CAEN
Tools for Discovery

UM1935

CAENDigitizer User & Reference Manual

Rev. 5 - 08 May 2013

Purpose of this User Manual

This User Manual contains the full description of the C version of CAENDigitizer library, updated to the last rel. 2.3.1.

Change Document Record

Date	Revision	Changes
16 February 2012	01	Fully revised and implemented §5
18 June 2012	02	Fully revised to document the software library 2.2.1
08 October 2012	03	Removed LabVIEW content
10 December 2012	04	Revised functions at pp. 58 - 59
08 May 2013	05	Revised DPP-CI and DPP-PSD digital probes

Symbols, abbreviated terms and notation

ADC	Analog to Digital Converter
DPP	Digital Pulse Processing
FFT	Fast Fourier Transform
FSR	Full Scale Range
OS	Operating System
SBC	Single Board Computer

Reference Document

[RD1]   UM1934 - CAENComm User & Reference Manual

[RD2]   AN2472 - CONET1 to CONET2 migration

[RD3]   UM2784 - CAENDigitizer LabView User & Reference Manual

Index

CAEN Electronic Instrumentation

List of Figures

List of Tables

CAEN ⬡ Electronic Instrumentation

1 Introduction

CAEN has developed a family of Sampling ADCs modules with different form factors (VME, NIM and Desktop). They all provide the possibility to be handled and readout by a host PC via different communication channels.

The CAENDigitizer is a library of functions designed specifically for the digitizer family and it supports also the boards running special DPP (Digital Pulse Processing) firmware. The purpose of this library is to allow the user to open the digitizer, program it and manage the data acquisition in an easy way: with few lines of code the user can make a simple readout program without the necessity to know the details of the registers and the event data format.

The CAENDigitizer library implements a common interface to the higher software layers, masking the details of the physical channel and its protocol, thus making the libraries and applications that rely on the CAENDigitizer independent from the physical layer.

Supported platforms are Windows and Linux 32 and 64 bit. A specific version of CAENDigitizer library has been developed for LabVIEW and is documented in the soon to be relased **[RD3]**.

The CAENDigitizer library is based on the CAENComm library that manages the communication at low level (read and write access). The CAENComm requires the CAENVMELib library (access to the VME bus) even in the cases where the VME is not used. For this reason, the CAENVMELib and CAENComm libraries must be already installed on the host PC before installing the CAENDigitizer; however, both CAENVMELib and CAENComm libraries are completely transparent to the user.

Concerning the access through the VME bus, the CAENComm and the CAENDigitizer libraries have been designed to work with CAEN's VME bridges V1718 and V2718. It is possible to make the CAENDigitizer compatible for different types of VME controllers (such as a SBC); for this purpose, the user must provide a library that exports the functions used by the CAENComm. Refer to **[RD1]** for documentation.

Currently, the CAENComm (and so the CAENDigitizer) supports the following communication channels:

- PC → USB → Digitizer (either Desktop or NIM models)
- PC → USB → V1718 → VME → Digitizers (VME models only)
- PC → PCI (A2818) → CONET → Digitizers (all models)
- PC → PCI (A2818) → CONET → V2718 → VME → Digitizers (VME models only)
- PC → PCIe (A3818) → CONET → Digitizers (all models)
- PC → PCIe (A3818) → CONET → V2718 → VME → Digitizers (VME models only)

CONET (Chainable Optical NETwork) indicates the CAEN proprietary protocol for communication on Optical Link. Refer to **[RD2]** for useful information.
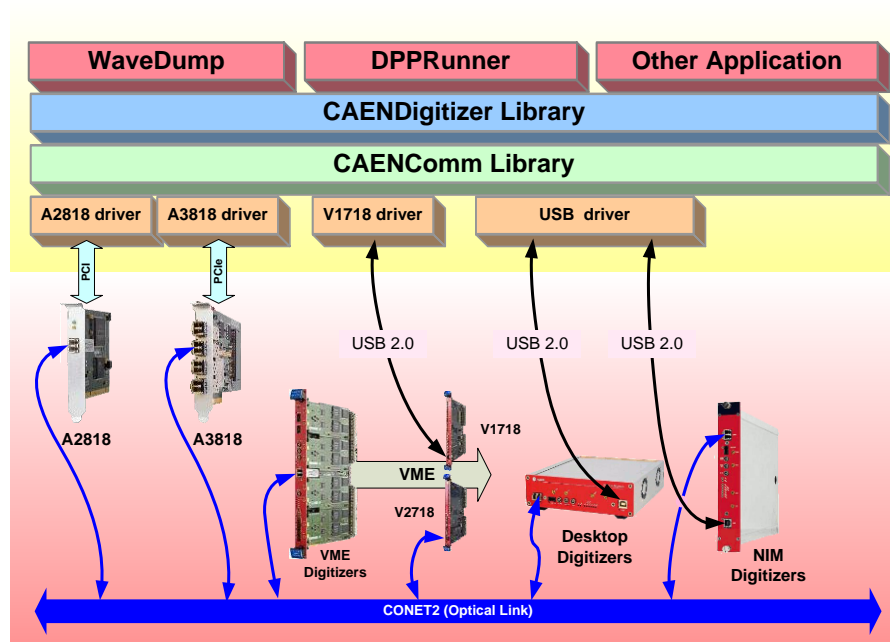
Fig. 1.1: Hardware and Software layers.

CAEN ⬡ **Electronic Instrumentation**

System requirements & installation setup

OS	OS version	CAEN Library required	Third-party software required
Windows	2000/XP/Vista/7	CAENComm CAENVMELib	n/a
Linux	kernel Rel. 2.4/2.6 with gnu C/C++ compiler		n/a

Tab. 1: Host PC requirements

Follow the next steps for the installation of CAENDigitizer library:

- Go to CAEN web site in the "Download" area of *CAENDigitizer* page.

- Download the **CAENDigitizer installation package** related to your OS and unpack it.

- Click on the red link under the library links and download the **CAEN required libraries**.

Software Libraries

| CAENDigitizer library | 2.2.1 | June, 2012 | XP/Vista/7 (32 - 64 bit) | C, LABVIEW |

Library 10.69 MB - Type: .zip
Release Notes 5.33 KB - Type: .txt
⚠ [-] CAENDigitizer library requires additional Libraries
CAENComm Library   Library 8.67 MB - Type: .zip
CAENVMELib (*)   Library 13.54 MB - Type: .zip

| CAENDigitizer library | 2.2.1 | June, 2012 | Kernel 2.4, Kernel 2.6 | C, LABVIEW |

Library 158.59 KB - Type: .tgz
Release Notes 5.23 KB - Type: .txt
⚠ [-] CAENDigitizer library requires additional Libraries
CAENComm library   Library 21.64 KB - Type: .tgz
CAENVMELib & demo   Library & Demo 412.18 KB - Type: .tgz

- Install the required libraries starting from CAENVMELib.

- For Windows users: run the *CAENDigitizer* setup executable file and follow the installer instructions.

- For Linux users: follow the instructions in the README file within the library package.

✎ **Note:** Installation of *CAENDitizer* also includes a folder "Samples" with a set of source files and projects for readout with standard firmware (p. **47**) and DPP firmware (p. **68**) to be available for user practice, as well as functions for the offline data correction (p.**50**) of x742 digitizers.

CAEN Electronic Instrumentation

Return Codes

Error code	Value	Meaning
CAEN_DGTZ_Success	0	Operation completed successfully
CAEN_DGTZ_CommError	-1	Communication error
CAEN_DGTZ_GenericError	-2	Unspecified error
CAEN_DGTZ_InvalidParam	-3	Invalid parameter
CAEN_DGTZ_InvalidLinkType	-4	Invalid Link Type
CAEN_DGTZ_InvalidHandler	-5	Invalid device handler
CAEN_DGTZ_MaxDevicesError	-6	Maximum number of devices exceeded
CAEN_DGTZ_BadBoardType	-7	Operation not allowed on this type of board
CAEN_DGTZ_BadInterruptLev	-8	The interrupt level is not allowed
CAEN_DGTZ_BadEventNumber	-9	The event number is bad
CAEN_DGTZ_ReadDeviceRegisterFail	-10	Unable to read the registry
CAEN_DGTZ_WriteDeviceRegisterFail	-11	Unable to write into the registry
CAEN_DGTZ_InvalidChannelNumber	-13	The Channel is busy
CAEN_DGTZ_ChannelBusy	-14	The channel number is invalid
CAEN_DGTZ_FPIOModeInvalid	-15	Invalid FPIO Mode
CAEN_DGTZ_WrongAcqMode	-16	Wrong acquisition mode
CAEN_DGTZ_FunctionNotAllowed	-17	This function is not allowed for this module
CAEN_DGTZ_Timeout	-18	Communication Timeout
CAEN_DGTZ_InvalidBuffer	-19	The buffer is invalid
CAEN_DGTZ_EventNotFound	-20	The event is not found
CAEN_DGTZ_InvalidEvent	-21	The event is invalid
CAEN_DGTZ_OutOfMemory	-22	Out of memory
CAEN_DGTZ_CalibrationError	-23	Unable to calibrate the board
CAEN_DGTZ_DigitizerNotFound	-24	Unable to open the digitizer
CAEN_DGTZ_DigitizerAlreadyOpen	-25	The Digitizer is already open
CAEN_DGTZ_DigitizerNotReady	-26	The Digitizer is not ready to operate
CAEN_DGTZ_InterruptNotConfigured	-27	The Digitizer has not the IRQ configured
CAEN_DGTZ_DigitizerMemoryCorrupted	-28	The digitizer flash memory is corrupted
CAEN_DGTZ_DPPFirmwareNotSupported	-29	The digitizer DPP firmware is not supported in this lib version
CAEN_DGTZ_NotYetImplemented	-99	The function is not yet implemented

Tab. 2: Return codes table

2 Communication

These functions allow to open and close the connection with the digitizer as well as get board information such as the serial number, the model, the firmware revision, etc. To open one board is necessary to describe the physical communication channel from the PC to the device (as already indicated in the introduction). Once the device is opened, the function returns a handle that becomes the unique identifier of that device; any access operation to the device (except for VME IRQ management) will take place according to its handle, thus making transparent the physical channel.

OpenDigitizer

Desktop and NIM versions can be directly handled via USB, just connecting the digitizer to the host PC via the USB cable (the USB driver is available on Digitizer web page).

Description

Opens the digitizer and gets the device handle. See the examples below for the different types of communication channels and the relevant parameters.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ OpenDigitizer (CAEN DGTZ ConnectionType LinkType,
                         int LinkNum,
                         int ConetNode,
                         uint32 t VMEBaseAddress,
                         int *handle
                         );

typedef enum {
  CAEN_DGTZ_USB                  = 0,  // USB (direct or V1718->VME)
  CAEN DGTZ PCI OpticalLink      = 1,  // PCI-A2818 (direct or V2718->VME)
  CAEN DGTZ PCIE OpticalLink     = 2,  // PCIe-A3818 (direct or V2718->VME)
  CAEN DGTZ PCIE EmbeddedDigitizer = 3,  // future development
} CAEN_DGTZ_ConnectionType;
```

Arguments

Name	Description
LinkType	Indicates the physical communication channel. It can be CAEN_DGTZ_USB (either direct connection or VME through V1718), CAEN_DGTZ_PCI_OpticalLink (A2818 -> Optical Link, either direct connection or VME through V2718) or CAEN_DGTZ_PCIE_OpticalLink (same as A2818 but using A3818).
LinkNum	Link number: in case of USB, the link numbers are assigned by the PC when you connect the cable to the device; it is 0 for the first device, 1 for the second and so on. There is not a fixed correspondence between the USB port and the link number. For the CONET, the link number indicates which link of A2818 or A3818 is used; Link index start from 0 (1st Optical link port in the 1st slot used). It is not known a priori which is the first slot used (it depends on the motherboard of the PC used.). **IMPORTANT NOTE: if A2818 and A3818 are installed together, the A2818 have lower index assigned**.
ConetNode	The CONET node identifies which device in the Daisy chain is being addressed. The node is 0 for the first device in the chain, 1 for the second and so on. In case of USB, *ConetNode* must be 0.
VMEBaseAddress	VME Base Address of the board (rotary switches setting) expressed as a 32-bit number. This argument is used only for the VME models accessed through the VME bus and **MUST BE 0** in all other cases.
***handle**	Pointer to the handler returned by the open function

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Examples

CAEN Electronic Instrumentation

CloseDigitizer

Description
This function closes the digitizer.

Synopsis
```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_CloseDigitizer (int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values
0: Success; Negative numbers are error codes (see Return Codes).

WriteRegister

Description
Generic write access to one register of the digitizer. The CAENDigitizer library provides specific functions for most of the parameters settings; in the case where there is not a specific function for accessing a particular register or the user wants to force the writing of a datum, this function makes it possible to perform a direct access to the registers. It is worth noticing that the overwriting of some settings can cause inconsistency of the operations.

Synopsis
```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ WriteRegister(int handle,
                        uint32_t Address,
                        uint32_t Data
                        );
```

Arguments

Name	Description
handle	Device handler
Address	Register address. For the VME access, this is the lower 16 bit part of the VME address bus
Data	32 bit data to write

Return Values
0: Success; Negative numbers are error codes (see Return Codes).

ReadRegister

Description
Generic read access to one register of the digitizer (see **WriteRegister** for more details).

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ ReadRegister(int handle,
                       uint32 t Address,
                       uint32 t *Data
                       );
```

Arguments

Name	Description
handle	Device handler
Address	Register address. For the VME access, this is the lower 16 bit part of the VME address bus
***Data**	Data read from the board (32 bit)

Return Values
0: Success; Negative numbers are error codes (see Return Codes).

Reset

Description

This function resets the Digitizer. All internal registers and states are restored to default.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_Reset (int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN ⬡ Electronic Instrumentation

GetInfo

Description

The function reads from the board some information such as serial number, model, number of channels, firmware release and other parameters of the device.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetInfo(int handle,
                CAEN_DGTZ_BoardInfo_t *BoardInfo
                );

typedef struct {
char                        ModelName[12];
uint32_t                    Model;
uint32_t                    Channels;
uint32_t                    FormFactor;
uint32_t                    FamilyCode;
char                        ROC_FirmwareRel[20];
char                        AMC_FirmwareRel[20];
uint32_t                    SerialNumber;
uint32_t                    PCB_Revision;
uint32_t                    ADC_NBits;
} CAEN_DGTZ_BoardInfo_t;

typedef enum {
CAEN_DGTZ_V1724             =0L,
CAEN_DGTZ_V1721             =1L,
CAEN_DGTZ_V1731             =2L,
CAEN_DGTZ_V1720             =3L,
CAEN_DGTZ_V1740             =4L,
CAEN_DGTZ_V1751             =5L,
CAEN_DGTZ_DT5724            =6L,
CAEN_DGTZ_DT5721            =7L,
CAEN_DGTZ_DT5731            =8L,
CAEN_DGTZ_DT5720            =9L,
CAEN_DGTZ_DT5740            =10L,
CAEN_DGTZ_DT5751            =11L,
CAEN_DGTZ_N6724            =12L,
CAEN_DGTZ_N6721            =13L,
CAEN_DGTZ_N6731            =14L,
CAEN_DGTZ_N6720            =15L,
CAEN_DGTZ_N6740            =16L,
CAEN_DGTZ_N6751            =17L,
CAEN_DGTZ_DT5742           =18L,
CAEN_DGTZ_N6742            =19L,
CAEN_DGTZ_V1742            =20L,
CAEN_DGTZ_DT5780           =21L,
CAEN_DGTZ_N6780            =22L,
CAEN_DGTZ_V1780            =23L,
CAEN_DGTZ_DT5761           =24L,
CAEN_DGTZ_N6761            =25L,
CAEN_DGTZ_V1761            =26L,
} CAEN_DGTZ_BoardModel_t;

typedef enum {
    CAEN_DGTZ_VME64_FORM_FACTOR   = 0L,
    CAEN_DGTZ_VME64X_FORM_FACTOR  = 1L,
    CAEN_DGTZ_DESKTOP_FORM_FACTOR = 2L,
    CAEN_DGTZ_NIM_FORM_FACTOR     = 3L,
} CAEN_DGTZ_BoardFormFactor_t;

typedef enum {
    CAEN_DGTZ_XX724_FAMILY_CODE  = 0L,  // 14 bit, 100 MS/s
    CAEN_DGTZ_XX721_FAMILY_CODE  = 1L,  //  8 bit, 500 MS/s
    CAEN_DGTZ_XX731_FAMILY_CODE  = 2L,  //  8 bit, 500-1000 MS/s
    CAEN_DGTZ_XX720_FAMILY_CODE  = 3L,  // 12 bit, 250 MS/s
    CAEN_DGTZ_XX740_FAMILY_CODE  = 4L,  // 12 bit, 65 MS/s
    CAEN_DGTZ_XX751_FAMILY_CODE  = 5L,  // 10 bit, 1000-2000 MS/s
    CAEN_DGTZ_XX742_FAMILY_CODE  = 6L,  // 12 bit, 5 GS/s, switched capacitor
    CAEN_DGTZ_XX780_FAMILY_CODE  = 7L,  // 14 bit, 100 MS/s Multi Channel Analyser
    CAEN_DGTZ_XX761_FAMILY_CODE  = 8L,  // 10 bit, 4 GS/s
} CAEN_DGTZ_BoardFamilyCode_t;
```

Arguments

Name	Description
`handle`	Device handler
`*Board Info`	Pointer to the structure containing the Board Info filled by the CAEN_DGTZ_GetInfo

BoardInfo Fields

Name	Description
`ModelName`	Model name: for example "V1724"
`Model`	See type enum `CAEN_DGTZ_BoardModel_t`
`Channels`	Number of channels
`FormFactor`	Format Factor (VME, NIM, Desktop); see type `CAEN_DGTZ_BoardFormFactor_t`
`FamilyCode`	Family (ADC type); see type `CAEN_DGTZ_FamilyCode_t`
`ROC_FirmwareRel`	Firmware Revision of the FPGA on the mother board (ROC); for example "01.02"
`AMC_FirmwareRel`	Firmware Revision of the FPGA on the daughter board (AMC)
`SerialNumber`	Serial number of the board
`PCB_Revision`	PCB Revision number
`ADC_NBits`	Number of bits of the ADC

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

Interrupt configuration

All digitizers can generate interrupt requests (IRQ) to the PC to the occurrence of a particular condition: if the memory contains at least Ne events ready for reading, where Ne is a programmable parameter.

This allows to create programs that build the process of readout (read access to the memory buffer) on interrupts: they perform passive wait cycles, until they are awakened by the driver at the arrival of an interrupt from the digitizer; at such point , the process can read data, aware to find at least Ne events in memory, without having to check in advance the presence of data, as in the case of the readout based on polling.

The readout based on the interrupts is therefore more efficient, in terms of employment of the PC resources, compared to the one based on polling.

The interrupt requests are transferred from the digitizer to the PC via the optical link, in one of the following ways:

- Direct connection to the optical link (all models): the digitizer sends the interrupt request on the optical link to the A2818 PCI or A3818 PCIe connected to the PC, and these, in their turn, assert the interrupt request on the PCI bus or PCIe respectively. In this case, the interrupt request coming to the PC is uniquely associated with the digitizer which sent it.

- Connection via VME bus: in this case, the digitizer asserts the interrupt request on the VME bus on one of the 7 IRQ lines, and this request is detected by the VME master (V2718), which sends it via optical link to the PC, in the same manner described above. In this case, since the lines IRQ [7 .. 1] of the VME are shared with all modules on VME bus, it is necessary to identify the module that sent the request, as explained farther.

Note: interrupts cannot be used in case of communication via USB (either directly or through V1718 and VME)

Set / GetInterruptConfig

Description

Enable / Disable the digitizer to generate an interrupt request when the memory contains at least Ne events ready for reading, where Ne is the parameter event_number.

- In the case of VME models, the IRQ level to be activated on VME bus can be set from 1 to 7;

- in the case of the optical link, level should be 1.

The status_id, according to the specifications of the VME bus, is the value returned by the card during the interrupt acknowledge cycle and allows the operator to see which digitizer has asserted the interrupt request on the VME bus; in the programming stage, the user must set different status_id values for each digitizer. In the case of the optical link, the status_id is meaningless.

The mode parameter sets the interrupt release policy of the digitizer: in particular, **Roak** (Release On Acknowledge) mode foresees that the request is issued immediately after the interrupt acknowledge cycle (IACK), while in the case of **Rora** (Release on Register Access) mode, the interrupt request is not released by the digitizer until the user accesses a particular registry to disable it; in the case of the digitizer, the release occurs by setting to zero the level in the VME Control register, by calling the "Set" function of **Set / GetInterruptConfig** with status = disabled.

The methods Rora and Roak, arising from the VME specifications, are implemented also in the CONET protocol of the optical link, with the exception that the Interrupt Acknowledge cycle with CONET is required only to release the interrupt and not to identify the device that has generated it, since this information is already determined from the handle

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ SetInterruptConfig (int handle,
                              CAEN DGTZ EnaDis t state,
                              uint8 t level,
                              uint32_t status_id,
                              uint16_t event_number,
                              CAEN_DGTZ_IRQMode_t mode
                              );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetInterruptConfig (int handle,
                              CAEN_DGTZ_EnaDis_t *state,
                              uint8 t *level,
                              uint32 t *status id,
                              uint16_t *event_number,
                              CAEN_DGTZ_IRQMode_t *mode
                              );

typedef enum {
                              CAEN DGTZ ENABLE = 1L,
                              CAEN_DGTZ_DISABLE = 0L,
} CAEN_DGTZ_EnaDis t;

typedef enum {
                               CAEN DGTZ IRQ MODE RORA = 0,
                               CAEN DGTZ IRQ MODE ROAK = 1,
} CAEN_DGTZ_IRQMode_t;
```

Arguments

Name	Description
handle	Device handler
state	Enable/Disable
level	VME IRQ Level (from 1 to 7). Must be 1 for direct connection through CONET
status_id	32 bit number assigned to the device and returned by the device during the Interrupt Acknowledge
event_number	If the number of events ready for the readout is equal to or greater than *event_number*, then the digitizer asserts the interrupt request
mode	Interrupt release mode: *CAEN_DGTZ_IRQ_MODE_RORA* (release on register access) or *CAEN_DGTZ_IRQ_MODE_ROAK* (release on acknowledge)

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

IRQWait

Description

Once set up the digitizer to generate an interrupt request by the function described above, the reading process can enter a state of passive waiting to be woken up as the interrupt request from the digitizer which is communicating with (the one identified uniquely from the handle passed as a parameter), is sent. This function is valid only for direct connection to link optical digitizer, in the case of communication via the VME, use **VMEIRQWait**. The timeout parameter indicates the maximum waiting time before being forced to wake up even without interrupt. In this case, the value returned by the function is 18.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_IRQWait(int handle,
                  uint32_t timeout
                  );
```

Arguments

Name	Description
handle	Device handler
timeout	Timeout (max wait time) in ms

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

VMEIRQWait

Description

This function, as the one described above, implements the passive waiting from which the waking occurs up in response to an interrupt request from the digitizer. The main difference is that in this case, the digitizer asserts a IRQ (1 to 7) on the VME bus and this is transferred to the PC by the master VME V2718. Since other digitizers could be on the VME bus (and therefore different handles that identify them within the program), and each one can generate interrupts, even on the same IRQ line, the management of interrupts cannot take place through the handle of the digitizer (which cannot be uniquely associated with the request arrived at the PC) but must be performed through the handle of the master VME V2718 which is the unique collector of interrupt requests to the PC. Once awakened from the waiting status, the process of reading can understand what digitizer has actually sent the request via the interrupt acknowledge cycle.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_VMEIRQWait(int LinkType,
                     int LinkNum,
                     int ConetNode,
                     uint32_t timeout,
                     int *VMEHandle
                     );
```

Arguments

Name	Description
LinkType	Indicates the physical communication channel used to connect the CAEN VME bridge that handles the interrupts on the VME bus. It can be `CAENComm_USB` for the V1718 or `CAENComm_PCI_OpticalLink` for the A2818 -> Optical Link -> V2718) or `CAENComm_PCIe_OpticalLink` (same as A2818 but using A3818)
LinkNum	Link number: in case of USB, the link numbers are assigned by the PC when you connect the cable to the device; it is 0 for the first device, 1 for the second and so on. There is not a fixed correspondence between the USB port and the link number. For the CONET, the link number indicates which A2818 or A3818 is used; also in this case, it is not known a priori which PCI/PCIe card is assigned to which number.
ConetNode	The CONET node identifies which device in the Daisy chain is being addressed. The node is 0 for the first device in the chain, 1 for the second and so on. In case of USB, ConetNode must be 0.
timeout	Timeout (max wait time) in msec
***VMEHandle**	Device handler of the CAEN VME Bridge that received the interrupt request

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

VMEIRQCheck

Description

This function allows to read the status of interrupt requests on the VME bus (IRQ1-7) and, for this reason, the handle to be passed is the VME master one, not the digitizer one. This function can only be used for digitizer that communicate via the VME bus. The purpose of this function is almost exclusively for debugging.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ VMEIRQCheck(int VMEHandle,
                      uint8 t *Mask
                      );
```

Arguments

Name	Description
VMEHandle	Device handler of the VME bridge that handles the interrupts
*Mask	Mask of the IRQ lines read from the VME bus (1=IRQ active, 0=IRQ not active)

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

IACKCycle

Description

This function performs an interrupt acknowledge cycle on the digitizer identified by the handle. This function can only be used for direct communications via optical links; in case of communication via the VME, it should be used **VMEIACKCycle** described farther. Although in the case of direct connection to the optical link there is not need to identify the digitizer that generated the interrupt request, the IACK cycle is still executed in the case of mode ROAK (release on acknowledge) to release the request

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ IACKCycle(int handle,
                    int32 t *board_id
                    );
```

Arguments

Name	Description
handle	Device handler of the digitizer
*board_id	Data (status_id) returned by the digitizer that asserted the interrupt request.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

VMEIACKCycle

Description

This function performs an interrupt acknowledge cycle to know the board_id of the board that raised an interrupt. As described previously, in the case of interrupt requests on the VME bus, it is not possible to know in advance which digitizer asserted a certain IRQ line. Indeed, it could also happen that a line is asserted by any other slave on the VME bus with which no communication is established. For this reason, when the reading process on hold in a specific IRQ is awakened, it must perform an interrupt acknowledge cycle to see which one generated the interupt. The identification is as follows: during acknowledge cycle (which is very similar to a read cycle), the slave that caused the interruption puts on his bus status_id, actually the value previously programmed by the user through the "Set" function of **Set / GetInterruptConfig** function. In the case of multiple cards having different values of the programmed status_id, the user will be able to figure out who sent the request, and then which one is to be read. It should be noted that in the case of multiple cards on the bus (even inhomogeneous), the interrupt management must be centralized, as the acknowledge cycle should be performed only once. It is therefore not recommended (although possible) to have more process waiting on the same IRQ line.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_VMEIACKCycle(int VMEHandle,
                       uint8 t level,
                       int32 t *board id
                       );
```

Arguments

Name	Description
VMEHandle	Device handler of the CAEN VME bridge that handles the interrupts
level	IRQ level (from 1 to 7) on which to perform the interrupt acknowledge cycle
***board_id**	Data (status_id) returned by the digitizer that asserted the interrupt request

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Examples

WAVEDUMP Code *(To be implemented)*

RearmInterrupt

Description
Rearm the Interrupt.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_RearmInterrupt (int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Data Readout

The data reading from the memories of the digitizer is done through BlockRead cycles (although it is possible also to run cycles to read each buffer). In the case of direct communication via USB or optical link, the protocol that manages the blocks transfer is CAEN proprietary and therefore there are no ambiguities or special options to be decided. Conversely, if reading takes place through the VME bus, since the standard provides different types of access and not all VME masters support all modes (or do it differently), the reading mode may need to be adapted according to the master features. The library foresees the use of master CAEN V1718 and V2718 and the readout mode is optimized for these modules.

ClearData

Description

This function Clears the data stored in the buffers of the Digitizer.

Note: generally it is not necessary to call this function, because the digitizer runs automatically a clear cycle when an acquisition starts. The function can be used during an acquisition when aware that the data stored in memory are not interesting and not going to be read

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_ClearData(int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

DisableEventAlignedReadout

Description

By default, in the data transfer from the memory of the digitizer to the PC, regardless of the type of link used, events are aligned: the digitizer stop the transfer after transferring an integer number Ne of events, where Ne is user programmable through the "Set" function of **Set / GetMaxNumEventsBLT**, even if the user has requested the transfer of more data. In the case of communication via USB and optical links, the premature termination of the transfer is foreseen by the protocol; instead, for the VME Block Transfer, the transfer is interrupted by the digitizer asserting the bus error (if enabled, see above).

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_DisableEventAlignedReadout(int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetMaxNumEventsBLT

Description

Concerning the Digitizers running the standard firmware, this function sets/gets the maximum number of events for each transfer. Regardless of the type of link, during a block transfer cycle, the digitizer stops the transfer after a predetermined number of events (or when the memory is empty). The greater the number of events transferred (and thus the size of the block read), the greater the efficiency of the readout, since the protocol overhead is smaller. In contrast, higher values for **MaxNumEventsBLT** imply the need to allocate a memory buffer for very large the readout.

Note: If using DPP-PHA, DPP-PSD or DPP-CI firmware, you have to refer to the **SetDPPEventAggregation** function.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetMaxNumEventsBLT(int handle,
                             uint32 t numEvents
                             );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetMaxNumEventsBLT(int handle,
                             uint32_t *numEvents
                             );
```

Arguments

Name	Description
`handle`	Device handler
`numEvents`	Maximum number of events to transfer in a BlockRead

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

MallocReadoutBuffer

Description

This function allocates the memory buffer for the data block transfer from the digitizer to the PC. The size of the buffer allocated is calculated by the function according to the size of the event, the number of enabled channels and the maximum number of events transferred by each block transfer (see previous function). For this reason, the function must be called after having programmed the digitizer, if the parameters that determine the size of the buffer change, it is necessary to free it by calling the **FreeReadoutBuffer** function and then reallocated.

Note: the buffer pointer must be initialized to NULL.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ MallocReadoutBuffer(int handle,
                              char **buffer
                              uint32_t *size);
```

Arguments

Name	Description
`handle`	Device handler
`**buffer`	Pointer to the readout buffer allocated **(WARNING: **buffer MUST be initialized to NULL)**
`*size`	The size in byte of the buffer allocated

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

FreeReadoutBuffer

Description

Frees memory allocated by the **MallocReadoutBuffer** function.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_FreeReadoutBuffer(char **buffer);
```

Arguments

Name	Description
**buffer	Pointer to the readout buffer to free, returned by the **MallocReadoutBuffer** function.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

ReadData

Description

This function performs a block transfer of data from the digitizer to the computer. The size of the block to be transferred is determined by the function according to parameters set and the mode of readout. The block can contain one or more events. The data is transferred into the buffer memory previously allocated by **MallocReadoutBuffer** function. The function returns in *bufferSize* the size of the data block read from the card, expressed in long words.

Note:

CAEN_DGTZ_SLAVE_TERMINATED_READOUT_MBLT for VME accesses:

In this case the digitizer is programmed to assert the VME Bus Error during a Block Transfer cycle to prematurely end the cycle when it no longer has data to transfer or has completed the transfer of the maximum number of events planned (see *BLT_EVENT_NUM* register, or **Set / GetMaxNumEventsBLT** function). This use of the Bus Error, though not specifically provided by the VME standard for this purpose, it is actually very common. However, some VME masters have a Bus Error management not suitable for this purpose.

CAEN_DGTZ_POLLING_MBLT for VME accesses:

The VME Bus Error generation is disabled, the transfer always continues until the completion of the number of bytes required and, if there are no data to be transferred, the digitizer will insert filler words (0xFFFFFFFF)

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_ReadData(int handle,
                   CAEN_DGTZ_ReadMode_t mode,
                   char *buffer,
                   uint32 t *bufferSize
                   );

typedef enum {
                        CAEN_DGTZ_SLAVE_TERMINATED_READOUT_MBLT  = 0,
                        CAEN DGTZ SLAVE TERMINATED READOUT 2eVME = 1,
                        CAEN DGTZ SLAVE TERMINATED READOUT 2eSST = 2,
                        CAEN_DGTZ_POLLING_MBLT                   = 3,
                        CAEN_DGTZ_POLLING_2eVME                  = 4,
                        CAEN_DGTZ_POLLING_2eSST                  = 5,
} CAEN_DGTZ_ReadMode_t;
```

Arguments

Name	Description	
handle	Device handler	
mode	CAEN_DGTZ_SLAVE_TERMINATED_READOUT_MBLT	= 0
	CAEN_DGTZ_SLAVE_TERMINATED_READOUT_2eVME	= 1
	CAEN_DGTZ_SLAVE_TERMINATED_READOUT_2eSST	= 2
	CAEN_DGTZ_POLLING_MBLT	= 3
	CAEN_DGTZ_POLLING_2eVME	= 4
	CAEN_DGTZ_POLLING_2eSST	= 5
*buffer	Pointer to the readout buffer	
*bufferSize	Size of the data block read from the board (expressed in bytes)	

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

GetNumEvents

Description

This function scans the readout buffer and gets the number of events contained in the data block previously read by the **ReadData** function. The number of events is returned in the parameter *numEvents*.

🖉 **Note:** If using DPP-PHA, DPP-PSD or DPP-CI firmware, you have to refer to the **GetDPPEvents** function.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetNumEvents(int handle,
                char *buffer,
                uint32_t buffsize,
                uint32_t *numEvents
                );
```

Arguments

Name	Description
`handle`	Device handler
`*buffer`	Pointer to the readout buffer
`buffsize`	Size of the data block contained in the readout buffer. This value is given by the **ReadData** function.
`*numEvents`	Number of events contained in the readout buffer

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

GetEventInfo

Description

This function retrieves the information (trigger time stamp, event number, channel mask, etc.) associated to one event contained in the readout buffer. This function reads the header of the *numEvent* event in the buffer, fills the eventInfo structure and set the data pointer *EventPtr* to the first word of the event data in the readout buffer. This pointer will be passed to the **DecodeEvent** function described below.

🖉 **Note:** If using DPP-PHA, DPP-PSD or DPP-CI firmware, you have to refer to the **GetDPPEvents** function.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetEventInfo(int handle,
                char *buffer,
                uint32_t buffsize,
                int32_t numEvent,
                CAEN_DGTZ_EventInfo_t *eventInfo,
                char **EventPtr
                );

typedef struct
{
                uint32_t EventSize;
                uint32_t BoardId;
                uint32_t Pattern;
                uint32_t ChannelMask;
                uint32_t EventCounter;
                uint32_t TriggerTimeTag;
} CAEN_DGTZ_EventInfo_t;
```

Arguments

Name	Description
`handle`	Device handler
`*buffer`	Pointer to the readout buffer
`buffsize`	Size of the data block contained in the readout buffer
`numEvent`	Number of the requested event in the readout buffer (0 is the first event in the buffer)
`*eventInfo`	Pointer to the structure that contains the information about the requested event
`**EventPtr`	Pointer to the requested event data in the readout buffer

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

DecodeEvent

Description

Each type of digitizer has a different event data format. This function decodes (unpacks) the data of a specified event and fills the event structure containing the data of each channel (i.e. the waveform and/or other parameters in case of DPP) separately. There are two ways to allocate the memory for the unpacked event data:

- If the pointer ****Evt** to the event structure passed to the function is initialized to NULL, then the event is automatically allocated by the **DecodeEvent** function that knows the exact size of the decoded event data, hence there is no waste in the memory usage. In this case, the user must free the event memory buffer once it has been used.

- The memory buffer for the decoded event can be allocated once at the beginning of the acquisition; this is done by the **AllocateEvent** function. This solution is more efficient in terms of readout rate (no waste of time to allocate and free the memory) but requires more memory because the buffer must be able to contain the maximum event size. In this mode, the memory free must be done at the end of the acquisition.

✎ **Note:** If using DPP-PHA, DPP-PSD or DPP-CI firmware, you have to refer to the **GetDPPEvents** function.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_DecodeEvent(int handle,
                      char *evtPtr,
                      void **Evt
                      );
```

Arguments

Name	Description
`handle`	Device handler
`*evtPtr`	Pointer to the event data in the readout buffer (this is the pointer returned by the **GetEventInfo** function).
`**Evt`	Pointer to the decoded event structure. This pointer must be initialized to NULL if you want the function to allocate the memory buffer automatically. Conversely, if the memory buffer has been already allocated, this is the pointer to that memory buffer. The latter case is more efficient in terms of readout rate.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

AllocateEvent

Description

This function allocates the memory buffer for the decoded event data. The size of the buffer is calculated in order to keep the maximum event size.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_AllocateEvent(int handle,
                        void **Evt
                        );
```

Arguments

Name	Description
`handle`	Device handler
`**Evt`	Pointer to memory buffer for the event structure.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

FreeEvent

Description

This function releases the event memory buffer allocated by either the **DecodeEvent** or **AllocateEvent** function.

Note: If using DPP-PHA, DPP-PSD or DPP-CI firmware, you have to refer to the **GetDPPEvents** function.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_FreeEvent(int handle,
                    void **Evt
                    );
```

Arguments

Name	Description
handle	Device handler
**Evt	Pointer to memory buffer for the event structure.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

LoadDRS4CorrectionData

Description

Regarding the x742 series, in order to compensate for unavoidable construction differences in the DRS4 chips, a data correction is required (for details, please refer to the User Manual of the board). This function loads the correction parameters stored on board, while a **DecodeEvent** function is then needed to apply them. The correction parameters to load depend on the operating sampling frequency.

Note: to be used only with x742 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_LoadDRS4CorrectionData (int handle,
                                 CAEN_DGTZ_DRS4Frequency_t frequency
                                 );

typedef enum
{
                                 CAEN_DGTZ_DRS4_5GHz   = 0L,
                                 CAEN_DGTZ_DRS4_2_5GHz = 1L,
                                 CAEN_DGTZ_DRS4_1GHz   = 2L,
} CAEN_DGTZ_DRS4Frequency_t;
```

Arguments

Name	Description
handle	Device handler
frequency	The DRS4 sampling frequency.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Enable/Disable DRS4Correction

Description

Enables/disables the data correction in the x742 series.

Note: to be used only with x742 series.

Note: If enabled, the data correction through the **DecodeEvent** function only applies if a **LoadDRS4CorrectionData** has been previously called, otherwise the **DecodeEvent** runs the same, but data will be provided out not compensated.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_EnableDRS4Correction (int handle);

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_DisableDRS4Correction (int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

3 Trigger configuration

The acquisition in the digitizer is ruled by the trigger, which is a signal that decides when to start the acquisition window and save samples of the ADC or the values of interest calculated on line (DPP) in the digitizer memory.

The digitizer can have the following trigger sources: External Trigger (digital signal from the panel), Software Trigger (write access to the specific register), Self Trigger Channel (internal signal generated by a digitizer channel under certain conditions, for example when the input signal exceeds a programmable threshold).

All trigger sources can be enabled or not to generate the acquisition trigger for the channels. Similarly, it is possible to decide what triggers should participate in the generation of the Trigger Output (NIM or TTL digital output of the digitizer panel). Trigger Output can not necessarily coincide with the acquisition trigger: for example, in order to trigger multiple cards at once, as one of their channel has "auto triggered"; for this purpose, the auto triggering channel is used only to generate the Trigger Outputs (but not for the acquisition trigger); all Trigger Outputs are ORed externally to the cards and the resulting signal is sent in parallel to all cards Trigger Inputs, which are programmed to enable only the Trigger Input to generate the acquisition Trigger.

Note: in digitizer series X740, the auto trigger channel is divided into two levels: each 8-channel group generates a "group local trigger", given by the OR a of channel triggers enabled to generate them. The group triggers, in their turn, may participate or not to generate the acquisition trigger and / or trigger output.

SendSWtrigger

Description

This function sends a Software trigger to the Digitizer. The SW trigger can be used to save an acquisition window on all channels at the same time and/or to generate a pulse on the Trigger Output of the board, according to the SW trigger mode set by the "Set" function of the **Set / GetSWTriggerMode**.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SendSWtrigger (int handle);
```

Arguments

Name	Description
handle	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Examples

WAVEDUMP Code *(To be implemented)*

Set / GetSWTriggerMode

Description

This function decides whether the trigger software should only be used to generate the acquisition trigger, only to generate the trigger output, or both.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetSWTriggerMode(int handle,
                      CAEN_DGTZ_TriggerMode_t mode
                      );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetSWTriggerMode(int handle,
                      CAEN_DGTZ_TriggerMode_t *mode);
typedef enum
{
                      CAEN_DGTZ_TRGMODE_DISABLED      = 0,
                      CAEN_DGTZ_TRGMODE_EXTOUT_ONLY   = 2,
                      CAEN_DGTZ_TRGMODE_ACQ_ONLY      = 1,
                      CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,
}CAEN_DGTZ_TriggerMode_t;
```

Arguments

Name	Description
handle	Device handler
mode	SW Trigger mode: CAEN_DGTZ_TRGMODE_DISABLED = 0, CAEN_DGTZ_TRGMODE_EXTOUT_ONLY = 2, CAEN_DGTZ_TRGMODE_ACQ_ONLY = 1, CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetExtTriggerInputMode

Description

This function decides whether the external trigger should only be used to generate the acquisition trigger, only to generate the trigger output, or both.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetExtTriggerInputMode(int handle,
                      CAEN_DGTZ_TriggerMode_t mode
                      );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetExtTriggerInputMode(int handle,
                      CAEN_DGTZ_TriggerMode_t *mode);
typedef enum
{
                      CAEN_DGTZ_TRGMODE_DISABLED      = 0,
                      CAEN_DGTZ_TRGMODE_EXTOUT_ONLY   = 2,
                      CAEN_DGTZ_TRGMODE_ACQ_ONLY      = 1,
                      CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,
}CAEN_DGTZ_TriggerMode_t;
```

Arguments

Name	Description
handle	Device handler
mode	External Trigger mode CAEN_DGTZ_TRGMODE_DISABLED = 0, CAEN_DGTZ_TRGMODE_EXTOUT_ONLY = 2, CAEN_DGTZ_TRGMODE_ACQ_ONLY = 1, CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

Set / GetChannelSelfTrigger

Description

This function decides whether the trigger of a channel should be used only to generate the acquisition trigger, only to generate the trigger output, or both.

For the x740 series, use the **Set / GetGroupSelfTrigger** function.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetChannelSelfTrigger(int handle,
                                CAEN DGTZ TriggerMode t mode,
                                uint32_t channelmask
                                );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ GetChannelSelfTrigger(int handle,
                                uint32 t channel,
                                CAEN_DGTZ_TriggerMode_t *mode
                                );

typedef enum
{
                                CAEN DGTZ TRGMODE DISABLED      = 0,
                                CAEN_DGTZ_TRGMODE_EXTOUT_ONLY   = 2,
                                CAEN_DGTZ_TRGMODE_ACQ_ONLY      = 1,
                                CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,
}CAEN_DGTZ_TriggerMode_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode`	Channel Self Trigger mode CAEN_DGTZ_TRGMODE_DISABLED = 0, CAEN_DGTZ_TRGMODE_EXTOUT_ONLY = 2, CAEN_DGTZ_TRGMODE_ACQ_ONLY = 1, CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,
`channelmask`	(only for Set): the function applies only to those channels that have the relevant bit in the mask equal to 1
`channel`	(only for Get): channel for which the mode is get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetGroupSelfTrigger

Description

This function is valid only for the x740 series. In fact, in this type of digitizer, the channels are grouped 8 by 8. The trigger properties are referred to the groups and cannot be set individually channel by channel. Each group of 8 channels generates one single self trigger which is the OR of the 8 self triggers in the group (with a programmable trigger enable mask, see next function). The group self trigger can generate the acquisition trigger for the board and/or a pulse on the Trigger Output.

Note: to be used only with x740 series.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetGroupSelfTrigger(int handle,
                              CAEN DGTZ TriggerMode t mode,
                              uint32 t groupmask
                              );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetGroupSelfTrigger(int handle,
                              uint32 t group,
                              CAEN DGTZ TriggerMode t *mode
                              );
typedef enum
{
                              CAEN DGTZ TRGMODE DISABLED       = 0,
                              CAEN DGTZ TRGMODE EXTOUT ONLY     = 2,
                              CAEN_DGTZ_TRGMODE_ACQ_ONLY        = 1,
                              CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,
}CAEN_DGTZ_TriggerMode_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode`	Group Self Trigger mode CAEN_DGTZ_TRGMODE_DISABLED = 0, CAEN_DGTZ_TRGMODE_EXTOUT_ONLY = 2, CAEN_DGTZ_TRGMODE_ACQ_ONLY = 1, CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = 3,
`groupmask`	(only for Set): the function applies only to those groups that have the relevant bit in the mask equal to 1
`group`	(only for Get): group for which the mode is get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN ⓝ Electronic Instrumentation

Set / GetChannelGroupMask

Description

This function decides which channels in a group of 8 participate to the generation of the self-trigger of that group. The self-trigger is the OR of the channels enabled by this function that are above the threshold. **WARNING:** the channels that are not connected must be disabled here, otherwise it may happen that one channel has a DC offset higher than the threshold and it keeps the OR always active.

🖉 **Note:** to be used only with x740 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetChannelGroupMask(int handle,
                              uint32_t group,
                              uint32_t channelmask
                              );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetChannelGroupMask(int handle,
                              uint32_t group,
                              uint32_t *channelmask
                              );
```

Arguments

Name	Description
`handle`	Device handler
`group`	Group for which the mask is set
`channelmask`	Channels Trigger mask for the group (8 bits)

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetChannelTriggerThreshold

Description

This function sets the Trigger Threshold for a specific channel. The threshold is applied to the digital signal after the ADC and it is expressed in ADC counts. The user should take care of the DC offset adjust when converting the digital threshold in the corresponding voltage level on the analog input.

For the x740 series, use the **Set / GetGroupTriggerThreshold** function. For the DPP firmware, use the **SetDPPParameters** function.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetChannelTriggerThreshold(int handle,
                                     uint32_t channel,
                                     uint32_t Tvalue
                                     );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetChannelTriggerThreshold(int handle,
                                     uint32_t channel,
                                     uint32_t *Tvalue
                                     );
```

Arguments

Name	Description
`handle`	Device handler
`channel`	Channel to set
`Tvalue`	Threshold value (in ADC counts)

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetGroupTriggerThreshold

Description

This function sets/gets the Trigger Threshold for a specified group of channel. The threshold is common to the 8 channels in the group. See the **Set / GetChannelTriggerThreshold** function for further details.

Note: to be used only with x740 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ SetGroupTriggerThreshold(int handle,
                                   uint32 t group,
                                   uint32 t Tvalue
                                   );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ GetGroupTriggerThreshold(int handle,
                                   uint32 t group,
                                   uint32_t *Tvalue
                                   );
```

Arguments

Name	Description
`handle`	Device handler
`group`	Group to set
`Tvalue`	Threshold value

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetChannelPulsePolarity

Description

Sets/gets the value of the pulse polarity for the specified channel.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetChannelPulsePolarity (int handle,
                                   uint32_t channel,
                                   CAEN DGTZ PulsePolarity t pol
                                   );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetChannelPulsePolarity (int handle,
                                   uint32_t channel,
                                   CAEN DGTZ PulsePolarity t *pol
                                   );

typedef enum
{
                                   CAEN DGTZ PulsePolarityPositive = 0,
                                   CAEN DGTZ PulsePolarityNegative = 1,
} CAEN_DGTZ_PulsePolarity_t;
```

Arguments

Name	Description
`handle`	Device handler
`channel`	The channel to set/get information for
`pol/*pol`	Value of the pulse polarity

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

Set / GetRunSynchronizationMode

Description

Sets/gets the run synchronization mode of the digitizer, used to synchronize an acquisition on multiple boards.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetRunSynchronizationMode (int handle,
                                     CAEN_DGTZ_RunSyncMode_t mode
                                     );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ GetRunSynchronizationMode (int handle,
                                     CAEN_DGTZ_RunSyncMode_t *mode
                                     );

typedef enum
{
                                     CAEN_DGTZ_RUN_SYNC_Disabled,
                                     CAEN_DGTZ_RUN_SYNC_TrgOutTrgInDaisyChain,
                                     CAEN_DGTZ_RUN_SYNC_TrgOutSinDaisyChain,
                                     CAEN_DGTZ_RUN_SYNC_SinFanout,
                                     CAEN DGTZ RUN SYNC GpioGpioDaisyChain
} CAEN_DGTZ_RunSyncMode_t;
```

Arguments

Name	Description
handle	Device handler
mode/*mode	The run synchronization mode to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetIOLevel

Description

Sets/gets the I/O level.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetIOLevel (int handle,
                      CAEN DGTZ IOLevel t level
                      );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetIOLevel (int handle,
                      CAEN_DGTZ_IOLevel_t *level
                      );

typedef enum
{
                      CAEN_DGTZ_IOLevel_NIM = 0L,
                      CAEN_DGTZ_IOLevel_TTL = 1L,
} CAEN_DGTZ_IOLevel_t;
```

Arguments

Name	Description
handle	Device handler
level/*level	The I/O level of the digitizer to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetTriggerPolarity

Description

Sets/gets the trigger polarity of a specified channel.

Note: not to be used with DPP firmware.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetTriggerPolarity (int handle,
                              uint32_t channel,
                              CAEN_DGTZ_TriggerPolarity_t Polarity
                              );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetTriggerPolarity (int handle,
                              uint32_t channel,
                              CAEN_DGTZ_TriggerPolarity_t *Polarity
                              );

typedef enum
{
                              CAEN_DGTZ_TriggerOnRisingEdge  = 0L,
                              CAEN_DGTZ_TriggerOnFallingEdge = 1L,
} CAEN_DGTZ_TriggerPolarity_t;
```

Arguments

Name	Description
`handle`	Device handler
`channel/*channel`	Selects the channel to set/get the trigger polarity for
`Polarity/*Polarity`	The polarity of the trigger to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetGroupFastTriggerThreshold

Description

Sets/gets the threshold value on TRn input (used as external trigger) for the local trigger generation in x742 series. As the threshold is an hardware threshold (input of a programmable 16-bit DAC, whose voltage output goes to a comparator), it is not easy to set and the user can refer to the board User Manual for setting examples.

Note: to be used only with x742 series.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetGroupFastTriggerThreshold (int handle,
                                        uint32_t group,
                                        uint32_t Tvalue
                                        );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetGroupFastTriggerThreshold (int handle,
                                        uint32_t group,
                                        uint32_t *Tvalue
                                        );
```

Arguments

Name	Description
`handle`	Device handler
`group`	The channels group the threshold is applied to
`Tvalue/*Tvalue`	The value of the TRn threshold to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetGroupFastTriggerDCOffset

Description

Regarding the x742 series, sets/gets the TRn signal DC offset when it is sampled in the DRS4 chips in order to make positive, negative or bipolar input signals to be compliant with the DRS4 input dynamics. The DC offset also affects the TRn when used as trigger, in this case it relates to the threshold setting above described (please refer to the board User Manual for setting examples).

Note: to be used only with x742 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetGroupFastTriggerDCOffset (int handle,
                                       uint32_t group,
                                       uint32_t DCvalue
                                       );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetGroupFastTriggerDCOffset (int handle,
                                       uint32_t group,
                                       uint32_t *DCvalue
                                       );
```

Arguments

Name	Description
`handle`	Device handler
`group`	The channels group the DC offset is applied to
`DCvalue/*DCvalue`	The value of the TRn DC offset to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetFastTriggerDigitizing

Description

Regarding the x742 series, enables/disables (set) the presence of the TRn signal in the data readout as well as allows for checking the status of the setting (get).

Note: to be used only with x742 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetFastTriggerDigitizing (int handle,
                                    CAEN_DGTZ_EnaDis_t enable
                                    );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetFastTriggerDigitizing (int handle,
                                    CAEN_DGTZ_EnaDis_t *enable
                                    );

typedef enum
{
                                    CAEN_DGTZ_ENABLE  = 1L,
                                    CAEN_DGTZ_DISABLE = 0L,
} CAEN_DGTZ_EnaDis_t;
```

Arguments

Name	Description
`handle`	Device handler
`enable/*enable`	The enable flag to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetFastTriggerMode

Description

Enables/disables (set) the TRn input as local trigger in x742 series, as wells allows for checking the status of the setting (get).

Note: to be used only with x742 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ SetFastTriggerMode (int handle,
                              CAEN DGTZ TriggerMode t mode
                              );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetFastTriggerMode (int handle,
                              CAEN DGTZ TriggerMode t *mode
                              );

typedef enum
{
                              CAEN_DGTZ_TRGMODE_DISABLED    = 0L,
                              CAEN DGTZ TRGMODE ACQ ONLY     = 1L,
}CAEN_DGTZ_TriggerMode_t;
```

Arguments

Name	Description
handle	Device handler
mode/*mode	The fast trigger value to set/get.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetDRS4SamplingFrequency

Description

Regarding the x742 series, sets/gets the sampling frequency of the DRS4 chips which sample the input analog signal and the fast trigger signal.

Note: to be used only with x742 series.

Synopsis
```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetDRS4SamplingFrequency (int handle,
                              CAEN_DGTZ_DRS4Frequency_t frequency
                              );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ GetDRS4SamplingFrequency (int handle,
                              CAEN_DGTZ_DRS4Frequency_t *frequency
                              );

typedef enum
{
                              CAEN DGTZ DRS4 5GHz    = 0L,
                              CAEN_DGTZ_DRS4_2_5GHz = 1L,
                              CAEN_DGTZ_DRS4_1GHz    = 2L,
} CAEN_DGTZ_DRS4Frequency_t;
```

Arguments

Name	Description
handle	Device handler
frequency/*frequency	The sampling frequency value to set/get

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

Set / GetOutputSignalMode

Description

Sets/gets the signal to be provided out over the TRG-OUT output channel in the x742 series.

Note: to be used only with x742 series.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetOutputSignalMode (int handle,
                               CAEN_DGTZ_OutputSignalMode_t mode
                               );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetOutputSignalMode (int handle,
                               CAEN_DGTZ_OutputSignalMode_t *mode
                               );

typedef enum
{
                               CAEN_DGTZ_TRIGGER          = 0L,
                               CAEN_DGTZ_FASTTRG_ALL      = 1L,
                               CAEN_DGTZ_FASTTRG_ACCEPTED = 2L,
                               CAEN_DGTZ_BUSY             = 3L,
} CAEN_DGTZ_OutputSignalMode_t;
```

Arguments

Name	Description
handle	Device handler
mode/*mode	The output signal mode to set/get.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

4 Acquisition

Set / GetChannelEnableMask

Description

This function enables/disables the channels for the acquisition. Disabled channels don't give any trigger and don't participate to the event data.

For the x740 and x742 series, use the **Set / GetGroupEnableMask** function

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetChannelEnableMask(int handle,
                               uint32_t mask
                               );
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetChannelEnableMask(int handle,
                               uint32_t *mask
                               );
```

Arguments

Name	Description
handle	Device handler
mask	Enable Mask. Bit n (with 0 <= n <= 7) corresponds to channel n.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Examples

WAVEDUMP Code *(To be implemented)*

Set / GetGroupEnableMask

Description

This function enables/disables the groups for the acquisition. This function is valid only for the x740 and x742 series. Disabled groups don't give any trigger and don't participate to the event data. The 8 channel in a group are all enabled/disabled according to the relevant bit in the enable mask.

🖉 **Note:** to be used only with x740 and x742 series.

Synopsis
```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetGroupEnableMask(int handle,
                             uint32_t mask
                             );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetGroupEnableMask(int handle,
                             uint32_t *mask
                             );
```

Arguments

Name	Description
handle	Device handler
mask	Enable Mask. Bit n (with 0 <= n <= 7) corresponds to group n.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

SWStartAcquisition

Description

This function starts the acquisition in a board using a software command. When the acquisition starts, the relevant RUN LED on the front panel lights up. It is worth noticing that in case of multiple board systems, the software start doesn't allow the digitizer to start synchronously. For this purpose, it is necessary to use to start the acquisition using a physical signal, such as the S-IN or GPI as well as the TRG-IN-TRG-OUT Daisy chain. Please refer to Digitizer manual for more details on this issue.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SWStartAcquisition(int handle);
```

Arguments

Name	Description
`handle`	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

SWStopAcquisition

Description

This function stops the acquisition in a board using a software command.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SWStopAcquisition(int handle);
```

Arguments

Name	Description
`handle`	Device handler

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetRecordLength

Description

This function sets the size of the acquisition window, that is the number of samples that belong to it. Due to the way the samples are written into the memory (more samples are put in parallel), there is a specific granularity of the record length depending on the board model. For example, in the x720 series, the samples are written 4 by 4, hence the record length must be a multiple of 4. The function accepts any value for the parameter size and then takes the closest value multiple of the granularity. The function **GetRecordLength** returns the exact value.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetRecordLength (int handle,
                           uint32_t size,
                           ...
                           );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetRecordLength (int handle,
                           uint32_t *size,
                           ...
                           );
```

Arguments

Name	Description
`handle`	Device handler
`size/*size`	The size of the record (in samples) to set/get
`channel (optional)`	A *int* specifying the channel to set/get the record length for. **Used only for digitizers running DPP firmware, in particular DPP-PSD and DPP-CI**

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetPostTriggerSize

Description

This function sets the post trigger size, that is the position of the trigger within the acquisition window. The size is expressed in percentage of the record length. 0% means that the trigger is at the end of the window, while 100% means that it is at the beginning.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetPostTriggerSize(int handle,
                        uint32 t percent
                        );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ GetPostTriggerSize(int handle,
                        uint32 t *percent
                        );
```

Arguments

Name	Description
handle	Device handler
percent	Post trigger in percent of the record length

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetAcquisitionMode

Description

Gets/Sets digitizer acquisition mode.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetAcquisitionMode(int handle,
                        CAEN DGTZ AcqMode t mode
                        );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetAcquisitionMode(int handle,
                        CAEN DGTZ AcqMode t *mode
                        );

typedef enum
{
                        CAEN_DGTZ_SW_CONTROLLED    = 0,
                        CAEN DGTZ S IN CONTROLLED  = 1,
}CAEN_DGTZ_AcqMode_t;
```

Arguments

Name	Description
handle	Device handler
mode	The acquisition mode CAEN_DGTZ_SW_CONTROLLED or CAEN_DGTZ_S_IN_CONTROLLED

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetChannelDCOffset

Description

This function sets the 16 bit DAC that adds a DC offset to the input signal in order to adapt it to the dynamic range of the ADC. By default, the DAC is set to middle scale (0x8000) which corresponds to a DC offset of –Vpp/2, where Vpp is the voltage range (peak to peak) of the ADC. This means that the input signal can range from –Vpp/2 to +Vpp/2. If the DAC is set to 0x0000, then no DC offset is added and the range of the input signal goes from 0 to +Vpp. Conversely, when the DAC is set to 0xFFFF, the DC offset is –Vpp and the range goes from –Vpp to 0. The DC offset can be set on channel basis except for the x740 in which it is set on group basis; in this case, you must use the **Set / GetGroupDCOffset** functions.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetChannelDCOffset(int handle,
                             uint32_t channel,
                             uint32_t Tvalue
                             );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ GetChannelDCOffset(int handle,
                             uint32_t channel,
                             uint32_t *Tvalue
                             );
```

Arguments

Name	Description
handle	Device handler
channel	Channel to which the DAC setting is applied. Use -1 for all channels
Tvalue	DAC value (from 0x0000 to 0xFFFF)

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetGroupDCOffset

Description

The same as Set/Get ChannelDCoffset, but in this case it is applied to the groups of the x740 series.

✏ **Note:** to be used only with x740 series.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetGroupDCOffset(int handle,
                           uint32 t group,
                           uint32_t Tvalue
                           );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_GetGroupDCOffset(int handle,
                           uint32_t group,
                           uint32_t *Tvalue
                           );
```

Arguments

Name	Description
handle	Device handler
group	Group to which the DAC setting is applied. Use -1 for all groups
Tvalue	DAC value (from 0x0000 to 0xFFFF)

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetDESMode

Description

This function enables or disables the Dual Edge Sampling mode, that is the channel interleaving option to double the sampling frequency. This option is available in the x731 and x751 series only.

WARNING: when the DES mode is enabled, only the odd channels (for the x751) or the even channels (for the x731) will work; the other channels must be left unconnected

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetDESMode(int handle,
                     CAEN_DGTZ_EnaDis_t mode);

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ GetDESMode(int handle,
                     CAEN DGTZ EnaDis t *mode);
typedef enum
{
                    CAEN_DGTZ_ENABLE     = 1,
                    CAEN_DGTZ_DISABLE    = 0,
} CAEN_DGTZ_EnaDis_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode`	CAEN_DGTZ_ENABLE to enable the DES mode, CAEN_DGTZ_DISABLE to disable the DES mode

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN ⬡ Electronic Instrumentation

Set / GetZeroSuppressionMode

Description

sets/gets the Zero Suppression mode.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetZeroSuppressionMode(int handle,
                                 CAEN_DGTZ_ZS_Mode_t mode
                                 );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ GetZeroSuppressionMode (int handle,
                                 CAEN_DGTZ_ZS_Mode_t *mode
                                 );
typedef enum
{
                                 CAEN DGTZ ZS NO      = 0,
                                 CAEN_DGTZ_ZS_INT     = 1,
                                 CAEN_DGTZ_ZS_ZLE     = 2,
                                 CAEN_DGTZ_ZS_AMP     = 3,
} CAEN_DGTZ_ZS_Mode_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode`	Zero Suppression Mode : CAEN_DGTZ_ZS_NO = 0 (no Zero suppression), CAEN_DGTZ_ZS_INT = 1 (Full Suppression based on the integral of the signal), CAEN_DGTZ_ZS_ZLE = 2 (Zero Length Encoding), CAEN_DGTZ_ZS_AMP = 3 (Full Suppression based on the signal amplitude),

Supported digitizers and permitted zero suppression modes

Digitizer	0	1	2	3
`x720`	X		X	X
`V1721/V1731`	X		X	X
`x724`	X	X	X	X

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetChannelZSParams

Description

Sets/Gets Zero Suppression parameters for a specific channel in the supported digitizers (see the table in the **Set / GetZeroSuppressionMode** functions).

✏️ **Note:** the **Set / GetChannelZSParams** functions are to be used in combination with **Set / GetTriggerPolarity** and **Set / GetZeroSuppressionMode** functions which relate to the trigger polarity logic and the zero suppression algorithm.

Synopsis
```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ SetChannelZSParams(int handle,
                            uint32_t channel,
                            CAEN_DGTZ_ThresholdWeight_t weight,
                            int32_t threshold,
                            int32_t nsamp
                            );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetChannelZSParams(int handle,
                            uint32 t channel,
                            CAEN DGTZ ThresholdWeight t *weight,
                            int32 t *threshold,
                            int32 t *nsamp
                            );
typedef enum
{
                            CAEN DGTZ ZS FINE   = 0,
                            CAEN DGTZ ZS COARSE = 1,
}CAEN_DGTZ_ThresholdWeight_t;
```

Arguments

Name	Description
`handle`	Device handler
`channel`	Channel to which the ZS settings are applied. Use -1 for all channels
`weight`	Zero Suppression weight*. **Used in "Full Suppression based on the integral of the signal" supported only by x724 series.** CAEN_DGTZ_ZS_FINE = 0 (Fine threshold step; the threshold is the *threshold* parameter), CAEN_DGTZ_ZS_COARSE = 1 (Coarse threshold step; the threshold is *threshold* × 64) For "Full Suppression based on the signal amplitude" and "Zero Length Encoding" algorithms, the value of *weight* doesn't affect the function working.
`threshold`	Zero Suppression Threshold to be used depending on the ZS algorithm*.
`nsamp`	Number of samples to be used by the ZS algorithm*.

*Refer to the digitizer User Manual for definition and representation.

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetAnalogMonOutput

Description

Sets/Gets the signal to output on the Analog Monitor Front Panel output in VME digitizers running standard firmware.

Note: the function is not supported by V1742 and digitizers running DPP firmware.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetAnalogMonOutput(int handle,
                             CAEN DGTZ AnalogMonitorOutputMode t mode
                             );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_GetAnalogMonOutput(int handle,
                             CAEN_DGTZ_AnalogMonitorOutputMode_t *mode
                             );

typedef enum
{
                    CAEN_DGTZ_AM_TRIGGER_MAJORITY    = 0,
                    CAEN_DGTZ_AM_TEST                = 1,
                    CAEN DGTZ AM ANALOG INSPECTION   = 2,
                    CAEN DGTZ AM BUFFER OCCUPANCY    = 3,
                    CAEN DGTZ AM VOLTAGE LEVEL       = 4,
}CAEN_DGTZ_AnalogMonitorOutputMode_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode`	Analog Monitor Mode CAEN_DGTZ_AM_TRIGGER_MAJORITY = 0 (Trigger Majority Mode), CAEN_DGTZ_AM_TEST = 1 (Test Mode), CAEN_DGTZ_AM_ANALOG_INSPECTION = 2 (Analog Inspection Mode), CAEN_DGTZ_AM_BUFFER_OCCUPANCY = 3 (Buffer Occupancy Mode), CAEN_DGTZ_AM_VOLTAGE_LEVEL = 4 (Voltage Level Mode),

Supported digitizers and permitted AM modes

Digitizer	0	1	2	3	4
`V1720-V1721-V1731-` `V1740-V1751`	X	X		X	X
`V1724`	X	X	X	X	X

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

Set / GetAnalogInspectionMonParams

Description

Sets/Gets the Analog Inspection Monitor parameters for a V1724 digitizer running standard firmware.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetAnalogInspectionMonParams(int handle,
                                       uint32_t channelmask,
                                       uint32_t offset,
                                       CAEN DGTZ AnalogMonitorMagnify t mf,
                                       CAEN DGTZ AnalogMonitorInspectorInverter t ami
                                       );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetAnalogInspectionMonParams(int handle,
                                       uint32 t channelmask,
                                       uint32 t *offset,
                                       CAEN_DGTZ_AnalogMonitorMagnify_t *mf,
                                       CAEN_DGTZ_AnalogMonitorInspectorInverter_t *ami
                                       );

typedef enum
{
                              CAEN_DGTZ_AM_MAGNIFY_1X            = 0,
                              CAEN_DGTZ_AM_MAGNIFY_2X            = 1,
                              CAEN_DGTZ_AM_MAGNIFY_4X            = 2,
                              CAEN_DGTZ_AM_MAGNIFY_8X            = 3,
}CAEN DGTZ AnalogMonitorMagnify t;

typedef enum
{
                              CAEN_DGTZ_AM_INSPECTORINVERTER_P_1X    = 0,
                              CAEN DGTZ AM INSPECTORINVERTER N 1X    = 1,
}CAEN_DGTZ_AnalogMonitorInspectorInverter_t;
```

Arguments

Name	Description
handle	Device handler
channelmask	channel enable mask
offset	DC Offset for the analog output signal
mf	Multiply factor
ami	Invert Output

Return Values

0: Success; Negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

Set / GetEventPackaging

Description
This function allows to enable or disable the Pack 2.5 mode of V1720/DT5720 Digitizers

Synopsis
```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetEventPackaging(int handle,
                           CAEN_DGTZ_EnaDis_t mode
                           );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ GetEventPackaging(int handle,
                           CAEN_DGTZ_EnaDis_t *mode
                           );

typedef enum {
                    CAEN DGTZ ENABLE = 1L,
                    CAEN_DGTZ_DISABLE = 0L,
} CAEN_DGTZ_EnaDis_t;
```

Arguments

Name	Description
handle	Device handler
mode	Enable/Disable the Pack 2.5 mode

Return Values
0: Success; Negative numbers are error codes (see Return Codes).

Acquisition example

The following example shows how to perform a data acquisition cycle. **CAEN provides this example also as source files and project inside the CAENDigitizer full installation package, compliant to Visual Studio Professional 2010**.

```c
#include <stdio.h>
#include "CAENDigitizer.h"

#include "keyb.h"

#define CAEN USE DIGITIZERS
#define IGNORE DPP DEPRECATED

#define MAXNB 1 /* Number of connected boards */

int checkCommand() {
            int c = 0;
            if(!kbhit())
                                return 0;

            c = getch();
            switch (c) {
                            case 's':
                             return 9;
                             break;
                            case 'k':
                             return 1;
                             break;
                            case 'q':
                             return 2;
                             break;
            }
            return 0;
}

int main(int argc, char* argv[])
{
    /* The following variable is the type returned from most of CAENDigitizer
    library functions and is used to check if there was an error in function
    execution. For example:
    ret = CAEN_DGTZ_some_function(some_args);
    if(ret) printf("Some error"); */
            CAEN_DGTZ_ErrorCode ret;

    /* The following variable will be used to get an handler for the digitizer. The
    handler will be used for most of CAENDigitizer functions to identify the board */
            int               handle[MAXNB];

    CAEN DGTZ BoardInfo t BoardInfo;
            CAEN DGTZ EventInfo t eventInfo;
            CAEN_DGTZ_UINT16_EVENT_t *Evt = NULL;
            char *buffer = NULL;

            int i,b;
            int c = 0, count[MAXNB];
            char * evtptr = NULL;
            uint32_t size,bsize;
            uint32_t numEvents;
            i = sizeof(CAEN_DGTZ_TriggerMode_t);

    for(b=0; b<MAXNB; b++){
        /* IMPORTANT: The following function identifies the different boards with a system
                            which may change
        for different connection methods (USB, Conet, ecc). Refer to CAENDigitizer user
                            manual for more info.
        brief:
            CAEN DGTZ OpenDigitizer(<LikType>, <LinkNum>, <ConetNode>, <VMEBaseAddress>,
                            <*handler>);
        Some examples below */

        /* The following is for b boards connected via b USB direct links
        in  this  case  you  must  set  <LikType>  =  CAEN DGTZ USB  and  <ConetNode>  =
                            <VMEBaseAddress> = 0 */
        //ret = CAEN_DGTZ_OpenDigitizer(CAEN_DGTZ_USB, b, 0, 0, &handle[b]);
```

```
        /* The following is for b boards connected via 1 opticalLink in dasy chain
        in this case you must set <LikType> = CAEN DGTZ PCI OpticalLink and <LinkNum> =
                            <VMEBaseAddress> = 0 */
        //ret = CAEN DGTZ OpenDigitizer(Params[b].LinkType, 0, b, Params[b].VMEBaseAddress,
                            &handle[b]);


        /* The following is for b boards connected to A2818 (or A3818) via opticalLink (or
                            USB with A1718)
        in this case the boards are accessed throught VME bus, and you must specify the VME
                            address of each board:
        <LikType> = CAEN_DGTZ_PCI_OpticalLink (CAEN_DGTZ_PCIE_OpticalLink for A3818 or
                            CAEN_DGTZ_USB for A1718)
        <LinkNum> must be the bridge identifier
        <ConetNode> must be the port identifier in case of A2818 or A3818 (or 0 in case of
                            A1718)
        <VMEBaseAddress>[0] = <0xXXXXXXXX> (address of first board)
        <VMEBaseAddress>[1] = <0xYYYYYYYY> (address of second board)
        ...
        <VMEBaseAddress>[b-1] = <0xZZZZZZZZ> (address of last board)
        See the manual for details */
        ret = CAEN DGTZ OpenDigitizer(CAEN DGTZ USB,0,0,0x11110000,&handle[b]);
        if(ret != CAEN_DGTZ_Success) {
            printf("Can't open digitizer\n");
            goto QuitProgram;
        }
        /* Once we have the handler to the digitizer, we use it to call the other functions
                            */
        ret = CAEN_DGTZ_GetInfo(handle[b], &BoardInfo);
        printf("\nConnected to CAEN Digitizer Model %s, recognized as board %d\n",
                            BoardInfo.ModelName, b);
        printf("\tROC FPGA Release is %s\n", BoardInfo.ROC FirmwareRel);
        printf("\tAMC FPGA Release is %s\n", BoardInfo.AMC FirmwareRel);

        ret = CAEN_DGTZ_Reset(handle[b]);                                    /*
                            Reset Digitizer */
            ret           =            CAEN DGTZ GetInfo(handle[b],         &BoardInfo);
                            /* Get Board Info */
            ret              =              CAEN DGTZ SetRecordLength(handle[b],4096);
                            /* Set the lenght of each waveform (in samples) */
            ret                =              CAEN_DGTZ_SetChannelEnableMask(handle[b],1);
                            /* Enable channel 0 */
            ret        =        CAEN DGTZ SetChannelTriggerThreshold(handle[b],0,32768);
                            /* Set selfTrigger threshold */
            ret                                                                  =
                            CAEN_DGTZ_SetChannelSelfTrigger(handle[b],CAEN_DGTZ_TRGMODE
                            _ACQ_ONLY,1);   /* Set trigger on channel 0 to be ACQ_ONLY
                            */
            ret   =  CAEN DGTZ SetSWTriggerMode(handle[b],CAEN DGTZ TRGMODE ACQ ONLY);
                            /* Set the behaviour when a SW tirgger arrives */
            ret              =              CAEN_DGTZ_SetMaxNumEventsBLT(handle[b],3);
                            /* Set the max number of events to transfer in a sigle
                            readout */
        ret = CAEN DGTZ SetAcquisitionMode(handle[b],CAEN DGTZ SW CONTROLLED);       /*
                            Set the acquisition mode */
        if(ret != CAEN_DGTZ_Success) {
            printf("Errors during Digitizer Configuration.\n");
            goto QuitProgram;
        }
}
        printf("\n\nPress 's' to start the acquisition\n");
printf("Press 'k' to stop  the acquisition\n");
printf("Press 'q' to quit  the application\n\n");
while (1) {
                        c = checkCommand();
                        if (c == 9) break;
                        if (c == 2) return;
                        Sleep(100);
}
/* Malloc Readout Buffer.
NOTE1: The mallocs must be done AFTER digitizer's configuration!
NOTE2: In this example we use the same buffer, for every board. We
Use the first board to allocate the buffer, so if the configuration
is different for different boards (or you use different board models), may be
that the size to allocate must be different for each one. */
ret = CAEN DGTZ MallocReadoutBuffer(handle[0],&buffer,&size);


for(b=0; b<MAXNB; b++)
```

```
          /* Start Acquisition
          NB: the acquisition for each board starts when the following line is executed
          so in general the acquisition does NOT starts syncronously for different boards
                              */
          ret = CAEN_DGTZ_SWStartAcquisition(handle[b]);

    // Start acquisition loop
          while(1) {
      for(b=0; b<MAXNB; b++) {
                              ret = CAEN DGTZ SendSWtrigger(handle[b]); /* Send a SW
                      Trigger */

                              ret                                        =
                      CAEN DGTZ ReadData(handle[b],CAEN DGTZ SLAVE TERMINATED REA
                      DOUT MBLT,buffer,&bsize);  /*  Read  the  buffer  from  the
                      digitizer */

          /* The buffer red from the digitizer is used in the other functions to get the
                              event data
          The following function returns the number of events in the buffer */
                              ret                                        =
                      CAEN_DGTZ_GetNumEvents(handle[b],buffer,bsize,&numEvents);

                              printf(".");
                              count[b] +=numEvents;
                              for (i=0;i<numEvents;i++) {
            /* Get the Infos and pointer to the event */
                                ret                                      =
                      CAEN_DGTZ_GetEventInfo(handle[b],buffer,bsize,i,&eventInfo,
                      &evtptr);

            /* Decode the event to get the data */
                              ret = CAEN_DGTZ_DecodeEvent(handle[b],evtptr,&Evt);
                              //************************************
                              // Event Elaboration
                              //************************************
                              ret = CAEN DGTZ FreeEvent(handle[b],&Evt);
                              }
                              c = checkCommand();
                              if (c == 1) goto Continue;
                              if (c == 2) goto Continue;
        } // end of loop on boards
    } // end of readout loop

Continue:
    for(b=0; b<MAXNB; b++)
        printf("\nBoard %d: Retrieved %d Events\n",b, count[b]);
    goto QuitProgram;

/* Quit program routine */
QuitProgram:
    // Free the buffers and close the digitizers
            ret = CAEN DGTZ FreeReadoutBuffer(&buffer);
    for(b=0; b<MAXNB; b++)
        ret = CAEN_DGTZ_CloseDigitizer(handle[b]);
            printf("Press 'Enter' key to exit\n");
            c = getchar();
            return 0;
}
```

CAEN Electronic Instrumentation

x742 Offline data correction functions

In the installation package of CAENDigitizer library, additional functions are provided inside the "Sample" folder to let the user perform offline the correction of raw data acquired with x742 digitizers.

Note: The functions are not included in the CAENDigitizer run time library and are intended also for offline use.

LoadCorrectionTables

Description

Loads the correction table stored onto the board into a user defined structure.

Synopsis
```
int32_t LoadCorrectionTables(int handle, DataCorrection_t *Table,
                             uint8_t group,
                             uint32_t frequency
                             );

typedef struct {
                int16_t     cell[MAX_X742_CHANNELS+1][1024];
                int8_t      nsample[MAX_X742_CHANNELS+1][1024];
                float       time[1024];
} DataCorrection_t;
```

Arguments

Name	Description
`handle`	Device handle
`Table`	Pointer to the structure to be filled with the correction table values
`group`	Channel group
`frequency`	DSR4 sampling frequency

Return Values

0: Success.

ApplyDataCorrection

Description

Applies the desired correction data (configured through a mask) to the raw data acquired by the user.

Synopsis

```
void ApplyDataCorrection(DataCorrection t* CTable,
                         CAEN_DGTZ_DRS4Frequency_t frequency,
                         int CorrectionLevelMask,
                         CAEN_DGTZ_X742_GROUP_t *data
                         );

typedef struct {
                int16_t      cell[MAX_X742_CHANNELS+1][1024];
                int8_t       nsample[MAX_X742_CHANNELS+1][1024];
                float        time[1024];
} DataCorrection_t;
```

Arguments

Name	Description
CTable	Pointer to the structure filled with the correction data
frequency	DSR4 sampling frequency
CorrectionLevelMask	Mask for the correction type to be applied (3-bit): Bit0 = Cell Offset correction Bit1 = Index Sampling correction Bit2= Time correction
data	Raw acquired data to be corrected

Return Values

0: Success.

GetNumEvents

Description

Gets the current number of events stored in the acquisition buffer.

Synopsis

```
int32_t GetNumEvents(char *buffer,
                     uint32_t buffsize,
                     uint32_t *numEvents
                     );
```

Arguments

Name	Description
buffer	Address of the acquisition buffer
buffersize	Size of the data stored in the acquisition buffer
numEvens	Number of events stored in the acquisition buffer

Return Values

0: Success.

CAEN ⬡ Electronic Instrumentation

GetEventPtr

Description
Retrieves the event pointer of a specified event in the acquisition buffer.

Synopsis
```
int32 t GetEventPtr(char *buffer,
                    uint32_t buffsize,
                    int32_t numEvent,
                    char **EventPtr
                    );
```

Arguments

Name	Description
buffer	Address of the acquisition buffer
buffersize	Acquisition buffer size
numEvent	Index of the requested event
EventPtr	Pointer to the requested event in the acquisition buffer

Return Values
0: Success.

X742_DecodeEvent

Description
Decodes a specified event stored in the acquisition buffer writing data in Evt memory.

✎   **Note:** Once used, the Evt memory MUST be deallocated by the caller.

Synopsis
```
int32_t X742_DecodeEvent(char *evtPtr,
                         void **Evt
                         );
```

Arguments

Name	Description
evtPtr	Pointer to the requested event in the acquisition buffer
Evt	Pointer to the event structure with decoded event (MUST BE NULL)

Return Values
0: Success.

5 DPP specific functions

In order to handle acquisitions with the DPP firmware (PHA, PSD, CI), the C functions described in this chapter can be used.

Set / GetDPPPreTriggerSize

Description

Sets/gets the pre-trigger size, which is the portion of acquisition window visible before a trigger.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetDPPPreTriggerSize (int handle,
                                int ch,
                                uint32 t samples
                                );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN DGTZ GetDPPPreTriggerSize (int handle,
                                int ch,
                                uint32 t *samples
                                );
```

Arguments

Name	Description
`handle`	Device handler
`samples/*samples`	The size of the record (in samples)
`ch`	The channel whose pre-trigger has to be set/get. ch=-1 writes the same value for all channels. DPP-CI only supports ch=-1 (different channels must have the same pre-trigger)

Return Values

0: Success; negative numbers are error codes (see Return Codes).

GetDPPEvents

Description

Decodes and returns all the DPP events stored in the acquisition buffers.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetDPPEvents (int handle,
                        char *buffer,
                        uint32 t buffsize,
                        void **events,
                        uint32_t *numEventsArray
                        );
```

Arguments

Name	Description
`handle`	Device handler
`*buffer`	The address of the acquisition buffer
`buffsize`	The acquisition buffer size (in samples)
`**events`	The pointer to the event list (allocated via MallocDPPEvents)
`*numEventsArray`	The pointer to an array of int which will contain the number of events found per channel

Return Values

0: Success; negative numbers are error codes (see Return Codes).

CAEN Electronic Instrumentation

MallocDPPEvents

Description

Allocates the event buffer matrix which is handled by the **GetDPPEvents** function. The matrix has one event array per channel and must be declared as a MAX_CH-sized array of pointers.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_MallocDPPEvents (int handle,
                           void **events,
                           uint32_t *allocatedSize
                           );

typedef struct
{
    uint32_t Format;
    uint64_t TimeTag;
    uint16_t Energy;
    int16_t Extras;
    uint32_t *Waveforms; /*!< pointer to coded data inside the readout buffer. only meant
                             to be supplied to CAEN_DGTZ_DecodeDPPWaveforms */
} CAEN_DGTZ_DPP_PHA_Event_t;

typedef struct
{
    uint32_t Format;
    uint32_t TimeTag;
    int16_t ChargeShort;
    int16_t ChargeLong;
    int16_t Baseline;
    int16_t Pur;
    uint32_t *Waveforms; /*!< pointer to coded data inside the readout buffer. only meant
                             to be supplied to CAEN_DGTZ_DecodeDPPWaveforms */
} CAEN_DGTZ_DPP_PSD_Event_t;

typedef struct
{
    uint32_t Format;
    uint32_t TimeTag;
    int16_t Charge;
    int16_t Baseline;
    uint32_t *Waveforms; /*!< pointer to coded data inside the readout buffer. only meant
                             to be supplied to CAEN_DGTZ_DecodeDPPWaveforms */
} CAEN_DGTZ_DPP_CI_Event_t;
```

Arguments

Name	Description
`handle`	Device handler
`**events`	The pointer to the event matrix, which shall be of type: CAEN_DGTZ_DPP_PHA_Event_t, for DPP-PHA, CAEN_DGTZ_DPP_PSD_Event_t, for DPP-PSD CAEN_DGTZ_DPP_CI_Event_t, for DPP-CI
`*allocatedSize`	The size in bytes of the event list

Return Values

0: Success; negative numbers are error codes (see Return Codes).

FreeDPPEvents

Description
Deallocates the event buffer matrix.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_FreeDPPEvents (int handle,
                        void **events
                        );
```

Arguments

Name	Description
handle	Device handler
**events	The pointer to the event buffer

Return Values
0: Success; negative numbers are error codes (see Return Codes).

MallocDPPWaveforms

Description

Allocates the waveform buffer, which is used by **CAEN_DGTZ_DecodeDPPWaveforms**.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_MallocDPPWaveforms (int handle,
                              void **waveforms,
                              uint32_t *allocatedSize
                              );

typedef struct
{
    uint32_t Ns;
    uint8_t  DualTrace;
    uint8_t  VProbe1;
    uint8_t  VProbe2;
    uint8_t  VDProbe;
    int16_t *Trace1;
    int16_t *Trace2;
    uint8_t  *DTrace1;
    uint8_t  *DTrace2;
} CAEN DGTZ DPP PHA Waveforms t;

typedef struct
{
    uint32_t Ns;
    uint8_t  dualTrace;
    uint8_t  anlgProbe;
    uint8_t  dgtProbe1;
    uint8_t  dgtProbe2;
    uint16_t *Trace1;
    uint16_t *Trace2;
    uint8_t  *DTrace1;
    uint8_t  *DTrace2;
    uint8_t  *DTrace3;
    uint8_t  *DTrace4;
} CAEN DGTZ DPP PSD Waveforms t;

#define  CAEN DGTZ DPP CI Waveforms t  CAEN DGTZ DPP PSD Waveforms t  /*!< \brief  Waveform
                             types  for  DPP-CI  and  DPP-PSD  are  the  same,  hence  this
                             define */
```

Arguments

Name	Description
handle	Device handler
**waveforms	The pointer to the waveform buffer, which shall be of type: CAEN_DGTZ_DPP_PHA_Waveforms_t, for DPP-PHA / CAEN_DGTZ_DPP_PSD_Waveforms_t, for DPP-PSD / CAEN_DGTZ_DPP_CI_Waveforms_t, for DPP-CI
*allocatedSize	The size in bytes of the waveform buffer

Return Values

0: Success; negative numbers are error codes (see Return Codes).

FreeDPPWaveforms

Description

Deallocates the waveform buffer.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_FreeDPPWaveforms (int handle,
                            void *waveforms
                            );
```

Arguments

Name	Description
handle	Device handler
*waveforms	The pointer to the waveform buffer

Return Values

0: Success; negative numbers are error codes (see Return Codes).

DecodeDPPWaveforms

Description

Decodes the waveforms contained inside an event.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN DGTZ DecodeDPPWaveforms (int handle,
                              void *event,
                              void *waveforms
                              );
```

Arguments

Name	Description
handle	Device handler
*event	The pointer to the event
*waveforms	The pointer to the (preallocated) waveform list

Return Values

0: Success; negative numbers are error codes (see Return Codes).

SetDPPEventAggregation

Description

Sets event aggregation parameters.

✏️ **Note:** This function has to be used only after the record length parameter has been set (by the "Set" function of the **Set / GetRecordLength**).

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetDPPEventAggregation (int handle,
                                  int threshold,
                                  int maxsize
                                  );
```

Arguments

Name	Description
handle	Device handler
threshold	Specifies how many events to let accumulate in the board memory before they are rendered available for readout. A low number maximizes responsiveness, since data are read as soon as they are stored in memory, while a high number maximizes efficiency, since fewer transfers are made. Supplying 0 will let the library choose the most reasonable value depending on acquisition mode and other parameters.
maxsize	Specifies the maximum size in bytes of the event buffer on the PC side. This parameter might be useful in case the computer has very low RAM. Normally, though, it is safe to supply 0 as this parameter, so that the library will choose an appropriate value automatically.

Return Values

0: Success; negative numbers are error codes (see Return Codes).

Set / GetNumEventsPerAggregate

Description

Sets/Gets the number of events that each aggregate will contain.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetNumEventsPerAggregate (int handle,
                                    uint32_t numEvents,
                                    ...
                                    );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_GetNumEventsPerAggregate (int handle,
                                    uint32_t *numEvents,
                                    ...
                                    );
```

Arguments

Name	Description
handle	Device handler
numEvents	Number of events per aggregater.
channel	Optional parameter in the form of an int to specify the channel (required for DPP-PSD and DPP-CI, ignored by DPP-PHA).

Return Values

0: Success; negative numbers are error codes (see Return Codes).

Set / GetMaxNumAggregatesBLT

Description

Sets/Gets the maximum number of aggregatess for each transfer.

Note: with DPP-PHA, DPP-PSD and DPP-CI, also the *maxsize* parameter of **SetDPPEventAggregation** can be used.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetMaxNumAggregatesBLT (int handle,
                                 uint32 t numAggr
                                 );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetMaxNumAggregatesBLT (int handle,
                                  uint32_t *numAggr
                                  );
```

Arguments

Name	Description
handle	Device handler
numAggr	Max number of aggregates per block transfer (BLT)

Return Values

0: Success; negative numbers are error codes (see Return Codes).

CAEN ⓝ Electronic Instrumentation

SetDPPParameters

Description
Sets DPP configuration parameters for DPP-PHA, DPP-PSD or DPP-CI.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetDPPParameters (int handle,
                            uint32_t channelMask,
                            void *params
                            );

/* DPP parameter structure to be initialized and passed to CAEN DGTZ SetDPPParameters.
   To be used only for DPP-PHA */

typedef struct{
      int M          [MAX V1724DPP CHANNEL SIZE]; //Signal Decay Time Constant
      int m          [MAX_V1724DPP CHANNEL SIZE]; //Trapezoid Flat Top
      int k          [MAX_V1724DPP_CHANNEL_SIZE]; //Trapezoid Rise Time
      int ftd        [MAX_V1724DPP_CHANNEL_SIZE]; //Flat Top Delay
      int a          [MAX_V1724DPP_CHANNEL_SIZE]; //Trigger Filter smoothing factor
      int b          [MAX_V1724DPP_CHANNEL_SIZE]; //Input Signal Rise time
      int thr        [MAX V1724DPP CHANNEL SIZE]; //Trigger Threshold
      int nsbl       [MAX V1724DPP CHANNEL SIZE]; //Number of Samples for Baseline Mean
      int nspk       [MAX V1724DPP CHANNEL SIZE]; //Number of Samples for Peak Mean
      int pkho       [MAX_V1724DPP CHANNEL SIZE]; //Peak Hold Off
      int blho       [MAX_V1724DPP CHANNEL SIZE]; //Base Line Hold Off
      int otrej      [MAX_V1724DPP CHANNEL SIZE]; //
      int trgho      [MAX V1724DPP CHANNEL SIZE]; //Trigger Hold Off
      int twwdt      [MAX_V1724DPP CHANNEL SIZE]; //
      int trgwin     [MAX_V1724DPP_CHANNEL_SIZE]; //
      int dgain      [MAX_V1724DPP_CHANNEL_SIZE]; //Digital Probe Gain
      float enf      [MAX_V1724DPP_CHANNEL_SIZE]; //Energy Normalization Factor
      int decimation [MAX V1724DPP CHANNEL SIZE]; //Decimation of Input Signal
} CAEN DGTZ DPP PHA Params t;

/* DPP parameter structure to be initialized and passed to CAEN_DGTZ_SetDPPParameters.
   To be used only for DPP-PSD */

typedef struct {
      int blthr;
      int bltmo;
      int thr                        [MAX_V1720DPP_CHANNEL_SIZE];
      int selft                      [MAX V1720DPP CHANNEL SIZE];
      int csens                      [MAX V1720DPP CHANNEL SIZE];
      int sgate                      [MAX V1720DPP CHANNEL SIZE];
      int lgate                      [MAX_V1720DPP CHANNEL SIZE];
      int pgate                      [MAX_V1720DPP_CHANNEL_SIZE];
      int tvaw                       [MAX_V1720DPP_CHANNEL_SIZE];
      int nsbl                       [MAX V1720DPP CHANNEL SIZE];
      CAEN DGTZ DPP TriggerConfig t trgc [MAX V1720DPP CHANNEL SIZE]; // Ignored for x751
      CAEN DGTZ DPP PUR t purh; // Ignored for x751
      int purgap; // Ignored for x751
} CAEN_DGTZ_DPP_PSD_Params_t;

/* DPP parameter structure to be initialized and passed to CAEN DGTZ SetDPPParameters.
   To be used only for DPP-CI */

typedef struct {
      int blthr;
      int bltmo;
      int thr                        [MAX V1720DPP CHANNEL SIZE];
      int selft                      [MAX V1720DPP CHANNEL SIZE];
      int csens                      [MAX_V1720DPP_CHANNEL_SIZE];
      int gate                       [MAX_V1720DPP_CHANNEL_SIZE];
      int pgate                      [MAX_V1720DPP_CHANNEL_SIZE];
      int tvaw                       [MAX V1720DPP CHANNEL SIZE];
      int nsbl                       [MAX V1720DPP CHANNEL SIZE];
      CAEN DGTZ DPP TriggerConfig t trgc [MAX V1720DPP CHANNEL SIZE];
} CAEN_DGTZ_DPP_CI_Params_t;
```

Arguments

Name	Description
`handle`	Device handler
`channelMask`	A bit mask indicating the channels to apply the DPP parameters
`*params`	The pointer to a preallocated struct of type: CAEN_DGTZ_DPP_PHA_Params_t, in case of DPP-PHA CAEN_DGTZ_DPP_PSD_Params_t, in case of DPP-PSD CAEN_DGTZ_DPP_CI_Params_t, in case of DPP-CI

Return Values

0: Success; negative numbers are error codes (see Return Codes).

CAEN **Electronic Instrumentation**

Set / GetDPPAcquisitionMode

Description

Sets/gets the DPP acquisition mode.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetDPPAcquisitionMode (int handle,
                                 CAEN_DGTZ_DPP_AcqMode_t mode,
                                 CAEN_DGTZ_DPP_SaveParam_t param
                                 );

CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_GetDPPAcquisitionMode (int handle,
                                 CAEN_DGTZ_DPP_AcqMode_t * mode,
                                 CAEN_DGTZ_DPP_SaveParam_t *param
                                 );

typedef enum
{
                                 CAEN_DGTZ_DPP_ACQ_MODE_Oscilloscope = 0L,
                                 CAEN_DGTZ_DPP_ACQ_MODE_List        = 1L,
                                 CAEN DGTZ DPP ACQ MODE Mixed       = 2L,
} CAEN DGTZ DPP AcqMode t;

typedef enum
{
                                 CAEN_DGTZ_DPP_SAVE_PARAM_EnergyOnly    = 0L,
                                 CAEN DGTZ DPP SAVE PARAM TimeOnly      = 1L,
                                 CAEN_DGTZ_DPP_SAVE_PARAM_EnergyAndTime = 2L,
                                 CAEN_DGTZ_DPP_SAVE_PARAM_ChargeAndTime = 4L,
                                 CAEN_DGTZ_DPP_SAVE_PARAM_None          = 3L,
} CAEN_DGTZ_DPP_SaveParam_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode/*mode`	The DPP acquisition mode to set/get. CAEN_DGTZ_DPP_ACQ_MODE_Oscilloscope = 0L: enables the acquisition of the samples of the digitized waveforms. CAEN_DGTZ_DPP_ACQ_MODE_List = 1L: enables the acquisition of time stamps and energy values in case of DPP-PHA, or charge in case of DPP-CI and DPP-PSD. CAEN_DGTZ_DPP_ACQ_MODE_Mixed = 2L: enables the acquisition of both waveforms, energies or charges, and time stamps.
`param/*param`	The acquisition data to retrieve in acquisition

Return Values

0: Success; negative numbers are error codes (see Return Codes).

Set / GetDPPTriggerMode

Description
Sets/gets the DPP Trigger mode.

Note: to be used only with DPP-PSD and DPP-CI enabled firmware.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetDPPTriggerMode (int handle,
                            CAEN DGTZ DPP TriggerMode t mode
                            );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetDPPTriggerMode (int handle,
                            CAEN_DGTZ_DPP_TriggerMode_t *mode
                            );

typedef enum
{
                            CAEN_DGTZ_DPP_TriggerMode_Normal,
                            CAEN_DGTZ_DPP_TriggerMode_Coincidence,
} CAEN_DGTZ_DPP_TriggerMode_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode/*mode`	For SetDPPTriggerMode, it is the desired trigger mode which can be set: CAEN_DGTZ_DPP_TriggerMode_Normal CAEN_DGTZ_DPP_TriggerMode_Coincidence For GetDPPTriggerMode, it is the current trigger mode.

Return Values
0: Success; negative numbers are error codes (see Return Codes).

Set / GetDPP_PHA_VirtualProbe

Description

Set/gets the information about the output signal of the DPP-PHA acquisition mode.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetDPP_PHA_VirtualProbe (int handle,
                                   CAEN_DGTZ_DPP_VirtualProbe_t mode,
                                   CAEN_DGTZ_DPP_PHA_VirtualProbe1_t vp1,
                                   CAEN DGTZ DPP PHA VirtualProbe2 t vp2,
                                   CAEN DGTZ DPP PHA DigitalProbe t dp
                                   );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetDPP_PHA_VirtualProbe (int handle,
                                   CAEN DGTZ DPP VirtualProbe t *mode,
                                   CAEN DGTZ DPP PHA VirtualProbe1 t *vp1,
                                   CAEN_DGTZ_DPP_PHA_VirtualProbe2_t *vp2,
                                   CAEN_DGTZ_DPP_PHA_DigitalProbe_t *dp
                                   );

typedef enum
{
                                   CAEN_DGTZ_DPP_VIRTUALPROBE_SINGLE = 0L,
                                   CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL   = 1L,
} CAEN_DGTZ_DPP_VirtualProbe_t;

typedef enum
{
                                   CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Input     = 0L,
                                   CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Delta     = 1L,
                                   CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Delta2    = 2L,
                                   CAEN DGTZ DPP PHA VIRTUALPROBE1 trapezoid = 3L,
} CAEN DGTZ DPP PHA VirtualProbe1 t;

typedef enum
{
                                   CAEN DGTZ DPP PHA VIRTUALPROBE2 Input        = 0L,
                                   CAEN DGTZ DPP PHA VIRTUALPROBE2 S3           = 1L,
                                   CAEN DGTZ DPP PHA VIRTUALPROBE2 DigitalCombo  = 2L,
                                   CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_trapBaseline = 3L,
                                   CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_None         = 4L,
} CAEN DGTZ DPP PHA VirtualProbe2 t;

typedef enum
{
                                   CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_trgKln    = 0L,
                                   CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_Armed     = 1L,
                                   CAEN DGTZ DPP PHA DIGITAL PROBE PkRun     = 2L,
                                   CAEN DGTZ DPP PHA DIGITAL PROBE PkAbort   = 3L,
                                   CAEN DGTZ DPP PHA DIGITAL PROBE Peaking   = 4L,
                                   CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_PkHoldOff = 5L,
                                   CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_Flat      = 6L,
                                   CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_trgHoldOff = 7L,
} CAEN_DGTZ_DPP_PHA_DigitalProbe_t;
```

Arguments

Name	Description
`handle`	Device handler
`mode/*mode`	The Virtual Probe mode to set/get.
`vp1/*vp1`	The Virtual Probe1 mode to set/get
`vp2/*vp2`	The Virtual Probe2 mode to set/get
`dp/*dp`	The Digital Probe mode to set/get

Return Values

0: Success; negative numbers are error codes (see Return Codes).

Set / GetDPP_PSD_VirtualProbe

Description

Sets/gets the information about the output signal of the DPP-PSD acquisition mode.

Synopsis

```
CAEN DGTZ ErrorCode CAENDGTZ API
CAEN_DGTZ_SetDPP_PSD_VirtualProbe (int handle,
                                   CAEN_DGTZ_DPP_VirtualProbe_t mode,
                                   CAEN_DGTZ_DPP_PSD_VirtualProbe_t vp,
                                   CAEN DGTZ DPP PSD DigitalProbe1 t dp1,
                                   CAEN DGTZ DPP PSD DigitalProbe2 t dp2
                                   );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetDPP_PSD_VirtualProbe (int handle,
                                   CAEN DGTZ DPP VirtualProbe t *mode,
                                   CAEN DGTZ DPP PSD VirtualProbe t *vp,
                                   CAEN_DGTZ_DPP_PSD_DigitalProbe1_t *dp1,
                                   CAEN_DGTZ_DPP_PSD_DigitalProbe2_t *dp2
                                   );

typedef enum
{
                                   CAEN_DGTZ_DPP_VIRTUALPROBE_SINGLE = 0L,
                                   CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL   = 1L,
} CAEN_DGTZ_DPP_VirtualProbe_t;

typedef enum
{
                            CAEN_DGTZ_DPP_PSD_VIRTUALPROBE_Baseline  = 0L,
                            CAEN_DGTZ_DPP_PSD_VIRTUALPROBE_Threshold = 1L,
} CAEN_DGTZ_DPP_PSD_VirtualProbe_t;

typedef enum
{
    /***********************************************************
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     *  The following values are valid for the following DPP-PSD *
     *  Firmwares:                                               *
     *       x720 Boards: AMC REL <= 131.5                       *
     *       x751 Boards: AMC_REL <= 132.5                       *
     *  For newer firmwares, use the values marked with 'R4' in  *
     *  the name.                                                *
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     ***********************************************************/

    /* x720 Digital Probes Types */
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_Armed        = 0L,
                            CAEN DGTZ DPP PSD DIGITALPROBE1 Trigger      = 1L,
                            CAEN DGTZ DPP PSD DIGITALPROBE1 ChargeReady  = 2L,
                            CAEN DGTZ DPP PSD DIGITALPROBE1 PileUp       = 3L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_BlOutSafeBand = 4L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_BlTimeout    = 5L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_CoincidenceMet = 6L,
                            CAEN DGTZ DPP PSD DIGITALPROBE1 Tvaw         = 7L,

    /* x751 Digital Probes Types */
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_OverThr      = 8L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_GateShort    = 9L,
                            CAEN DGTZ DPP PSD DIGITALPROBE1 None         = 10L,

    /***********************************************************
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     *  The following values are valid for the following DPP-PSD *
     *  Firmwares:                                               *
     *       x720 Boards: AMC REL >= 131.6                       *
     *       x751 Boards: AMC REL >= 132.6                       *
     *  For older firmwares, use the values above.              *
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     ***********************************************************/
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_ExtTrg = 11L,/*x720 only*/
                            CAEN DGTZ DPP PSD DIGITALPROBE1 R6 OverThr    = 12L,
                            CAEN DGTZ DPP PSD DIGITALPROBE1 R6 TrigOut    = 13L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_CoincWin   = 14L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_PileUp     = 15L,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_Coincidence = 16L,
```

```
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_GateLong = 17L,/*x751 only*/
} CAEN DGTZ DPP PSD DigitalProbe1 t;

typedef enum
{
    /**************************************************************
    *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
    *  The following values are valid for the following DPP-PSD *
    *  Firmwares:                                               *
    *       x720 Boards: AMC REL <= 131.5                       *
    *       x751 Boards: AMC_REL <= 132.5                       *
    *  For newer firmwares, use the values marked with 'R4' in  *
    *  the name.                                                *
    *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
    **************************************************************/

    /* x720 Digital Probes Types */
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_Armed         = 0L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 Trigger       = 1L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 ChargeReady   = 2L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 PileUp        = 3L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_BlOutSafeBand = 4L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_BlTimeout     = 5L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_CoincidenceMet = 6L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 Tvaw          = 7L,

    /* x751 Digital Probes Types */
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_GateShort     = 8L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_GateLong      = 9L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 None          = 10L,

    /**************************************************************
    *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
    *  The following values are valid for the following DPP-PSD *
    *  Firmwares:                                               *
    *       x720 Boards: AMC REL >= 131.6                       *
    *       x751 Boards: AMC REL >= 132.6                       *
    *  For older firmwares, use the values above.              *
    *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
    **************************************************************/
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_GateShort  = 11L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 R6 OverThr     = 12L,
                              CAEN DGTZ DPP PSD DIGITALPROBE2 R6 TrgVal      = 13L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_TrgHO       = 14L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_PileUp      = 15L,
                              CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_Coincidence = 16L,
} CAEN_DGTZ_DPP_PSD_DigitalProbe2_t;
```

Arguments

Name	Description
`handle`	Device handler
mode/*mode	The Virtual Probe mode to set/get.
`vp/*vp`	The Virtual Probe to set/get. **NOTE:** ignored for x751; VirtualProbes are always Input and Baseline
`dp1/*dp1`	The Digital Probe1 to set/get
`dp2/*dp2`	The Digital Probe2 to set/get

Return Values
0: Success; negative numbers are error codes (see Return Codes).

Set / GetDPP_CI_VirtualProbe

Description
Sets/gets the information about the output signal of the DPP-CI acquisition mode.

✏️ **Note:** this function is supported only by DPP-CI firmware from release 3.4_130.16 on.

Synopsis

```
CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_SetDPP_CI_VirtualProbe (int handle,
                                  CAEN_DGTZ_DPP_VirtualProbe_t mode,
                                  CAEN_DGTZ_DPP_CI_VirtualProbe_t vp,
                                  CAEN_DGTZ_DPP_CI_DigitalProbe1_t dp1,
                                  CAEN_DGTZ_DPP_CI_DigitalProbe2_t dp2
                                  );

CAEN_DGTZ_ErrorCode CAENDGTZ_API
CAEN_DGTZ_GetDPP_CI_VirtualProbe (int handle,
                                  CAEN_DGTZ_DPP_VirtualProbe_t *mode,
                                  CAEN_DGTZ_DPP_CI_VirtualProbe_t *vp,
                                  CAEN_DGTZ_DPP_CI_DigitalProbe1_t *dp1,
                                  CAEN_DGTZ_DPP_CI_DigitalProbe2_t *dp2
                                  );

typedef enum
{
                                  CAEN_DGTZ_DPP_VIRTUALPROBE_SINGLE = 0L,
                                  CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL   = 1L,
} CAEN_DGTZ_DPP_VirtualProbe_t;

typedef enum
{
                            CAEN_DGTZ_DPP_CI_VIRTUALPROBE_Baseline = 0L,
} CAEN_DGTZ_DPP_CI_VirtualProbe_t;

typedef enum
{
    /************************************************************
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     *  The following values are valid for the following DPP-CI  *
     *  Firmwares:                                               *
     *      x720 Boards: AMC_REL <= 130.20                       *
     *  For newer firmwares, use the values marked with 'R21' in *
     *  the name.                                                *
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     ************************************************************/
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_BlOutSafeBand   = 0L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_BlTimeout       = 1L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_CoincidenceMet  = 2L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_Tvaw            = 3L,

    /************************************************************
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     *  The following values are valid for the following DPP-CI  *
     *  Firmwares:                                               *
     *      x720 Boards: AMC REL >= 130.22                       *
     *  For older firmwares, use the values above.              *
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     ************************************************************/
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_ExtTrg      = 4L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_OverThr     = 5L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_TrigOut     = 6L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_CoincWin    = 7L,
                            CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_Coincidence = 9L,
} CAEN_DGTZ_DPP_CI_DigitalProbe1_t;

typedef enum
{
    /************************************************************
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
     *  The following values are valid for the following DPP-CI  *
     *  Firmwares:                                               *
     *      x720 Boards: AMC REL <= 130.20                       *
     *  For newer firmwares, use the values marked with 'R21' in *
     *  the name.                                                *
     *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING  *
```

```
                           **************************************************/
                                CAEN DGTZ DPP CI DIGITALPROBE2 BlOutSafeBand    = 0L,
                                CAEN DGTZ DPP CI DIGITALPROBE2 BlTimeout        = 1L,
                                CAEN DGTZ DPP CI DIGITALPROBE2 CoincidenceMet   = 2L,
                                CAEN_DGTZ_DPP_CI_DIGITALPROBE2_Tvaw             = 3L,

        /*************************************************************
        *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING   *
        *  The following values are valid for the following DPP-CI   *
        *  Firmwares:                                                *
        *        x720 Boards: AMC_REL >= 130.22                      *
        *  For older firmwares, use the values above.                *
        *  WARNING WARNING WARNING WARNING WARNING WARNING WARNING   *
        *************************************************************/
                                CAEN DGTZ DPP CI DIGITALPROBE2 R22 OverThr      = 5L,
                                CAEN DGTZ DPP CI DIGITALPROBE2 R22 TrgVal       = 6L,
                                CAEN_DGTZ_DPP_CI_DIGITALPROBE2_R22_TrgHO        = 7L,
                                CAEN_DGTZ_DPP_CI_DIGITALPROBE2_R22_Coincidence = 9L,
} CAEN DGTZ DPP CI DigitalProbe2 t;
```

Arguments

Name	Description
`handle`	Device handler
mode/*mode	The Virtual Probe mode to set/get.
`vp/*vp`	The Virtual Probe to set/get
`dp1/*dp1`	The Digital Probe1 to set/get
`dp2/*dp2`	The Digital Probe2 to set/get

Return Values
0: Success; negative numbers are error codes (see Return Codes).

DPP code examples

The following example codes are intended to let the developer deal with the library C functions to build up a readout cycle when using DPP-PHA, DPP-CI and DPP-PSD firmware. **CAEN provides these examples also as source files and projects inside the CAENDigitizer full installation package, compliant to Visual Studio Professional 2010**.

Note: the DPP-CI example code works only with the DPP-CI firmware from release 3.4_130.16 on.

DPP-PHA EXAMPLE CODE

```
#include <CAENDigitizer.h>
#include <stdio.h>
#include <stdlib.h>

// #define INDIVIDUAL_TRIGGER_INPUTS
// NB: the following define MUST specify the ACTUAL max allowed number of boards
#define MAXNB    1

/* NB: the following define MUST specify the ACTUAL max allowed number of board's channels
it is needed for consistency inside the CAENDigitizer's functions used to allocate the
memory*/
#define MaxNChannels 8

#define MAXNBITS 14

/* include some useful functions from file Functions.c
you can find this file in the src directory */
#include "Functions.h"

/* #####################################################################
*  Functions
*   ##################################################################### */

/*--------------------------------------------------------------------------------------*/
/*! \fn int  ProgramDigitizer(int handle, DigitizerParams t Params,
                              CAEN_DGTZ_DPPParamsPHA_t DPPParams)
```

```
*    \brief    Program the registers of the digitizer with the relevant parameters
*    \return   0=success; -1=error */
/*-------------------------------------------------------------------------------------*/
int  ProgramDigitizer(int  handle,  DigitizerParams t  Params,  CAEN DGTZ DPP PHA Params t
                               DPPParams)
{
 /* This function uses the CAENDigitizer API functions to perform the digitizer's initial
 configuration */
 int i, ret = 0;

/* Reset the digitizer */
 ret |= CAEN_DGTZ_Reset(handle);

 if (ret) {
        printf("ERROR: can't reset the digitizer.\n");
        return -1;
            }
 ret |= CAEN_DGTZ_WriteRegister(handle, 0x8000, 0x01000114); /*Channel Control Reg (indiv
trg, seq readout)*/

/* Set the DPP acquisition mode.
   This setting affects the modes Mixed and List (see CAEN_DGTZ_DPP_AcqMode_t definition
   for details)*/
   CAEN_DGTZ_DPP_SAVE_PARAM_EnergyOnly;     Only energy (DPP-PHA) or charge (DPP-PSD/DPP-CI)
   is returned
   CAEN DGTZ DPP SAVE PARAM TimeOnly;       Only time is returned
   CAEN DGTZ DPP SAVE PARAM EnergyAndTime; Both energy/charge and time are returned
   CAEN_DGTZ_DPP_SAVE_PARAM_None;           No histogram data is returned */
 Ret |= CAEN_DGTZ_SetDPPAcquisitionMode(handle, Params.AcqMode,
                            CAEN DGTZ DPP SAVE PARAM EnergyAndTime);

    // Set the digitizer acquisition mode (CAEN DGTZ SW CONTROLLED or
                              CAEN_DGTZ_S_IN_CONTROLLED)
    ret |= CAEN_DGTZ_SetAcquisitionMode(handle, CAEN_DGTZ_SW_CONTROLLED);

    // Set the number of samples for each waveform
    ret |= CAEN DGTZ SetRecordLength(handle, Params.RecordLength);

    // Set the I/O level (CAEN_DGTZ_IOLevel_NIM or CAEN_DGTZ_IOLevel_TTL)
    ret |= CAEN_DGTZ_SetIOLevel(handle, Params.IOlev);

    /* Set the digitizer's behaviour when an external trigger arrives:

    CAEN_DGTZ_TRGMODE_DISABLED: do nothing
    CAEN_DGTZ_TRGMODE_EXTOUT_ONLY: generate the Trigger Output signal
    CAEN_DGTZ_TRGMODE_ACQ_ONLY = generate acquisition trigger
    CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = generate both Trigger Output and acquisition trigger

    see CAENDigitizer user manual, chapter "Trigger configuration" for details */
    ret |= CAEN_DGTZ_SetExtTriggerInputMode(handle, CAEN_DGTZ_TRGMODE_ACQ_ONLY);

    // Set the enabled channels
    ret |= CAEN DGTZ SetChannelEnableMask(handle, Params.ChannelMask);

    // Set how many events to accumulate in the board memory before being available for
                                readout
    ret |= CAEN DGTZ SetDPPEventAggregation(handle, Params.EventAggr, 0);

    /* Set the mode used to syncronize the acquisition between different boards.
    In this example the sync is disabled */
    ret |= CAEN_DGTZ_SetRunSynchronizationMode(handle, CAEN_DGTZ_RUN_SYNC_Disabled);

    // Set the DPP specific parameters for the channels in the given channelMask
    ret |= CAEN DGTZ SetDPPParameters(handle, Params.ChannelMask, &DPPParams);

    for(i=0; i<MaxNChannels; i++) {
        if (Params.ChannelMask & (1<<i)) {
            // Set a DC offset to the input signal to adapt it to digitizer's dynamic range
            ret |= CAEN DGTZ SetChannelDCOffset(handle, i, 0x8000);

            // Set the Pre-Trigger size (in samples)
            ret |= CAEN_DGTZ_SetDPPPreTriggerSize(handle, i, 80);

            // Set the polarity for the given channel (CAEN_DGTZ_PulsePolarityPositive or
                              CAEN DGTZ PulsePolarityNegative)
            ret |= CAEN DGTZ SetChannelPulsePolarity(handle, i, Params.PulsePolarity);
        }
    }
```

```
    /* Set the virtual probes settings
    DPP-PHA can save:
    2 analog waveforms:
        the first and the second can be specified with the VIRTUALPROBE 1 and 2 parameters

    4 digital waveforms:
        the first is always the trigger
        the second is always the gate
        the third and fourth can be specified with the DIGITALPROBE 1 and 2 parameters

    CAEN_DGTZ_DPP_VIRTUALPROBE_SINGLE -> Save only the Input Signal waveform
    CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL       -> Save also the waveform specified in
                                VIRTUALPROBE

    Virtual Probes 1 types:
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_trapezoid
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Delta
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Delta2
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Input

    Virtual Probes 2 types:
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_Input
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_S3
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_DigitalCombo
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_trapBaseline
    CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_None

    Digital Probes types:
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_trgKln
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_Armed
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_PkRun
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_PkAbort
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_Peaking
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_PkHoldOff
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_Flat
    CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_trgHoldOff */
    ret |= CAEN_DGTZ_SetDPP_PHA_VirtualProbe(handle, CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL,
                            CAEN_DGTZ_DPP_PHA_VIRTUALPROBE1_Delta2,
                            CAEN_DGTZ_DPP_PHA_VIRTUALPROBE2_Input,
                            CAEN_DGTZ_DPP_PHA_DIGITAL_PROBE_trgHoldOff);


    if (ret) {
printf("Warning: errors found during the programming of the digitizer.\nSome settings may
                            not be executed\n");
return ret;
    } else {
        return 0;
    }
}

/* ######################################################################### */
/* MAIN                                                                      */
/* ######################################################################### */
int main(int argc, char *argv[])
{
    /* The following variable is the type returned from most of CAENDigitizer
    library functions and is used to check if there was an error in function
    execution. For example:
    ret = CAEN_DGTZ_some_function(some args);
    if(ret) printf("Some error"); */
    CAEN_DGTZ_ErrorCode ret;

    /* Buffers to store the data. The memory must be allocated using the appropriate
    CAENDigitizer API functions (see below), so they must not be initialized here
    NB: you must use the right type for different DPP analysis (in this case PHA) */
    char *buffer = NULL;                                    // readout buffer
    CAEN_DGTZ_DPP_PHA_Event_t      *Events[MaxNChannels];  // events buffer
    CAEN_DGTZ_DPP_PHA_Waveforms_t  *Waveform=NULL;     // waveforms buffer

    /* The following variables will store the digitizer configuration parameters */
    CAEN_DGTZ_DPP_PHA_Params_t DPPParams[MAXNB];
    DigitizerParams_t Params[MAXNB];

    /* Arrays for data analysis */
    uint64_t PrevTime[MAXNB][MaxNChannels];
    uint64_t ExtendedTT[MAXNB][MaxNChannels];
    uint32_t *EHisto[MAXNB][MaxNChannels]; // Energy Histograms
```

```
        int ECnt[MAXNB][MaxNChannels];
        int TrgCnt[MAXNB][MaxNChannels];
        int PurCnt[MAXNB][MaxNChannels];

        /* The following variable will be used to get an handler for the digitizer. The
        handler will be used for most of CAENDigitizer functions to identify the board */
        int handle[MAXNB];

        /* Other variables */
        int i, b, ch, ev;
        int Quit=0;
        int AcqRun = 0;
        uint32 t AllocatedSize, BufferSize;
        int Nb=0;
        int DoSaveWave[MAXNB][MaxNChannels];
        int MajorNumber;
        int BitMask = 0;
        uint64_t CurrentTime, PrevRateTime, ElapsedTime;
        uint32 t NumEvents[MaxNChannels];
        CAEN DGTZ BoardInfo t          BoardInfo;

        memset(DoSaveWave, 0, MAXNB*MaxNChannels*sizeof(int));
        for (i=0; i<MAXNBITS; i++)
            BitMask |= 1<<i; /* Create a bit mask based on number of bits of the board */

/* ***************************************************************************************** */
/* Set Parameters                                                                            */
/* ***************************************************************************************** */
    memset(&Params, 0, MAXNB*sizeof(DigitizerParams_t));
    memset(&DPPParams, 0, MAXNB*sizeof(CAEN DGTZ DPP PHA Params t));
    for(b=0; b<MAXNB; b++) {
        for(ch=0; ch<MaxNChannels; ch++)
            EHisto[b][ch] = NULL; //set all histograms pointers to NULL (we will allocate
                                    them later)

        /****************************\
        *  Communication Parameters  *
        \****************************/
        // Direct USB connection
        //Params[b].LinkType = CAEN_DGTZ_USB;  // Link Type
        //Params[b].VMEBaseAddress = 0;  // For direct USB connection, VMEBaseAddress must
                                    be 0

        // Direct optical connection
        //Params[b].LinkType = CAEN_DGTZ_PCI_OpticalLink;  // Link Type
        //Params[b].VMEBaseAddress = 0;  // For direct CONET connection, VMEBaseAddress
                                    must be 0

        // Optical connection to A2818 (or A3818) and access to the board with VME bus
        //Params[b].LinkType = CAEN_DGTZ_PCI_OpticalLink;  // Link Type
                                    (CAEN_DGTZ_PCIE_OpticalLink for A3818)
        //Params[b].VMEBaseAddress = 0x32100000;  // VME Base Address (only for VME bus
                                    access; must be 0 for direct connection (CONET or USB)

        // USB connection to V1718 bridge and access to the board with VME bus
        Params[b].LinkType = CAEN_DGTZ_USB;  // Link Type
        Params[b].VMEBaseAddress = 0x32110000;  // VME Base Address (only for VME bus
                                    access; must be 0 for direct connection (CONET or USB)

        Params[b].IOlev = CAEN DGTZ IOLevel TTL;
        /****************************\
        *  Acquisition parameters    *
        \****************************/
        Params[b].AcqMode = CAEN DGTZ DPP ACQ MODE Mixed;         //
                                    CAEN DGTZ DPP ACQ MODE List or
                                    CAEN DGTZ DPP ACQ MODE Oscilloscope
        Params[b].RecordLength = 400;                             // Num of samples of the
                                    waveforms (only for Oscilloscope mode)
        Params[b].ChannelMask = 0xFF;                            // Channel enable mask
        Params[b].EventAggr = 0;                                 // number of events in
                                    one aggregate (0=automatic)
        Params[b].PulsePolarity = CAEN_DGTZ_PulsePolarityNegative; // Pulse Polarity (this
                                    parameter can be individual)

        /****************************\
        *      DPP parameters        *
        \****************************/
        for(ch=0; ch<MaxNChannels; ch++) {
```

```
            DPPParams[b].thr[ch] = 200;    // Trigger Threshold
            DPPParams[b].k[ch] = 1000;       // Trapezoid Rise Time (N*10ns)
            DPPParams[b].m[ch] = 500;        // Trapezoid Flat Top  (N*10ns)
            DPPParams[b].M[ch] = 200;        // Decay Time Constant (N*10ns) HACK-FPEP the
                               one expected from fitting algorithm?
            DPPParams[b].ftd[ch] = 30;     // Flat top delay (peaking time) (N*10ns) ??
            DPPParams[b].a[ch] = 2;          // Trigger Filter smoothing factor
            DPPParams[b].b[ch] = 100;        // Input Signal Rise time (N*10ns)
            DPPParams[b].trgho[ch] = 600;  // Trigger Hold Off
            DPPParams[b].nsbl[ch] = 2; // 3 = bx10 = 64 samples
            DPPParams[b].nspk[ch] = 2;
            DPPParams[b].pkho[ch] = 770;
            DPPParams[b].blho[ch] = 100;
            DPPParams[b].enf[ch] = 1.0; // Energy Normalization Factor
            //DPPParams[b].tsampl[ch] = 10;
            //DPPParams[b].dgain[ch] = 1;
        }
    }


/* ********************************************************************************** */
/* Open the digitizer and read board information                                    */
/* ********************************************************************************** */
/* The following function is used to open the digitizer with the given connection
   parameters and get the handler to it */
   for(b=0; b<MAXNB; b++) {
     /* IMPORTANT: The following function identifies the different boards with a system
        which may change for different connection methods (USB, Conet, ecc). Refer to
        CAENDigitizer user manual for more info. Some examples below */

       /* The following is for b boards connected via b USB direct links.
          In this case you must set Params[b].LinkType = CAEN DGTZ USB and
          Params[b].VMEBaseAddress = 0 */
          //ret = CAEN_DGTZ_OpenDigitizer(Params[b].LinkType, b, 0,
                          Params[b].VMEBaseAddress, &handle[b]);

       /* The following is for b boards connected via 1 opticalLink in dasy chain.
          In this case you must set Params[b].LinkType = CAEN DGTZ PCI OpticalLink and
          Params[b].VMEBaseAddress = 0 */
          //ret = CAEN_DGTZ_OpenDigitizer(Params[b].LinkType, 0, b,
                          Params[b].VMEBaseAddress, &handle[b]);

       /* The following is for b boards connected to A2818 (or A3818) via opticalLink (or
          USB with A1718). In this case the boards are accessed throught VME bus, and you
          must specify the VME address of each board:
          Params[b].LinkType = CAEN_DGTZ_PCI_OpticalLink (CAEN_DGTZ_PCIE_OpticalLink for
                          A3818 or CAEN_DGTZ_USB for A1718)
          Params[0].VMEBaseAddress = <0xXXXXXXXX> (address of first board)
          Params[1].VMEBaseAddress = <0xYYYYYYYY> (address of second board)
          etc */
          ret      =         CAEN_DGTZ_OpenDigitizer(Params[b].LinkType,       0,        0,
                          Params[b].VMEBaseAddress, &handle[b]);

          if (ret) {
           printf("Can't open digitizer\n");
           goto QuitProgram;
          }

     /* Once we have the handler to the digitizer, we use it to call the other functions
                         */
     ret = CAEN_DGTZ_GetInfo(handle[b], &BoardInfo);
     if (ret) {
         printf("Can't read board info\n");
         goto QuitProgram;
     }
     printf("\nConnected  to  CAEN  Digitizer  Model  %s,  recognized  as  board  %d\n",
                          BoardInfo.ModelName, b);
     printf("ROC FPGA Release is %s\n", BoardInfo.ROC_FirmwareRel);
     printf("AMC FPGA Release is %s\n", BoardInfo.AMC_FirmwareRel);

     /* Check firmware revision (only DPP firmwares can be used with this Demo) */
     sscanf(BoardInfo.AMC_FirmwareRel, "%d", &MajorNumber);
     if (MajorNumber != 128) {
         printf("This digitizer has not a DPP-PHA firmware\n");
         goto QuitProgram;
     }
   }
```

```
/* ********************************************************************************** */
/* Program the digitizer (see function ProgramDigitizer)                              */
/* ********************************************************************************** */
    for(b=0; b<MAXNB; b++) {
        ret = ProgramDigitizer(handle[b], Params[b], DPPParams[b]);
        if (ret) {
            printf("Failed to program the digitizer\n");
            goto QuitProgram;
        }
    }

    /* WARNING: The mallocs MUST be done after the digitizer programming,
    because the following functions needs to know the digitizer configuration
    to allocate the right memory amount */
    /* Allocate memory for the readout buffer */
    ret = CAEN_DGTZ_MallocReadoutBuffer(handle[0], &buffer, &AllocatedSize);
    /* Allocate memory for the events */
    ret |= CAEN_DGTZ_MallocDPPEvents(handle[0], Events, &AllocatedSize);
    /* Allocate memory for the waveforms */
    ret |= CAEN_DGTZ_MallocDPPWaveforms(handle[0], &Waveform, &AllocatedSize);
    if (ret) {
        printf("Can't allocate memory buffers\n");
        goto QuitProgram;
    }


/* ****************** ********************************************************************** */
/* Readout Loop                                                                             */
/* **************************************************************************************** */
    // Clear Histograms and counters
    for(b=0; b<MAXNB; b++) {
        for(ch=0; ch<MaxNChannels; ch++) {
            EHisto[b][ch] = (uint32_t *)malloc( (1<<MAXNBITS)*sizeof(uint32_t) );
            memset(EHisto[b][ch], 0, (1<<MAXNBITS)*sizeof(uint32_t));
            TrgCnt[b][ch] = 0;
            ECnt[b][ch] = 0;
            PrevTime[b][ch] = 0;
            ExtendedTT[b][ch] = 0;
            PurCnt[b][ch] = 0;
        }
    }
    PrevRateTime = get_time();
    AcqRun = 0;
    PrintInterface();
    printf("Type a command: ");
    while(!Quit) {

        // Check keyboard
        if(kbhit()) {
            char c;
            c = getch();
            if (c=='q')  Quit = 1;
            if (c=='t')
                for(b=0; b<MAXNB; b++)
                    CAEN_DGTZ_SendSWtrigger(handle[b]); /* Send a software trigger to each
                             board */
            if (c=='h')
                for(b=0; b<MAXNB; b++)
                    for(ch=0; ch<MaxNChannels; ch++)
                        if( ECnt[b][ch] != 0)
                            SaveHistogram("Histo", b, ch, EHisto[b][ch]);  /* Save
                                Histograms to file for each board */
            if (c=='w')
                for(b=0; b<MAXNB; b++)
                    for(ch=0; ch<MaxNChannels; ch++)
                        DoSaveWave[b][ch] = 1; /* save waveforms to file for each channel
                             for each board (at next trigger) */
            if (c=='r')  {
                for(b=0; b<MAXNB; b++) {
                    CAEN_DGTZ_SWStopAcquisition(handle[b]);
                    printf("Restarted\n");
                    CAEN_DGTZ_ClearData(handle[b]);
                    CAEN_DGTZ_SWStartAcquisition(handle[b]);
                }
            }
            if (c=='s')  {
                for(b=0; b<MAXNB; b++) {
                    // Start Acquisition
```

```
                        // NB: the acquisition for each board starts when the following line is
                                executed
                        // so in general the acquisition does NOT starts syncronously for
                                different boards
                        CAEN_DGTZ_SWStartAcquisition(handle[b]);
                        printf("Acquisition Started for Board %d\n", b);
                }
                AcqRun = 1;
            }
        if (c=='S')  {
                for(b=0; b<MAXNB; b++) {
                        // Stop Acquisition
                        CAEN_DGTZ_SWStopAcquisition(handle[b]);
                        printf("Acquisition Stopped for Board %d\n", b);
                }
                AcqRun = 0;
            }
    }
    if (!AcqRun) {
        Sleep(10);
        continue;
    }

    /* Calculate throughput and trigger rate (every second) */
    CurrentTime = get_time();
    ElapsedTime = CurrentTime - PrevRateTime; /* milliseconds */
    if (ElapsedTime > 1000) {
        system(CLEARSCR);
        PrintInterface();
        printf("Readout Rate=%.2f MB\n", (float)Nb/((float)ElapsedTime*1048.576f));
        for(b=0; b<MAXNB; b++) {
            printf("\nBoard %d:\n",b);
            for(i=0; i<MaxNChannels; i++) {
                if (TrgCnt[b][i]>0)
                    printf("\tCh %d:\tTrgRate=%.2f KHz\tPileUpRate=%.2f%%\n", i,
                            (float)TrgCnt[b][i]/(float)ElapsedTime,
                            (float)PurCnt[b][i]*100/(float)TrgCnt[b][i]);
                else
                    printf("\tCh %d:\tNo Data\n", i);
                TrgCnt[b][i]=0;
                PurCnt[b][i]=0;
            }
        }
        Nb = 0;
        PrevRateTime = CurrentTime;
        printf("\n\n");
    }

    /* Read data from the boards */
    for(b=0; b<MAXNB; b++) {
        /* Read data from the board */
        ret = CAEN_DGTZ_ReadData(handle[b], CAEN_DGTZ_SLAVE_TERMINATED_READOUT_MBLT,
                        buffer, &BufferSize);
        if (ret) {
            printf("Readout Error\n");
            goto QuitProgram;
        }
        if (BufferSize == 0)
            continue;

        Nb += BufferSize;
        //ret = DataConsistencyCheck((uint32_t *)buffer, BufferSize/4);
        ret |= CAEN_DGTZ_GetDPPEvents(handle[b], buffer, BufferSize, Events,
                        NumEvents);
        if (ret) {
            printf("Data Error: %d\n", ret);
            goto QuitProgram;
        }

        /* Analyze data */
        //for(b=0; b<MAXNB; b++) printf("%d now: %d\n", b, Params[b].ChannelMask);
        for(ch=0; ch<MaxNChannels; ch++) {
            if (!(Params[b].ChannelMask & (1<<ch)))
                continue;

            /* Update Histograms */
            for(ev=0; ev<NumEvents[ch]; ev++) {
                TrgCnt[b][ch]++;
```

```
                         /* Time Tag */
                         if (Events[ch][ev].TimeTag < PrevTime[b][ch])
                             ExtendedTT[b][ch]++;
                         PrevTime[b][ch] = Events[ch][ev].TimeTag;
                         /* Energy */
                         if (Events[ch][ev].Energy > 0) {
                             // Fill the histograms
                             EHisto[b][ch][(Events[ch][ev].Energy)&BitMask]++;
                             ECnt[b][ch]++;
                         } else {  /* PileUp */
                             PurCnt[b][ch]++;
                         }
                         /* Get Waveforms (only from 1st event in the buffer) */
                         if ((Params[b].AcqMode != CAEN DGTZ DPP ACQ MODE List) &&
                                     DoSaveWave[b][ch] && (ev == 0)) {
                             int size;
                             int16_t *WaveLine;
                             uint8_t *DigitalWaveLine;
                             CAEN DGTZ DecodeDPPWaveforms(handle[b], &Events[ch][ev], Waveform);

                             // Use waveform data here...
                             size = (int)(Waveform->Ns); // Number of samples
                             WaveLine = Waveform->Trace1; // First trace (VIRTUALPROBE1 set with
                                     CAEN_DGTZ_SetDPP_PSD_VirtualProbe)
                             SaveWaveform(b, ch, 1, size, WaveLine);

                             WaveLine = Waveform->Trace2; // Second Trace (if single trace mode,
                                     it is a sequence of zeroes)
                             SaveWaveform(b, ch, 2, size, WaveLine);

                             DigitalWaveLine = Waveform->DTrace1; // First Digital Trace
                                     (DIGITALPROBE1 set with CAEN DGTZ SetDPP PSD VirtualProbe)
                             SaveDigitalProbe(b, ch, 1, size, DigitalWaveLine);

                             DigitalWaveLine = Waveform->DTrace2; // Second Digital Trace (for
                                     DPP-PHA it is ALWAYS Trigger)
                             SaveDigitalProbe(b, ch, 2, size, DigitalWaveLine);
                             DoSaveWave[b][ch] = 0;
                             printf("Waveforms saved to
                                     'Waveform_<board>_<channel>_<trace>.txt'\n");
                         } // loop to save waves
                     } // loop on events
                 } // loop on channels
             } // loop on boards
     } // End of readout loop


QuitProgram:
     /* stop the acquisition, close the device and free the buffers */
     for(b=0; b<MAXNB; b++) {
         CAEN_DGTZ_SWStopAcquisition(handle[b]);
         CAEN_DGTZ_CloseDigitizer(handle[b]);
         for (ch=0; ch<MaxNChannels; ch++)
             if (EHisto[b][ch] != NULL)
                 free(EHisto[b][ch]);
     }
     CAEN DGTZ FreeReadoutBuffer(&buffer);
     CAEN DGTZ FreeDPPEvents(handle[0], Events);
     CAEN DGTZ FreeDPPWaveforms(handle[0], Waveform);
     return ret;
}
```

DPP-CI EXAMPLE CODE

```
#include <CAENDigitizer.h>
#include <stdio.h>
#include <stdlib.h>

//#define MANUAL_BUFFER_SETTING   0
// The following define must be set to the actual number of connected boards
#define MAXNB   1

// NB: the following define MUST specify the ACTUAL max allowed number of board's channels
// it is needed for consistency inside the CAENDigitizer's functions used to
//                              allocate the memory
#define MaxNChannels 8

#define MAXNBITS 12

/* include some useful functions from file Functions.c
you can find this file in the src directory */
#include "Functions.h"

/* #############################################################################
 *  Functions
 *  #############################################################################
 */

/* --------------------------------------------------------------------------- */
/*! \fn int ProgramDigitizer(int handle, DigitizerParams_t Params,
 *                                          CAEN_DGTZ_DPPParamsPHA_t DPPParams)
 *   \brief   Program the registers of the digitizer with the relevant parameters
 *   \return  0=success; -1=error */
/* --------------------------------------------------------------------------- */
int ProgramDigitizer(int handle, DigitizerParams_t Params,
                                          CAEN_DGTZ_DPP_CI_Params_t DPPParams)
{
    /* This  function  uses  the  CAENDigitizer  API  functions  to  perform  the  digitizer's
                          initial configuration */
    int i, ret = 0;

    /* Reset the digitizer */
    ret |= CAEN_DGTZ_Reset(handle);

    if (ret) {
        printf("ERROR: can't reset the digitizer.\n");
        return -1;
    }

    /* Set the DPP acquisition mode
    This setting affects the modes Mixed and List (see CAEN_DGTZ_DPP_AcqMode_t definition
                          for details)
    CAEN_DGTZ_DPP_SAVE_PARAM_EnergyOnly          Only  energy  (DPP-PHA)  or  charge  (DPP-
                          PSD/DPP-CI v2) is returned
    CAEN_DGTZ_DPP_SAVE_PARAM_TimeOnly       Only time is returned
    CAEN_DGTZ_DPP_SAVE_PARAM_EnergyAndTime    Both energy/charge and time are returned
    CAEN_DGTZ_DPP_SAVE_PARAM_None             No histogram data is returned */
    ret |= CAEN_DGTZ_SetDPPAcquisitionMode(handle, Params.AcqMode,
                                                CAEN_DGTZ_DPP_SAVE_PARAM_EnergyAndTime);

    // Set the digitizer acquisition mode (CAEN_DGTZ_SW_CONTROLLED or
                                                CAEN_DGTZ_S_IN_CONTROLLED)
    ret |= CAEN_DGTZ_SetAcquisitionMode(handle, CAEN_DGTZ_SW_CONTROLLED);

    // Set the number of samples for each waveform
    ret |= CAEN_DGTZ_SetRecordLength(handle, Params.RecordLength);

    // Set the I/O level (CAEN_DGTZ_IOLevel_NIM or CAEN_DGTZ_IOLevel_TTL)
    ret |= CAEN_DGTZ_SetIOLevel(handle, Params.IOlev);

    /* Set the digitizer's behaviour when an external trigger arrives:

    CAEN_DGTZ_TRGMODE_DISABLED: do nothing
    CAEN_DGTZ_TRGMODE_EXTOUT_ONLY: generate the Trigger Output signal
    CAEN_DGTZ_TRGMODE_ACQ_ONLY = generate acquisition trigger
    CAEN_DGTZ_TRGMODE_ACQ_AND_EXTOUT = generate both Trigger Output and acquisition trigger

    see CAENDigitizer user manual, chapter "Trigger configuration" for details */
    ret |= CAEN_DGTZ_SetExtTriggerInputMode(handle, CAEN_DGTZ_TRGMODE_ACQ_ONLY);
```

```
// Set the enabled channels
ret |= CAEN DGTZ SetChannelEnableMask(handle, Params.ChannelMask);

// Set how many events to accumulate in the board memory before being available for
                          readout
ret |= CAEN_DGTZ_SetDPPEventAggregation(handle, Params.EventAggr, 0);

/* Set the mode used to syncronize the acquisition between different boards.
In this example the sync is disabled */
ret |= CAEN DGTZ SetRunSynchronizationMode(handle, CAEN DGTZ RUN SYNC Disabled);

// Set the DPP specific parameters for the channels in the given channelMask
ret |= CAEN DGTZ SetDPPParameters(handle, Params.ChannelMask, &DPPParams);

for(i=0; i<MaxNChannels; i++) {
    if (Params.ChannelMask & (1<<i)) {
        // Set a DC offset to the input signal to adapt it to digitizer's dynamic range
        ret |= CAEN_DGTZ_SetChannelDCOffset(handle, i, 0x8000);

        // Set the Pre-Trigger size (in samples)
        ret |= CAEN DGTZ SetDPPPreTriggerSize(handle, i, 80);

        // Set the polarity for the given channel (CAEN_DGTZ_PulsePolarityPositive or
                            CAEN_DGTZ_PulsePolarityNegative)
        ret |= CAEN DGTZ SetChannelPulsePolarity(handle, i, Params.PulsePolarity);
    }
}


/* Set the virtual probes settings
DPP-CI can save:
2 analog waveforms:
    Analog Trace 1: it is always the input signal;
    Analog Trace 2: it can be specified with the VIRTUALPROBE parameter
4 digital waveforms:
    Digital Trace 1:   it is always the trigger
    Digital Trace 2:   it is always the gate
    Digital Trace 2/3: they can be specified with the DIGITALPROBE 1 and 2 parameters

CAEN_DGTZ_DPP_VIRTUALPROBE_SINGLE    -> Save only the Input Signal waveform
CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL       -> Save also the Trace specified in VIRTUALPROBE
                          (interleaved)

Probes types for Analog Trace 2:
    CAEN_DGTZ_DPP_CI_VIRTUALPROBE_Baseline

Probes types for Digital Trace 3:
  ### Virtual Probes only for FW >= 130.21 ###
    CAEN DGTZ DPP CI DIGITALPROBE1 R21 ExtTrg
    CAEN DGTZ DPP CI DIGITALPROBE1 R21 OverThr
    CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_TrigOut
    CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_CoincWin
    CAEN_DGTZ_DPP_CI_DIGITALPROBE1_R21_Coincidence
  ### Virtual Probes only for FW <= 130.20 ###
    CAEN DGTZ DPP CI DIGITALPROBE1 BlOutSafeBand
                                   CAEN_DGTZ_DPP_CI_DIGITALPROBE1_BlTimeout
                                   CAEN_DGTZ_DPP_CI_DIGITALPROBE1_CoincidenceMet
                                   CAEN DGTZ DPP CI DIGITALPROBE1 Tvaw

Probes types for Digital Trace 4:
  ### Virtual Probes only for FW >= 130.21 ###
    CAEN_DGTZ_DPP_CI_DIGITALPROBE2_R22_OverThr
    CAEN_DGTZ_DPP_CI_DIGITALPROBE2_R22_TrgVal
    CAEN DGTZ DPP CI DIGITALPROBE2 R22 TrgHO
    CAEN DGTZ DPP CI DIGITALPROBE2 R22 Coincidence
  ### Virtual Probes only for FW <= 130.20 ###
    CAEN DGTZ DPP CI DIGITALPROBE2 R22 OverThr
    CAEN_DGTZ_DPP_CI_DIGITALPROBE2_R22_TrgVal
    CAEN_DGTZ_DPP_CI_DIGITALPROBE2_R22_TrgHO
    CAEN DGTZ DPP CI DIGITALPROBE2 R22 Coincidence */
ret   |=   CAEN DGTZ SetDPP CI VirtualProbe(handle,  CAEN DGTZ DPP VIRTUALPROBE SINGLE,
                        CAEN DGTZ DPP CI VIRTUALPROBE Baseline,
                        CAEN_DGTZ_DPP_CI_DIGITALPROBE1_BlOutSafeBand,
                        CAEN_DGTZ_DPP_CI_DIGITALPROBE2_Tvaw);
if (ret) {
    printf("Warning: errors found during the programming of the digitizer.\nSome
                        settings may not be executed\n");
    return ret;
} else {
```

```
            return 0;
        }
}

/* ##################################################################### */
/* MAIN                                                                  */
/* ##################################################################### */
int main(int argc, char *argv[])
{
    /* The following variable is the type returned from most of CAENDigitizer
    library functions and is used to check if there was an error in function
    execution. For example:
    ret = CAEN DGTZ some function(some args);
    if(ret) printf("Some error"); */
    CAEN DGTZ ErrorCode ret;

    /* Buffers to store the data. The memory must be allocated using the appropriate
    CAENDigitizer API functions (see below), so they must not be initialized here
    NB: you must use the right type for different DPP analysis (in this case CI) */
    char *buffer = NULL;                                // readout buffer
    CAEN DGTZ DPP CI Event t        *Events[MaxNChannels];  // events buffer
    CAEN_DGTZ_DPP_CI_Waveforms_t    *Waveform=NULL;     // waveforms buffer

    /* The following variables will store the digitizer configuration parameters */
    CAEN DGTZ DPP CI Params t DPPParams[MAXNB];
    DigitizerParams t Params[MAXNB];

    /* Arrays for data analysis */
    uint64_t PrevTime[MAXNB][MaxNChannels];
    uint64 t ExtendedTT[MAXNB][MaxNChannels];
    uint32 t *EHisto[MAXNB][MaxNChannels]; // Energy Histograms
    int ECnt[MAXNB][MaxNChannels];
    int TrgCnt[MAXNB][MaxNChannels];

    /* The following variable will be used to get an handler for the digitizer. The
    handler will be used for most of CAENDigitizer functions to identify the board */
    int handle[MAXNB];

    /* Other variables */
    int i, b, ch, ev;
    int Quit=0;
    int AcqRun = 0;
    uint32 t AllocatedSize, BufferSize;
    int Nb=0;
    int DoSaveWave[MAXNB][MaxNChannels];
    int MajorNumber;
    int BitMask = 0;
    uint64 t CurrentTime, PrevRateTime, ElapsedTime;
    uint32 t NumEvents[MaxNChannels];
    CAEN_DGTZ_BoardInfo_t           BoardInfo;

    memset(DoSaveWave, 0, MAXNB*MaxNChannels*sizeof(int));
    for (i=0; i<MAXNBITS; i++)
        BitMask |= 1<<i; /* Create a bit mask based on number of bits of the board */

    /* *********************************************************************** */
    /* Set Parameters                                                         */
    /* *********************************************************************** */
    memset(&Params, 0, MAXNB*sizeof(DigitizerParams t));
    memset(&DPPParams, 0, MAXNB*sizeof(CAEN DGTZ DPP CI Params t));
    for(b=0; b<MAXNB; b++) {
        for(ch=0; ch<MaxNChannels; ch++)
            EHisto[b][ch] = NULL; //set all histograms pointers to NULL (we will allocate
                            them later)

        /****************************\
        * Communication Parameters   *
        \****************************/
        // Direct USB connection
        Params[b].LinkType = CAEN DGTZ USB;  // Link Type
        Params[b].VMEBaseAddress = 0;  // For direct USB connection, VMEBaseAddress must be
                            0

        // Direct optical connection
        //Params[b].LinkType = CAEN DGTZ PCI OpticalLink;  // Link Type
        //Params[b].VMEBaseAddress = 0;   // For direct CONET connection, VMEBaseAddress
                            must be 0
```

```
        // Optical connection to A2818 (or A3818) and access to the board with VME bus
        //Params[b].LinkType    =    CAEN DGTZ PCI OpticalLink;         //    Link    Type
                            (CAEN DGTZ PCIE OpticalLink for A3818)
        //Params[b].VMEBaseAddress = 0x32100000;  // VME Base Address (only for VME bus
                            access; must be 0 for direct connection (CONET or USB)


        // USB connection to V1718 bridge and access to the board with VME bus
        //Params[b].LinkType = CAEN DGTZ USB;  // Link Type (CAEN DGTZ PCIE OpticalLink for
                            A3818)
        //Params[b].VMEBaseAddress = 0x11110000;  // VME Base Address (only for VME bus
                            access; must be 0 for direct connection (CONET or USB)

        Params[b].IOlev = CAEN DGTZ IOLevel TTL;
        /*****************************\
        *   Acquisition parameters    *
        \*****************************/
        Params[b].AcqMode   =   CAEN_DGTZ_DPP_ACQ_MODE_Mixed;                        //
                                CAEN_DGTZ_DPP_ACQ_MODE_List                         or
                                CAEN DGTZ DPP ACQ MODE Oscilloscope
        Params[b].RecordLength = 300;                               // Num of samples of the
                                waveforms (only for Oscilloscope mode)
        Params[b].ChannelMask = 0xF;                               // Channel enable mask
        Params[b].EventAggr = 0;                                   // number of events in
                                one aggregate (0=automatic)
        Params[b].PulsePolarity = CAEN DGTZ PulsePolarityNegative; // Pulse Polarity (this
                                parameter can be individual)


        /***************************\
        *      DPP parameters       *
        \***************************/
        for(ch=0; ch<MaxNChannels; ch++) {
            DPPParams[b].thr[ch] = 100;        // Trigger Threshold
            /* The following parameter is used to specifiy the number of samples for the
                            baseline averaging:
            0 -> 8samp
            1 -> 16samp
            2 -> 32samp
            3 -> 64samp */
            DPPParams[b].nsbl[ch] = 2;
            DPPParams[b].gate[ch] = 200;       // Gate Width (N*4ns)
            DPPParams[b].pgate[ch] = 25;       // Pre Gate Width (N*4ns)
            /* Self Trigger Mode:
            0 -> Disabled
            1 -> Enabled */
            DPPParams[b].selft[ch] = 1;
            /* Trigger configuration:
            CAEN_DGTZ_DPP_TriggerConfig_Peak -> trigger on peak
            CAEN DGTZ DPP TriggerConfig Threshold -> trigger on threshold */
            DPPParams[b].trgc[ch] = CAEN DGTZ DPP TriggerConfig Peak;
            /* Trigger Validation Acquisition Window */
            DPPParams[b].tvaw[ch] = 50;
        }
        DPPParams[b].blthr = 3;   // Baseline Threshold
        DPPParams[b].bltmo = 100; // Baseline Timeout
        DPPParams[b].trgho = 0;   // Trigger Holdoff
    }

    /* *************************************************************************************** */
    /* Open the digitizer and read board information                                          */
    /* *************************************************************************************** */
    /* The following function is used to open the digitizer with the given connection
                            parameters and get the handler to it */
    for(b=0; b<MAXNB; b++) {
        /* IMPORTANT: The following function identifies the different boards with a system
                            which may change
        for different connection methods (USB, Conet, ecc). Refer to CAENDigitizer user
                            manual for more info.
        Some examples below */

        /* The following is for b boards connected via b USB direct links
        in   this   case   you   must   set   Params[b].LinkType  =  CAEN DGTZ USB  and
                            Params[b].VMEBaseAddress = 0 */
        ret = CAEN_DGTZ_OpenDigitizer(Params[b].LinkType, b, 0, Params[b].VMEBaseAddress,
                            &handle[b]);

        /* The following is for b boards connected via 1 opticalLink in dasy chain
        in  this  case  you  must  set  Params[b].LinkType = CAEN_DGTZ_PCI_OpticalLink  and
                            Params[b].VMEBaseAddress = 0 */
```

```
        //ret = CAEN_DGTZ_OpenDigitizer(Params[b].LinkType, 0, b, Params[b].VMEBaseAddress,
                          &handle[b]);

        /* The following is for b boards connected to A2818 (or A3818) via opticalLink (or
                          USB with A1718)
        in this case the boards are accessed throught VME bus, and you must specify the VME
                          address of each board:
        Params[b].LinkType  =  CAEN DGTZ PCI OpticalLink  (CAEN DGTZ PCIE OpticalLink  for
                          A3818 or CAEN DGTZ USB for A1718)
        Params[0].VMEBaseAddress = <0xXXXXXXXX> (address of first board)
        Params[1].VMEBaseAddress = <0xYYYYYYYY> (address of second board)
        etc */
        //ret = CAEN DGTZ OpenDigitizer(Params[b].LinkType, 0, 0, Params[b].VMEBaseAddress,
                          &handle[b]);

        if (ret) {
            printf("Can't open digitizer\n");
            goto QuitProgram;
        }

        /* Once we have the handler to the digitizer, we use it to call the other functions
                          */
        ret = CAEN_DGTZ_GetInfo(handle[b], &BoardInfo);
        if (ret) {
            printf("Can't read board info\n");
            goto QuitProgram;
        }
        printf("\nConnected  to  CAEN  Digitizer  Model  %s,  recognized  as  board  %d\n",
                          BoardInfo.ModelName, b);
        printf("ROC FPGA Release is %s\n", BoardInfo.ROC FirmwareRel);
        printf("AMC FPGA Release is %s\n", BoardInfo.AMC FirmwareRel);

        /* Check firmware revision (only DPP firmware can be used with this Demo) */
        sscanf(BoardInfo.AMC_FirmwareRel, "%d", &MajorNumber);
        if (MajorNumber != 130) {
            printf("This digitizer has not a DPP-CI firmware\n");
            goto QuitProgram;
        }
    }

    /* ***************************************************************************** */
    /* Program the digitizer (see function ProgramDigitizer)                       */
    /* ***************************************************************************** */
    for(b=0; b<MAXNB; b++) {
        ret = ProgramDigitizer(handle[b], Params[b], DPPParams[b]);
        if (ret) {
            printf("Failed to program the digitizer\n");
            goto QuitProgram;
        }
    }

    /* WARNING: The mallocs MUST be done after the digitizer programming,
    because the following functions needs to know the digitizer configuration
    to allocate the right memory amount */
    /* Allocate memory for the readout buffer */
    ret = CAEN_DGTZ_MallocReadoutBuffer(handle[0], &buffer, &AllocatedSize);
    /* Allocate memory for the events */
    ret |= CAEN DGTZ MallocDPPEvents(handle[0], Events, &AllocatedSize);
    /* Allocate memory for the waveforms */
    ret |= CAEN DGTZ MallocDPPWaveforms(handle[0], &Waveform, &AllocatedSize);
    if (ret) {
        printf("Can't allocate memory buffers\n");
        goto QuitProgram;
    }


    /* ***************************************************************************** */
    /* Readout Loop                                                                */
    /* ***************************************************************************** */
    // Clear Histograms and counters
    for(b=0; b<MAXNB; b++) {
        for(ch=0; ch<MaxNChannels; ch++) {
            EHisto[b][ch] = (uint32_t *)malloc( (1<<MAXNBITS)*sizeof(uint32_t) );
            memset(EHisto[b][ch], 0, (1<<MAXNBITS)*sizeof(uint32_t));
            TrgCnt[b][ch] = 0;
            ECnt[b][ch] = 0;
            PrevTime[b][ch] = 0;
            ExtendedTT[b][ch] = 0;
```

```
        }
    }
    PrevRateTime = get time();
    AcqRun = 0;
    PrintInterface();
    printf("Type a command: ");
    while(!Quit) {

        // Check keyboard
        if(kbhit()) {
            char c;
            c = getch();
            if (c=='q')  Quit = 1;
            if (c=='t')
                for(b=0; b<MAXNB; b++)
                    CAEN DGTZ SendSWtrigger(handle[b]); /* Send a software trigger to each
                                board */
            if (c=='h')
                for(b=0; b<MAXNB; b++)
                    for(ch=0; ch<MaxNChannels; ch++)
                        if( ECnt[b][ch] != 0)
                            SaveHistogram("Histo",  b,  ch,  EHisto[b][ch];     /*  Save
                                Histograms to file for each board */
            if (c=='w')
                for(b=0; b<MAXNB; b++)
                    for(ch=0; ch<MaxNChannels; ch++)
                        DoSaveWave[b][ch] = 1; /* save waveforms to file for each channel
                                for each board (at next trigger) */
            if (c=='r')  {
                for(b=0; b<MAXNB; b++) {
                    CAEN DGTZ SWStopAcquisition(handle[b]);
                    printf("Restarted\n");
                    CAEN_DGTZ_ClearData(handle[b]);
                    CAEN_DGTZ_SWStartAcquisition(handle[b]);
                }
            }
            if (c=='s')  {
                for(b=0; b<MAXNB; b++) {
                    // Start Acquisition
                    // NB: the acquisition for each board starts when the following line is
                                executed
                    // so in general the acquisition does NOT starts syncronously for
                                different boards
                    CAEN_DGTZ_SWStartAcquisition(handle[b]);
                    printf("Acquisition Started for Board %d\n", b);
                }
                AcqRun = 1;
            }
            if (c=='S')  {
                for(b=0; b<MAXNB; b++) {
                    // Stop Acquisition
                    CAEN_DGTZ_SWStopAcquisition(handle[b]);
                    printf("Acquisition Stopped for Board %d\n", b);
                }
                AcqRun = 0;
            }
        }
        if (!AcqRun) {
            Sleep(10);
            continue;
        }

        /* Calculate throughput and trigger rate (every second) */
        CurrentTime = get time();
        ElapsedTime = CurrentTime - PrevRateTime; /* milliseconds */
        if (ElapsedTime > 1000) {
            system(CLEARSCR);
            PrintInterface();
            printf("Readout Rate=%.2f MB\n", (float)Nb/((float)ElapsedTime*1048.576f));
            for(b=0; b<MAXNB; b++) {
                printf("\nBoard %d:\n",b);
                for(i=0; i<MaxNChannels; i++) {
                    if (TrgCnt[b][i]>0)
                        printf("\tCh         %d:\tTrgRate=%.2f         KHz\t\n",         i,
                                (float)TrgCnt[b][i]/(float)ElapsedTime);
                    else
                        printf("\tCh %d:\tNo Data\n", i);
                    TrgCnt[b][i]=0;
```

```
            }
        }
        Nb = 0;
        PrevRateTime = CurrentTime;
        printf("\n\n");
    }

    /* Read data from the boards */
    for(b=0; b<MAXNB; b++) {
        /* Read data from the board */
        ret = CAEN_DGTZ_ReadData(handle[b], CAEN_DGTZ_SLAVE_TERMINATED_READOUT_MBLT,
                        buffer, &BufferSize);
        if (ret) {
            printf("Readout Error\n");
            goto QuitProgram;
        }
        if (BufferSize == 0)
            continue;

        Nb += BufferSize;
        //ret = DataConsistencyCheck((uint32 t *)buffer, BufferSize/4);
        ret |= CAEN_DGTZ_GetDPPEvents(handle[b], buffer, BufferSize, Events,
                        NumEvents);
        if (ret) {
            printf("Data Error: %d\n", ret);
            goto QuitProgram;
        }

        /* Analyze data */
        for(ch=0; ch<MaxNChannels; ch++) {
            if (!(Params[b].ChannelMask & (1<<ch)))
                continue;

            /* Update Histograms */
            for(ev=0; ev<NumEvents[ch]; ev++) {
                TrgCnt[b][ch]++;
                /* Time Tag */
                if (Events[ch][ev].TimeTag < PrevTime[b][ch])
                    ExtendedTT[b][ch]++;
                PrevTime[b][ch] = Events[ch][ev].TimeTag;
                /* Energy */
                if (Events[ch][ev].Charge > 0) {
                    // Fill the histograms
                    EHisto[b][ch][(Events[ch][ev].Charge) & BitMask]++;
                    ECnt[b][ch]++;
                }

                /* Get Waveforms (only from 1st event in the buffer) */
                if ((Params[b].AcqMode != CAEN DGTZ DPP ACQ MODE List) &&
                        DoSaveWave[b][ch] && (ev == 0)) {
                    int size;
                    int16_t *WaveLine;
                    uint8 t *DigitalWaveLine;
                    CAEN DGTZ DecodeDPPWaveforms(handle[b], &Events[ch][ev], Waveform);

                    // Use waveform data here...
                    size = (int)(Waveform->Ns); // Number of samples
                    WaveLine = Waveform->Trace1; // First trace (for DPP-CI it is
                            ALWAYS the Input Signal)
                    SaveWaveform(b, ch, 1, size, WaveLine);

                    WaveLine = Waveform->Trace2; // Second Trace (if single trace mode,
                            it is a sequence of zeroes)
                    SaveWaveform(b, ch, 2, size, WaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine = Waveform->DTrace1; // First Digital Trace
                            (Trigger)
                    SaveDigitalProbe(b, ch, 1, size, DigitalWaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine = Waveform->DTrace2; // Second Digital Trace (Gate)
                    SaveDigitalProbe(b, ch, 2, size, DigitalWaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine = Waveform->DTrace3; // Third Digital Trace
                            (DIGITALPROBE1 set with CAEN_DGTZ_SetDPP_PSD_VirtualProbe)
                    SaveDigitalProbe(b, ch, 3, size, DigitalWaveLine);
```

```
                            DoSaveWave[b][ch] = 0;

                            DigitalWaveLine = Waveform->DTrace4;  // Fourth Digital Trace
                                    (DIGITALPROBE2 set with CAEN DGTZ SetDPP PSD VirtualProbe)
                            SaveDigitalProbe(b, ch, 4, size, DigitalWaveLine);
                            DoSaveWave[b][ch] = 0;
                            printf("Waveforms                    saved                    to
                                    'Waveform <board> <channel> <trace>.txt'\n");
                    } // loop to save waves
                } // loop on events
            } // loop on channels
        } // loop on boards
    } // End of readout loop


QuitProgram:
    /* stop the acquisition, close the device and free the buffers */
    for(b=0; b<MAXNB; b++) {
        CAEN DGTZ SWStopAcquisition(handle[b]);
        CAEN DGTZ CloseDigitizer(handle[b]);
        for (ch=0; ch<MaxNChannels; ch++)
            if (EHisto[b][ch] != NULL)
                free(EHisto[b][ch]);
    }
    CAEN DGTZ FreeReadoutBuffer(&buffer);
    CAEN DGTZ FreeDPPEvents(handle[0], Events);
    CAEN DGTZ FreeDPPWaveforms(handle[0], Waveform);
    return ret;
}
```

DPP-PSD EXAMPLE CODE

```
#include <CAENDigitizer.h>
#include <stdio.h>
#include <stdlib.h>

//#define MANUAL BUFFER SETTING   0
// The following define must be set to the actual number of connected boards
#define MAXNB    1
// NB: the following define MUST specify the ACTUAL max allowed number of board's channels
// it is needed for consistency inside the CAENDigitizer's functions used to allocate the
                                memory
#define MaxNChannels 8

#define MAXNBITS 12

/* include some useful functions from file Functions.h
you can find this file in the src directory */
#include "Functions.h"

/* ##########################################################################
*  Functions
*  ########################################################################## */

/* -------------------------------------------------------------------------- */
/*! \fn      int ProgramDigitizer(int handle, DigitizerParams_t Params,
                                            CAEN_DGTZ_DPPParamsPHA_t DPPParams)
*   \brief   Program the registers of the digitizer with the relevant parameters
*   \return  0=success; -1=error */
/* -------------------------------------------------------------------------- */
int ProgramDigitizer(int handle, DigitizerParams t Params,
                                            CAEN_DGTZ_DPP_PSD_Params_t DPPParams)
{
    /* This function uses the CAENDigitizer API functions to perform the digitizer's
                        initial configuration */
    int i, ret = 0;

    /* Reset the digitizer */
    ret |= CAEN_DGTZ_Reset(handle);

    if (ret) {
        printf("ERROR: can't reset the digitizer.\n");
```

```
        return -1;
    }

    /* Set the DPP acquisition mode
    This setting affects the modes Mixed and List (see CAEN_DGTZ_DPP_AcqMode_t definition
                            for details)
    CAEN DGTZ DPP SAVE PARAM EnergyOnly          Only energy (DPP-PHA) or charge (DPP-
                            PSD/DPP-CI v2) is returned
    CAEN DGTZ DPP SAVE PARAM TimeOnly      Only time is returned
    CAEN DGTZ DPP SAVE PARAM EnergyAndTime    Both energy/charge and time are returned
    CAEN_DGTZ_DPP_SAVE_PARAM_None          No histogram data is returned */
    ret |= CAEN_DGTZ_SetDPPAcquisitionMode(handle, Params.AcqMode,
                                            CAEN DGTZ DPP SAVE PARAM EnergyAndTime);

    // Set the digitizer acquisition mode (CAEN DGTZ SW CONTROLLED or
                                        CAEN DGTZ S IN CONTROLLED)
    ret |= CAEN_DGTZ_SetAcquisitionMode(handle, CAEN_DGTZ_SW_CONTROLLED);

    // Set the I/O level (CAEN DGTZ IOLevel NIM or CAEN DGTZ IOLevel TTL)
    ret |= CAEN DGTZ SetIOLevel(handle, Params.IOlev);

    /* Set the digitizer's behaviour when an external trigger arrives:

    CAEN_DGTZ_TRGMODE_DISABLED: do nothing
    CAEN DGTZ TRGMODE EXTOUT ONLY: generate the Trigger Output signal
    CAEN DGTZ TRGMODE ACQ ONLY = generate acquisition trigger
    CAEN DGTZ TRGMODE ACQ AND EXTOUT = generate both Trigger Output and acquisition trigger

    see CAENDigitizer user manual, chapter "Trigger configuration" for details */
    ret |= CAEN DGTZ SetExtTriggerInputMode(handle, CAEN DGTZ TRGMODE ACQ ONLY);

    // Set the enabled channels
    ret |= CAEN_DGTZ_SetChannelEnableMask(handle, Params.ChannelMask);

    // Set how many events to accumulate in the board memory before being available for
                            readout
    ret |= CAEN DGTZ SetDPPEventAggregation(handle, Params.EventAggr, 0);

    /* Set the mode used to syncronize the acquisition between different boards.
    In this example the sync is disabled */
    ret |= CAEN_DGTZ_SetRunSynchronizationMode(handle, CAEN_DGTZ_RUN_SYNC_Disabled);

    // Set the DPP specific parameters for the channels in the given channelMask
    ret |= CAEN_DGTZ_SetDPPParameters(handle, Params.ChannelMask, &DPPParams);

    for(i=0; i<MaxNChannels; i++) {
        if (Params.ChannelMask & (1<<i)) {
            // Set the number of samples for each waveform (you can set different RL for
                            different channels)
            ret |= CAEN_DGTZ_SetRecordLength(handle, Params.RecordLength, i);

            // Set a DC offset to the input signal to adapt it to digitizer's dynamic range
            ret |= CAEN DGTZ SetChannelDCOffset(handle, i, 0x8000);

            // Set the Pre-Trigger size (in samples)
            ret |= CAEN_DGTZ_SetDPPPreTriggerSize(handle, i, 80);

            // Set the polarity for the given channel (CAEN DGTZ PulsePolarityPositive or
                            CAEN DGTZ PulsePolarityNegative)
            ret |= CAEN DGTZ SetChannelPulsePolarity(handle, i, Params.PulsePolarity);
        }
    }

    /* Set the virtual probes

    DPP-PSD for x720 boards can save:
    2 analog waveforms:
        Analog Trace 1: it is always the input signal;
        Analog Trace 2: it can be specified with the VIRTUALPROBE parameter
    4 digital waveforms:
        Digital Trace 1:   it is always the trigger
        Digital Trace 2:   it is always the long gate
        Digital Trace 3/4: they can be specified with the DIGITALPROBE 1 and 2 parameters

    DPP-PSD for x751 boards can save:
    2 analog waveforms:
        Analog Trace 1: it is always the input signal;
        Analog Trace 2: it can be specified with the VIRTUALPROBE parameter
```

```
    3 digital waveforms:
        Digital Trace 1:   it is always the trigger
        Digital Trace 2/3: they can be specified with the DIGITALPROBE 1 and 2 parameters

    CAEN_DGTZ_DPP_VIRTUALPROBE_SINGLE    -> Save only the Input Signal waveform
    CAEN_DGTZ_DPP_VIRTUALPROBE_DUAL                -> Save  also  the  waveform  specified  in
                            VIRTUALPROBE

    Virtual Probes types for Trace 2:
        CAEN DGTZ DPP PSD VIRTUALPROBE Baseline        -> Save the Baseline waveform (mean
                            on nsbl parameter)
      ### Virtual Probes only for FW <= 13X.5 ###
        CAEN DGTZ DPP PSD VIRTUALPROBE Threshold       -> Save the (Baseline - Threshold)
                            waveform. NOTE: x720 only

    Digital Probes types for Digital Trace 3(x720)/2(x751):
      ### Virtual Probes only for FW >= 13X.6 ###
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_ExtTrg      NOTE: x720 only
        CAEN DGTZ DPP PSD DIGITALPROBE1 R6 OverThr
        CAEN DGTZ DPP PSD DIGITALPROBE1 R6 TrigOut
        CAEN DGTZ DPP PSD DIGITALPROBE1 R6 CoincWin
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_PileUp
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_Coincidence
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_GateLong    NOTE: x751 only
      ### Virtual Probes only for FW <= 13X.5 ###
        CAEN DGTZ DPP PSD DIGITALPROBE1 Armed          NOTE: x720 only
        CAEN DGTZ DPP PSD DIGITALPROBE1 Trigger        NOTE: x720 only
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_ChargeReady    NOTE: x720 only
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_PileUp         NOTE: x720 only
        CAEN DGTZ DPP PSD DIGITALPROBE1 BlOutSafeBand  NOTE: x720 only
        CAEN DGTZ DPP PSD DIGITALPROBE1 BlTimeout      NOTE: x720 only
        CAEN DGTZ DPP PSD DIGITALPROBE1 CoincidenceMet NOTE: x720 only
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_Tvaw           NOTE: x720 only
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_OverThr             NOTE: x751 only
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_GateShort       NOTE: x751 only
        CAEN DGTZ DPP PSD DIGITALPROBE1 None           NOTE: x751 only

    Digital Probes types for Digital Trace 4(x720)/3(x751):
      ### Virtual Probes only for FW >= 13X.6 ###
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_GateShort
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_OverThr
        CAEN DGTZ DPP PSD DIGITALPROBE2 R6 TrgVal
        CAEN DGTZ DPP PSD DIGITALPROBE2 R6 TrgHO
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_PileUp
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_Coincidence
      ### Virtual Probes only for FW <= 13X.5 ###
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_Armed          NOTE: x720 only
                            CAEN DGTZ DPP PSD DIGITALPROBE2 Trigger        NOTE:
                     x720 only
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_ChargeReady    NOTE:
                     x720 only
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_PileUp         NOTE:
                     x720 only
                            CAEN DGTZ DPP PSD DIGITALPROBE2 BlOutSafeBand  NOTE:
                     x720 only
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_BlTimeout      NOTE:
                     x720 only
                            CAEN DGTZ DPP PSD DIGITALPROBE2 CoincidenceMet NOTE:
                     x720 only
                            CAEN DGTZ DPP PSD DIGITALPROBE2 Tvaw           NOTE:
                     x720 only
        CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_GateShort      NOTE: x751 only
        CAEN DGTZ DPP PSD DIGITALPROBE2 GateLong       NOTE: x751 only
        CAEN DGTZ DPP PSD DIGITALPROBE2 None           NOTE: x751 only */
ret |=  CAEN DGTZ SetDPP PSD VirtualProbe(handle,  CAEN DGTZ DPP VIRTUALPROBE SINGLE,
                            CAEN DGTZ DPP PSD VIRTUALPROBE Baseline,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE1_R6_GateLong,
                            CAEN_DGTZ_DPP_PSD_DIGITALPROBE2_R6_OverThr);


    if (ret) {
        printf("Warning:  errors  found  during  the  programming  of  the  digitizer.\nSome
                            settings may not be executed\n");
        return ret;
    } else {
        return 0;
    }
}
```

```
/* ########################################################################## */
/* MAIN                                                                       */
/* ########################################################################## */
int main(int argc, char *argv[])
{
    /* The following variable is the type returned from most of CAENDigitizer
    library functions and is used to check if there was an error in function
    execution. For example:
    ret = CAEN DGTZ some function(some args);
    if(ret) printf("Some error"); */
    CAEN_DGTZ_ErrorCode ret;

    /* Buffers to store the data. The memory must be allocated using the appropriate
    CAENDigitizer API functions (see below), so they must not be initialized here
    NB: you must use the right type for different DPP analysis (in this case PSD) */
    char *buffer = NULL;                                     // readout buffer
    CAEN_DGTZ_DPP_PSD_Event_t       *Events[MaxNChannels];  // events buffer
    CAEN_DGTZ_DPP_PSD_Waveforms_t   *Waveform=NULL;         // waveforms buffer

    /* The following variables will store the digitizer configuration parameters */
    CAEN DGTZ DPP PSD Params t DPPParams[MAXNB];
    DigitizerParams_t Params[MAXNB];

    /* Arrays for data analysis */
    uint64 t PrevTime[MAXNB][MaxNChannels];
    uint64 t ExtendedTT[MAXNB][MaxNChannels];
    uint32 t  *EHistoShort[MAXNB][MaxNChannels];    // Energy Histograms for short gate
                            charge integration
    uint32_t *EHistoLong[MAXNB][MaxNChannels];     // Energy Histograms for long gate charge
                            integration
    float *EHistoRatio[MAXNB][MaxNChannels];        // Energy Histograms for ratio Long/Short
    int ECnt[MAXNB][MaxNChannels];                  // Number-of-Entries Counter for Energy
                            Histograms short and long gate
    int TrgCnt[MAXNB][MaxNChannels];

    /* The following variable will be used to get an handler for the digitizer. The
    handler will be used for most of CAENDigitizer functions to identify the board */
    int handle[MAXNB];

    /* Other variables */
    int i, b, ch, ev;
    int Quit=0;
    int AcqRun = 0;
    uint32_t AllocatedSize, BufferSize;
    int Nb=0;
    int DoSaveWave[MAXNB][MaxNChannels];
    int MajorNumber;
    int BitMask = 0;
    uint64 t CurrentTime, PrevRateTime, ElapsedTime;
    uint32_t NumEvents[MaxNChannels];
    CAEN_DGTZ_BoardInfo_t          BoardInfo;

    memset(DoSaveWave, 0, MAXNB*MaxNChannels*sizeof(int));
    for (i=0; i<MAXNBITS; i++)
        BitMask |= 1<<i; /* Create a bit mask based on number of bits of the board */

    /* ************************************************************************** */
    /* Set Parameters                                                           */
    /* ************************************************************************** */
    memset(&Params, 0, MAXNB*sizeof(DigitizerParams t));
    memset(&DPPParams, 0, MAXNB*sizeof(CAEN_DGTZ_DPP_PSD_Params_t));
    for(b=0; b<MAXNB; b++) {
        for(ch=0; ch<MaxNChannels; ch++) {
            EHistoShort[b][ch] = NULL; // Set all histograms pointers to NULL (we will
                            allocate them later)
            EHistoLong[b][ch] = NULL;
            EHistoRatio[b][ch] = NULL;
        }

        /***************************\
        * Communication Parameters   *
        \***************************/
        // Direct USB connection
        //Params[b].LinkType = CAEN_DGTZ_USB;  // Link Type
        //Params[b].VMEBaseAddress = 0;  // For direct USB connection, VMEBaseAddress must
                            be 0

        // Direct optical connection
```

```
        Params[b].LinkType = CAEN_DGTZ_PCI_OpticalLink;  // Link Type
        Params[b].VMEBaseAddress = 0;  // For direct CONET connection, VMEBaseAddress must
                            be 0

        // Optical connection to A2818 (or A3818) and access to the board with VME bus
        //Params[b].LinkType    =    CAEN_DGTZ_PCI_OpticalLink;        //    Link    Type
                            (CAEN DGTZ PCIE OpticalLink for A3818)
        //Params[b].VMEBaseAddress = 0x32100000;  // VME Base Address (only for VME bus
                            access; must be 0 for direct connection (CONET or USB)

        // USB connection to V1718 bridge and access to the board with VME bus
        //Params[b].LinkType = CAEN_DGTZ_USB;  // Link Type (CAEN_DGTZ_PCIE_OpticalLink for
                            A3818)
        //Params[b].VMEBaseAddress = 0x32110000;  // VME Base Address (only for VME bus
                            access; must be 0 for direct connection (CONET or USB)

        Params[b].IOlev = CAEN_DGTZ_IOLevel_TTL;
        /***************************\
        *  Acquisition parameters     *
        \***************************/
        Params[b].AcqMode   =   CAEN DGTZ DPP ACQ MODE Mixed;                           //
                            CAEN_DGTZ_DPP_ACQ_MODE_List                                or
                            CAEN_DGTZ_DPP_ACQ_MODE_Oscilloscope
        Params[b].RecordLength = 12;                          // Num of samples of the
                            waveforms (only for Oscilloscope mode)
        Params[b].ChannelMask = 0xF;                          // Channel enable mask
        Params[b].EventAggr = 17554;                          // number of events
                            in one aggregate (0=automatic)
        Params[b].PulsePolarity = CAEN_DGTZ_PulsePolarityNegative; // Pulse Polarity (this
                            parameter can be individual)

        /***************************\
        *      DPP parameters        *
        \***************************/
        for(ch=0; ch<MaxNChannels; ch++) {
            DPPParams[b].thr[ch] = 50;          // Trigger Threshold
            /* The following parameter is used to specifiy the number of samples for the
                            baseline averaging:
            0 -> absolute Bl
            1 -> 4samp
            2 -> 8samp
            3 -> 16samp
            4 -> 32samp
            5 -> 64samp
            6 -> 128samp */
            DPPParams[b].nsbl[ch] = 2;
            DPPParams[b].lgate[ch] = 32;    // Long Gate Width (N*4ns)
            DPPParams[b].sgate[ch] = 24;    // Short Gate Width (N*4ns)
            DPPParams[b].pgate[ch] = 8;     // Pre Gate Width (N*4ns)
            /* Self Trigger Mode:
            0 -> Disabled
            1 -> Enabled */
            DPPParams[b].selft[ch] = 1;
            // Trigger configuration:
            // CAEN_DGTZ_DPP_TriggerConfig_Peak      -> trigger on peak. NOTE: Only for FW
                            <= 13X.5
            // CAEN DGTZ DPP TriggerConfig Threshold  -> trigger on threshold */
            DPPParams[b].trgc[ch] = CAEN DGTZ DPP TriggerConfig Threshold;
            /* Trigger Validation Acquisition Window */
            DPPParams[b].tvaw[ch] = 50;
            /* Charge sensibility: 0->40fc/LSB; 1->160fc/LSB; 2->640fc/LSB; 3->2,5pc/LSB */
            DPPParams[b].csens[ch] = 0;
        }
        /* Pile-Up rejection Mode
        CAEN DGTZ DPP PSD PUR DetectOnly -> Only Detect Pile-Up
        CAEN DGTZ DPP PSD PUR Enabled -> Reject Pile-Up */
        DPPParams[b].purh = CAEN_DGTZ_DPP_PSD_PUR_DetectOnly;
        DPPParams[b].purgap = 100;  // Purity Gap
        DPPParams[b].blthr = 3;     // Baseline Threshold
        DPPParams[b].bltmo = 100;   // Baseline Timeout
        DPPParams[b].trgho = 8;     // Trigger HoldOff
    }

    /* ******************************************************************************** */
    /* Open the digitizer and read board information                                    */
    /* ******************************************************************************** */
    /* The following function is used to open the digitizer with the given connection
                            parameters
```

```
                  and get the handler to it */
                  for(b=0; b<MAXNB; b++) {
                      /* IMPORTANT: The following function identifies the different boards with a system
                                          which may change
                      for different connection methods (USB, Conet, ecc). Refer to CAENDigitizer user
                                          manual for more info.
                      Some examples below */

                      /* The following is for b boards connected via b USB direct links
                      in   this   case   you   must   set   Params[b].LinkType   =   CAEN DGTZ USB  and
                                          Params[b].VMEBaseAddress = 0 */
                      //ret = CAEN_DGTZ_OpenDigitizer(Params[b].LinkType, b, 0, Params[b].VMEBaseAddress,
                                          &handle[b]);

                      /* The following is for b boards connected via 1 opticalLink in dasy chain
                      in  this  case  you  must  set  Params[b].LinkType  =  CAEN DGTZ PCI OpticalLink  and
                                          Params[b].VMEBaseAddress = 0 */
                      ret = CAEN_DGTZ_OpenDigitizer(Params[b].LinkType, 0, b, Params[b].VMEBaseAddress,
                                          &handle[b]);

                      /* The following is for b boards connected to A2818 (or A3818) via opticalLink (or
                                          USB with A1718)
                      in this case the boards are accessed throught VME bus, and you must specify the VME
                                          address of each board:
                      Params[b].LinkType   =   CAEN DGTZ PCI OpticalLink  (CAEN DGTZ PCIE OpticalLink  for
                                          A3818 or CAEN DGTZ USB for A1718)
                      Params[0].VMEBaseAddress = <0xXXXXXXXX> (address of first board)
                      Params[1].VMEBaseAddress = <0xYYYYYYYY> (address of second board)
                      etc */
                      //ret = CAEN DGTZ OpenDigitizer(Params[b].LinkType, 0, 0, Params[b].VMEBaseAddress,
                                          &handle[b]);
                      if (ret) {
                          printf("Can't open digitizer\n");
                          goto QuitProgram;
                      }

                      /* Once we have the handler to the digitizer, we use it to call the other functions
                                          */
                      ret = CAEN_DGTZ_GetInfo(handle[b], &BoardInfo);
                      if (ret) {
                          printf("Can't read board info\n");
                          goto QuitProgram;
                      }
                      printf("\nConnected  to  CAEN  Digitizer  Model  %s,  recognized  as  board  %d\n",
                                          BoardInfo.ModelName, b);
                      printf("ROC FPGA Release is %s\n", BoardInfo.ROC_FirmwareRel);
                      printf("AMC FPGA Release is %s\n", BoardInfo.AMC_FirmwareRel);

                      // Check firmware revision (only DPP firmware can be used with this Demo) */
                      sscanf(BoardInfo.AMC_FirmwareRel, "%d", &MajorNumber);
                      if (MajorNumber != 131 && MajorNumber != 132 ) {
                          printf("This digitizer has not a DPP-PSD firmware\n");
                          goto QuitProgram;
                      }
                  }

                  /* ******************************************************************************** */
                  /* Program the digitizer (see function ProgramDigitizer)                          */
                  /* ******************************************************************************** */
                  for(b=0; b<MAXNB; b++) {
                      ret = ProgramDigitizer(handle[b], Params[b], DPPParams[b]);
                      if (ret) {
                          printf("Failed to program the digitizer\n");
                          goto QuitProgram;
                      }
                  }

                  /* WARNING: The mallocs MUST be done after the digitizer programming,
                  because the following functions needs to know the digitizer configuration
                  to allocate the right memory amount */
                  /* Allocate memory for the readout buffer */
                  ret = CAEN_DGTZ_MallocReadoutBuffer(handle[0], &buffer, &AllocatedSize);
                  /* Allocate memory for the events */
                  ret |= CAEN_DGTZ_MallocDPPEvents(handle[0], Events, &AllocatedSize);
                  /* Allocate memory for the waveforms */
                  ret |= CAEN DGTZ MallocDPPWaveforms(handle[0], &Waveform, &AllocatedSize);
                  if (ret) {
                      printf("Can't allocate memory buffers\n");
```

```
            goto QuitProgram;
    }


    /* ************************************************************************** */
    /* Readout Loop                                                            */
    /* ************************************************************************** */
    // Clear Histograms and counters
    for(b=0; b<MAXNB; b++) {
        for(ch=0; ch<MaxNChannels; ch++) {
            // Allocate Memory for Histos and set them to 0
            EHistoShort[b][ch] = (uint32_t *)malloc( (1<<MAXNBITS)*sizeof(uint32_t) );
            memset(EHistoShort[b][ch], 0, (1<<MAXNBITS)*sizeof(uint32 t));
            EHistoLong[b][ch] = (uint32 t *)malloc( (1<<MAXNBITS)*sizeof(uint32 t) );
            memset(EHistoLong[b][ch], 0, (1<<MAXNBITS)*sizeof(uint32 t));
            EHistoRatio[b][ch] = (float *)malloc( (1<<MAXNBITS)*sizeof(float) );
            memset(EHistoRatio[b][ch], 0, (1<<MAXNBITS)*sizeof(float));
            TrgCnt[b][ch] = 0;
            ECnt[b][ch] = 0;
            PrevTime[b][ch] = 0;
            ExtendedTT[b][ch] = 0;
        }
    }
    PrevRateTime = get time();
    AcqRun = 0;
    PrintInterface();
    printf("Type a command: ");
    while(!Quit) {

        // Check keyboard
        if(kbhit()) {
            char c;
            c = getch();
            if (c=='q')  Quit = 1;
            if (c=='t')
                for(b=0; b<MAXNB; b++)
                    CAEN DGTZ SendSWtrigger(handle[b]); /* Send a software trigger to each
                             board */
            if (c=='h')
                for(b=0; b<MAXNB; b++)
                    for(ch=0; ch<MaxNChannels; ch++)
                        if( ECnt[b][ch] != 0) {
                            /* Save Histograms to file for each board and channel */
                            SaveHistogram("HistoShort", b, ch, EHistoShort[b][ch]);
                            SaveHistogram("HistoLong", b, ch, EHistoLong[b][ch]);
                        }
            if (c=='w')
                for(b=0; b<MAXNB; b++)
                    for(ch=0; ch<MaxNChannels; ch++)
                        DoSaveWave[b][ch] = 1; /* save waveforms to file for each channel
                                 for each board (at next trigger) */
            if (c=='r')  {
                for(b=0; b<MAXNB; b++) {
                    CAEN DGTZ SWStopAcquisition(handle[b]);
                    printf("Restarted\n");
                    CAEN_DGTZ_ClearData(handle[b]);
                    CAEN DGTZ SWStartAcquisition(handle[b]);
                }
            }
            if (c=='s')  {
                for(b=0; b<MAXNB; b++) {
                    // Start Acquisition
                    // NB: the acquisition for each board starts when the following line is
                    //         executed
                    // so in general the acquisition does NOT starts syncronously for
                    //         different boards
                    CAEN_DGTZ_SWStartAcquisition(handle[b]);
                    printf("Acquisition Started for Board %d\n", b);
                }
                AcqRun = 1;
            }
            if (c=='S')  {
                for(b=0; b<MAXNB; b++) {
                    // Stop Acquisition
                    CAEN DGTZ SWStopAcquisition(handle[b]);
                    printf("Acquisition Stopped for Board %d\n", b);
                }
                AcqRun = 0;
```

```
        }
    }
    if (!AcqRun) {
        Sleep(10);
        continue;
    }

    /* Calculate throughput and trigger rate (every second) */
    CurrentTime = get time();
    ElapsedTime = CurrentTime - PrevRateTime; /* milliseconds */
    if (ElapsedTime > 1000) {
        system(CLEARSCR);
        PrintInterface();
        printf("Readout Rate=%.2f MB\n", (float)Nb/((float)ElapsedTime*1048.576f));
        for(b=0; b<MAXNB; b++) {
            printf("\nBoard %d:\n",b);
            for(i=0; i<MaxNChannels; i++) {
                if (TrgCnt[b][i]>0)
                    printf("\tCh %d:\tTrgRate=%.2f KHz\t%\n", b*8+i,
                                                (float)TrgCnt[b][i]/(float)ElapsedTime);
                else
                    printf("\tCh %d:\tNo Data\n", i);
                TrgCnt[b][i]=0;
            }
        }
        Nb = 0;
        PrevRateTime = CurrentTime;
        printf("\n\n");
    }

    /* Read data from the boards */
    for(b=0; b<MAXNB; b++) {
        /* Read data from the board */
        ret  =  CAEN_DGTZ_ReadData(handle[b],  CAEN_DGTZ_SLAVE_TERMINATED_READOUT_MBLT,
                        buffer, &BufferSize);
        if (ret) {
            printf("Readout Error\n");
            goto QuitProgram;
        }
        if (BufferSize == 0)
            continue;

        Nb += BufferSize;
        //ret = DataConsistencyCheck((uint32_t *)buffer, BufferSize/4);
        ret  |=  CAEN_DGTZ_GetDPPEvents(handle[b],  buffer,  BufferSize,  Events,
                        NumEvents);
        if (ret) {
            printf("Data Error: %d\n", ret);
            goto QuitProgram;
        }

        /* Analyze data */
        for(ch=0; ch<MaxNChannels; ch++) {
            if (!(Params[b].ChannelMask & (1<<ch)))
                continue;

            /* Update Histograms */
            for(ev=0; ev<NumEvents[ch]; ev++) {
                TrgCnt[b][ch]++;
                /* Time Tag */
                if (Events[ch][ev].TimeTag < PrevTime[b][ch])
                    ExtendedTT[b][ch]++;
                PrevTime[b][ch] = Events[ch][ev].TimeTag;
                /* Energy */
                if ( (Events[ch][ev].ChargeLong > 0) && (Events[ch][ev].ChargeShort >
                        0)) {
                    // Fill the histograms
                    EHistoShort[b][ch][(Events[ch][ev].ChargeShort) & BitMask]++;
                    EHistoLong[b][ch][(Events[ch][ev].ChargeLong) & BitMask]++;
                    ECnt[b][ch]++;
                }

                /* Get Waveforms (only from 1st event in the buffer) */
                if   ((Params[b].AcqMode   !=   CAEN_DGTZ_DPP_ACQ_MODE_List)   &&
                        DoSaveWave[b][ch] && (ev == 0)) {
                    int size;
                    int16_t *WaveLine;
                    uint8_t *DigitalWaveLine;
```

```
                    CAEN_DGTZ_DecodeDPPWaveforms(handle[b], &Events[ch][ev], Waveform);

                    // Use waveform data here...
                    size = (int)(Waveform->Ns); // Number of samples
                    WaveLine = Waveform->Trace1; // First trace (for DPP-PSD it is
                            ALWAYS the Input Signal)
                    SaveWaveform(b, ch, 1, size, WaveLine);

                    WaveLine = Waveform->Trace2; // Second Trace (if single trace mode,
                            it is a sequence of zeroes)
                    SaveWaveform(b, ch, 2, size, WaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine = Waveform->DTrace1; // First Digital Trace (Gate
                            Short)
                    SaveDigitalProbe(b, ch, 1, size, DigitalWaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine = Waveform->DTrace2; // Second Digital Trace (Gate
                            Long)
                    SaveDigitalProbe(b, ch, 2, size, DigitalWaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine  =  Waveform->DTrace3;  //  Third  Digital  Trace
                            (DIGITALPROBE1 set with CAEN DGTZ SetDPP PSD VirtualProbe)
                    SaveDigitalProbe(b, ch, 3, size, DigitalWaveLine);
                    DoSaveWave[b][ch] = 0;

                    DigitalWaveLine  =  Waveform->DTrace4;  //  Fourth  Digital  Trace
                            (DIGITALPROBE2 set with CAEN DGTZ SetDPP PSD VirtualProbe)
                    SaveDigitalProbe(b, ch, 4, size, DigitalWaveLine);
                    DoSaveWave[b][ch] = 0;
                    printf("Waveforms                    saved                    to
                            'Waveform_<board>_<channel>_<trace>.txt'\n");
                } // loop to save waves
            } // loop on events
        } // loop on channels
    } // loop on boards
} // End of readout loop


QuitProgram:
    /* stop the acquisition, close the device and free the buffers */
    for(b=0; b<MAXNB; b++) {
        CAEN_DGTZ_SWStopAcquisition(handle[b]);
        CAEN_DGTZ_CloseDigitizer(handle[b]);
        for (ch=0; ch<MaxNChannels; ch++) {
            free(EHistoShort[b][ch]);
            free(EHistoLong[b][ch]);
            free(EHistoRatio[b][ch]);
        }
    }
    CAEN DGTZ FreeReadoutBuffer(&buffer);
    CAEN DGTZ FreeDPPEvents(handle[0], Events);
    CAEN_DGTZ_FreeDPPWaveforms(handle[0], Waveform);
    return ret;
}
```
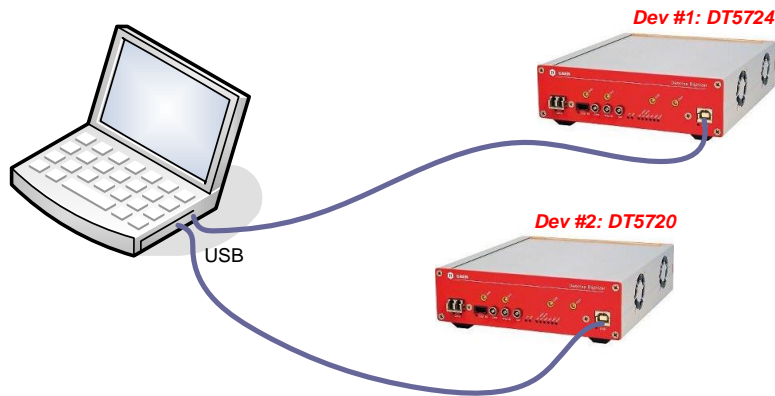
6 ZLE x751 specific functions

Under development.

7 Examples of communication settings

Example No.1

Fig. 7.1: Connection example no.1.

The host PC is connected via 2 USB ports to two desktop digitizer:

- Dev#1: DT5724 - 4 Channel 14 bit 100 MS/s Digitizer

- Dev#2: DT5720 - 4 Channel 12 bit 250 MS/s Digitizer

The computer is first connected to DT5724 then to the DT5720.

Open Dev#1: DT5724 connected via USB cable
```
CAEN_DGTZ_OpenDigitizer (
                    CAEN_DGTZ_USB,    LinkType: physical communication channel = USB
                    0,                LinkNum: Link number = 0 first device
                    0,                ConetNode: if USB = 0
                    0,                VMEBaseAddress: must be= 0
                    &handleDT5724_1   Pointer to the handler returned by function
);
```
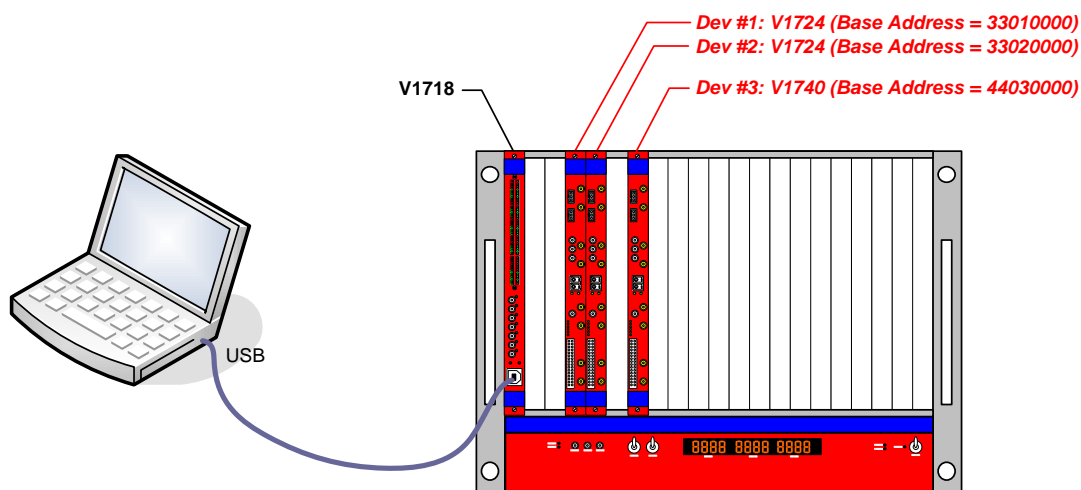
Open Dev#2: DT5720 connected via USB cable
```
CAEN_DGTZ_OpenDigitizer (
                    CAEN_DGTZ_USB,    LinkType: physical communication channel = USB
                    1,                LinkNum: Link number = 1 second device
                    0,                ConetNode: if USB = 0
                    0,                VMEBaseAddress: must be = 0
                    &handleDT5720_2   Pointer to the handler returned by function
);
```

Arguments description

Name	Description
LinkType	= CAEN_DGTZ_USB. Indicates USB as the physical communication channel.
LinkNum	Link number: in case of USB, the link numbers are assigned by the PC when you connect the cable to the device; it is 0 for the first device (DT5724), 1 for the second (DT5720) There is not a fixed correspondence between the USB port and the link number.
ConetNode	In case of USB, ConetNode must be 0.
VMEBaseAddress	Not used = 0 (used only for model accessed via VME).

Example No.2

Fig. 7.2: Connection example no.2.

The host PC is connected via USB ports to one V1718 VME-USB2.0 Bridge housed in a VME crate. The crate contains also the following boards

- Dev#1: V1724 - 8 Channel 14 bit 100 MS/s Digitizer (Base address = 0x33010000)

- Dev#2: V1724 - 8 Channel 14 bit 100 MS/s Digitizer (Base address = 0x33020000)

- Dev#3: V1740 - 64 Channel 12 bit 62.5 MS/s Digitizer (Base address = 0x44030000)

Open Dev#1: V1724 (VME base address 0x33010000) accessed via VMEbus through the V1718:

```
CAEN_DGTZ_OpenDigitizer (
                    CAEN_DGTZ_USB,      LinkType: physical communication channel = USB
                    0,                  LinkNum: Link number = 0 first device
                    0,                  ConetNode: if USB = 0
                    0x33010000,         VMEBaseAddress
                    &handleV1724 1      Pointer to the handler returned by function
);
```

Open Dev#12: V1724 (VME base address 0x33020000) accessed via VMEbus through the V1718:

```
CAEN DGTZ OpenDigitizer (
                    CAEN_DGTZ_USB,      LinkType: physical communication channel = USB
                    0,                  LinkNum: Link number = 0 first device
                    0,                  ConetNode: if USB = 0
                    0x33020000,         VMEBaseAddress
                    &handleV1724_2      Pointer to the handler returned by function
);
```

Open Dev#3: V1740 (VME base address 0x44030000) accessed via VMEbus through the V1718:

```
CAEN_DGTZ_OpenDigitizer (
                    CAEN DGTZ USB,      LinkType: physical communication channel = USB
                    0,                  LinkNum: Link number = 0 first device
                    0,                  ConetNode: if USB = 0
                    0x44030000,         VMEBaseAddress
                    &handleV1740_3      Pointer to the handler returned by function
);
```

Arguments description

| Name	Description
LinkType	= CAEN_DGTZ_USB. Indicates USB as the physical communication channel .
LinkNum	Link number: in case of USB, the link numbers are assigned by the PC when you connect the cable to the device; it is 0 for the first device, 1 for the second There is not a fixed correspondence between the USB port and the link number.
ConetNode	In case of USB, ConetNode must be 0.
VMEBaseAddress	VME Base Address of the board (rotary switches setting) expressed as a 32 bit number. This argument is used only for the VME models accessed through the VME bus and MUST BE 0 in all other cases.

Example No.3
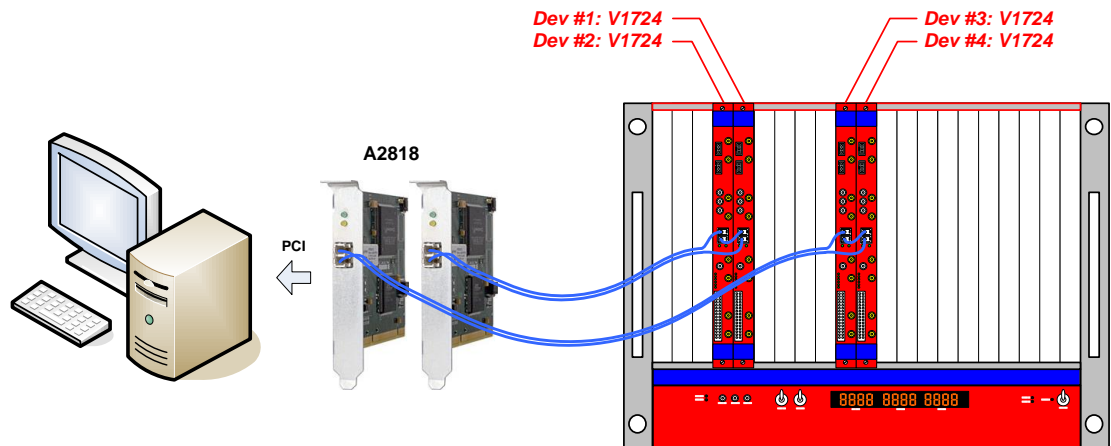
Fig. 7.3: Connection example no.3.

The host PC houses two CAEN A2818 PCI CONET Controllers; the VME crate houses the following boards:

- Two V1724 Digitizer connected in a Daisy chain between them end to the A2818 #0: Dev#1 (first in Daisy chain) and Dev#2 (second in Daisy chain)

- Two V1724 Digitizer connected in a Daisy chain between them end to the A2818 #1: Dev#3 (first in Daisy chain) and Dev#4 (second in Daisy chain)

✎ **Note:** ▢ The A2818 number refers to the PCI slot and depends on the motherboard of the PC used. **It is not known a priori which PCI card is assigned to which number.** In this example we assume that the A2818 connected to Dev#1 and Dev#2, is inserted into the first PCI slot and get Link Number = 0.

Open Dev#1: V1724 first device in Daisy chain of A2818#0:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCI_OpticalLink,    LinkType: physical communication channel = Optical Link via A2818 (PCI Controller)
        0,                            LinkNum: Link number = 0 first device
        0,                            ConetNode: first device in the chain  =0
        0,                            VMEBaseAddress: must be = 0
        &handleV1724_1                Pointer to the handler returned by function
);
```

Open Dev#2: V1724 second device in Daisy chain of A2818#0:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCI_OpticalLink,    LinkType: physical communication channel = Optical Link via A2818 (PCI Controller)
        0,                            LinkNum: Link number = 0 first device
        1,                            ConetNode: second device in the chain = 1
        0,                            VMEBaseAddress: must be = 0
        &handleV1724 2                Pointer to the handler returned by function
);
```

Open Dev#3: V1724 first device in Daisy chain of A2818#1:

```
CAEN DGTZ OpenDigitizer (
        CAEN_DGTZ_PCI_OpticalLink,    LinkType: physical communication channel = Optical Link via A2818 (PCI Controller)
        1,                            LinkNum: Link number = 1 second  device
        0,                            ConetNode: first device in the chain =0
        0,                            VMEBaseAddress: must be = 0
        &handleV1724_3                Pointer to the handler returned by function
);
```

Open Dev#4: V1724 second device in Daisy chain of A2818#1:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN DGTZ PCI OpticalLink,    LinkType: physical communication channel = Optical Link via A2818 (PCI Controller)
        1,                            LinkNum: Link number = 1 second  device
        1,                            ConetNode: second device in the chain = 1
        0,                            VMEBaseAddress: must be = 0
        &handleV1724_4                Pointer to the handler returned by function
);
```

CAEN ⬡ Electronic Instrumentation

Arguments description

Name	Description
`LinkType`	= CAEN_DGTZ_PCI_OpticalLink. Indicates A2818 -> Optical Link, either direct connection or VME through V2718 as the physical communication channel .
`LinkNum`	Link number: For the CONET, the link number indicates which link of A2818 or A3818 is used. For A2818 refers to the PCI slot and depends on the motherboard of the PC used. Link index start from 0 (1st link in the 1st slot used). It is not known a priori which is the first slot used.
`ConetNode`	The CONET node identifies which device in the Daisy chain is being addressed. The node is 0 for the first device in the chain, 1 for the second and so on. See Fig. 7.4.
`VMEBaseAddress`	Not used = 0 (used only for model accessed via VME).
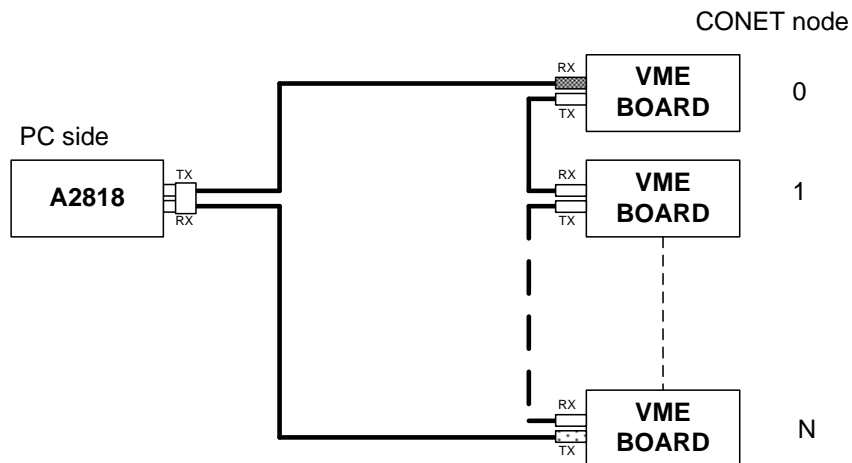
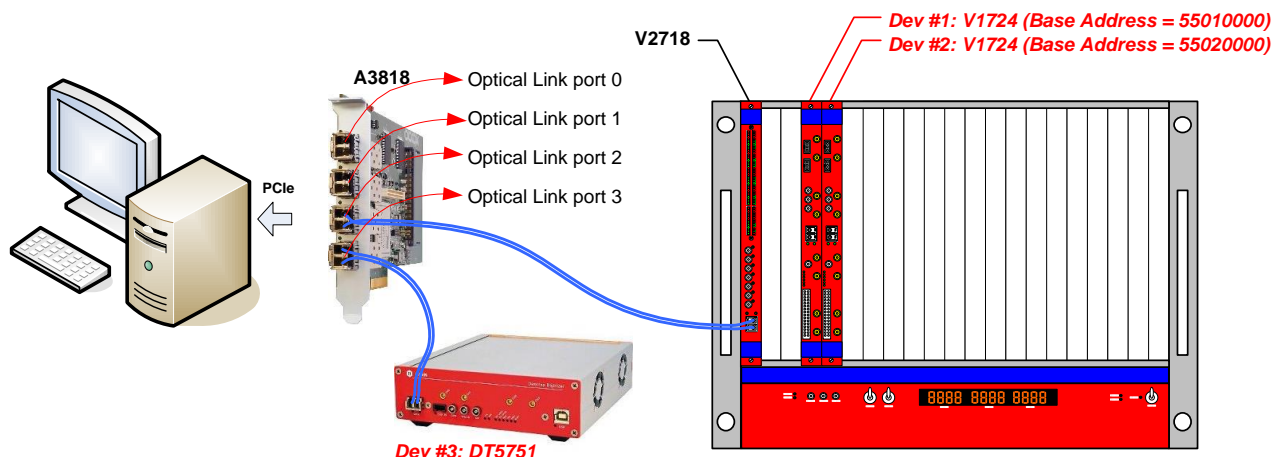Fig. 7.4: A2818 network scheme.

Example No.4

Fig. 7.5: Connection example no.4

The host PC houses one CAEN A3818C PCIe CONET Controller with 4 Optical Link;

- port#3 is connected to Dev#3 (DT5751 - 2/4 Channel 10 bit 2/1 GS/s Digitizer)

- port#2 is connected to a V2718 VME-PCI Optical Link Bridge housed in a VME crate that contains the following boards:

    o Dev#1: V1724 - 8 Channel 14 bit 100 MS/s Digitizer (Base address = 0x55010000)

    o Dev#2: V1724 - 8 Channel 14 bit 100 MS/s Digitizer (Base address = 0x55020000)

Open Dev#1: V1724 (VME base address 0x55010000) accessed via VMEbus through the V2718 connected to A3818 port#2:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCIE_OpticalLink,   LinkType: physical communication channel = Optical Link via A3818 (PCIe Controller)
        2,                            LinkNum: unique device, Link number =A3818 port number: 2
        0,                            ConetNode: unique device in the chain =0
        0x55010000,                   VMEBaseAddress
        &handleV1724_1                Pointer to the handler returned by function
);
```

Open Dev#2: V1724 (VME base address 0x55020000) accessed via VMEbus through the V2718 connected to A3818 port#2:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCIE_OpticalLink,   LinkType: physical communication channel = Optical Link via A3818 (PCIe Controller)
        2,                            LinkNum: unique device, Link number =A3818 port number: 2
        0,                            ConetNode: unique device in the chain =0
        0x55020000,                   VMEBaseAddress
        &handleV1724_2                Pointer to the handler returned by function
);
```

Open Dev#3: DT5751 first device in Daisy chain of A3818 port#2

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCIE_OpticalLink,   LinkType: physical communication channel = Optical Link via A3818 (PCIe Controller)
        3,                            LinkNum: unique device, Link number =A3818 port number: 3
        0,                            ConetNode: unique device in the chain =0
        0,                            VMEBaseAddress: must be = 0
        &handleDT5751_3               Pointer to the handler returned by function
);
```

CAEN Electronic Instrumentation

Arguments description

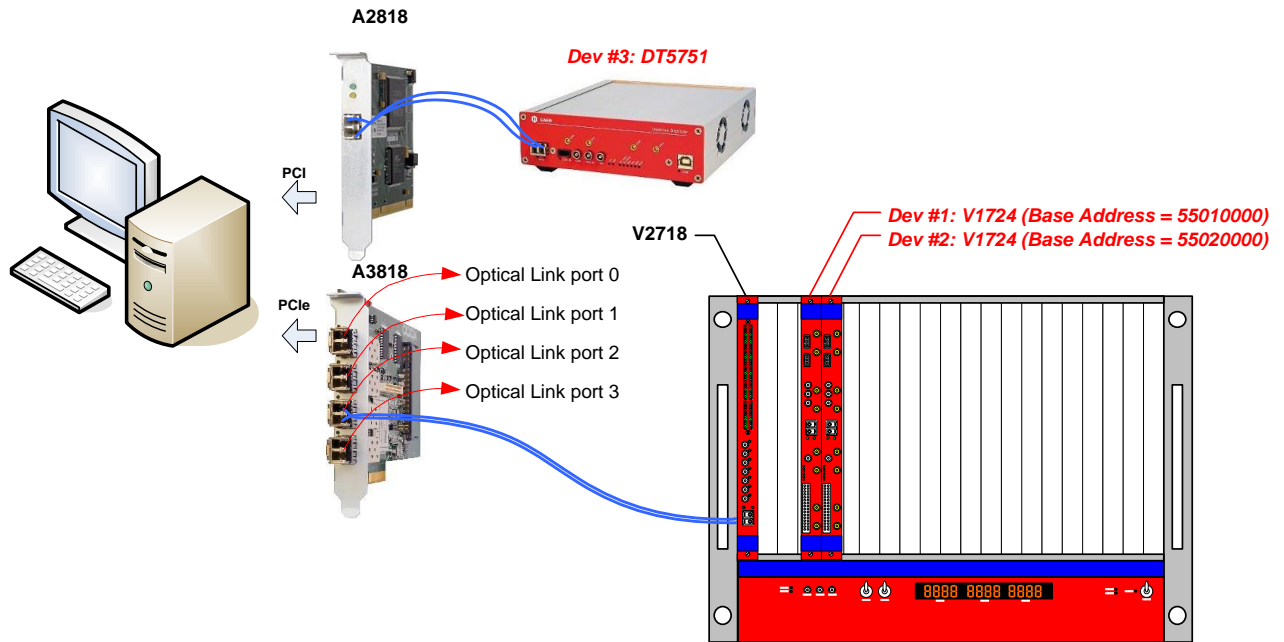| Name	Description
LinkType	= CAEN_DGTZ_PCIE_OpticalLink. Indicates A3818 -> Optical Link, either direct connection or VME through V2718 as the physical communication channel .
LinkNum	Link number: For the CONET, the link number indicates which link of A2818 or A3818 is used. For A3818 refers to the PCI slot and depends on the motherboard of the PC used. Link index start from 0 (1st Optical link port in the 1st slot used). It is not known a priori which is the first slot used. **Important note: if also A2818s are installed, these ones have lower index assigned**.
ConetNode	The CONET node identifies which device in the Daisy chain is being addressed. The node is 0 for the first device in the chain, 1 for the second and so on .
VMEBaseAddress	used only for model accessed via VME. Must be 0 in other cases

Example No.5

Fig. 7.6: Connection example no.5

The host PC houses

- one A2818 PCI CONET Controller connected to Dev#3 (DT5751 - 2/4 Channel 10 bit 2/1 GS/s Digitizer)

- one CAEN A3818C PCIe CONET Controller with 4 Optical Link; with port#2 connected to a V2718 VME-PCI Optical Link Bridge housed in a VME crate that contains the following boards:

  - Dev#1: V1724 - 8 Channel 14 bit 100 MS/s Digitizer (Base address = 0x55010000)

  - Dev#2: V1724 - 8 Channel 14 bit 100 MS/s Digitizer (Base address = 0x55020000)

Open Dev#1: V1724 (VME base address 0x55010000) accessed via VMEbus through the V2718 connected to A3818 port#2:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCIE_OpticalLink,   LinkType: physical communication channel = Optical Link via A3818 (PCIe Controller)
        3,                            LinkNum: 3 = A3818 port number+1 (to A2818 is assigned the first link =0)
        0,                            ConetNode: unique device in the chain  =0
        0x55010000,                   VMEBaseAddress
        &handleV1724_1                Pointer to the handler returned by function
);
```

Open Dev#2: V1724 (VME base address 0x55020000) accessed via VMEbus through the V2718 connected to A3818 port#2:

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCIE_OpticalLink,   LinkType: physical communication channel = Optical Link via A3818 (PCIe Controller)
        3,                            LinkNum: 3 = A3818 port number+1 (to A2818 is assigned the first link =0)
        0,                            ConetNode: unique device in the chain  =0
        0x55020000,                   VMEBaseAddress
        &handleV1724_1                Pointer to the handler returned by function
);
```

Open Dev#3: DT5751 first device in Daisy chain of A2818

```
CAEN_DGTZ_OpenDigitizer (
        CAEN_DGTZ_PCI_OpticalLink,    LinkType: physical communication channel = Optical Link via A2818 (PCI Controller)
        0,                            LinkNum: A2818 has lower index assigned = 0
        0,                            ConetNode: unique device in the chain  =0
        0,                            VMEBaseAddress: must be = 0
        &handleDT5751_3               Pointer to the handler returned by function
);
```

CAEN Electronic Instrumentation

Arguments description

Name	Description
`LinkType`	= CAEN_DGTZ_PCIE_OpticalLink. Indicates A3818 -> Optical Link, either direct connection or VME through V2718 as the physical communication channel . = CAEN_DGTZ_PCI_OpticalLink. Indicates A2818 -> Optical Link, either direct connection or VME through V2718 as the physical communication channel .
`LinkNum`	Link number: For the CONET, the link number indicates which link of A2818 or A3818 is used. For A3818/A2818 refers to the PCI slot and depends on the motherboard of the PC used. Link index start from 0 (1st Optical link port in the 1st slot used). It is not known a priori which is the first slot used. **Important note: if also A2818s are installed, these ones have lower index assigned**.
`ConetNode`	The CONET node identifies which device in the Daisy chain is being addressed. The node is 0 for the first device in the chain, 1 for the second and so on .
`VMEBaseAddress`	Used only for model accessed via VME. Must be 0 in other cases

CAEN SpA is acknowledged as the only company in the world providing a complete range of High/Low Voltage Power Supply systems and Front-End/Data Acquisition modules which meet IEEE Standards for Nuclear and Particle Physics. Extensive Research and Development capabilities have allowed CAEN SpA to play an important, long term role in this field. Our activities have always been at the forefront of technology, thanks to years of intensive collaborations with the most important Research Centres of the world. Our products appeal to a wide range of customers including engineers, scientists and technical professionals who all trust them to help achieve their goals faster and more effectively.

CAEN S.p.A.

Via Vetraia, 11

55049 Viareggio
Italy
Tel. +39.0584.388.398
Fax +39.0584.388.959
info@caen.it
www.caen.it

CAEN GmbH

Klingenstraße 108

D-42651 Solingen
Germany
Tel. +49 (0)212 254 4077
Mobile +49 (0)151 16 548 484
Fax +49 (0)212 25 44079
info@caen-de.com
www.caen-de.com
CAEN GmbH

CAEN Technologies, Inc.

1140 Bay Street - Suite 2 C

Staten Island, NY 10305
USA
Tel. +1.718.981.0401
Fax +1.718.556.9185
info@caentechnologies.com
www.caentechnologies.com

CAEN Tools for Discovery **Electronic Instrumentation**