697008132934570
ch51:  1.000034462660551071166992188  0.0000762939453125000  1.000042255502194166183471680
ch52:  1.000020204577594995498657227 -0.0001525878906250000  1.000030491501092910766601562
ch53:  1.000030837021768093109130859  0.0000000000000000000  1.000043619889765977859497070
ch54:  0.999996385071426630020141602  0.0000000000000000000  1.000005447771400213241577148
ch55:  0.999992591794580221176147461  0.0000762939453125000  0.999998908489942550659179688
ch56:  1.000176913104951381683349609  0.0000762939453125000  1.000179749447852373123168945
ch57:  1.000093434471637010574340820  0.0001525878906250000  1.000098186079412698745727539
ch58:  1.000042880419641733169555664 -0.0000762939453125000  1.000060809310525655746459961
ch59:  1.000205467455089092254638672  0.0001525878906250000  1.000202169176191091537475586
ch60:  1.000177376437932252883911133 -0.0000762939453125000  1.000182859599590301513671875
ch61:  1.000130820553747997997283935555 -0.0000762939453125000  1.000148957595229148864746094
ch62:  1.000131698790937662124633789 -0.0000762939453125000  1.000147680286318063735961914
ch63:  1.000189523678272962570190430 -0.0000762939453125000  1.000199154019355773925781250
```

3.2.3 lib/ccrtaicc_adc_fifo

This test performs validation of the Analog Input ADC FIFO operation of the card.

```
Usage: ./ccrtaicc_adc_fifo [-A] [-b BoardNo] [-c StartChan,EndChan]
                           [-C AdcUpdateClock] [-d Delay] [-D DMAEngine]
                           [-E ExpInpVolt] [-f DataFormat] [-F DebugFile] [-i]
                           [-j SpeedSelect] [-l LoopCnt] [-m XferMode] [-N]
                           [-p ClockTolerance] [-P FromChan,ToChan]
                           [-s InputSignal] [-S NumberOfSamples] [-T TestBus]
                           [-V MaxBoardVolts] [-w RawDataFile] [-X ExtClock]
 -A                      (Perform Auto Calibration first using reference voltage)
 -b BoardNo              (Board number -- default is 0)
 -c StartChan,EndChan    (Select start and end channel numbers -- default 0,63)
    -c 7,16              (select channels 7 through 16 for processing)
    -c 32                (select channels 32 through 63 for processing)
 -C AdcUpdateClock       (select ADC update clock, a,b,c,d,e,A,B,C,D,E or 'n|N')
    -C a                 (Ch0..63=Normal Clock 0 set to MAX SPS 500000)
    -C b@20000.0/n       (Ch0..15=Normal Clock 1 at 20000 SPS, Ch16..63=No Clock)
    -C a,b,A,B           (Ch0..15=Normal Clock 0, Ch16..31 Normal Clock 1,
                          Ch32..47 Inverted Clock 0, Ch48..63 Inverted Clock 1)
    -C c,d@350000,e      (Ch0..15=Normal Clock 2 at MAX SPS 500000, Ch16..31
                          Normal Clock 3 at 350000 SPS, Ch 32-63 Normal External
                          Signal)
```

```
-d Delay                (Delay between screen refresh -- default is 0 milli-
                         seconds)
-D DMA Engine           (DMA Engine number -- default = 0)
-E <ExpInpVolts>@<Tol>  (Expected Input Volts@Tolerance -- default Tol=0.005000)
   +@<Tol>              (Positive Calibration Ref Volt@Tolerance)
   -@<Tol>              (Negative Calibration Ref Volt@Tolerance)
   s@<Tol>              (Requires '-s' input signal option to specify voltage
                         Volt@Tolerance)
                        (valid '-s' arguments are 'g','+','-','f','n','t')
-f DataFormat           (select data format, '2' or 'b')
   -f b,2               (Ch0..7=Offset binary, Ch8..15=Two's complement)
   -f 2/b               (Ch0..7=Two's complement, Ch8..15=Offset binary)
   -f b                 (Ch0..15=Offset binary)
-F DebugFile            (Debug file with rate display -- default "=== None ===")
   @DebugFile           (Debug file without rate display -- default
                         "=== None ===")
   ~DebugFile           (For gnuplot, no header or summary -- default
                         "=== None ===")
   @ or ~               (No debug file and no rate display -- default
                         "=== None ===")
-i                      (Enable Interrupts -- default = Disable)
-j SpeedSelect          (select data speed, 'n' or 'h')
   -j n,h,n,h           (Ch0..15 & Ch32..47=normal speed, Ch16..31 &
                         Ch48..63=high speed)
   -j h/n               (Ch0..15=normal speed, Ch16..63=high speed)
   -j h                 (Ch0..63=high speed)
-l LoopCnt              (Loop count -- default is 0)
-m XferMode             (Transfer Mode -- default = Library DMA)
   -mdP                 (Driver:  (FIFO) PIO mode)
   -mlD                 (Library: (FIFO) DMA mode)
   -mlM                 (Library: (FIFO) Modular scatter-gather DMA mode)
   -mlP                 (Library: (FIFO) PIO mode)
-N                      (Open device with O_NONBLOCK flag for driver operations)
-p ClockTolerance       (select clock tolerance in parts/trillion. default is
                         system default 0.0070)
-P FromChan,ToChan      (Pair FromChan to ToChan when Debug File specified --
                         default is paired to itself)
-s InputSignal          (select input signal, 'e', 'g', '+', '-', 'f', '-n',
                         't')
   -s g                 (All channels set to ground calibration)
   -s e                 (All channels set to external input)
   -s +                 (All channels set to positive 9.91V reference
                         calibration)
   -s -                 (All channels set to negative 9.91V reference
                         calibration)
   -s f                 (All channels set to positive 5V reference calibration)
   -s n                 (All channels set to negative 5V reference calibration)
   -s t                 (All channels set to positive 2V reference calibration)
-S NumberOfSamples      (Number of Samples -- default is 49152, MsgDma is 12288)
-T TestBus              (Test Bus Control 'b' or 'o'. Exit after programming
                         this option)
   -T b                 (Calibration Bus Control)
   -T o                 (Open Bus Control)
-V MaxBoardVolts        (Voltage range 'b5', 'u5', 'b10' or 'u10')
   -V b5,b10            (Ch0..15=+/-5V, Ch16..63=+/-10V)
   -V u5/u10/b5,b10     (Ch0..15=+5V, Ch16..31=+10V, Ch32..47=+/-5V,
                         Ch48..63=+/-10V)
   -V b10               (Ch0..63=+/-10V)
-w RawDataFile          (Only raw sample data written to file)
-X[0..3,e|E,n|N]        (Board External Clock Output Selection)
                           '0..3' - Clock Generator Output Number
```

```
                          'e|E'  - External clock input (redrive)
                          'n|N'  - No Clock

 e.g. ./ccrtaicc_adc_fifo -Ca@100000,b@12345 -s+ (ADC0 is 100000Hz, ADC1, ADC2
                                                  and ADC3 is 12345Hz, all
                                                  Positive 9.91v Cal.)
      ./ccrtaicc_adc_fifo -Ca,B -P16,15 -c15,16 -F~Outfile -l100 -S50000
                                                 (ADC0=500000Hz, ADC1=Inverted
                                                  500000Hz, Channel 16 merged
                                                  into channel 15, Samples in
                                                  Outfile for gnuplot)
      ./ccrtaicc_adc_fifo -A -Ca@50000 -sf -Es   (Autocal, All channels 50000Hz,
                                                  all Positive 5V Cal, Expected
                                                  5V)
```

Example display:

./ccrtaicc_adc_fifo -Ca@100000,b@12345 -s+ -l500 *(if MsgDma is NOT supported)*

```
local_ptr=0x7ffff7fbf000
           Number of Samples =49152
           Transfer Mode     =Library DMA Mode
           Physical Memory Information:
             UserPID         =13479
             PhysMemPtr      =0x15180000
             DriverVirtMemPtr=0xffff917a15180000
             MmapedUserMemPtr=0x7ffff7f3f000
             PhysMemSize     =0x00080000
             PhysMemSizeFreed=0x00000000
             EntryInTxTbl    =0
             NumOfEntriesUsed=1
             Flags           =0x0000
    Channels: Total=64, First=0, Last=63, Adc0Chans=16, Adc1Chans=16 Adc2Chans=16,
              Adc3Chans=16
    Time in microseconds (TT=Total, WT=Work, FT=Free, RT=Read, mi=min, ma=max, av=ave)
    Measuring how long it takes to collect 49152 samples...Slow Clock...Collecting
              Samples 0    done. (22452.002 usecs)
    500: TT=22407.09 WT=22395.28 FT= 11.81 RT=8984.73 (mi=8982.44/ma=8991.53/av=8984.16)
              21.88 MB/S - EmptyCnt=110000 (84%)
=====================================================================
                   Date: Thu Jan 20 09:39:14 2022
   Expected Input Volts: === Not Specified ===
            Scan Counter: ADC0=1120881 ADC1=138373 ADC2=138373 ADC3=138373
  Approx. Sample/Second: ADC0=100000 ADC1=12345 ADC2=12345 ADC3=12345
          NumberOfChans: ADC0=16 ADC1=16 ADC2=16 ADC3=16
        Channel Pairing:  *** No pairing of any channels ***
   WorstMinChanVoltsHWM:   9.893494 (Ch04)
   WorstMaxChanVoltsHWM:   9.919968 (Ch02)
=====================================================================
      <----------- (volts) ----------->
Chan  Min         Max         Ave        DetectedCnt TolerExeededCnt
====  =========   =========   =========  =========== ===============
 00    9.894867    9.918900    9.911320      1120881       -
 01    9.896164    9.918518    9.912050      1120881       -
 02    9.897461    9.919968    9.912698      1120881       -
 03    9.895477    9.917603    9.911132      1120881       -
 04    9.893494    9.916077    9.909596      1120881       -
 05    9.893494    9.915771    9.909277      1120881       -
 06    9.894028    9.916840    9.910055      1120881       -
 07    9.895554    9.918365    9.911687      1120881       -
 08    9.894714    9.917450    9.910810      1120881       -
 09    9.896240    9.919205    9.912443      1120881       -
```

```
 10    9.895706    9.918442    9.911446      1120881       -
 11    9.896774    9.918900    9.912469      1120881       -
 12    9.895554    9.917450    9.910481      1120881       -
 13    9.895020    9.916916    9.910598      1120881       -
 14    9.894791    9.916840    9.910369      1120881       -
 15    9.894562    9.917374    9.910468      1120881       -
 16    9.901505    9.917603    9.910075       138373       -
 17    9.903107    9.918671    9.910929       138373       -
 18    9.901123    9.919510    9.912582       138373       -
 19    9.901505    9.919205    9.910526       138373       -
 20    9.904099    9.914093    9.910592       138373       -
 21    9.904633    9.914246    9.911114       138373       -
 22    9.904633    9.914474    9.911247       138373       -
 23    9.903488    9.913254    9.909916       138373       -
 24    9.906082    9.915161    9.912137       138373       -
 25    9.905777    9.915237    9.912124       138373       -
 26    9.904785    9.915085    9.911601       138373       -
 27    9.903564    9.912720    9.909703       138373       -
 28    9.903946    9.913330    9.910096       138373       -
 29    9.904480    9.913635    9.910646       138373       -
 30    9.902878    9.911728    9.908817       138373       -
 31    9.904251    9.913406    9.910407       138373       -
 32    9.905014    9.914093    9.911108       138373       -
 33    9.905930    9.914856    9.911856       138373       -
 34    9.904404    9.913559    9.910417       138373       -
 35    9.906006    9.914932    9.912107       138373       -
 36    9.905701    9.915009    9.911822       138373       -
 37    9.905090    9.914017    9.911092       138373       -
 38    9.905701    9.915009    9.911782       138373       -
 39    9.905853    9.914856    9.911769       138373       -
 40    9.904633    9.914093    9.910722       138373       -
 41    9.904861    9.913635    9.910920       138373       -
 42    9.904022    9.913177    9.910155       138373       -
 43    9.903336    9.912338    9.909232       138373       -
 44    9.904709    9.913559    9.910709       138373       -
 45    9.904022    9.912872    9.909851       138373       -
 46    9.905090    9.913788    9.910931       138373       -
 47    9.905472    9.914169    9.911337       138373       -
 48    9.906235    9.915237    9.912102       138373       -
 49    9.905167    9.914017    9.910922       138373       -
 50    9.905167    9.914246    9.911477       138373       -
 51    9.905396    9.914474    9.911523       138373       -
 52    9.905777    9.914474    9.911666       138373       -
 53    9.905319    9.914093    9.911277       138373       -
 54    9.905472    9.915237    9.912057       138373       -
 55    9.905701    9.914856    9.911901       138373       -
 56    9.904251    9.913483    9.910399       138373       -
 57    9.905319    9.913864    9.911094       138373       -
 58    9.905090    9.914551    9.911383       138373       -
 59    9.903641    9.912720    9.909688       138373       -
 60    9.904480    9.913025    9.910162       138373       -
 61    9.904709    9.913254    9.910470       138373       -
 62    9.905014    9.913483    9.910616       138373       -
 63    9.904175    9.913177    9.910060       138373       -
=====================================================================

Below are the statistics for 49152 samples:
   Estimated time to collect samples:     22452.002 usecs
   Total work time breakdown:             22435.601 usecs
      Average time to fill FIFO:          12843.171 usecs (### User blocking for FIFO to
                                                           fill  ###)
```

```
      Average time to read samples:        8984.163 usecs (### This time excludes FIFO
                                                           fill time ###)
      Average time to process samples:      598.028 usecs
      Average time other:                    10.239 usecs
   Approximate free time available:       12869.811 usecs
```

./ccrtaicc_adc_fifo -Ca@100000,b@12345 -s+ -l500 *(if MsgDma IS supported)*

```
local_ptr=0x7ffff7fbf000
           Number of Samples =12288
           Transfer Mode     =Library MODULAR SCATTER-GATHER DMA Mode
           Physical Memory Information:
             UserPID         =13472
             PhysMemPtr      =0x15180000
             DriverVirtMemPtr=0xffff917a15180000
             MmapedUserMemPtr=0x7ffff7f3f000
             PhysMemSize     =0x00080000
             PhysMemSizeFreed=0x00000000
             EntryInTxTbl    =0
             NumOfEntriesUsed=1
             Flags           =0x0000
    Channels: Total=64, First=0, Last=63, Adc0Chans=16, Adc1Chans=16 Adc2Chans=16,
              Adc3Chans=16
    Time in microseconds (TT=Total, WT=Work, FT=Free, RT=Read, mi=min, ma=max, av=ave)
    Measuring how long it takes to collect 12288 samples...Slow Clock...Collecting
              Samples 0    done. (5622.506 usecs)
    500: TT=5610.18 WT=5602.41 FT=  7.77 RT=131.76 (mi=130.59/ma=133.44/av=131.75)
              373.04 MB/S - EmptyCnt=130400 (99%)
======================================================================
                   Date: Thu Jan 20 09:31:14 2022
   Expected Input Volts: === Not Specified ===
            Scan Counter: ADC0=280221 ADC1=34593 ADC2=34593 ADC3=34593
  Approx. Sample/Second: ADC0=99999 ADC1=12345 ADC2=12345 ADC3=12345
           NumberOfChans: ADC0=16 ADC1=16 ADC2=16 ADC3=16
         Channel Pairing:  *** No pairing of any channels ***
   WorstMinChanVoltsHWM:   9.893646 (Ch05)
   WorstMaxChanVoltsHWM:   9.920273 (Ch18)
======================================================================
      <----------- (volts) ----------->
Chan  Min         Max         Ave        DetectedCnt TolerExeededCnt
====  =========   =========   =========  =========== ===============
00    9.894714    9.918747    9.911246       280221       -
 01    9.896393    9.918289    9.912007       280221       -
 02    9.897308    9.918976    9.912633       280221       -
 03    9.896393    9.917297    9.911092       280221       -
 04    9.893951    9.915924    9.909601       280221       -
 05    9.893646    9.915619    9.909294       280221       -
 06    9.894714    9.916534    9.910001       280221       -
 07    9.896240    9.917831    9.911672       280221       -
 08    9.895020    9.917297    9.910847       280221       -
 09    9.896545    9.918823    9.912499       280221       -
 10    9.896088    9.917755    9.911371       280221       -
 11    9.896698    9.918823    9.912450       280221       -
 12    9.895096    9.917450    9.910445       280221       -
 13    9.895630    9.916916    9.910559       280221       -
 14    9.894791    9.916840    9.910397       280221       -
 15    9.895401    9.916840    9.910540       280221       -
 16    9.903259    9.917526    9.910049        34593       -
 17    9.903336    9.918289    9.910892        34593       -
 18    9.903336    9.920273    9.912503        34593       -
```

```
 19    9.903336    9.918747    9.910459        34593       -
 20    9.904480    9.913788    9.910570        34593       -
 21    9.905014    9.914246    9.911075        34593       -
 22    9.905167    9.914474    9.911273        34593       -
 23    9.904099    9.913025    9.909992        34593       -
 24    9.906082    9.915237    9.912122        34593       -
 25    9.906158    9.915390    9.912118        34593       -
 26    9.905472    9.914627    9.911528        34593       -
 27    9.903717    9.912491    9.909618        34593       -
 28    9.904022    9.912872    9.910030        34593       -
 29    9.904633    9.913406    9.910586        34593       -
 30    9.903030    9.911575    9.908867        34593       -
 31    9.904633    9.913406    9.910431        34593       -
 32    9.905396    9.913940    9.911105        34593       -
 33    9.906158    9.914474    9.911864        34593       -
 34    9.904327    9.913712    9.910408        34593       -
 35    9.906235    9.915009    9.912106        34593       -
 36    9.906235    9.914551    9.911821        34593       -
 37    9.905167    9.913864    9.911058        34593       -
 38    9.906082    9.914398    9.911717        34593       -
 39    9.905853    9.914246    9.911670        34593       -
 40    9.904633    9.913177    9.910697        34593       -
 41    9.905243    9.913712    9.910893        34593       -
 42    9.904480    9.912720    9.910118        34593       -
 43    9.903259    9.911880    9.909184        34593       -
 44    9.905167    9.913559    9.910726        34593       -
 45    9.904022    9.912491    9.909877        34593       -
 46    9.905014    9.913864    9.910882        34593       -
 47    9.905624    9.913940    9.911305        34593       -
 48    9.906082    9.914856    9.912113        34593       -
 49    9.905090    9.913712    9.910924        34593       -
 50    9.905472    9.913940    9.911503        34593       -
 51    9.905167    9.914169    9.911531        34593       -
 52    9.906082    9.914322    9.911644        34593       -
 53    9.905624    9.913788    9.911247        34593       -
 54    9.906311    9.914856    9.912053        34593       -
 55    9.906158    9.914474    9.911903        34593       -
 56    9.904709    9.913177    9.910396        34593       -
 57    9.905396    9.913712    9.911071        34593       -
 58    9.905472    9.914093    9.911402        34593       -
 59    9.903946    9.912186    9.909713        34593       -
 60    9.904327    9.912872    9.910180        34593       -
 61    9.904633    9.913177    9.910477        34593       -
 62    9.904938    9.913101    9.910609        34593       -
 63    9.904327    9.912643    9.910071        34593       -
=====================================================================

Below are the statistics for 12288 samples:
   Estimated time to collect samples:      5622.506 usecs
   Total work time breakdown:              5604.112 usecs
      Average time to fill FIFO:           5312.594 usecs (### User blocking for FIFO to
                                                           fill  ###)
      Average time to read samples:         131.749 usecs (### This time excludes FIFO
                                                           fill time ###)
      Average time to process samples:      149.632 usecs
      Average time other:                    10.137 usecs
   Approximate free time available:        5341.125 usecs
```

3.2.4 lib/ccrtaicc_adc_sps

This is a useful tool to display the sample rate of various channels.

```
Usage: ./ccrtaicc_adc_sps [-b Board] [-c StartChan,StopChan] [-C AdcUpdateClock]
                          [-E ExpSPS@Tol] [-j SpeedSelect] [-l LoopCnt]
                          [-m XferMode] [-S NumSamples] [-T SglBrdClkLpbkTst]
                          [-X ExtClock]
 -b Board                (Board number -- default is 0)
 -c StartChan,EndChan    (Select start and end channel numners -- default 0,63
    -c 7,16              (select channels 7 through 16 for processing
    -c 32                (select channels 32 through 63 for processing
 -C AdcUpdateClock       (select ADC update clock, a,b,c,d,e,A,B,C,D,E or 'n|N')
    -C a                 (Ch0..63=Normal Clock 0 set to MAX SPS 500000)
    -C b@20000.0/n       (Ch0..15=Normal Clock 1 at 20000 SPS, Ch16..63=No Clock)
    -C a,b,A,B           (Ch0..15=Normal Clock 0, Ch16..31 Normal Clock 1,
                          Ch32..47 Inverted Clock 0, Ch48..63 Inverted Clock 1)
    -C c,d@350000,e      (Ch0..15=Normal Clock 2 at MAX SPS 500000, Ch16..31
                          Normal Clock 3 at 350000 SPS, Ch 32-63 Normal External
                          Signal
 -E ExpSPS@Tol           (specify expected samples/second and tolerance for each
                          ADC)
    -E C                 (All ADC's to use clock samples/second and default
                          tolerance 0.010%)
    -E c@0.02,30000      (ADC 0 uses clock samples/second and tolerance 0.02%,
                          remaining use 30,000 SPS and default tolerance 0.010%)
    -E C@0.02,C          (All ADC's to use clock samples/second and default
                          tolerance except for ADC 0 tolerance of 0.02%)
    -E 10000,c           (ADC 0 to use 10000 SPS, rest of ADCs to use clock
                          samples/second. Default tolerance for all ADCs)
 -F DebugFile            (Debug file with menu display -- default "=== None ===")
    @DebugFile           (Debug file without menu display (only summary and rate
                          display) -- default "=== None ===")
    @                    (No debug file and no menu display (only summary and
                          rate display) -- default "=== None ===")
 -j SpeedSelect          (select data speed, 'n' or 'h')
    -j n,h,n,h           (Ch0..15 & Ch32..47=normal speed, Ch16..31 &
                          Ch48..63=high speed)
    -j h/n               (Ch0..15=normal speed, Ch16..63=high speed)
    -j h                 (Ch0..63=high speed)
 -l LoopCnt              (Loop Count -- default is 10000000)
 -l 0                    (Loop forever)
 -m XferMode             (Transfer Mode -- default = 'DMA Channel' for old
                          firmware, 'MsgDma' for new firmware)
    -md0                 (Library: DMA 0 mode)
    -md1                 (Library: DMA 1 mode)
    -mm                  (Library: Modular Scatter-Gather DMA mode)
 -S NumSamples           (Number of Samples/Read -- default is 4096 for DMA and
                          2000 for MsgDma)
 -T                      (Single Board Clock Loopback Test - External Clock
                          In/Out requires loopback cable
 -X[0..3,e|E,n|N]        (Board External Clock Output Selection)
                             '0..3' - Clock Generator Output Number
                             'e|E'  - External clock input (redrive)
```

```
                                'n|N'  - No Clock

 e.g. ./ccrtaicc_adc_sps -Ca@123456,n,c@78912,n (ADC0 is 123456Hz, ADC1 is off,
                                                 ADC2 is 78912Hz and ADC3 is off)
```

Example display:

./ccrtaicc_adc_sps -Ca@123456,n,c@78912,n

```
local_ptr=0x7ffff7fd7000
           Physical Memory Information:
             UserPID         =21205
             PhysMemPtr      =0x615a0000
             DriverVirtMemPtr=0xffff8800615a0000
             MmapedUserMemPtr=0x7ffff7fcb000
             PhysMemSize     =0x00002000
             PhysMemSizeFreed=0x00000000
             EntryInTxTbl    =0
             NumOfEntriesUsed=1
             Flags           =0x0000

 Board Number          [-b]: 0
 Channel Selection     [-c]: Start=Ch0, End=Ch63 (Number of Active Channels=64)
                           : Active Channel Mask=0xffffffffffffffff
 Update Clock Selected [-C]: Ch00..15 [00]Normal Clock 0     (123456.000 SPS)
                           : Ch16..31 [15]### CLOCK IS NOT CONNECTED ###
                           : Ch32..47 [02]Normal Clock 2     (78912.000 SPS)
                           : Ch48..63 [15]### CLOCK IS NOT CONNECTED ###
 Speed Select          [-j]: Ch00..15 [0]Normal Speed
                           : Ch16..31 [0]Normal Speed
                           : Ch32..47 [0]Normal Speed
                           : Ch48..63 [0]Normal Speed
 Loop Count            [-l]: 10000000
 Transfer Mode         [-m]: Library: (FIFO) MODULAR SCATTER-GATHER DMA I/O
 Number of Samples     [-S]: 2000 (8000 bytes)
 Clock Loopback Test   [-T]: No
 External Clock Output [-X]: 7 (No Clock)
 Input Signal              : [0]External Signal
 Voltage Range             : Ch00..15 [1]+/-10 Volts
                           : Ch16..31 [1]+/-10 Volts
                           : Ch32..47 [1]+/-10 Volts
                           : Ch48..63 [1]+/-10 Volts
 Data Format               : Ch00..15 [0]Offset binary
                           : Ch16..31 [0]Offset binary
                           : Ch32..47 [0]Offset binary
                           : Ch48..63 [0]Offset binary

 Read: Size 8000, Count 24 (FIFO wait: 602.7us, Read time/rate: 25.3us/316.5MBPS)
          ============================== Samples/Second ==============================
          [0]       [1]       [2]       [3]       [4]       [5]       [6]       [7]
          ======    ======    ======    ======    ======    ======    ======    ======
 [00 07]  123459    123459    123459    123459    123459    123459    123459    123459
 [08 15]  123459    123459    123459    123459    123459    123459    123459    123459
 [16 23]  000000    000000    000000    000000    000000    000000    000000    000000
 [24 31]  000000    000000    000000    000000    000000    000000    000000    000000
 [32 39]  078915    078915    078915    078915    078915    078915    078915    078915
 [40 47]  078915    078915    078915    078915    078915    078915    078915    078915
 [48 55]  000000    000000    000000    000000    000000    000000    000000    000000
 [56 63]  000000    000000    000000    000000    000000    000000    000000    000000

==== No overflow occurred (HWM Samples In fifo 2368) ====

================================
       <-- (Samples/Second) -->
Chan   Min      Max      Ave
====   ======   ======   ======
  0    123450   123461   123456
```

```
 1    123450   123461   123456
 2    123450   123461   123456
 3    123450   123461   123456
 4    123450   123461   123456
 5    123450   123461   123456
 6    123450   123461   123456
 7    123450   123461   123456
 8    123450   123461   123456
 9    123450   123461   123456
10    123450   123461   123456
11    123450   123461   123456
12    123450   123461   123456
13    123450   123461   123456
14    123450   123461   123456
15    123450   123461   123456
16    000000   000000   000000
17    000000   000000   000000
18    000000   000000   000000
19    000000   000000   000000
20    000000   000000   000000
21    000000   000000   000000
22    000000   000000   000000
23    000000   000000   000000
24    000000   000000   000000
25    000000   000000   000000
26    000000   000000   000000
27    000000   000000   000000
28    000000   000000   000000
29    000000   000000   000000
30    000000   000000   000000
31    000000   000000   000000
32    078909   078915   078912
33    078909   078915   078912
34    078909   078915   078912
35    078909   078915   078912
36    078909   078915   078912
37    078909   078915   078912
38    078909   078915   078912
39    078909   078915   078912
40    078909   078915   078912
41    078909   078915   078912
42    078909   078915   078912
43    078909   078915   078912
44    078909   078915   078912
45    078909   078915   078912
46    078909   078915   078912
47    078909   078915   078912
48    000000   000000   000000
49    000000   000000   000000
50    000000   000000   000000
51    000000   000000   000000
52    000000   000000   000000
53    000000   000000   000000
54    000000   000000   000000
55    000000   000000   000000
56    000000   000000   000000
57    000000   000000   000000
58    000000   000000   000000
59    000000   000000   000000
60    000000   000000   000000
61    000000   000000   000000
62    000000   000000   000000
63    000000   000000   000000
```

./ccrtaicc_adc_sps -Ca@123456 -T // An external clock loopback cable needs to be connected

```
local_ptr=0x7ffff7fd7000
          Physical Memory Information:
            UserPID         =21353
```

```
            PhysMemPtr      =0x3fd90000
            DriverVirtMemPtr=0xffff88003fd90000
            MmapedUserMemPtr=0x7ffff7fcb000
            PhysMemSize     =0x00002000
            PhysMemSizeFreed=0x00000000
            EntryInTxTbl    =0
            NumOfEntriesUsed=1
            Flags           =0x0000

 Board Number          [-b]: 0
 Channel Selection     [-c]: Start=Ch0, End=Ch63 (Number of Active Channels=64)
                           : Active Channel Mask=0xffffffffffffffff
 Update Clock Selected [-C]: Ch00..15 [08]Normal External Signal
                           : Ch16..31 [08]Normal External Signal
                           : Ch32..47 [08]Normal External Signal
                           : Ch48..63 [08]Normal External Signal
 Speed Select          [-j]: Ch00..15 [0]Normal Speed
                           : Ch16..31 [0]Normal Speed
                           : Ch32..47 [0]Normal Speed
                           : Ch48..63 [0]Normal Speed
 Loop Count            [-l]: 10000000
 Transfer Mode         [-m]: Library: (FIFO) MODULAR SCATTER-GATHER DMA I/O
 Number of Samples     [-S]: 2000 (8000 bytes)
 Clock Loopback Test   [-T]: Yes (Loopback cable required)
 External Clock Output [-X]: 0 (Clock Generator Output 0)
 Input Signal              : [0]External Signal
 Voltage Range             : Ch00..15 [1]+/-10 Volts
                           : Ch16..31 [1]+/-10 Volts
                           : Ch32..47 [1]+/-10 Volts
                           : Ch48..63 [1]+/-10 Volts
 Data Format               : Ch00..15 [0]Offset binary
                           : Ch16..31 [0]Offset binary
                           : Ch32..47 [0]Offset binary
                           : Ch48..63 [0]Offset binary

 Read: Size 8000, Count 51 (FIFO wait: 184.2us, Read time/rate: 25.3us/316.1MBPS)
          ============================== Samples/Second ==============================
          [0]       [1]       [2]       [3]       [4]       [5]       [6]       [7]
          ======    ======    ======    ======    ======    ======    ======    ======
 [00 07]  123459    123459    123459    123459    123459    123459    123459    123459
 [08 15]  123459    123459    123459    123459    123459    123459    123459    123459
 [16 23]  123460    123460    123460    123460    123460    123460    123460    123460
 [24 31]  123460    123460    123460    123460    123460    123460    123460    123460
 [32 39]  123460    123460    123460    123460    123460    123460    123460    123460
 [40 47]  123460    123460    123460    123460    123460    123460    123460    123460
 [48 55]  123460    123460    123460    123460    123460    123460    123460    123460
 [56 63]  123460    123460    123460    123460    123460    123460    123460    123460

==== No overflow occurred (HWM Samples In fifo 3072) ====

================================
       <-- (Samples/Second) -->
Chan   Min      Max      Ave
====   ======   ======   ======
  0    123450   123463   123456
  1    123450   123463   123456
  2    123450   123463   123456
  3    123450   123463   123456
  4    123450   123463   123456
  5    123450   123463   123456
  6    123450   123463   123456
  7    123450   123463   123456
  8    123450   123463   123456
  9    123450   123463   123456
 10    123450   123463   123456
 11    123450   123463   123456
 12    123450   123463   123456
 13    123450   123463   123456
 14    123450   123463   123456
```

```
15    123450   123463   123456
16    123449   123464   123456
17    123449   123464   123456
18    123449   123464   123456
19    123449   123464   123456
20    123449   123464   123456
21    123449   123464   123456
22    123449   123464   123456
23    123449   123464   123456
24    123449   123464   123456
25    123449   123464   123456
26    123449   123464   123456
27    123449   123464   123456
28    123449   123464   123456
29    123449   123464   123456
30    123449   123464   123456
31    123449   123464   123456
32    123449   123464   123456
33    123449   123464   123456
34    123449   123464   123456
35    123449   123464   123456
36    123449   123464   123456
37    123449   123464   123456
38    123449   123464   123456
39    123449   123464   123456
40    123449   123464   123456
41    123449   123464   123456
42    123449   123464   123456
43    123449   123464   123456
44    123449   123464   123456
45    123449   123464   123456
46    123449   123464   123456
47    123449   123464   123456
48    123449   123464   123456
49    123449   123464   123456
50    123449   123464   123456
51    123449   123464   123456
52    123449   123464   123456
53    123449   123464   123456
54    123449   123464   123456
55    123449   123464   123456
56    123449   123464   123456
57    123449   123464   123456
58    123449   123464   123456
59    123449   123464   123456
60    123449   123464   123456
61    123449   123464   123456
62    123449   123464   123456
63    123449   123464   123456
```

3.2.5 lib/ccrtaicc_check_bus

This is a simple test to check whether there is intereference from other cards that may be sharing the same bus. It simply computes the time it takes to perform hardware reads and computes the jitter. It must be run as *root*.

```
Usage: ./ccrtaicc_check_bus [-b Board] [-c CPU] [-l LoopCnt] [-t Tolerance]
 -b Board     (Board number -- default is 0)
 -c CPU       (CPU number -- default is 1)
 -l LoopCnt   (Loop Count -- default is 10000000)
 -l 0         (Loop forever)
 -t Tolernace (Tolerance -- default is 2.00 micro-seconds)
```

Example display:

sudo ./ccrtaicc_check_bus

```
local_ptr=0x7ffff7fd7000
10000000: usec/read: Cur=1.167 (Min=1.092 Max=1.768 Ave=1.143276)
          [Bus Jitter (usec): 0.676 ===> LOW]
```

3.2.6 lib/ccrtaicc_clock

This is a useful tool to display information of the various clocks and also program them.

```
Usage: ./ccrtaicc_clock [-b BoardNo] [-C UpdateClock] [-d Delay] [-l LoopCnt]
                        [-R]
 -b BoardNo              (Board number -- default is 0)
 -C <Clock>@<Frequency>  (set update clock '0..6' with frequency )
 -d Delay                (Delay between screen refresh -- default is 10 milli-
                          seconds)
 -l LoopCnt              (Loop count -- default is 0)
 -R                      (Reset/Clear all clocks)

 e.g. ./ccrtaicc_clock -C 1@300000
                         (Set Clock 1 to 300000 SPS - do not change any other
                          running clocks)
      ./ccrtaicc_clock -R -C0@100000 -C4@12345
                         (Reset all clocks and then set Clock 0 to 100000 SPS and
                          Clock 4 to 12345 SPS)
```

Example display:

./ccrtaicc_clock -R -C0@100000 -C4@12345

```
                  Board Number [-b]: 0
                        Delay [-d]: 10 milli-seconds
                    Loop Count [-l]: ***Forever***
                        Scan Count: 1416

                  _________ Clock Revision ________
                   Silicon Revision: A2
                   Base Part Number: 5341
                 Device Speed Grade: A
                    Device Revision: B

                  _________ Clock CSR ________
                    Clock Interface: Idle
                       Clock Output: Enabled
                        Clock State: Active

                  _________ Input Clock Status _________
                        Calibration: Not In-Progress
                      SMBUS Timeout: Not Timed Out
                           PLL Lock: Locked
                       Input Signal: Present
                      Input_0 Clock: Present
                      Input_1 Clock: Present
                      Input_2 Clock: *** Not Present ***
                     Input_FB Clock: Present
                   XAXB Input Clock: *** Not Present ***

      ____________________ Output Clock Setting ____________________
      User output clock frequency 0:   100000.000 Samples/Second/Channel
      User output clock frequency 1: *** Not Set ***
      User output clock frequency 2: *** Not Set ***
      User output clock frequency 3: *** Not Set ***
```

```
     User output clock frequency 4:    12345.000 Samples/Second/Channel
     User output clock frequency 5: *** Not Set ***
     User output clock frequency 6: *** Not Set ***
   SD-RAM output clock frequency 7: 10000000.000 Samples/Second/Channel
 External output clock frequency 8: 10000000.000 Samples/Second/Channel
Feed-Back output clock frequency 9: 10000000.000 Samples/Second/Channel
```

3.2.7 lib/ccrtaicc_disp

Useful program to display the local board registers. This program uses the *curses* library. This test is similar to the previous non-library test.

```
Usage: ./ccrtaicc_disp [-b Board] [-d Delay] [-D DMAEngineNo] [-H] [-i]
                       [-l LoopCnt] [-m XferMode] [-o Offset] [-P Pause]
                       [-s XferSize] [-S DispSize]
 -b Board        (Board number -- default board is 0)
 -d Delay        (Delay between screen refresh -- default is 0)
 -D DMAEngineNo  (DMA Engine number -- default = 0)
 -H              (Enable Hyper-Drive Mode -- default "=== Disabled ===")
 -i              (Enable Interrupts -- default = Disable)
 -l LoopCnt      (Loop Count - default = 0)
 -m XferMode     (Transfer Mode -- default = DMA)
    -md          (Avalon Memory: DMA mode)
    -mm          (Avalon Memory: Modular Scatter-Gather DMA mode)
    -mp          (Avalon Memory: Programmed I/O mode)
 -o Offset       (Hex offset to read from -- default is 0x0)
 -P Pause        (Microseconds to sleep in User Function loop -- default is 0)
 -s XferSize     (Number of bytes to transfer -- default is 0x1000)
 -S DispSize     (Number of bytes to display -- default is 0x200)
```

Example display:

./ccrtaicc_disp

```
local_ptr=0x7ffff7fd7000
           Physical Memory Information:
             UserPID         =16618
             PhysMemPtr      =0x7c2be000
             DriverVirtMemPtr=0xffff88007c2be000
             MmapedUserMemPtr=0x7ffff7fcc000
             PhysMemSize     =0x00001000
             PhysMemSizeFreed=0x00000000
             EntryInTxTbl    =0
             NumOfEntriesUsed=1
             Flags           =0x0000
----------------------------------------------------------------------
 Board Number          [-b]: 0
 Delay                 [-d]: 0 milli-seconds
 DMA Engine            [-D]: 0
 Hyper-Drive           [-H]: Disabled
 Interrupts            [-i]: Disabled
 Loop Count            [-l]: ***Forever***
 Transfer Mode         [-m]: Basic DMA I/O (Avalon Memory)
 Offset                [-o]: 0x00000000
 Transfer Size         [-s]: 0x00001000 (4096) bytes (  17.308 MBytes/Second)
 Display Size          [-S]: 0x00000200 (512) bytes

 ScanCount                 : 13228
 Read Duration (microsecs) :   236.660 (min= 234.615/max= 247.757/ave= 236.132)

         00       04       08       0C       10       14       18       1C
```

```
        ======== ======== ======== ======== ======== ======== ======== ========
000000  93500101 04032019 00020000 00000000 00000000 00000000 00000000 00000000
000020  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000040  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000060  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000080  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0000a0  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0000c0  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0000e0  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000100  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000120  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000140  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000160  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
000180  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0001a0  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0001c0  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0001e0  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

3.2.8 lib/ccrtaicc_dma

This test transfers data from physical memory to the Local register area and back. There are three modes of operation. One is regular DMA, the second is Modular Scatter-Gather DMA and the third is programmed I/O. Depending on the number of DMA engines supported by the card, the user can select one of them to perform the DMA. Additionally, if the card supports Modular Scatter-Gather DMA, then they can also select that. Area select is one of three areas the user can specify. They represent the area in physical memory and local register where the transfer is to occur. The test automatically switches to a different area corresponding to the regular DMA engine supplied. If multiple copies of this application is run on the same card using the same DMA engine, then the user needs to manually select a different area '-A' so the data mismatch does not occur due to using the same area region.

```
Usage:./ccrtaicc_dma [-A Area2Select] [-b Board] [-D DMAEngineNo] [-i]
                     [-l LoopCnt] [-m XferMode] [-s Size] [-v VerboseNo]
 -A Area2Select (Area to select -- default = -1)
 -b Board       (Board number -- default = 0)
 -D DMAEngineNo (DMA Engine number -- default = 0)
 -i             (Enable Interrupts -- default = Disable)
 -l LoopCnt     (Loop Count - default = 1000)
 -m XferMode    (Transfer Mode -- default = DMA)
    -md         (DMA mode)
    -mm         (MsgDma mode - '-D' option is ignored)
    -mp         (Programmed I/O mode)
 -s Size        (Transfer Size in bytes (multiple of byte width) –
                 default = 12288)
 -V VerboseNo   (verbose -- default = 0)

 e.g. ./ccrtaicc_dma -A1    (perform dma using DMA0 on area 1 )
      ./ccrtaicc_dma -i -D1 (perform dma using DMA1 with interrupts on area 0)
      ./ccrtaicc_dma -mm    (perform dma using MsgDMA on area 0)
```

Example display:

./ccrtaicc_dma

```
Device Name: /dev/ccrtaicc0
local_ptr=0x7ffff7fd7000
          Physical Memory Information:
            UserPID         =16945
            PhysMemPtr      =0x5a00000
            DriverVirtMemPtr=0xffff880005a00000
            MmapedUserMemPtr=0x7ffff70e8000
```

```
            PhysMemSize     =0x00200000
            PhysMemSizeFreed=0x00000000
            EntryInTxTbl    =0
            NumOfEntriesUsed=2
### Avalon Address[A0]: 0x00001000 - 0x00004000
###    DMA Address[A0]: 0x00100400 - 0x00103400
###      Transfer Size: 12288 (0x00003000) bytes (DMA without Interrupts:
                                                  DMA Engine 0) ###
  1000: A2P: Total:  697.244us (  17.62 MB/s): first=0xface0000 last=0xface0bff

         (micro-seconds)          (MBytes/second)
       Min     Max     Ave      Min     Max     Ave
    ----------------------  ------------------------
P2A:  427.70  433.56  429.61     28.34   28.73   28.60
A2P:  696.25  722.41  697.19     17.01   17.65   17.63
```

./ccrtaicc_dma -mm

```
Device Name: /dev/ccrtaicc0
local_ptr=0x7ffff7fb7000
          Physical Memory Information:
            UserPID         =25623
            PhysMemPtr      =0x35000000
            DriverVirtMemPtr=0xffff96d0f5000000
            MmapedUserMemPtr=0x7ffff7065000
            PhysMemSize     =0x00200000
            PhysMemSizeFreed=0x00000000
            EntryInTxTbl    =0
            NumOfEntriesUsed=2
            Flags           =0x0000
### Avalon Address[A0]: 0x00001000 - 0x00004000
###    DMA Address[A0]: 0x00100400 - 0x00103400
###      Transfer Size: 12288 (0x00003000) bytes (DMA without Interrupts: MsgDma
                       Engine) ###
  1000: A2P: Total:   37.131us ( 330.94 MB/s): first=0xface0000 last=0xface0bff

         (micro-seconds)          (MBytes/second)
       Min     Max     Ave      Min     Max     Ave
    ----------------------  ------------------------
P2A:   45.77   51.63   46.49    237.99  268.45  264.34
A2P:   37.07   43.19   37.21    284.53  331.51  330.24
```

3.2.9 lib/ccrtaicc_example

This test provides a simple example of programming ADC.

```
Usage: ./ccrtaicc_example [-b Board]
 -b Board     (Board number -- default is 0)
```

Example display:

./ccrtaicc_example

```
local_ptr=0x7ffff7fd7000
          Physical Memory Information:
            UserPID         =17871
            PhysMemPtr      =0x7c291000
            DriverVirtMemPtr=0xffff88007c291000
            MmapedUserMemPtr=0x7ffff7fcc000
            PhysMemSize     =0x00001000
            PhysMemSizeFreed=0x00000000
```

```
            EntryInTxTbl    =0
            NumOfEntriesUsed=1
            Flags           =0x0000
### Configuring ADC ###
  - Activate ADC
  - Configure ADC
  - Set Input Control to Calibration Bus
  - Set Calibration to Positive Reference Voltage
### Programming Clocks ###
### Calibrate All ADC Channels ###
### Reading ADC Channels using ccrtAICC_Transfer_Data() ###

     ==== ADC Channels - Using ccrtAICC_Transfer_Data() ==== (length=64)
     +DMP+        0   0001fb6b  0001fb6f  0001fb6e  0001fb6b *...k...o...n...k*
     +DMP+     0x10   0001fb68  0001fb6c  0001fb6d  0001fb69 *...h...l...m...i*
     +DMP+     0x20   0001fb6d  0001fb6e  0001fb66  0001fb6a *...m...n...f...j*
     +DMP+     0x30   0001fb6a  0001fb6a  0001fb64  0001fb64 *...j...j...d...d*

### Reading ADC Channels using ccrtAICC_DMA_Configure()/ccrtAICC_DMA_Fire() ###
  - Convert Physical DMA Memory Address to Avalon Equivalent Address
  - Configure DMA
  - Fire DMA

     ==== ADC Channels - Using ccrtAICC_DMA_Fire() ==== (length=64)
     +DMP+        0   0001fb6c  0001fb66  0001fb66  0001fb6a *...l...f...f...j*
     +DMP+     0x10   0001fb69  0001fb67  0001fb6c  0001fb68 *...i...g...l...h*
     +DMP+     0x20   0001fb65  0001fb6b  0001fb6b  0001fb6a *...e...k...k...j*
     +DMP+     0x30   0001fb70  0001fb6b  0001fb69  0001fb6a *...p...k...i...j*
### Single (one descriptor) Modular Scatter-Gather DMA ###
  - Allocating memory and seeding with pattern
  - Seizing MSGDMA
  - Configure Single MSGDMA (PCIe ==> Avalon)
  - Fire Single MSGDMA: Xfer 0x8000 bytes: Pcie ==> Avalon (@0x8000)
  - Validating data
  - Configure Single MSGDMA (Avalon ==> PCIe)
  - Fire Single MSGDMA: Xfer 0x8000 bytes: Avalon (@0x8000) ==> PCIe
  - Validating data
  - Releasing MSGDMA
### Multi (four descriptor) Modular Scatter-Gather DMA (Single-Shot) ###
  - Allocating memory and seeding with pattern
  - Seizing MSGDMA
  - Configure multi MSGDMA (PCIe ==> Avalon ==> PCIe ==> Avalon ==> PCIe)
  - Setup Multi MSGDMA
  - Fire Multi MSGDMA (Single-Shot)
  - Validating data
  - Releasing MSGDMA
### Multi (four descriptor) Modular Scatter-Gather DMA (Clone) ###
  - Allocating memory and seeding with pattern
  - Seizing MSGDMA
  - Configure multi MSGDMA (PCIe ==> Avalon ==> PCIe ==> Avalon ==> PCIe)
  - Setup Multi MSGDMA
  - Stop and Initialize Multi MSGDMA (Clone)
  - Fire Multi MSGDMA and wait one cycle (Clone: Once cycle wait)
  - Validating data
  - Releasing MSGDMA
```

3.2.10 lib/ccrtaicc_expires

This test is useful in displaying board expires information.

```
Usage: ./ccrtaicc_expires -[b Board] -[s]
```

```
          -b <board>            (board #, default = 0)
          -s                    (short display, default = verbose)
```

Example display:

./ccrtaicc_expires *(for card that has no restrictions)*

```
          Device Name: /dev/ccrtaicc0
      Board Serial No: 687377 (0x000a7d11)

##############################################
###                                        ###
###         UNRESTRICTED FIRMWARE          ###
###                                        ###
##############################################
```

./ccrtaicc_expires *(for restricted card that has NO expiration date)*

```
          Device Name: /dev/ccrtaicc0
      Board Serial No: 98765 (0x000181cd)

##########################################
###                                    ###
###         RESTRICTED FIRMWARE        ###
###                                    ###
##########################################

=========================
=== No Expiration Date ===
=========================
```

./ccrtaicc_expires *(for restricted card that has expiration date)*

```
          Device Name: /dev/ccrtaicc0
      Board Serial No: 98765 (0x000181cd)

##########################################
###                                    ###
###         RESTRICTED FIRMWARE        ###
###                                    ###
##########################################

=====================================================================
Local Expiration Date: 03/11/2018 13:21:52
  GMT Expiration Date: 03/11/2018 17:21:52
   Duration to Expire: Days=122, Hours=2, Minutes=49, Seconds=20
=====================================================================
```

./ccrtaicc_expires -s *(for card that has no restructions)*

```
Unrestricted
```

./ccrtaicc_expires -s *(for restricted card that has NO expiration date)*

```
Restricted: No expiration date
```

./ccrtaicc_expires -s *(for restricted card that has expiration date)*

```
Restricted: Expire in 10550462 seconds
```

3.2.11 lib/ccrtaicc_identify

This test is useful in identifying a particular card by displaying its LED.

```
Usage: ./ccrtaicc_identify -[absx]
          -a                    (Identify all cards through a light sequence)
          -b <board>            (board #, default = 0)
          -s <seconds)          (Identify Board: ENABLED for number of seconds,
                                 default = 10)
          -s 0                  (Identify Board: DISABLED)
          -s <negative value>   (Identify Board: ENABLED forever)
          -x                    (silent)

If the '-a' option is selected, all other options are ignored. This option will
sequence through all the cards found in turn as follows:
  1) The first device number will flash its LED for 10 seconds
  2) The remaining devices numbers will be selected sequentially and flash their LEDs for
3 seconds
```

Example display:

./ccrtaicc_identify

```
Device Name       : /dev/ccrtaicc0
Board ID          : 9350
Board Type        : 01
Board Function    : 01
Board Serial No   : 687377 (0x000a7d11)
Firmware Revision : 2.0 (Major.Minor)
MsgDma Support    : 31 descriptors (Yes)

Identify ENABLED on board 0 (LED should start flashing for 10 seconds)
Sleeping for 10 seconds...
Identify DISABLED on board 0 (LED should stop flashing)
```

./ccrtaicc_identify -a

```
TotalBoardCount=2
 # DNum IRQ MSI Bu:Sl:Fn VnID:Sub  BdID:Ty:Fu:Sub  FMaj.Min(mm:dd:yy hh:mm:ss)  MC
FmFlvCod FwbRev   Temp:C/F SerialNo RLS# Func
 0  0   165  Y  b6:00:00 1542:1542 9350.01.01:0100 0002.000(04/03/19 00:00:00)  C7
00000000 00000000  0/ 32.0 687376   150  AICC
 1  1   167  Y  b7:00:00 1542:1542 9350.01.01:0100 0098.000(11/02/4020 00:00:00)  C7
00000000 00000000  0/ 32.0 687377   150  AICC

Device Numbers: (enter <CTRL-C> to terminate)
============================================
 0*   1
```

3.2.12 lib/ccrtaicc_info

This test is useful in getting information for all the *ccrtaicc* devices in the system.

```
Usage: ./ccrtaicc_info -[b Board] -[l] -[v]
          -b <board>            (board #, default = 0)
          -l                    (long display, default = short)
          -v                    (long display and verbose, default = no verbose)
          -l -v                 (long display and verbose, default = no verbose)
```

Example display:

./ccrtaicc_info

```
# IRQ MSI Bu:Sl:Fn VnID:Sub  BdID:Ty:Fu:Sub   FMaj.Min(mm:dd:yy hh:mm:ss)  MC FmFlvCod FwbRev   Temp:C/F
SerialNo RLS# Func
 0  59  Y  05:00:00 1542:1542 9350.01.01:0100 0002.000(04/03/19 00:00:00)  C7 00000000 00000000  0/ 32.0
687377   150  AICC
```

./ccrtaicc_info -l

```
        ###################### Board 0 ######################
                        Version:  2022.1.0
                          Build:  Thu Jan 20 08:22:20 EST 2022
                         Module:  ccrtaicc
                    Board Index:  0 (PCIe-CCRT_FPGA_AICC)
                            Bus:  0x07
                           Slot:  0x00
                           Func:  0x00
                      Vendor ID:  0x1542
                  Sub-Vendor ID:  0x1542
                     Board Info:  0x93500101 (id=9350, type=0x01, func=0x01 (AICC))
                    Member Code:  1 (C7)
                  Sub-Device ID:  0x0100
              Firmware Date/Time:  0x04032019 0x00000000 (04/03/2019 00:00:00)
               Firmware Revision:  0x00020000 (2.0)
                 Fpgawb Revision:  0x00000000 (0000.00-00) (Not Supported)
             Firmware Flavor Code:  0x00000000 (0) (****)
              Board Serial Number:  0x000a7d11 (687377)
            FPGA Chip Temperature:  0x00 (0 degree C, 32.0 degree F)
          Run Level Sector Number:  0x96 (150)
           Multi-Firmware Support:  0x1 (Yes)
                      MSI Support:  Enabled
      Scatter-Gather DMA Support:  Yes
    Number of MSG DMA Descriptors:  31
     Max MSG DMA Xfer Memory Size:  131068 (bytes)
               Max MSG DMA Width:  4 (bytes)
       Max MSG DMA Xfer FIFO Size:  8192 (bytes)
             Double-Word Support:  Yes
                       IRQ Level:  69
              Maximum Link Width:  4
           Negotiated Link Width:  4
                 Cloning Support:  3 (Cloning is supported. Region addressing allowed for any user)
        10V Calibration Reference:  9.91 Volts
         5V Calibration Reference:  4.95 Volts
```

./ccrtaicc_info -l –v

```
        ###################### Board 0 ######################
                        Version:  2022.1.0
                          Build:  Thu Jan 20 08:22:20 EST 2022
                         Module:  ccrtaicc
                    Board Index:  0 (PCIe-CCRT_FPGA_AICC)
                            Bus:  0x07
                           Slot:  0x00
                           Func:  0x00
                      Vendor ID:  0x1542
                  Sub-Vendor ID:  0x1542
                     Board Info:  0x93500101 (id=9350, type=0x01, func=0x01 (AICC))
                    Member Code:  1 (C7)
                  Sub-Device ID:  0x0100
              Firmware Date/Time:  0x04032019 0x00000000 (04/03/2019 00:00:00)
               Firmware Revision:  0x00020000 (2.0)
                 Fpgawb Revision:  0x00000000 (0000.00-00) (Not Supported)
             Firmware Flavor Code:  0x00000000 (0) (****)
              Board Serial Number:  0x000a7d11 (687377)
            FPGA Chip Temperature:  0x00 (0 degree C, 32.0 degree F)
          Run Level Sector Number:  0x96 (150)
           Multi-Firmware Support:  0x1 (Yes)
                      MSI Support:  Enabled
```

```
   Scatter-Gather DMA Support:  Yes
 Number of MSG DMA Descriptors:  31
  Max MSG DMA Xfer Memory Size:  131068 (bytes)
            Max MSG DMA Width:  4 (bytes)
    Max MSG DMA Xfer FIFO Size:  8192 (bytes)
           Double-Word Support:  Yes
                     IRQ Level:  69
          Maximum Link Width:  4
       Negotiated Link Width:  4
             Cloning Support:  3 (Cloning is supported. Region addressing allowed for any user)
    10V Calibration Reference:  9.91 Volts
     5V Calibration Reference:  4.95 Volts

            ---ADC Information---
       Maximum Voltage Range:  10 Volts
              Number of ADCs:  4
     Number of ADC Channels:  64
    Number of ADC Resolution:  18 Bits
       All ADC Channels Mask:  0xffffffffffffffff
   Maximum ADC Fifo Threshold:  0x00020000

            ---DMA Information---
              Driver DMA Size:  524288
    Num of Trans Tbl Entries:  8
Num of Physical Memory Entries:  512
             Avalon Page Bits:  20
             Avalon Page Size:  1048576
            TX Interface Base:  8388608
         DMA Maximum Engines:  2
       DMA Maximum Burst Size:  1024
    DMA Maximum Transactions:  32
             DMA Maximum Size:  1048576 (DMA 0)
           DMA Width in Bytes:  4       (DMA 0)
             DMA Fire Command:  140     (DMA 0)
             DMA Maximum Size:  1048576 (DMA 1)
           DMA Width in Bytes:  4       (DMA 1)
             DMA Fire Command:  140     (DMA 1)

         ---Analog/DMA Interrupt Information---
              Interrupt Count:  0
                  DMA 0 Count:  0
                  DMA 1 Count:  0
                MSG DMA Count:  0
    Interrupts Occurred Mask:  0x00000000
       Wakeup Interrupt Mask:  0x00000000
             Timeout Seconds:  0
                  DMA Control:  0x00000000

         ---Memory Regions Information---
                      Region 0:  Addr=0xbd220000  Size=32768 (0x8000)
                      Region 2:  Addr=0xbd200000  Size=131072 (0x20000)
```

3.2.13 lib/ccrtaicc_msgdma

This test performs a modular scatter-gather DMA test on boards that support it. Additionally, it displays performance information for each mode of operation.

```
Usage: ./ccrtaicc_msgdma [-a AddrOff,ToAddrOff] [-b Board] [-C] [-d NumDesc]
                         [-f Input,Output] [-i] [-l LoopCnt] [-m Mode]
                         [-s TotalXferSize] [-v] [-X]
        -a <AddrOff,ToAddrOff> (First Avalon Address Offset, default DiagRam offset)
                               (Second 'ToAddrOff' only for Avalon2Avalon mode
        -b <Board>             (board #, default = 0)
        -C                     (Perform Clone mode scatter-gather instead of single-
                                shot)
        -d <NumDesc>           (Number of Descriptors, default = 1)
```

```
          -f <Input>,<#Output>   (Use input file as input data. default None)
                                 (Use Output file to write 'to' data. default None)
                                 (Prepend with '#' to remove comments and address)
          -i                     (Use interrupts, default is poll)
          -l <LoopCnt>           (Loop Count, default = 1000)
          -m <Mode>              (Mode of Operation, default = all)
             'a2p'               (Avalon memory address to Pci memory address)
             'p2a'               (Pci memory address to Avalon memory address)
             'p2p'               (Pci memory address to Pci memory address)
             'a2a'               (Avalon memory address to Avalon memory address)
             'all'               (All above modes with only memory addresses)

             'A2p'               (Avalon FIFO address to Pci memory address - specify
                                  FIFO address '-a')
             'p2A'               (Pci memory address to Avalon FIFO address - specify
                                  FIFO address '-a')
             'A2A'               (Avalon FIFO address to Avalon FIFO address - specify
                                  FIFO address '-a')
          -s <TotalXferSize>     (Total Transfer Size in bytes, default size of DiagRam)
                                 (Maximum transfer size is 0x3FFFF)
          -v                     (Verbose operation. default is quiet)
          -X                     (Skip Data Validation, default is to validate)

Notes:
     1) For modes 'p2a' or 'a2p' only the first address 'AddrOff' is used in option '-a'
     2) For modes 'a2a' the first address 'AddrOff' is "FROM" and second address
        'ToAddrOff' is "TO"
     3) If Input file is specified in the '-f' option, its contents is used to seed
        input
     4) If '-X' option is specified, no pattern is written to input, unless '-f Input'
        option is specified
     5) Multiple '-m' options can be specified on a single command line
     6) When address '-a' option is not specified, DiagRam offset is used for Analog
        input/output
     7) Normal running process if no arguments specified is as follows:
          a) Incrementing pattern written to the input using programmed I/O and readback
             validated
          b) Output written with 'baadbeef' pattern using programmed I/O
          c) Scatter-Gather DMA performed from Input to Output
          d) Data is read back from both Input and Output using programmed I/O and
             compared
     8) An upper case 'A' in the -m option represents an Avalon FIFO address, while
        a lower case 'a' in the -m option represents a regular Avalon memory address
     9) If a regular memory Avalon address is specified as an Avalon FIFO address and
        vice-versa results will be unpredictable
    10) When either input or output Avalon address is pointing to a FIFO, then data
        validation is skipped
    11) If a size is specified for a memory or FIFO address that is greater than it can
        handle, the result will be unpredictable. You will need to reset the firmware to
        restore proper operation

e.g. ./ccrtaicc_msgdma -mall                    (Run all transfer modes with validation)
     ./ccrtaicc_msgdma -a0x8000 -s0x100         (Run all modes with Avalon Address
                                                 0x8000 and size 0x100)
     ./ccrtaicc_msgdma -a0xA000 -s0x200 -ma2a   (Run a2a with Avalon Address 0xA000 and
                                                 size 0x200)
     ./ccrtaicc_msgdma -mp2a -l1 -d1 -fHexFile_16K -a0x10004 -X
                               (Transfer Input file to Avalon memory at 0x10004)
     ./ccrtaicc_msgdma -ma2p -l1 -d1 -f,OutFile -s0x4000 -a0x10004 -X
                               (Transfer Avalon memory at 0x10004 to output file
                                'OutFile')
     ./ccrtaicc_msgdma -mA2p -l10000 -s0x20000 -d16 -a0x18010
                               (Transfer Avalon FIFO at 0x18010 to PCI memory with 16
                                descriptors where each descriptor has a transfer size
                                of 0x2000 bytes. No validation will be performed)
```

Example display:

./ccrtaicc_msgdma

```
### TotalXferSize = 0x00008000, individual descriptor length=0x008000 ###
    1000: P2P Total: Size 0x8000, Fire= 109.84us/ 298.32MB/s
              (mi/ma/av:  289.46/ 298.55/ 298.10 MB/s, 109.76/ 113.20/ 109.92 us)
              LastWord=0x007cffff
    1000: A2A Total: Size 0x4000, Fire=  84.59us/ 193.68MB/s
              (mi/ma/av:  186.51/ 195.22/ 193.18 MB/s,  83.92/  87.85/  84.81 us)
              LastWord=0x003e7fff
    1000: P2A Total: Size 0x8000, Fire= 108.52us/ 301.97MB/s
              (mi/ma/av:  286.60/ 302.22/ 300.36 MB/s, 108.42/ 114.33/ 109.10 us)
              LastWord=0x007cffff
    1000: A2P Total: Size 0x8000, Fire=  88.08us/ 372.05MB/s
              (mi/ma/av:  358.45/ 376.44/ 372.26 MB/s,  87.05/  91.42/  88.03 us)
              LastWord=0x007cffff
```

./ccrtaicc_msgdma -C *(Cloning option)*

```
### Cloning Option Selected ###
### TotalXferSize = 0x00008000, individual descriptor length=0x008000 ###
    1000: P2P Total: Size 0x8000, Fire= 107.44us/ 304.99MB/s
              (mi/ma/av:  294.01/ 305.36/ 305.21 MB/s, 107.31/ 111.45/ 107.36 us)
              LastWord=0x007cffff
    1000: A2A Total: Size 0x4000, Fire=  86.84us/ 188.67MB/s
              (mi/ma/av:  181.29/ 188.76/ 188.55 MB/s,  86.80/  90.37/  86.89 us)
              LastWord=0x003e7fff
    1000: P2A Total: Size 0x8000, Fire= 106.87us/ 306.61MB/s
              (mi/ma/av:  295.68/ 306.81/ 306.56 MB/s, 106.80/ 110.82/ 106.89 us)
              LastWord=0x007cffff
    1000: A2P Total: Size 0x8000, Fire=  86.92us/ 377.00MB/s
              (mi/ma/av:  361.70/ 377.35/ 376.78 MB/s,  86.84/  90.59/  86.97 us)
              LastWord=0x007cffff
```

3.2.14 lib/ccrtaicc_msgdma_clone

Cloning is an optional feature of this card that can be purchased separately. The basic cloning option is an extremely powerful tool that gives the user the ability to continuously transfer the contents of a region on the card to a physical memory entirely under hardware control, once cloning has commenced. This continuous transfer is performed at MsgDma speeds. A more advanced cloning option that can be purchased is known as Region Addressing. This option allows the board to Clone any MsgDma location to another MsgDma location, i.e. the source and destination locations can be any valid MsgDma able physical address in the system.

Since there is only one MsgDma engine on the card, only one Cloning or MsgDma operation can be active at a given time. Additionally, it is meaningless to perform Cloning on a FIFO region for two reasons. Firstly, each data in a FIFO is synchronous, however, the Cloned region is accessed asynchronously. Secondly, when the FIFO runs empty *(underflow)* or cannot accept more data *(overflow)* the results are unpredictable.

Caution: Since physical addresses are supplied to this test, care must be taken to ensure that the supplied addresses are valid and that while cloning is in progress, the memory regions must not be freed or made inactive, otherwise, the results could be unpredictable and could lead to the possible corruption of the system.

This test show the capabilities of this new cloning option.

```
Usage: ./ccrtaicc_msgdma_clone [-a FromAddr,ToAddr] [-b Board] [-d Delay]
```

```
                          [-F DebugFile] [-l LoopCnt] [-P] [-q] [-s XferSize]
                          [-S DisplaySize] [-v Delay] [-X] [-Z]
          -a <FromAddr,ToAddr> (Clone address space From/To address in Hex)
                          (If address less than board size, board offset
                           used)
          -b <Board>      (board #, default = 0)
          -d <Delay>      (Delay between screen refresh -- default is 0
                           milli-seconds)
          -F DebugFile    (Debug file -- default "=== None ===")
             @DebugFile   (Debug file and no display)
             @            (No Debug file and no display)
          -l LoopCnt      (Loop count -- default is 0)
          -P              (Program Board)
          -q              (Quite (non-interactive) mode)
          -s <XferSize>   (Transfer size bytes)
          -S <DisplaySize> (Display size bytes)
          -v Delay        (Verify data. Add additional one cycle delay in
                           micro-seconds if specified)
          -X              (Disable region protection)
          -Z              (Disable address cache - default is enabled)

e.g.
  ./ccrtaicc_msgdma_clone                          (Clone ADC_Data to physical memory
                                                    created by this program)
  ./ccrtaicc_msgdma_clone -a,                      (Clone ADC_Data to board at offset
                                                    0x0000)
  ./ccrtaicc_msgdma_clone -a,-1                    (Clone ADC_Data to physical memory
                                                    created by this program)
  ./ccrtaicc_msgdma_clone -a-1,-1 -v               (Clone physical memory to physical
                                                    memory created by this program
                                                    and verify)
  ./ccrtaicc_msgdma_clone -a,8000 -s0x100          (Clone ADC_Data to board DiagRam
                                                    at 0x8000)
  ./ccrtaicc_msgdma_clone -a8000,c000 -s0x4000 -v  (Clone DiagRam at 0x8000 to
                                                    DiagRam at 0xC000 and verify)
  ./ccrtaicc_msgdma_clone -a8000,-1 -s0x4000 -v    (Clone DiagRam at 0x8000 to
                                                    physical memory created and verify)
  ./ccrtaicc_msgdma_clone -a-1,8000 -s0x4000 -v    (Clone physical memory created to
                                                    DiagRam at 0x8000 and verify)
  ./ccrtaicc_msgdma_clone -a,0xbd308000 -X         (Clone ADC_Data to some other board
                                                    at specified physical address)
```

Example display:

./ccrtaicc_msgdma_clone

```
Device Name                 : /dev/ccrtaicc0
Board ID                    : 9350
Board Type                  : 01
Board Function              : 01
Board Serial No             : 687377 (0x000a7d11)
Number of MsgDMA Descriptors: 31

Local Region  (BAR2) Size   : 0x00020000
Local Region  (BAR2) Address: 0xbd400000
Config Region (BAR0) Size   : 0x00008000
Config Region (BAR0) Address: 0xbd420000


>>>####### Processing 'From' Address (0x00003200) ######<<<
```

```
From_____________________________________
  TranslationRequired         = 0
  UserSuppliedPhysicalAddress = 0x00003200
  AvalonEquivalentAddress     = 0x00003200
  PhysicalMemoryToAttach      = 0xbd403200
  PhysicalMemorySize          = 0x00000100
  VirtualUserAddress          = 0x7ffff7fb7200
  Flags                       = 0x0000

>>>####### Processing 'To' Address (0xfffffffffffffffc) ######<<<
           Physical Memory Information:
             UserPID          =5943
             PhysMemPtr       =0x340c5000
             DriverVirtMemPtr =0xffff96d0f40c5000
             MmapedUserMemPtr =0x7ffff7fec000
             PhysMemSize      =0x00001000
             PhysMemSizeFreed =0x00000000
             EntryInTxTbl     =0
             NumOfEntriesUsed =1
             Flags            =0x0000

To_______________________________________
  TranslationRequired         = 1
  UserSuppliedPhysicalAddress = 0x340c5000
  AvalonEquivalentAddress     = 0x008c5000
  PhysicalMemoryToAttach      = 0x340c5000
  PhysicalMemorySize          = 0x00001000
  VirtualUserAddress          = 0x7ffff7fec000
  Flags                       = 0x0000

 Physical Address      [-a]: 0xBD403200/0x340C5000 (From/To)
 Board Number          [-b]: 0
 Delay                 [-d]: 0       (milli-seconds)
 Loop Count            [-l]: 0       (forever)
 Program Board         [-P]: 0       (no)
 Quiet Mode            [-q]: 0       (interactive)
 Transfer Size         [-s]: 256     (bytes)
 Display Size          [-S]: 256     (bytes)
 Verify Data           [-v]: no
 Region Protection     [-X]: 1       (enabled)
 Address Cache         [-Z]: 0       (enabled)
 One Cycle Time            : 3.482   (micro-seconds)

 From_____________________________________  To_____________________________________
 TranslationRequired      = 0               TranslationRequired      = 1
 UserSuppliedPhysicalAddr = 0x00003200      UserSuppliedPhysicalAddr = 0x340c5000
 AvalonEquivalentAddress  = 0x00003200      AvalonEquivalentAddress  = 0x008c5000
 PhysicalMemoryToAttach   = 0xbd403200      PhysicalMemoryToAttach   = 0x340c5000
 PhysicalMemorySize       = 0x00000100      PhysicalMemorySize       = 0x00001000
 VirtualUserAddress       = 0x7ffff7fb7200  VirtualUserAddress       = 0x7ffff7fec000
 Flags                    = 0x0000          Flags                    = 0x0000

ScanCount=7000 (XferSize=256, DisplaySize=256) (CopyTime: From   54.387 usecs,
                                                          To    0.261 usecs)

___From___   ___00___ ___04___ ___08___ ___0C___ ___10___ ___14___ ___18___ ___1C___
0x00003200  0001fb5a 0001fb55 0001fb58 0001fb5a 0001fb5e 0001fb60 0001fb60 0001fb62
0x00003220  0001fb5a 0001fb5e 0001fb6a 0001fb69 0001fb5f 0001fb5f 0001fb5d 0001fb60
0x00003240  0001fb5d 0001fb5c 0001fb66 0001fb63 0001fb69 0001fb68 0001fb68 0001fb64
0x00003260  0001fb62 0001fb64 0001fb6a 0001fb69 0001fb6c 0001fb68 0001fb6f 0001fb69
0x00003280  0001fb64 0001fb65 0001fb64 0001fb69 0001fb6c 0001fb6b 0001fb66 0001fb67
```

```
0x000032a0  0001fb65 0001fb67 0001fb68 0001fb6b 0001fb69 0001fb6e 0001fb6d 0001fb6e
0x000032c0  0001fb69 0001fb6c 0001fb69 0001fb66 0001fb6d 0001fb70 0001fb68 0001fb65
0x000032e0  0001fb6e 0001fb6f 0001fb6a 0001fb6d 0001fb65 0001fb61 0001fb66 0001fb66

____To____  ___00___ ___04___ ___08___ ___0C___ ___10___ ___14___ ___18___ ___1C___
0x340c5000  0001fb67 0001fb68 0001fb67 0001fb67 0001fb69 0001fb67 0001fb67 0001fb68
0x340c5020  0001fb67 0001fb67 0001fb68 0001fb66 0001fb6c 0001fb68 0001fb69 0001fb64
0x340c5040  0001fb69 0001fb63 0001fb66 0001fb62 0001fb67 0001fb68 0001fb66 0001fb69
0x340c5060  0001fb69 0001fb69 0001fb6a 0001fb67 0001fb6d 0001fb6a 0001fb69 0001fb6a
0x340c5080  0001fb68 0001fb66 0001fb69 0001fb67 0001fb64 0001fb67 0001fb66 0001fb66
0x340c50a0  0001fb6b 0001fb69 0001fb69 0001fb6c 0001fb6c 0001fb6a 0001fb66 0001fb68
0x340c50c0  0001fb69 0001fb6d 0001fb69 0001fb69 0001fb68 0001fb66 0001fb67 0001fb65
0x340c50e0  0001fb69 0001fb67 0001fb6a 0001fb5f 0001fb65 0001fb61 0001fb64 0001fb63
```

./ccrtaicc_msgdma_clone -a8000,-1 -s0x4000 -v

```
Device Name                 : /dev/ccrtaicc0
Board ID                    : 9350
Board Type                  : 01
Board Function              : 01
Board Serial No             : 687377 (0x000a7d11)
Number of MsgDMA Descriptors: 31

Local Region  (BAR2) Size   : 0x00020000
Local Region  (BAR2) Address: 0xbd400000
Config Region (BAR0) Size   : 0x00008000
Config Region (BAR0) Address: 0xbd420000


>>>####### Processing 'From' Address (0x00008000) ######<<<

From_____________________________________
  TranslationRequired         = 0
  UserSuppliedPhysicalAddress = 0x00008000
  AvalonEquivalentAddress     = 0x00008000
  PhysicalMemoryToAttach      = 0xbd408000
  PhysicalMemorySize          = 0x00004000
  VirtualUserAddress          = 0x7ffff7fbc000
  Flags                       = 0x0000

>>>####### Processing 'To' Address (0xfffffffffffffffc) ######<<<
           Physical Memory Information:
             UserPID          =6535
             PhysMemPtr       =0x34128000
             DriverVirtMemPtr =0xffff96d0f4128000
             MmapedUserMemPtr =0x7ffff7fe9000
             PhysMemSize      =0x00004000
             PhysMemSizeFreed =0x00000000
             EntryInTxTbl     =0
             NumOfEntriesUsed =1
             Flags            =0x0000

To_______________________________________
  TranslationRequired         = 1
  UserSuppliedPhysicalAddress = 0x34128000
  AvalonEquivalentAddress     = 0x00828000
  PhysicalMemoryToAttach      = 0x34128000
  PhysicalMemorySize          = 0x00004000
  VirtualUserAddress          = 0x7ffff7fe9000
  Flags                       = 0x0000
```

```
 Physical Address      [-a]: 0xBD408000/0x34128000 (From/To)
 Board Number          [-b]: 0
 Delay                 [-d]: 0       (milli-seconds)
 Loop Count            [-l]: 0       (forever)
 Program Board         [-P]: 0       (no)
 Quiet Mode            [-q]: 0       (interactive)
 Transfer Size         [-s]: 16384   (bytes)
 Display Size          [-S]: 256     (bytes)
 Verify Data           [-v]: 0.000   (Additional One Cycle Delay in micro-seconds)
 Region Protection     [-X]: 1       (enabled)
 Address Cache         [-Z]: 0       (enabled)
 One Cycle Time            : 45.731  (micro-seconds)

 From_____________________________________  To_____________________________________
 TranslationRequired      = 0               TranslationRequired      = 1
 UserSuppliedPhysicalAddr = 0x00008000      UserSuppliedPhysicalAddr = 0x34128000
 AvalonEquivalentAddress  = 0x00008000      AvalonEquivalentAddress  = 0x00828000
 PhysicalMemoryToAttach   = 0xbd408000      PhysicalMemoryToAttach   = 0x34128000
 PhysicalMemorySize       = 0x00004000      PhysicalMemorySize       = 0x00004000
 VirtualUserAddress       = 0x7ffff7fbc000  VirtualUserAddress       = 0x7ffff7fe9000
 Flags                    = 0x0000          Flags                    = 0x0000

FailCount=0          (==== passed ====)
ScanCount=1169 (XferSize=16384, DisplaySize=256) (WaitAfterPatternWrite: 46.012 usecs)

___From___  ___00___ ___04___ ___08___ ___0C___ ___10___ ___14___ ___18___ ___1C___
0x00008000  00490000 00490001 00490002 00490003 00490004 00490005 00490006 00490007
0x00008020  00490008 00490009 0049000a 0049000b 0049000c 0049000d 0049000e 0049000f
0x00008040  00490010 00490011 00490012 00490013 00490014 00490015 00490016 00490017
0x00008060  00490018 00490019 0049001a 0049001b 0049001c 0049001d 0049001e 0049001f
0x00008080  00490020 00490021 00490022 00490023 00490024 00490025 00490026 00490027
0x000080a0  00490028 00490029 0049002a 0049002b 0049002c 0049002d 0049002e 0049002f
0x000080c0  00490030 00490031 00490032 00490033 00490034 00490035 00490036 00490037
0x000080e0  00490038 00490039 0049003a 0049003b 0049003c 0049003d 0049003e 0049003f

____To____  ___00___ ___04___ ___08___ ___0C___ ___10___ ___14___ ___18___ ___1C___
0x34128000  00490000 00490001 00490002 00490003 00490004 00490005 00490006 00490007
0x34128020  00490008 00490009 0049000a 0049000b 0049000c 0049000d 0049000e 0049000f
0x34128040  00490010 00490011 00490012 00490013 00490014 00490015 00490016 00490017
0x34128060  00490018 00490019 0049001a 0049001b 0049001c 0049001d 0049001e 0049001f
0x34128080  00490020 00490021 00490022 00490023 00490024 00490025 00490026 00490027
0x341280a0  00490028 00490029 0049002a 0049002b 0049002c 0049002d 0049002e 0049002f
0x341280c0  00490030 00490031 00490032 00490033 00490034 00490035 00490036 00490037
0x341280e0  00490038 00490039 0049003a 0049003b 0049003c 0049003d 0049003e 0049003f
```

3.2.15 lib/ccrtaicc_msgdma_info

This test provides useful modular scatter-gather DMA information for cards that support it.

```
Usage: ./ccrtaicc_msgdma_info [-b Board] [-l]
          -b <Board>            (board #, default = 0)
          -l                    (long format)
```

Example display:

./ccrtaicc_msgdma_info

```
============= Dispatcher ==============
 Status                     = 0x0000000a
 Control                    = 0x0000000c
 ReadFillLevel              = 0x00000000
 WriteFillLevel             = 0x00000000
```

```
        ResponseFillLevel          = 0x00000000
        ReadSequenceNumber         = 0x00000001
        WriteSequenceNumber        = 0x00000001

        ============= Prefetcher ==============
        Status                     = 0x00000000
        Control                    = 0x00000000
        NextDescriptorPointer      = 0xbaadbeef00004800 (### Descriptor ID 1 ###)
        DescriptorPollingFrequency = 0x00000000

========================================== Descriptors ========================================
 ID  Addr   ReadAddr WritAddr Length Stat Control  SeqN Rbct Wbct Rstr Wstr ActBytXfr NextPtr
 ==  ====   ======== ======== ====== ==== ======== ==== ==== ==== ==== ==== ========= ==========
  1 (4800): 00008000 00870000 008000 0000 80000000 00   00   00   0000 0000 00000000  00004fc0
                                                                                      (Terminator)
  2 (4840): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  3 (4880): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  4 (48c0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  5 (4900): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  6 (4940): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  7 (4980): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  8 (49c0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
  9 (4a00): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 10 (4a40): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 11 (4a80): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 12 (4ac0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 13 (4b00): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 14 (4b40): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 15 (4b80): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 16 (4bc0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 17 (4c00): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 18 (4c40): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 19 (4c80): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 20 (4cc0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 21 (4d00): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 22 (4d40): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 23 (4d80): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 24 (4dc0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 25 (4e00): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 26 (4e40): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 27 (4e80): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 28 (4ec0): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 29 (4f00): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 30 (4f40): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
 31 (4f80): 00000000 00000000 000000 0000 00000000 00   00   00   0000 0000 00000000  00000000
```

./ccrtaicc_msgdma_info -l

```
        ============= Dispatcher ==============
        Status                     = 0x0000000a
        Control                    = 0x0000000c
        ReadFillLevel              = 0x00000000
        WriteFillLevel             = 0x00000000
        ResponseFillLevel          = 0x00000000
        ReadSequenceNumber         = 0x00000001
        WriteSequenceNumber        = 0x00000001

        ============= Prefetcher ==============
        Status                     = 0x00000000
        Control                    = 0x00000000
        NextDescriptorPointer      = 0xbaadbeef00004800 (### Descriptor ID 1 ###)
        DescriptorPollingFrequency = 0x00000000

        ============ Descriptor ID 1 (address: 0x4800) =============
        ReadAddress                = 0x0000000000008000
```

```
 WriteAddress               = 0x0000000000840000
 NextDescriptorPointer      = 0x0000000000004fc0 (### Terminator ###)
 Status                     = 0x0000
 Control                    = 0x80000000
 Length                     = 0x00008000 (32768)
 SequenceNumber             = 0x0001     (1)
 ReadBurstCount             = 0x00       (0)
 WriteBurstCount            = 0x00       (0)
 ReadStride                 = 0x0000     (0)
 WriteStride                = 0x0000     (0)
 ActualBytesTransferred     = 0x00000000 (0)

 ============ Descriptor ID 2 (address: 0x4840) =============
 ReadAddress                = 0x0000000000000000
 WriteAddress               = 0x0000000000000000
 NextDescriptorPointer      = 0x0000000000000000
 Status                     = 0x0000
 Control                    = 0x00000000
 Length                     = 0x00000000 (0)
 SequenceNumber             = 0x0000     (0)
 ReadBurstCount             = 0x00       (0)
 WriteBurstCount            = 0x00       (0)
 ReadStride                 = 0x0000     (0)
 WriteStride                = 0x0000     (0)
 ActualBytesTransferred     = 0x00000000 (0)
.
.
.
============ Descriptor ID 29 (address: 0x4f00) =============
 ReadAddress                = 0x0000000000000000
 WriteAddress               = 0x0000000000000000
 NextDescriptorPointer      = 0x0000000000000000
 Status                     = 0x0000
 Control                    = 0x00000000
 Length                     = 0x00000000 (0)
 SequenceNumber             = 0x0000     (0)
 ReadBurstCount             = 0x00       (0)
 WriteBurstCount            = 0x00       (0)
 ReadStride                 = 0x0000     (0)
 WriteStride                = 0x0000     (0)
 ActualBytesTransferred     = 0x00000000 (0)

 ============ Descriptor ID 30 (address: 0x4f40) =============
 ReadAddress                = 0x0000000000000000
 WriteAddress               = 0x0000000000000000
 NextDescriptorPointer      = 0x0000000000000000
 Status                     = 0x0000
 Control                    = 0x00000000
 Length                     = 0x00000000 (0)
 SequenceNumber             = 0x0000     (0)
 ReadBurstCount             = 0x00       (0)
 WriteBurstCount            = 0x00       (0)
 ReadStride                 = 0x0000     (0)
 WriteStride                = 0x0000     (0)
 ActualBytesTransferred     = 0x00000000 (0)

 ============ Descriptor ID 31 (address: 0x4f80) =============
 ReadAddress                = 0x0000000000000000
 WriteAddress               = 0x0000000000000000
 NextDescriptorPointer      = 0x0000000000000000
 Status                     = 0x0000
```

```
Control                   = 0x00000000
Length                    = 0x00000000 (0)
SequenceNumber            = 0x0000     (0)
ReadBurstCount            = 0x00       (0)
WriteBurstCount           = 0x00       (0)
ReadStride                = 0x0000     (0)
WriteStride               = 0x0000     (0)
ActualBytesTransferred    = 0x00000000 (0)
```

3.2.16 lib/ccrtaicc_msgdma_multi_clone

This test is a more powerful version of the *ccrtaicc_msgdma_clone* test above. It allows the users to specify multiple source and destination addresses during the cloning operation. There is a limit on the number of physical memory that can be created or mapped. When that limit is reached, the tests fail to run. Additionally, there is a limit to the number of MsgDma descriptors that can be specified. Once again, if that limit is exceed the test will fail to run.

<u>Caution</u>: Since physical addresses are supplied to this test, care must be taken to ensure that the supplied addresses are valid and that while cloning is in progress, the memory regions must not be freed or made inactive, otherwise, the results could be unpredictable and could lead to the possible corruption of the system.

```
Usage: ./ccrtaicc_msgdma_multi_clone [-a FromAddr,ToAddr,Size] [-b Board] [-d Delay]
                                     [-F DebugFile] [-l LoopCnt] [-P] [-q] [-s XferSize]
                                     [-S DisplaySize] [-t|T FromAddr,Size] [-X] [-Z]
          -a <FromAddr,ToAddr,Size> (Clone address space From/To address (hex) and
                                     size (bytes))
                                    (If address less than board size, board offset used)
          -b <Board>                (board #, default = 0)
          -d <Delay>                (Delay between screen refresh -- default is
                                     5 milli-seconds)
          -F DebugFile              (Debug file -- default "=== None ===")
             @DebugFile             (Debug file and no display)
             @                      (No Debug file and no display)
          -l LoopCnt                (Loop count -- default is 0)
          -P                        (Program Board)
          -q                        (Quite (non-interactive) mode)
          -s <XferSize>             (Transfer size in bytes)
          -S <DisplaySize>          (Display size in bytes)
          -t <FromAddr,Size>        (Perform debug firmware testing - From address (hex)
                                     and size (bytes) - non-verbose)
          -T <FromAddr,Size>        (Perform debug firmware testing - From address (hex)
                                     and size (bytes) - verbose)
          -X                        (Disable region protection)
          -Z                        (Disable address cache - default is enabled)


Note: If the size is not specifed in the '-a' option, then the default size or that
      specifed in the '-s' option is used
      If debug firmware is installed, you can use the '-t|T' option
      The debug firmware uses Clock 3 and its value is programmed by the 't|T' option

e.g.
```

```
  ./ccrtaicc_msgdma_multi_clone                       (Clone DiagRam to physical
                                                       memory created by this program)
  ./ccrtaicc_msgdma_multi_clone -a,-1                 (Clone DiagRam to physical memory
                                                       created by this program)
  ./ccrtaicc_msgdma_multi_clone -a-1,-1               (Clone physical memory to physical
                                                       memory created by this program)
  ./ccrtaicc_msgdma_multi_clone -a,c000 -s0x1000      (Clone DiagRam at 0x8000 to board
                                                       DiagRam at 0xc000)
  ./ccrtaicc_msgdma_multi_clone -a8000,c000 -s0x4000 (Clone DiagRam at 0x8000 to DiagRam
                                                       at 0xC000)
  ./ccrtaicc_msgdma_multi_clone -a,0xbd308000 -X      (Clone DiagRam to some other board
                                                       at specified physical address)
  ./ccrtaicc_msgdma_multi_clone -a8000,8800 -a8800,9000 -a9000,9800 -a9800,a000
                                -aa000,a800 -aa800,b000 -ab000,b800 -ab800,c000
                                -ac000,c800 -s256
                                                      (Clone through all 9 descriptors)
  ./ccrtaicc_msgdma_multi_clone -a8000,8800 -a8800,9000 -a9000,9800 -a9800,a000,128
                                -aa000,a800 -aa800,b000 -ab000,b800 -ab800,c000
                                -ac000,c800,288 -s256 -S288
                                                      (Clone through all 9 descriptors
                                                       with different sizes)
  ./ccrtaicc_msgdma_multi_clone -t                    (Perform non-verbose Debug Firmware
                                                       testing using default address
                                                       0x6000 and size 256 (64 samples))
  ./ccrtaicc_msgdma_multi_clone -T,256 -F/tmp/LOG     (Perform verbose Debug Firmware
                                                       testing using default address, 256
                                                       bytes and send output to /tmp/LOG)
```

Example display:

./ccrtaicc_msgdma_multi_clone

```
 Physical Address      [-a]: 0xC0508000/0x2D198000 (From/To)
 Board Number          [-b]: 0
 Delay                 [-d]: 5       (milli-seconds)
 Loop Count            [-l]: 0       (forever)
 Program Board         [-P]: 0       (no)
 Quiet Mode            [-q]: 0       (interactive)
 Transfer Size         [-s]: 16384   (bytes)
 Display Size          [-S]: 256     (bytes)
 Region Protection     [-X]: 1       (enabled)
 Address Cache         [-Z]: 0       (enabled)
 One Cycle Time            : 45.947  (micro-seconds)
 Current Descriptor        : 0

 From_____________________________________  To_____________________________________
 TranslationRequired      = 0               TranslationRequired      = 1
 UserSuppliedPhysicalAddr = 0x00008000      UserSuppliedPhysicalAddr = 0x2d198000
 UserSuppliedSize         = 0x00004000      UserSuppliedSize         = 0x00004000
 AvalonEquivalentAddress  = 0x00008000      AvalonEquivalentAddress  = 0x00898000
 PhysicalMemoryToAttach   = 0xc0508000      PhysicalMemoryToAttach   = 0x2d198000
 PhysicalMemorySize       = 0x00004000      PhysicalMemorySize       = 0x00004000
 VirtualUserAddress       = 0x7ffff7fbc000  VirtualUserAddress       = 0x7ffff7fe9000
 Flags                    = 0x0000          Flags                    = 0x0000

ScanCount=428        (XferSize=16384, DisplaySize=256) (CopyTime: From 11297.727 usec,
                                                                  To    3.754 usec)

___From___   ___00___ ___04___ ___08___ ___0C___ ___10___ ___14___ ___18___ ___1C___
0x00008000  0012d000 0012d001 0012d002 0012d003 0012d004 0012d005 0012d006 0012d007
0x00008020  0012d008 0012d009 0012d00a 0012d00b 0012d00c 0012d00d 0012d00e 0012d00f
0x00008040  0012d010 0012d011 0012d012 0012d013 0012d014 0012d015 0012d016 0012d017
0x00008060  0012d018 0012d019 0012d01a 0012d01b 0012d01c 0012d01d 0012d01e 0012d01f
0x00008080  0012d020 0012d021 0012d022 0012d023 0012d024 0012d025 0012d026 0012d027
0x000080a0  0012d028 0012d029 0012d02a 0012d02b 0012d02c 0012d02d 0012d02e 0012d02f
```

```
0x000080c0  0012d030 0012d031 0012d032 0012d033 0012d034 0012d035 0012d036 0012d037
0x000080e0  0012d038 0012d039 0012d03a 0012d03b 0012d03c 0012d03d 0012d03e 0012d03f

____To____  ___00___ ___04___ ___08___ ___0C___ ___10___ ___14___ ___18___ ___1C___
0x2d198000  0012d000 0012d001 0012d002 0012d003 0012d004 0012d005 0012d006 0012d007
0x2d198020  0012d008 0012d009 0012d00a 0012d00b 0012d00c 0012d00d 0012d00e 0012d00f
0x2d198040  0012d010 0012d011 0012d012 0012d013 0012d014 0012d015 0012d016 0012d017
0x2d198060  0012d018 0012d019 0012d01a 0012d01b 0012d01c 0012d01d 0012d01e 0012d01f
0x2d198080  0012d020 0012d021 0012d022 0012d023 0012d024 0012d025 0012d026 0012d027
0x2d1980a0  0012d028 0012d029 0012d02a 0012d02b 0012d02c 0012d02d 0012d02e 0012d02f
0x2d1980c0  0012d030 0012d031 0012d032 0012d033 0012d034 0012d035 0012d036 0012d037
0x2d1980e0  0012d038 0012d039 0012d03a 0012d03b 0012d03c 0012d03d 0012d03e 0012d03f

Enter 'c|C' to clear the pattern
      'w|W' toggle pattern write  (Pattern Write Enabled)
      'q|Q' ->
```

3.2.17 lib/ccrtaicc_smp_affinity

This test provides a useful mechanism to display or set the IRQ to specific set of CPUs. This is useful when we want to make sure that the driver interrupts are not being interfered with other CPU activity.

```
Usage: ./ccrtaicc_smp_affinity [-b Board] [-c CpuMask]
 -b Board           (Board number -- default is 0)
 -c CpuMask         (CPU mask in HEX -- default is none)

 e.g. ./ccrtaicc_smp_affinity        (display IRQ CPU mask for selected board)
      ./ccrtaicc_smp_affinity -c2    (set IRQ CPU for cpu 1)
      ./ccrtaicc_smp_affinity -c4    (set IRQ CPU for cpu 2)
      ./ccrtaicc_smp_affinity -c0x8  (set IRQ CPU for cpu 3)
      ./ccrtaicc_smp_affinity -cE2   (set IRQ CPU for cpu 1,5,6,7)
```

Example display:

./ccrtaicc_smp_affinity
(IRQ57) fc user f8 actual

./ccrtaicc_smp_affinity -b1 -c8
(IRQ57) 08 user 08 actual

3.2.18 lib/ccrtaicc_transfer

This test performs various DMA and Programmed I/O transfers between the board components and the PCI memory.

```
Usage: ./ccrtaicc_transfer [-b Board] [-c CaseNum] [-i] [-l LoopCnt]
                           [-s XferSize]
 -b Board     (Board number -- default is 0)
 -c CaseNum   (Select Case Numbers -- default = ALL CASES)
    -c 4,1,7-9 select case 1,4,7,8,9)
    -c 8-      select case 8 to end)
    -c -3      select case 1,2,3)
 -i           (Enable Interrupts -- default = Disable)
 -l LoopCnt   (Loop Count -- default is 100)
 -s XferSize  (Avalon Ram Xfer Size in bytes -- default is 32768)
```

Example display:

./ccrtaicc_transfer

```
local_ptr=0x7ffff7fd7000
Size of Avalon RAM = 32768 (0x00008000)
```

```
          Physical Memory Information:
            UserPID         =28194
            PhysMemPtr      =0x4340000
            DriverVirtMemPtr=0xffff880004340000
            MmapedUserMemPtr=0x7ffff7fc5000
            PhysMemSize     =0x00008000
            PhysMemSizeFreed=0x00000000
            EntryInTxTbl    =0
            NumOfEntriesUsed=1
            Flags           =0x0000

  1: Memory -> Avalon RAM (DMA0) (Size=0x8000):              100 (1404.64 us, 23.33 MBytes/Sec)
  2: Memory -> Avalon RAM (DMA1) (Size=0x8000):              100 (1404.64 us, 23.33 MBytes/Sec)
  3: Memory -> Avalon RAM (MSGDMA) (Size=0x8000):            100 (111.45 us, 294.01 MBytes/Sec)
  4: Memory -> Avalon RAM  (PIO) (Size=0x8000):              100 (124.85 us, 262.45 MBytes/Sec)
  5: Avalon RAM -> Memory (DMA0) (Size=0x8000):              100 (529.98 us, 61.83 MBytes/Sec)
  6: Avalon RAM -> Memory (DMA1) (Size=0x8000):              100 (530.00 us, 61.83 MBytes/Sec)
  7: Avalon RAM -> Memory (MSGDMA) (Size=0x8000):            100 (90.12 us, 363.62 MBytes/Sec)
  8: Avalon RAM -> Memory  (PIO) (Size=0x8000):              100 (12380.83 us, 2.65 MBytes/Sec)
  9: Memory -> Avalon ADC Calibration (DMA0) (Size=0x100):   10000 (17.14 us, 14.93 MBytes/Sec)
 10: Memory -> Avalon ADC Calibration  (PIO) (Size=0x100):   10000 (0.55 us, 462.64 MBytes/Sec)
 11: Avalon ADC Calibration -> Memory (DMA0) (Size=0x100):   10000 (12.91 us, 19.82 MBytes/Sec)
 12: Avalon ADC Calibration -> Memory  (PIO) (Size=0x100):   10000 (131.22 us, 1.95 MBytes/Sec)
**** Test Passed ****
```

3.2.19 lib/ccrtaicc_tst_lib

This is an interactive test that accesses the various supported API calls.

```
Usage: ./ccrtaicc_tst_lib [-b board]
 -b board: board number -- default board is 0
```

Example display:

./ccrtaicc_tst_lib

```
Device Name: /dev/ccrtaicc0
  01 = Abort DMA                          02 = Clear Cable Fault
  03 = Clear Driver Error                 04 = Clear Library Error
  05 = Display BOARD Registers            06 = Display CONFIG Registers
  07 = Dump Physical Memory List          08 = Get All Boards Driver Information
  09 = Get Board CSR                      10 = Get Board Information
  11 = Get Driver Error                   12 = Get External Clock CSR
  13 = Get Cable Fault CSR                14 = Get Driver Information
  15 = Get Library Error                  16 = Get Mapped Config Pointer
  17 = Get Mapped Driver/Library Pointer  18 = Get Mapped Local Pointer
  19 = Get Physical Memory                20 = Get Test Bus Control
  21 = Get Value                          22 = Initialize Board
  23 = MMap Physical Memory               24 = Munmap Physical Memory
  25 = Reload Firmware                    26 = Reset Board
  27 = Set Board CSR                      28 = Set External Clock CSR
  29 = Set Test Bus Control               30 = Set Value
  31 = ### ADC MENU ###                   32 = ### CALIBRATION MENU ###
  33 = ### CLOCK GENERATOR MENU ###       34 = ### INTERRUPT MENU ###

Main Selection ('h'=display menu, 'q'=quit)->
```

```
Main Selection ('h'=display menu, 'q'=quit)-> 31
   Command: ADC_menu()
  01 = ADC Activate                       02 = ADC Disable
  03 = ADC Reset (disable/activate)       04 = ADC Driver Read Operation
  05 = ADC Get CSR                        06 = ADC Get Driver Read Mode
  07 = ADC Get FIFO Channel Select        08 = ADC Get FIFO Information
  09 = ADC Get FIFO Status                10 = ADC Get FIFO Threshold
  11 = ADC Get Input Control              12 = ADC Read Channels
```

```
  13 = ADC Reset FIFO                          14 = ADC Set CSR
  15 = ADC Set Driver Read Mode                16 = ADC Set FIFO Channel Select
  17 = ADC Set FIFO Threshold                  18 = ADC Set Input Control

ADC Selection ('h'=display menu, 'q'=quit)->
```

```
Main Selection ('h'=display menu, 'q'=quit)-> 32
   Command: calibration_menu()
  01 = ADC: Get Calibrated Values              02 = ADC: Perform Auto Calibration
  03 = ADC: Perform External Negative Calib.   04 = ADC: Perform External Offset Calib.
  05 = ADC: Perform External Positive Calib.   06 = ADC: Perform Negative Calibration
  07 = ADC: Perform Offset Calibration         08 = ADC: Perform Positive Calibration
  09 = ADC: Read Channels Calibration          10 = ADC: Reset Calibration
  11 = ADC: Write Channels Calibration         12 = Get Calibration CSR
  13 = Set Calibration CSR

Calibration Selection ('h'=display menu, 'q'=quit)->
```

```
Main Selection ('h'=display menu, 'q'=quit)-> 33
   Command: clock_generator_menu()
  01 = Clock Disable Outputs                   02 = Clock Enable Outputs
  03 = Clock Get Generator CSR                 04 = Clock Get Generator Dividers
  05 = Clock Get Generator Information         06 = Clock Get Generator Input Clock Enable
  07 = Clock Get Generator Input Clock Select  08 = Clock Get Generator Input Clock Status
  09 = Clock Get Generator Output Config       10 = Clock Get Generator Output Format
  11 = Clock Get Generator Output Mode         12 = Clock Get Generator Output Mux
  13 = Clock Get Generator P-Divider Enable    14 = Clock Get Generator Revision
  15 = Clock Get Generator Value               16 = Clock Get Generator Voltage Select
  17 = Clock Get Generator Zero Delay          18 = Clock Set Generator CSR
  19 = Clock Set Generator Dividers            20 = Clock Set Generator Input Clock Enable
  21 = Clock Set Generator Input Clock Select  22 = Clock Set Generator Output Config
  23 = Clock Set Generator Output Format       24 = Clock Set Generator Output Mode
  25 = Clock Set Generator Output Mux          26 = Clock Set Generator P-Divider Enable
  27 = Clock Set Generator Value               28 = Clock Set Generator Voltage Select
  29 = Clock Set Generator Zero Delay          30 = Compute All Output Clocks
  31 = Program All Output Clocks               32 = Read Clock Registers
  33 = Reset Clock (Hardware)                  34 = Soft Reset
  35 = Update Clock Generator Divider          36 = Write Clock Registers

Clock Generator Selection ('h'=display menu, 'q'=quit)->
```

```
Main Selection ('h'=display menu, 'q'=quit)-> 34
   Command: interrupt_menu()
  01 = Add Irq                                 02 = Disable Pci Interrupts
  03 = Enable Pci Interrupts                   04 = Get Interrupt Status
  05 = Get Interrupt Timeout                   06 = Remove Irq
  07 = Set Interrupt Status                    08 = Set Interrupt Timeout

Interrupt Selection ('h'=display menu, 'q'=quit)->
```

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