Rev. 2 - June 12th, 2024

CAEN FELib Library User Guide

High level library for CAEN Digitizers 2.0

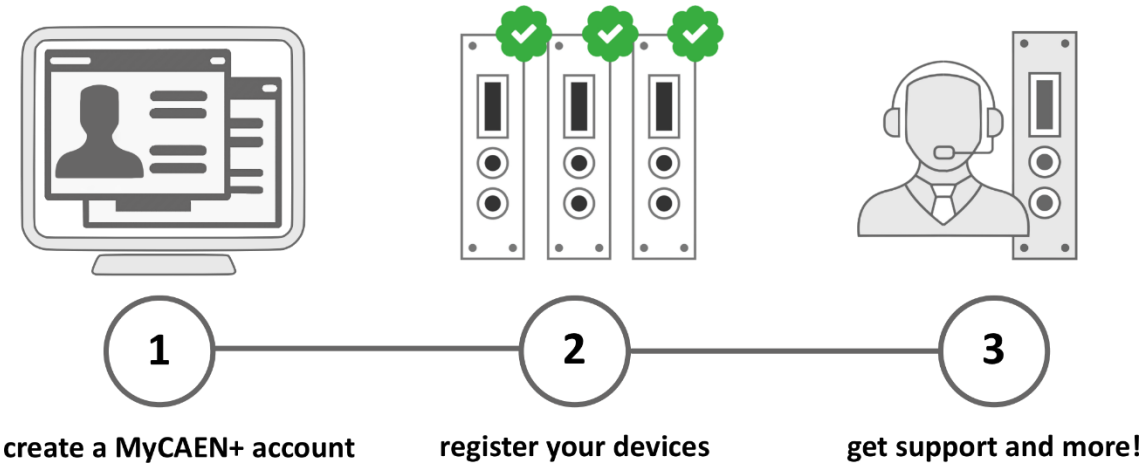
CAEN
Tools for Discovery

User Guide
GD9764

Register your device

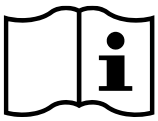
Register your device to your **MyCAEN+** account and get access to our customer services, such as notification for new firmware or software upgrade, tracking service procedures or open a ticket for assistance. **MyCAEN+** accounts have a dedicated support service for their registered products. A set of basic information can be shared with the operator, speeding up the troubleshooting process and improving the efficiency of the support interactions.

MyCAEN+ dashboard is designed to offer you a direct access to all our after sales services. Registration is totally free, to create an account go to https://www.caen.it/become-mycaenplus-user and fill the registration form with your data.



https://www.caen.it/become-mycaenplus-user/

Purpose of this User Guide



This User Guide contains the full description of the new CAEN FELib SDK for CAEN Digitizers.

Change Document Record

Date	Revision	Changes
August 21st, 2023	00	Initial release
March 7th, 2024	01	Updated chapter **4.2**
June 10th, 2024	02	Added Labview package details.

Symbols, Abbreviated Terms and Notations

SDK	Software Development Kit
DAQ	Data Acquisition
FIFO	First In First Out
FPGA	Field Programmable Gate Array
OS	Operating system

Reference Document

[RD1] UM8717 - 2740-2745_Digitizers_User_Manual_rev8

All CAEN documents can be downloaded at:

https://www.caen.it/support-services/documentation-area/ (**login required**)

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Limitation of Responsibility

If the warnings contained in this manual are not followed, CAEN will not be responsible for damage caused by improper use of the device. The manufacturer declines all responsibility for damage resulting from failure to comply with the instructions for use of the product. The equipment must be used as described in the user manual, with particular regard to the intended use, using only accessories as specified by the manufacturer. No modification or repair can be performed.

Disclaimer

The information contained herein has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies. CAEN spa reserves the right to modify its products specifications without giving any notice; for up to date information please visit www.caen.it.

Made in Italy

We remark that all our boards have been designed and assembled in Italy. In a challenging environment where a competitive edge is often obtained at the cost of lower wages and declining working conditions, we proudly acknowledge that all those who participated in the production and distribution process of our devices were reasonably paid and worked in a safe environment (this is true for the boards marked "MADE IN ITALY", while we cannot guarantee for third-party manufactures).

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1 Introduction

The new CAEN FELib represents a significant advancement in accessing firmware parameters compared to the previous CAEN Digitizer Library. Previously, the approach involved directly exposing individual firmware registers. However, the new generation of digitizers introduces a more user-friendly abstraction of the registers in the form of library parameters.

This innovative approach aims to simplify the lives of users who are tasked with constructing their own DAQ (Data Acquisition) systems and software, as it provides a much easier-to-understand and user-friendly interface. By utilizing library parameters, users can effortlessly access the digitizer firmware parameters, streamlining the process of building their custom DAQ systems for both CAEN Digitizer 2.0 and CAEN Digitizer 1.0.

The new library is composed by two layers, as illustrated in **Figure 1.1**:

- The CAEN FELib which provides generic APIs
- The CAEN Dig2 or CAEN Dig1 which implements the parameters for the CAEN FELib APIs for the CAEN digitizers 2.0 and 1.0 respectively.

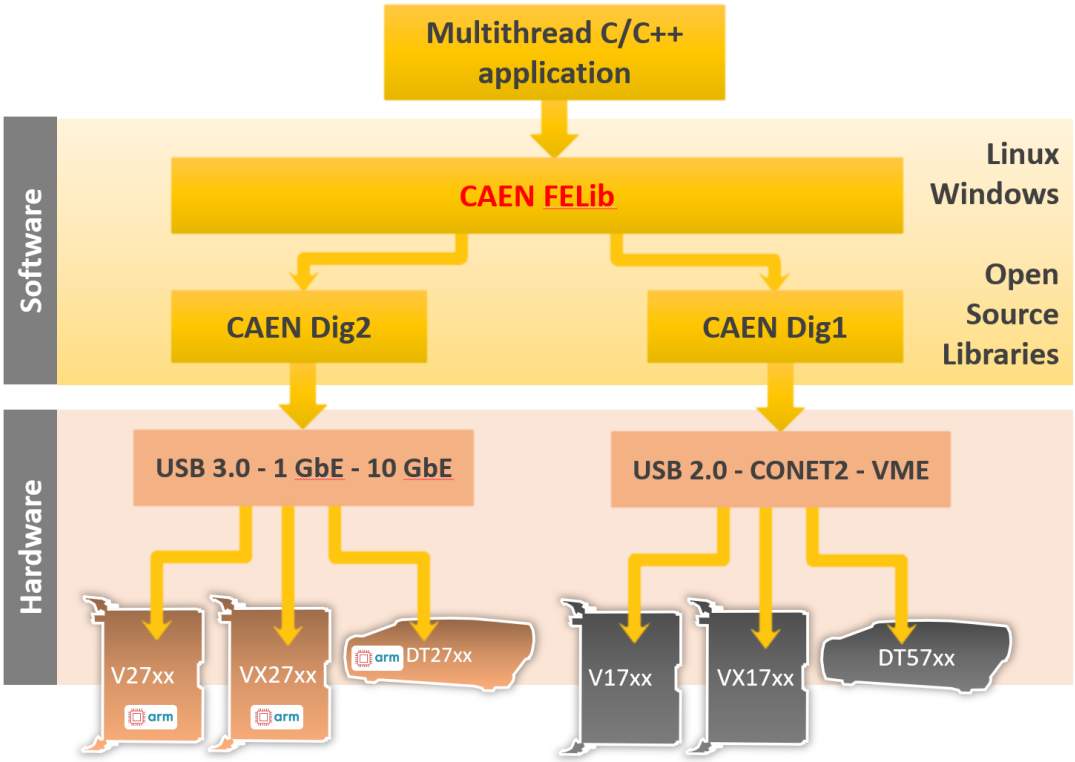


Figure 1.1: Block diagram of the new CAEN FELib

The library is available for C and C++ environments on our website. A Python wrapper is also available on the *pip* package manager.
All packages are compatible with Windows and Linux operating systems. Additionally, a binary distribution for the Digitizer OpenARM is available for the CAEN FELib and CAEN DIG2 libraries.

2 Technical Specifications

SUPPORTED OPERATING SYSTEMS:	Windows, Linux (source code provided), Arm
LANGUAGE:	C, Python
SUPPORTED PRODUCTS:	Digitizer 2.0 (2740 family, 2745 family, and 2730 family) Digitizer 1.0
LICENSE:	GNU Lesser General Public License 3

Table 2.1: Specifications table

3 CAEN FELib

To install the CAEN FELib library, follow the steps below:

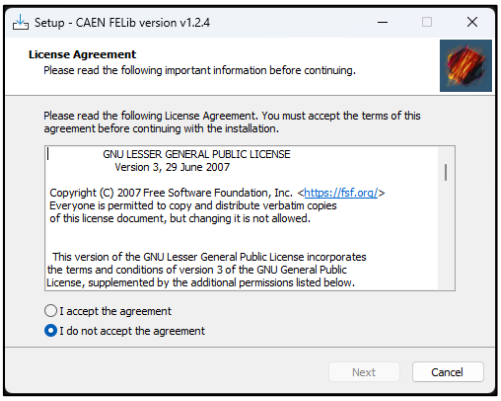
- Log in to the CAEN website (www.caen.it) and download the installation package for your OS from the CAEN FELib page
- Unpack the package on your host PC.

3.1 Installation

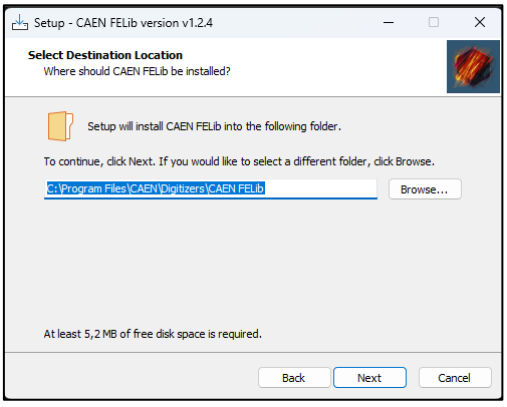
3.1.1 Windows

The Windows distribution can be installed via the CAEN FELib Installation Wizard:

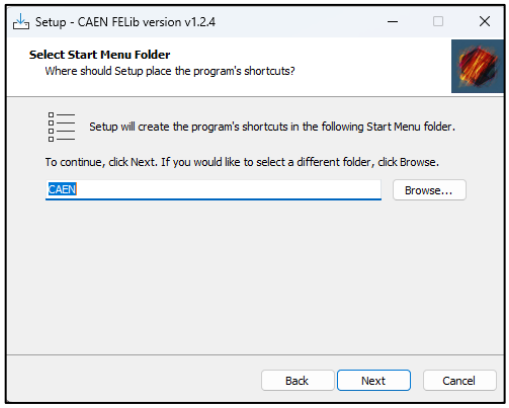
- Launch the executable downloaded from the CAEN website
- Accept the License Agreement



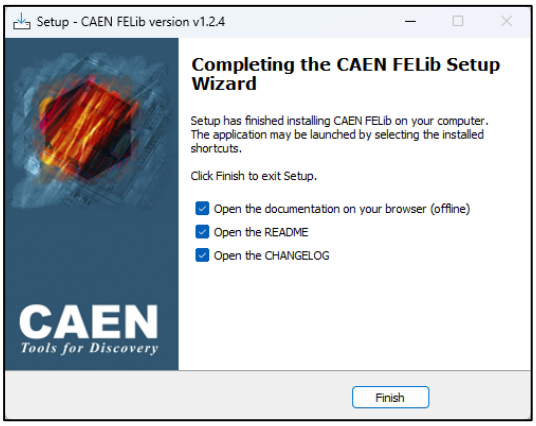
- Select the installation folder



- Select the Start Menu folder



- Press the *Install* button to start the installation
- Once the library is installed you can close the Setup Wizard



3.1.2 Linux

For Linux users, the following instructions are provided in the INSTALL file within the library package:

- Open the terminal and navigate to the library directory.
- Execute the command: *./configure --disable-assert*
- Execute the command: *make*
- Execute the command: *sudo make install*
- Execute the command: *sudo ldconfig*

The library will be installed in the */usr/local/lib folder*, while the header files will be installed in the */usr/local/include/* folder.

3.1.3 Digitizer OpenARM

The library can be installed on the Digitizer OpenARM embedded in the x27XX Digitizer by following the steps described in the INSTALL file within the library package:

- Copy the preferred archive from the bin/ directory of this package to your target system.
- Log in as root.
- Execute the command: *# tar -xvf caen_felib-{version}-bin-{platform}.tar.gz -C / --no-overwrite-dir*
- Execute the command: *# ldconfig*

The library will be installed in the */usr/local/lib* folder, while the header files will be installed in the */usr/local/include/* folder.

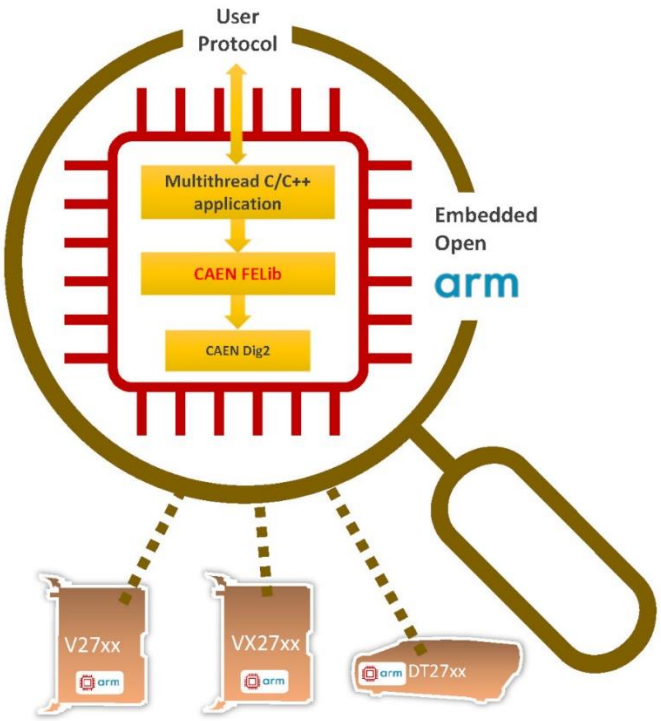


Figure 3.1: Digitizer OpenARM block diagram

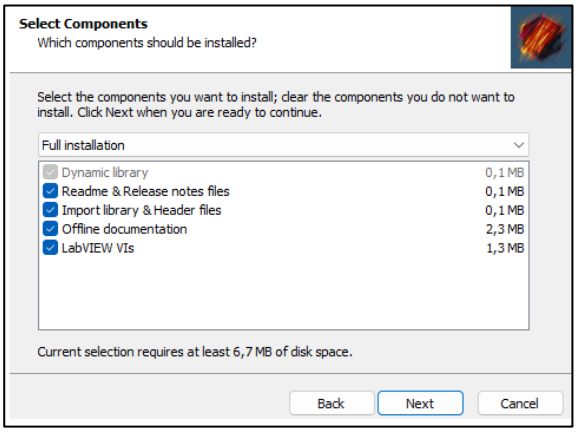
3.1.4 Python Package

The Python wrapper of the CAEN FELib library is available for installation on the pip package manager. To install it, you will need the latest version of CAEN FELib and an implementation, such as the CAEN Dig2 from the CAEN website.

Both Windows and Linux users can install the Python wrapper by executing the command *pip install caen-felib*.

3.1.5 LabVIEW Package

The LabVIEW wrapper of the CAEN FELib library is available for installation. To install it, launch the Windows installer and select the LabVIEW component.



More information about the Labview wrapper can be found in the documentation of the CAEN FELib.

3.2 Documentation

To access the comprehensive documentation of CAEN FELib, please follow the steps outlined below:

- Locate the installation folder of CAEN FELib on your system (*/usr/local/share/doc/caen_dig2* for Linux users). This folder contains the necessary files for the library's functioning.

- Within the installation folder, you will find a subfolder labelled *"doc"* This folder holds all the relevant documentation files for CAEN FELib.
- Open the *"doc"* folder, and you will discover an HTML documentation file that serves as a user manual for the library.
- Click on the *index.html* documentation file to access its contents.

The documentation provided within the HTML file covers various aspects of CAEN FELib and offers valuable guidance for its utilization. It consists of the following sections:

- **Introduction:** This section provides a concise overview of CAEN FELib, introducing its purpose and capabilities.
- **Installation:** The installation chapter elaborates on the necessary steps to set up CAEN FELib correctly on your system.
- **Library Entities**: Here, you will find a detailed description of all the entities and components incorporated within the CAEN FELib.
- **Software Development:** The "*Software Development*" chapter offers comprehensive guidance on implementing software using CAEN FELib. It provides insights into building software applications from scratch, ensuring a smooth development process.

By referring to the documentation, you can gain a solid understanding of CAEN FELib and utilize its features effectively. Should you encounter any difficulties or require further assistance, please consult the relevant sections within the provided documentation.

4 CAEN DIG2

To install the CAEN DIG2 library, follow the steps below:

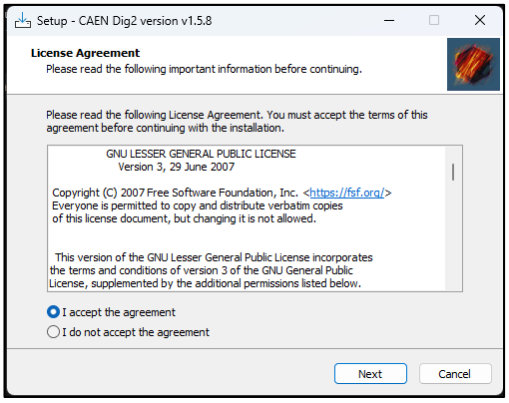
- Log in to the CAEN website (www.caen.it) and download the installation package for your OS from the CAEN FELib page
- Unpack the package on your host PC.

4.1 Installation

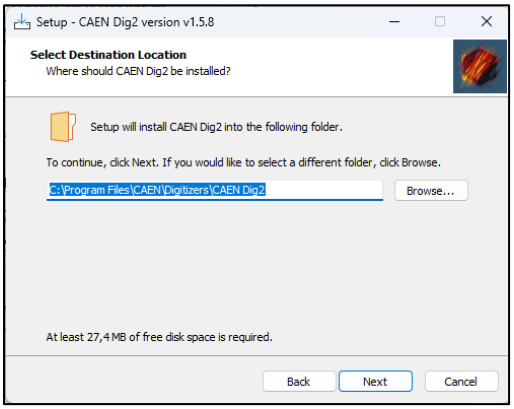
4.1.1 Windows

The Windows distribution can be installed via the CAEN DIG2 Installation Wizard:

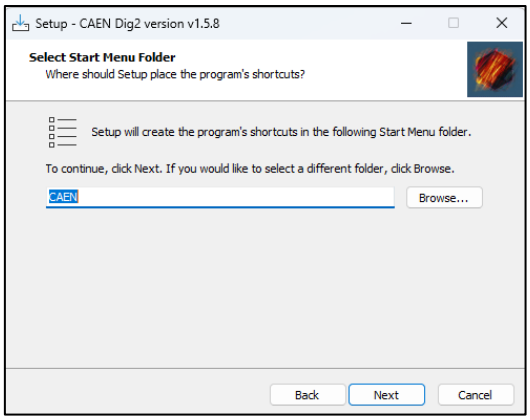
- Launch the executable downloaded from the CAEN website
- Accept the License Agreement



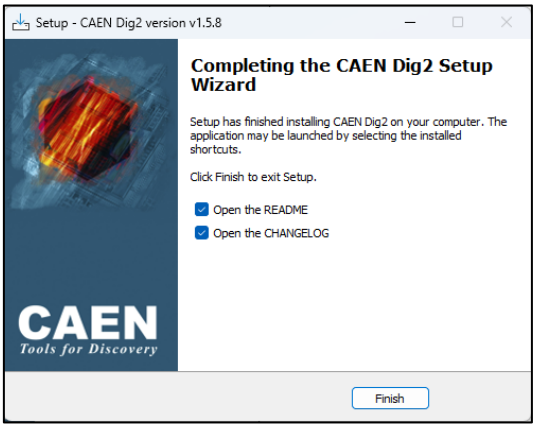
- Select the installation folder



- Select the Start Menu folder



- Press the *Install* button to start the installation
- Once the library is installed you can close the Setup Wizard



4.1.2 Linux

For Linux users, the following instructions are provided in the INSTALL file within the library package:

- Open the terminal and navigate to the library directory.
- Execute the command: *./configure --disable-assert*
- Execute the command: *make*
- Execute the command: *sudo make install*
- Execute the command: *sudo ldconfig*

The library will be installed in the */usr/local/lib folder*, while the header files will be installed in the */usr/local/include/* folder.

4.1.3 Digitizer OpenARM

The library can be installed on the Digitizer OpenARM embedded in the x27XX Digitizer by following the steps described in the INSTALL file within the library package:

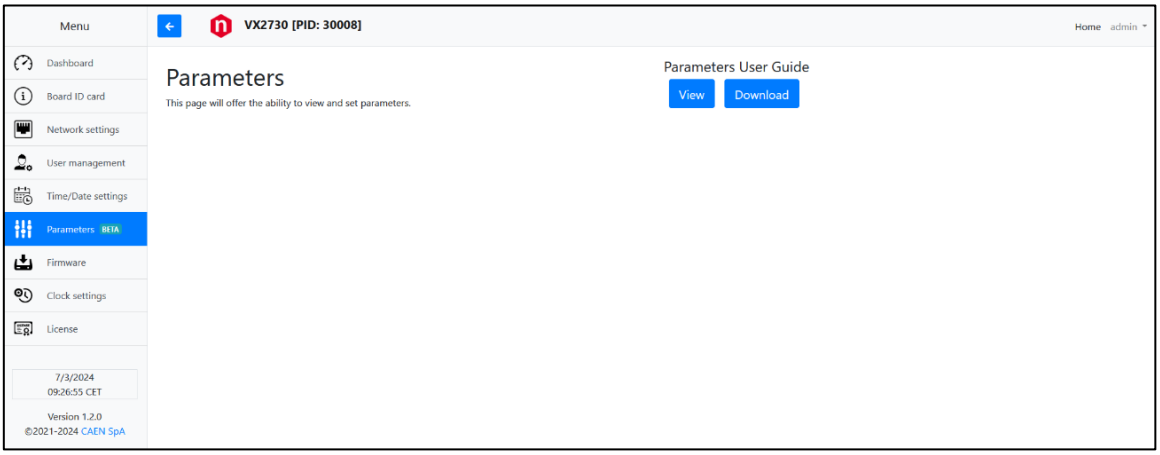
- Copy the preferred archive from the bin/ directory of this package to your target system.
- Log in as root.
- Execute the command: *# tar -xvf caen_dig2-{version}-bin-{platform}.tar.gz -C / --no-overwrite-dir*
- Execute the command: *# ldconfig*

The library will be installed in the */usr/local/lib* folder, while the header files will be installed in the */usr/local/include/* folder.

4.2 Documentation

To access the comprehensive documentation of the firmware parameters associated with the currently in-use firmware in CAEN DIG2, please follow the steps outlined below:

- Launch the Web Interface of the Digitizer.
- Navigate to the "**Parameters (BETA)**" tab within the Web Interface. This tab specifically provides access to the documentation related to the firmware parameters.



- Upon reaching the "**Parameters (BETA)**" tab, you will find a comprehensive list of parameters associated with the currently in-use firmware.
- Each parameter is accompanied by a detailed description, including its purpose, functionality, and any relevant constraints or considerations.
- Browse through the list of parameters to locate the specific information you require. You can refer to the descriptions to gain a better understanding of each parameter and its significance.

By accessing the firmware parameters documentation through the Web Interface, you can gain valuable insights into the functionality and customization options available in CAEN DIG2. This documentation ensures that you have a clear understanding of how to configure and optimize the parameters for your specific needs.

The online documentation of the DIG2 parameters is available for CUP versions higher than 2023072004.

Parameters documentation of older cup versions is available upon request to the CAEN Support.

5 CAEN DIG1

To install the CAEN DIG2 library, follow the steps below:

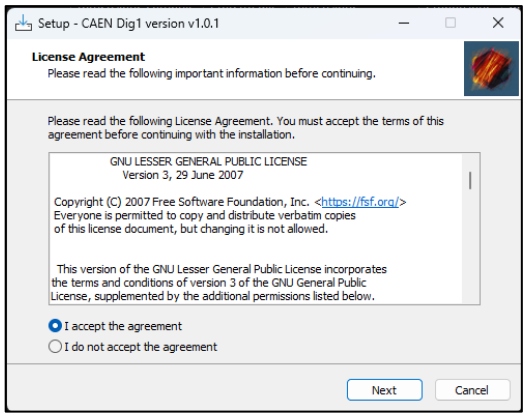
- Log in to the CAEN website (www.caen.it) and download the installation package for your OS from the CAEN FELib page
- Unpack the package on your host PC.

5.1 Installation

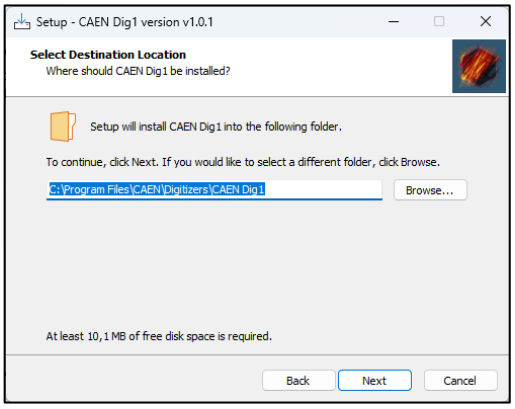
5.1.1 Windows

The Windows distribution can be installed via the CAEN DIG1 Installation Wizard:

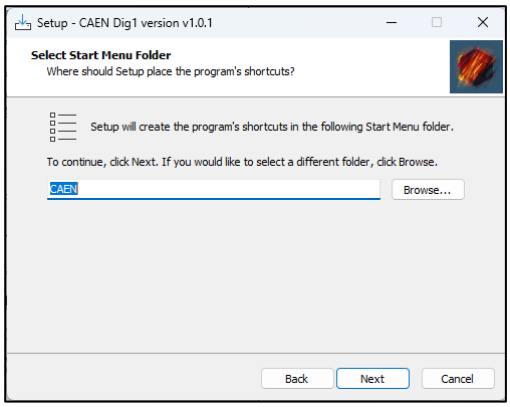
- Launch the executable downloaded from CAEN website



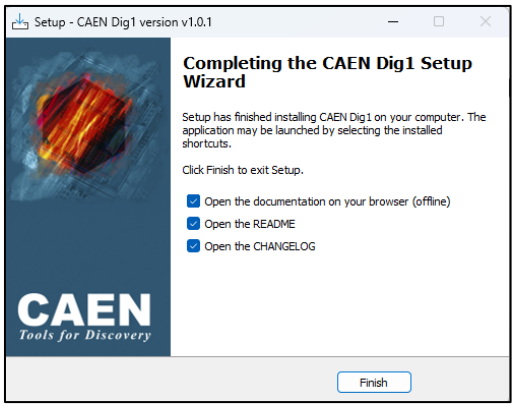
- Accept the License Agreement



- Select the installation folder
- Select the Start Menu folder



- Press the *Install* button to start the installation
- Once the library is installed you can close the Setup Wizard



5.1.2 Linux

For Linux users, the following instructions are provided in the INSTALL file within the library package:

- Open the terminal and navigate to the library directory.
- Execute the command: *./configure --disable-assert*
- Execute the command: *make*
- Execute the command: *sudo make install*
- Execute the command: *sudo ldconfig*

The library will be installed in the */usr/local/lib folder*, while the header files will be installed in the */usr/local/include/* folder.

5.2 Documentation

To access the comprehensive documentation for the parameters related to CAEN DIG1, please follow the steps outlined below:

- Locate the installation folder of CAEN DIG1 on your system (*/usr/local/share/doc/caen_dig1/* for Linux Users). This folder contains the necessary files for the library's functioning.
- Within the installation folder, navigate to the *"doc"* folder. This specific folder houses all the relevant documentation files for CAEN DIG1.
- Open the "*doc*" folder, and you will find an HTML documentation file that serves as a user manual for the library's parameters.
- Click on the HTML documentation file to access its contents.

The documentation provided within the HTML file covers various aspects of CAEN DIG1, specifically focusing on the parameters associated with different boards and supported firmware. This documentation offers valuable guidance and information on how to configure and utilize the parameters effectively.

6 Connect to a Device

To connect to a device, simply call the CAEN_FELib_Open() function, which provides the handle to the digitizer node:

```
uint64_t dev_handle;
int ec = CAEN_FELib_Open(url, &dev_handle);
```

To close the connection and release any allocated memory, you can use the CAEN_FELib_Close() function:

```
int ec = CAEN_FELib_Close(dev_handle);
```

The URL argument follows the standard form described in RFC 3986:

```
[scheme]:[//authority][path][?query][#fragment]
```

scheme represent the underlying library that implements the connection. The existing implementations are:

- ***dig2*** for the CAEN Digitizers 2.0 (CAEN Dig2 library is required)
- ***dig1*** for the CAEN Digitizers 1.0 (CAEN Dig1 library is required)

The URL is not case sensitive. Multiple queries can be concatenated using the "&" character.
The meaning of the other fields is implementation-specific, as described in the following sections.

6.1 DIG2

CAEN Dig2 is accessed using the ***dig2*** *scheme*. The authority field is the IP or the domain name of the device. In case of IPv4 addresses it would be something like:

```
dig2://192.0.2.1
```

or, using an IPv6 address:

```
dig2://[2001:db8::1]
```

For USB connections, default host name of the form ***caendgtz-usb-<pid>*** can be used, where ***<pid>*** is the serial number of the device.

```
dig2://caendgtz-usb-<pid>
```

Additionally, a reserved authority ***caen.internal*** with path ***/usb/<pid>***, like:

```
dig2://caen.internal/usb/<pid>
```

can be used for USB connections.
For ethernet connection digitizers provides a mDNS host name in the form:

```
dig2://caendgtz-eth-<pid>
```

that may not work directly, because behaviour is operating system dependent: for example Linux requires *.local* at the end. For ethernet connection we suggest using the IP directly, or a domain name provided by your DNS.
When developing on the embedded Open ARM environment, you may use the special path */openarm* on the reserved authority:

```
dig2://caen.internal/openarm
```

instead of the IP address 172.17.0.1, that is the IP address of the Docker host in the embedded environment.
Only one connection is supported per time. If called from another instance, ***CAEN_FELib_Open()*** on the same hostname forcibly disconnects the previously connected client, if present. If invoked from the same instance, nothing is done and ***CAEN_FELib_DeviceAlreadyOpen()*** is returned.

6.2 DIG1

CAEN Dig1 is accessed using the ***dig1*** scheme.

The connection type is specified by the URI path, and the authority meaning depends on the connection type. Each of the following path maps an enumeration of ***CAEN Digitizer CAEN_DGTZ_ConnectionType.***

- ***/usb,*** equivalent to ***CAEN_DGTZ_USB***
- ***/optical_link***, equivalent to **CAEN_DGTZ_OpticalLink**
- ***/usb_a4818_v2718***, equivalent to **CAEN_DGTZ_USB_A4818_V2718**
- ***/usb_a4818_v3718***, equivalent to **CAEN_DGTZ_USB_A4818_V3718**
- ***/usb_a4818_v4718***, equivalent to **CAEN_DGTZ_USB_A4818_V3718**
- ***/usb_a4818,*** equivalent to **CAEN_DGTZ_USB_A4818**
- ***/eth_v4718,*** equivalent to **CAEN_DGTZ_ETH_V4718**
- ***/usb_v4718,*** equivalent to **CAEN_DGTZ_USB_V4718**

For all paths except */eth_v4718*, the authority must be *caen.internal*, while for */eth_v4718* it is the IP address of the V4718.

Some queries are provided to specify connection parameters, where meaningful:

- ***link_num=<num>***, to specify the link number (or PID on A4818 and USB V4718)
- ***conet_node=<num>***, to specify the CONET node
- ***vme_base_address=<addr>***, to specify the VME base address

For example, to connect to a digitizer using the link 2 of an A3818 and a bridge V3718, at VNE base address 0x32100000, you may use something like:

```
dig1://caen.internal/optical_link?link_num=2&vme_base_address=0x32100000
```

7 Technical Support

To contact CAEN specialists for requests on the software, hardware, and board return and repair, it is necessary a MyCAEN+ account on www.caen.it:

https://www.caen.it/support-services/getting-started-with-mycaen-portal/

All the instructions for use the Support platform are in the document:

A paper copy of the document is delivered with CAEN boards.

The document is downloadable for free in PDF digital format at:

https://www.caen.it/safety-information-product-support

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