USER MANUAL

ProDAQ Signal Conditioning Cards

ProDAQ 5828 16-Channel Isolation Amplifier Signal Conditioning Card

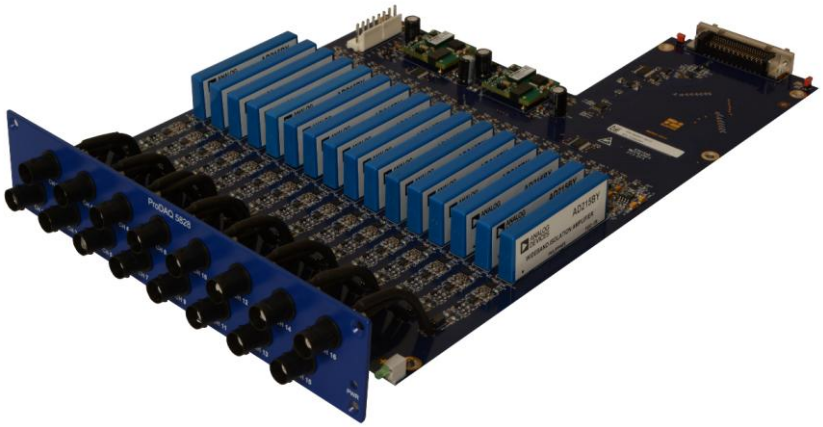

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Table of Contents

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Table of Figures

Reference Documents

Title	Number
ProDAQ 3416 User Manual	3416-XX-UM
ProDAQ 6100 User Manual	6100-XX-UM
ProDAQ 5720 User Manual	5720-XX-UM

Safety

This equipment contains voltage hazardous to human life and safety and is able to inflict personal injury. Disconnect the device from the AC line (mains) and all channel inputs that may be connected to hazardous voltages (higher than 42.4 VAC peak or 60 VDC) before opening the covers.

When hazardous voltages (higher than 42.4 VAC peak or 60 VDC) are present on any channel, all channels are considered hazardous. Ensure that external wiring or any circuits connected to the device are properly insulated from human contact.

To operate this device, use a three-conductor power cord and an power outlet providing protective earth. Do not use a two-conductor extension cord or a three-prong/two-prong adapter.

If you replace the power cord provided, make sure that the replacement is rated for the power consumption stated in the specifications.

Do not position the device so that it is difficult to operate the disconnecting device.

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use: IEC 61010-1 ed.3.0, IEC 6101-2-030 ed.1.0.

If the equipment is used in a manner not specified by the manufacturer, its safety may be impaired.

Waste Electrical and Electronic Equipment (EU customers only)

This product complies with the WEEE Directive 2002/96/EC marking requirement. The affixed product label indicates that you must not discard this electrical product in domestic household waste.

Product Category: Monitoring and Control Instrumentation

To return unwanted products, contact Bustec Ltd.

1. Introduction

1.1. Overview

The ProDAQ 5828 Signal Conditioning Card is designed to amplify input voltage signals and to provide galvanic isolation between up to 16 external voltage signal sources and the data acquisition card. The ProDAQ 5828 card offers a wide analog channel full power bandwidth as high as 50kHz combined with a working voltage across the isolation barrier of up to 350 VDC or AC rms. This isolation is built into both channel-to-ground and channel-to-channel paths.

Figure 1 - ProDAQ 5720 Signal Conditioning Carrier with two
ProDAQ 5828 Isolation Amplifier cards

The ProDAQ 5828 card is designed to work with the ProDAQ 3416 16-channel, 24-bit Sigma-Delta ADC function card installed in one of the ProDAQ function card carriers for VXI or LXI systems. The connection between the ADC function card and the signal conditioning card is done via standard ProDAQ 8010 data I/O cable. It carries the analog signals as well as the control signals for the conditioning card.

The control of the signal conditioning card is done via an additional VXIplug&play driver which links to the standard ProDAQ 3416 driver dynamically. In this way, drivers for different signal conditioning cards can be used at the same time with the ProDAQ 3416 driver.

1.1.1. ProDAQ 5720 Signal Conditioning Carrier

The ProDAQ 5720 can host up to two signal conditioning cards of the 5820 Series. It provides power and cooling to the cards but provides no functionality of its own. It is designed to be mounted in a standard 19” rack. Refer to 5720-XX-UM for further details.

1.2. Features

The ProDAQ 5828 Isolation Amplifier Signal Conditioning Card provides

- 16 isolated channels in a 5720 SCU half-width card format
- channel-to-ground and channel-to-channel isolation with $350V_{RMS}$ working voltage
- 1, 10, 100, 1000 gain selection per channel
- 50 kHz Analog channel full power bandwidth

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2. Getting Started

The ProDAQ 582X series signal conditioning cards are factory mounted into the ProDAQ 5720 carrier. Please refer to the ProDAQ 5720 user manual, 5720-XX-UM, for rack mount installation and general operation.

2.1. Connecting to a ProDAQ 3416 ADC Function Card

For the connection between the ProDAQ 5828 Signal Conditioning Card and a ProDAQ 3416 ADC function card a standard ProDAQ 8010-Bx series data I/O cable is used. The ProDAQ 5828 card is equipped with a standard 50-pin SCSI connector on its rear panel to attach the cable to.

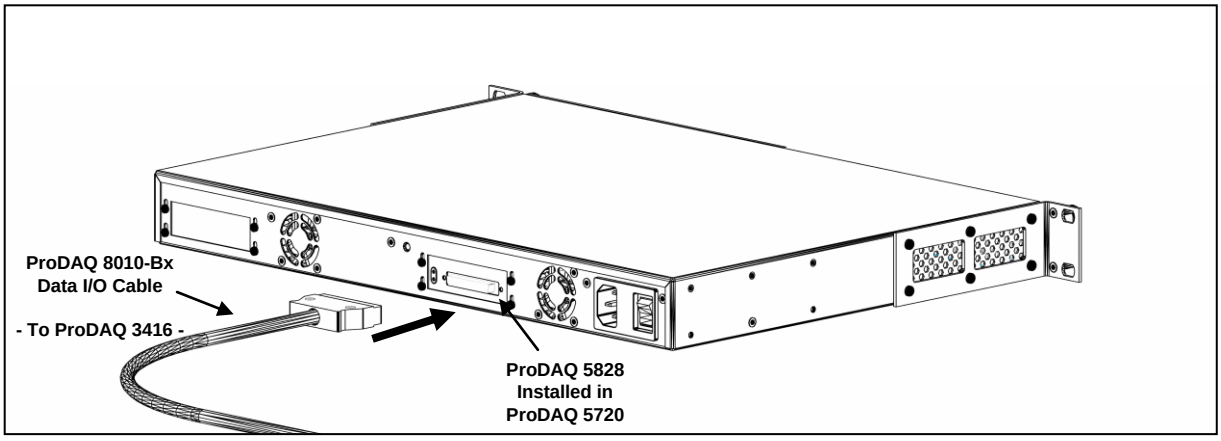

Figure 2 – Connecting SCSI cable to ProDAQ 5828 installed in 5720

2.2. Connecting your Signal Sources

The ProDAQ 5828 uses an isolated version of the standard BNC connector for the signal connection. There are 16 BNC connectors located on the front panel of the 5828 board. They are arranged in two rows, where odd channel inputs are in lower row and even channel inputs are in upper row, as shown on the Figure 3.

Figure 3 - ProDAQ 5828 Front Panel View

The center pin of the BNC connector is the positive input while the outer shell (which, in the case of the isolated version, is kept hidden as internal part) is the negative input (reference).

Figure 4 – Isolated BNC Input Connector Pin-out

The recommended mating plug for the isolated BNC socket used on 5828 Front Panel is the touch-protected XBS-58 plug from Multi-Contact (order number 67.9760-21 for black color), conforming to RG-58 leads standard. A picture of the XBS-58 is shown on Figure 5.

Figure 5 – Recommended BNC plug – XBS-58

WARNING

When hazardous voltages (higher than 42.4 VAC peak or 60 VDC) are present on any channel, all channels should be considered hazardous. Ensure that external wiring or any circuits connected to the device are properly insulated from human contact.

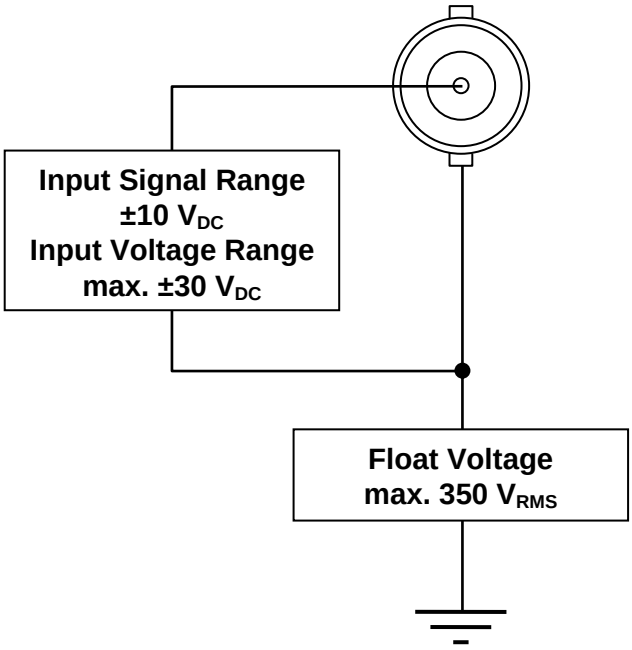

Figure 6 - Channel Voltage Rating (all channels)

3. Theory of Operation

The ProDAQ 5828 is a 16-channel Signal Conditioning card that is designed to provide amplification of the input signal and isolation between signal source and data acquisition system. The robust isolation of every channel consists of channel-to-ground and channel-to-channel separation.

The ProDAQ 5828 card is designed to direct interface with the ProDAQ 3416 16-channel Sigma-Delta ADC Function Card. The pin-out of the SCSI connector is compatible with the 3416 front panel connector allowing all 16 channel outputs to be directly connected to 16 AD converter inputs on the ProDAQ 3416 Function Card.

The ProDAQ 5828 card is controlled by a function card using I2C interface available on the SCSI connector of 3416. This interface allows setup of the channel gain and the access to the local EEPROM memory which stores calibration coefficients.

Figure 7 shows a ProDAQ 5720 system overview with the 5828 and 3416 cards used.

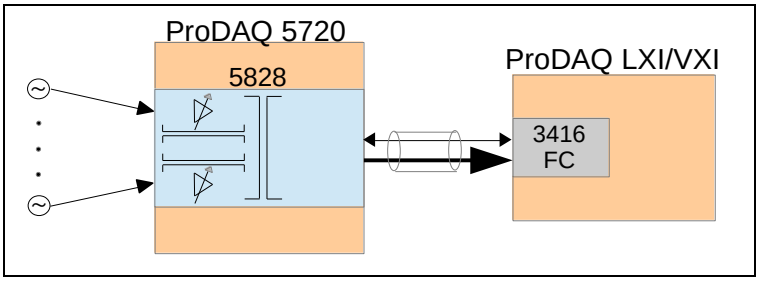

Figure 7 – Overview of the 5828 card usage

3.1. ProDAQ 5828 Isolation

The ProDAQ 5828 isolation is based on the two isolation barriers: channel-to-system isolation and channel-to-channel isolation. It means that every channel is separated galvanically from the system where the 3416 Function Card is installed and, in addition, the channels are galvanically separated from each other.

The isolation allows for precision voltage measurement of signals where high common mode voltages are present as the isolation barrier prevents this common mode voltage from passing through the barrier. Note that the differential input measurement range is still up to a maximum of ±10V.

The signal source is connected to every channel through a High Voltage BNC connector and after passing through the isolation barrier, signals from all channels are available on the 50-pin SCSI connector.

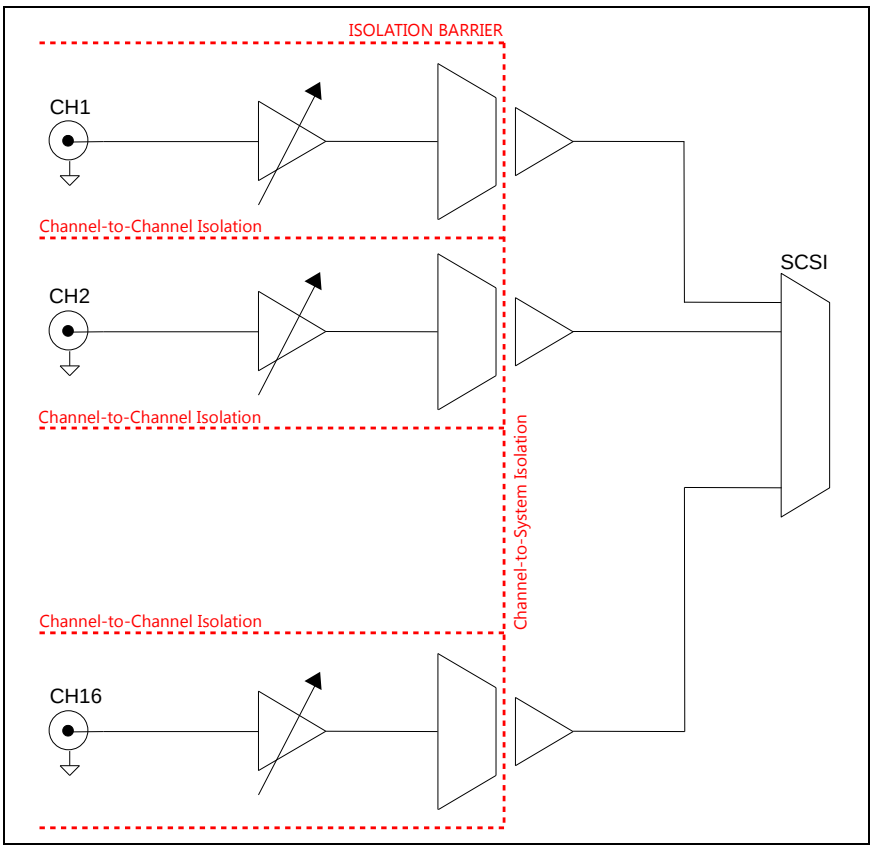

Figure 8 – ProDAQ 5828 Board Isolation Barriers

3.2. Isolated Channel Block Diagram

A block diagram of an isolated channel is shown on Figure 9. The input signal first goes through noise suppression and overvoltage protection circuitry. Then the signal is amplified in the programmable gain amplifier with possible gains of 1, 10, 100, 1000. The gain settings are individually programmable for each channel.

The amplified signal goes then through isolation barrier and on the safe side all frequencies above the specified bandwidth range are filtered out by a low pass filter.

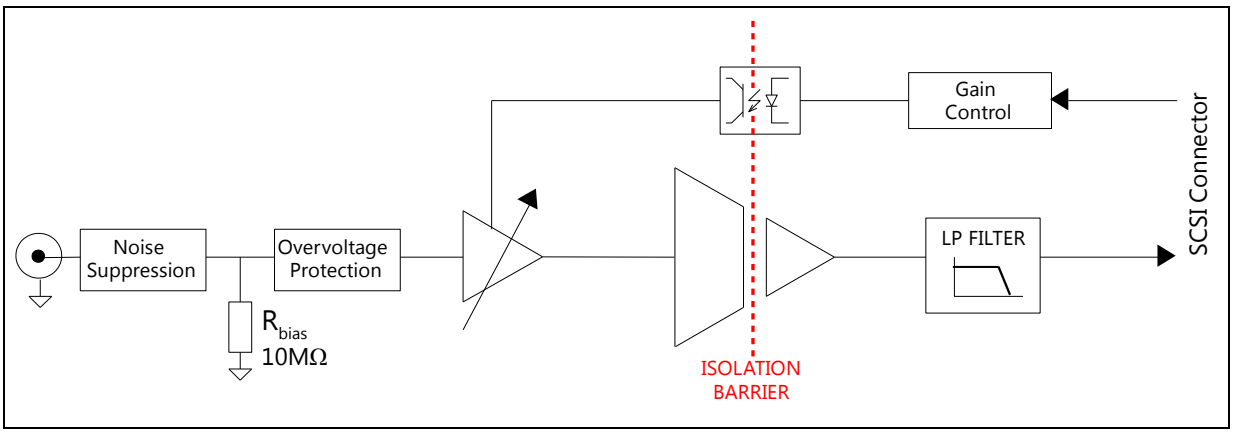

Figure 9 – Block diagram of the isolated channel on 5828

3.3. Calibration

The ProDAQ 5828 board shipped to the user is calibrated by the factory. The calibration factors are stored in an EEPROM memory on the board and are used by the software driver provided to achieve the accuracy stated in the specification. The recommended calibration interval required to maintain the specified accuracy is 1 year.

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4. The ProDAQ 5828 Soft Front Panel

The 5828 soft front panel is implemented as a plug-in module into the ProDAQ 3416 soft front panel. After the ProDAQ 3416 soft front panel is started it connects to and initializes the selected ProDAQ 3416 card. Then it uses the ProDAQ 3416 driver functions to detect whether a ProDAQ signal conditioning card such as the ProDAQ 5828 is connected to the ProDAQ 3416 card. When a ProDAQ signal conditioning card is detected, its controls are shown as a separate tab in the ProDAQ 3416 soft front panel.

After the start of the ProDAQ 3416 soft front panel application, the user has the choice to either enter the address information (VISA resource specification and function card number) of the function card the soft front panel application shall connect to or else to use the built-in “Auto Find” functionality in order to discover accessible ProDAQ 3416 cards.

Figure 10 – Function Card Selection

Please note that the “Auto Find” find functionality will only inspect network resources that are known to the VISA library to avoid unwanted accesses of network resources that might be unintentionally reachable via the local network. For VXIbus resources, running the VISA resource manager prior to running the soft front panel application is necessary for both the “Auto Find” functionality to work and in general the access to the function card to be possible.

If “Auto Find” is selected and there are multiple ProDAQ 3416 cards, the user will be presented with a dialog box showing all available ProDAQ 3416 cards, allowing the selection of one or multiple function card(s) to connect to (Figure 11).

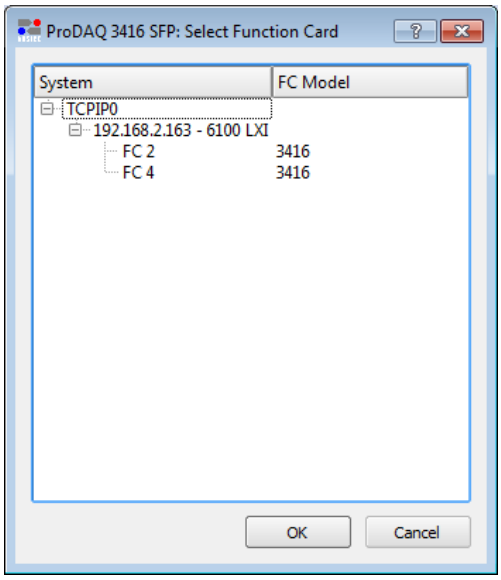

Figure 11 – Function Cards found after Auto Find

If there is only one function card / signal conditioning card available, the dialog box will not appear and the soft front panel application will automatically establish communication to this instrument. If no ProDAQ 3416 is available in your system, the soft front panel application can be run in demo mode, allowing operation of all controls, as if connected to an instrument.

If “Enter Address” is selected, the user is presented with a dialog box that allows entering the VISA resource string and the 3416 function card number directly, as shown in Figure 12.

The resource string and range of function card numbers differ depending on the ProDAQ motherboard or carrier that the ProDAQ 3416 is installed on. Please refer to the motherboard or carrier user manual for more information.

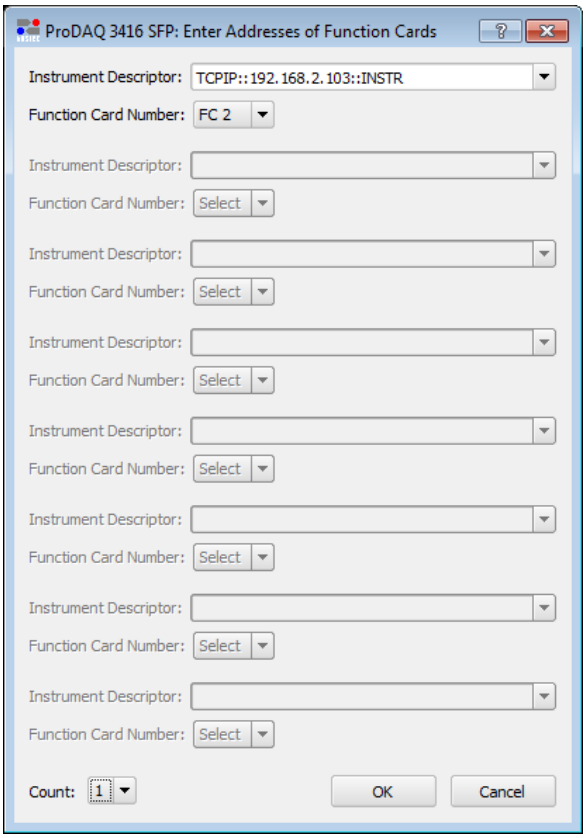

Figure 12 – Entering Function Card Address Information

After initializing the ProDAQ 3416 function card(s) and the connected ProDAQ 5828 signal conditioning card(s), during which a splash screen is displayed, the soft front panel window shown in Figure 13 will appear.

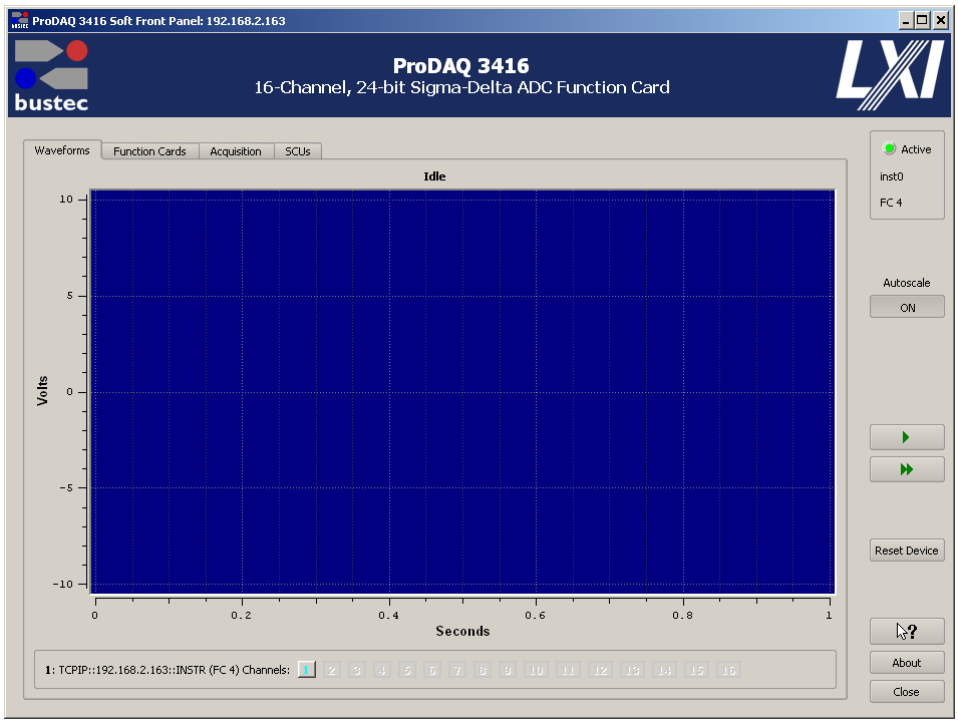

Figure 13 – ProDAQ 3416/5828 SFP Initial Start Up Screen

If any signal conditioning cards are detected, an additional tab labeled “SCUs” is shown along with the standard ‘Waveforms’, ‘Function Cards’ and ‘Acquisition’ tabs of the ProDAQ 3416 soft front panel. The SCUs tab (see Figure 14) provides the operator with control over the functionality of the signal condition card(s) as the ProDAQ 5828 and should be used in conjunction with the other tabs in order to set-up the ProDAQ 3416/5828 system to measure correctly.

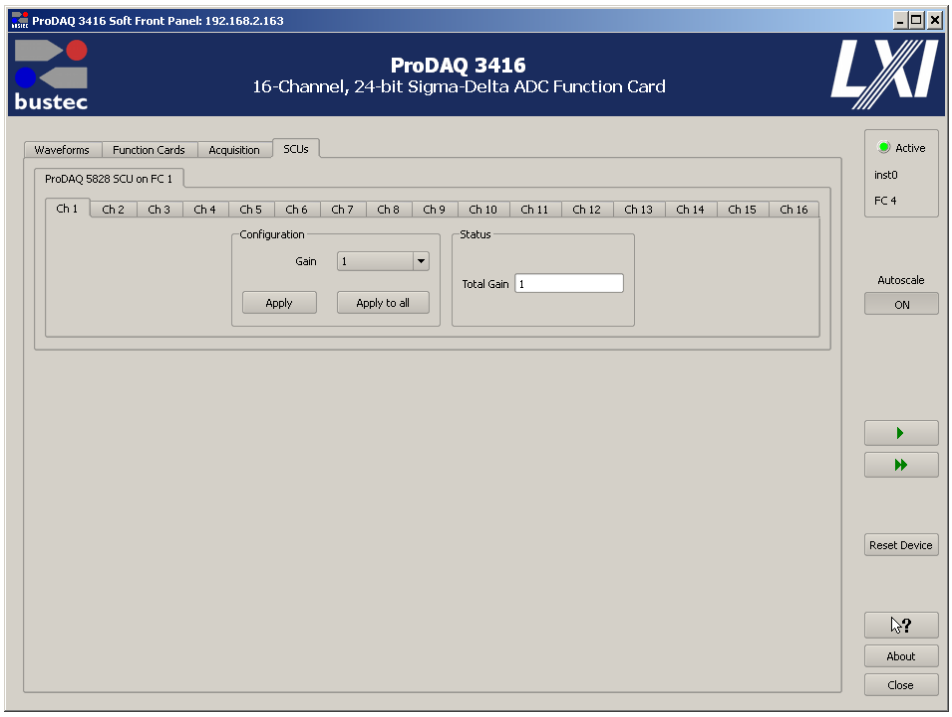

Figure 14 – ProDAQ 5828 SCU SFP Tab

The ProDAQ 5828 tab consists of 16 tabs, one for each channel. Each channel tab contains a Gain Configuration frame, a Gain Status frame.

Note

Only channels that are enabled on the ProDAQ 3416 ADC function card via the controls in the tab "Function Cards" (see Figure 16) can be configured here. Only channel 1 is initially enabled by default.

4.1. Channel Configuration

The configuration of the channel on 5828 SCU consists on selecting the gain: the gains 1, 10, 100 and 1000 are possible to select using a drop-down box, as shown in Figure 15. To apply the settings to the channel, press the "Apply" button. To apply this settings to all channels, press "Apply to all" – it will be applied to all channels enabled in Function Cards tab. After either button is clicked it is grayed out until a combo box change is once again made.

After changing the gain the Status section of the SCUs tab is updated to show the current total gain of the analog path: the total gain is a combined gain of the SCU gain and 3416 gain, for example, if the 3416 gain in channel 1 is set to 2 (as shown in Figure 16) and the SCU gain in channel 1 is set to 10, then the gain in status box will be shown as 20 (Figure 17).

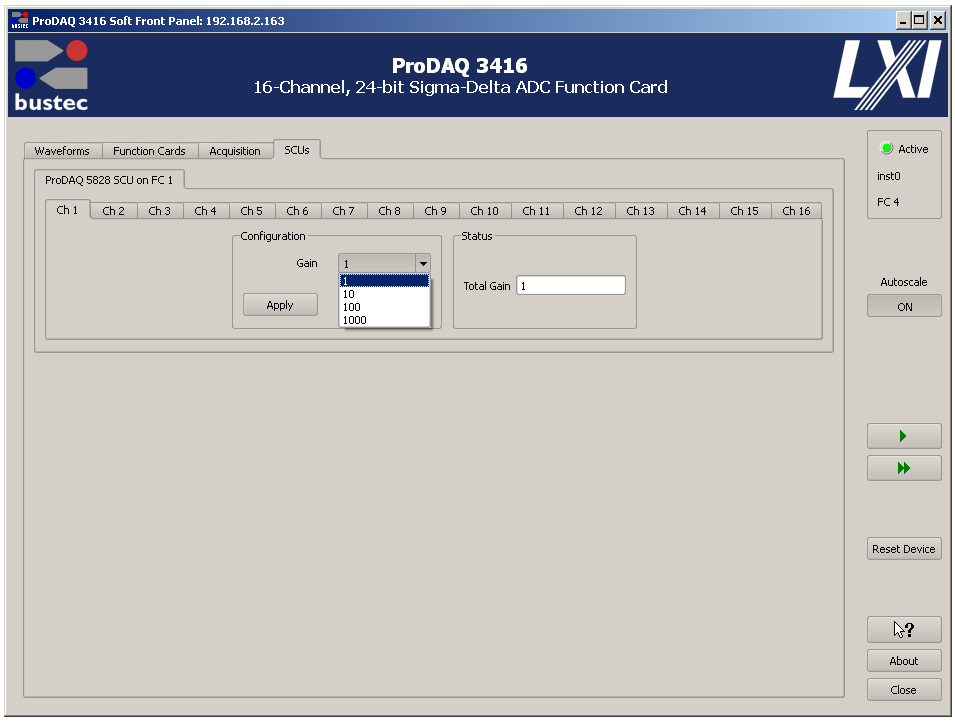

Figure 15 – Configuring the ProDAQ 5828 gain

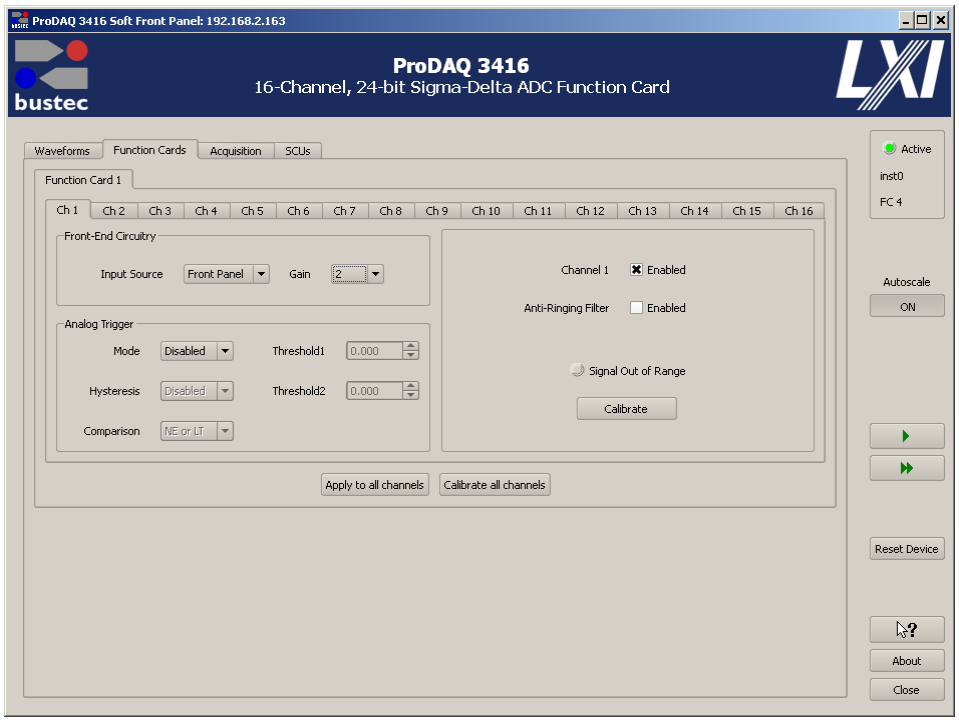

Figure 16 – 3416 Front End Settings (channel 1 enabled and gain set to 2)

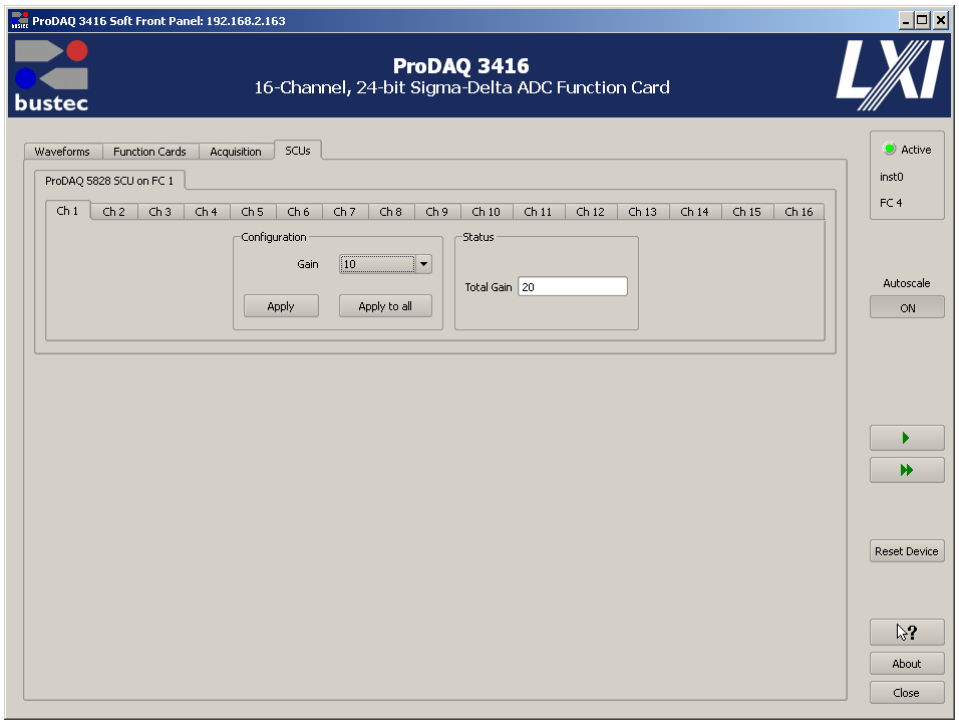

Figure 17 – Total gain status for the analog channel of 3416 with 5828 SCU

4.2. Software and Hardware Revisions

By using the “About” button, the soft front panel shows the user the information about the software and hardware revisions. The hardware information contains also the model of the hardware installed (see
Figure 18).

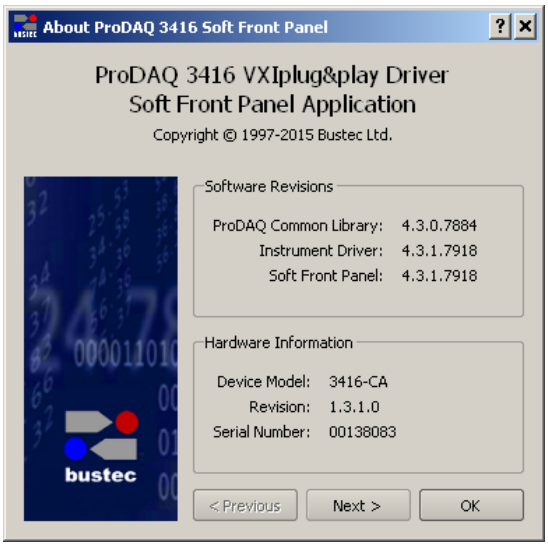

Figure 18 – 3416 Software and Hardware revisions

To display the information about the SCU revisions the user needs to press “Next” button. The second part of software and hardware information is shown in Figure 19.

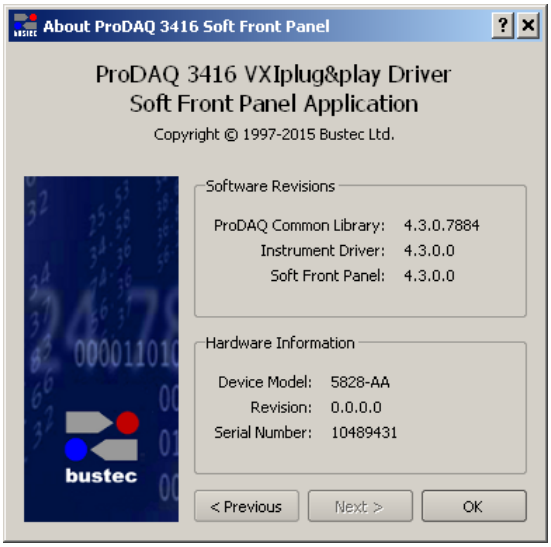

Figure 19 – 5828 Software and Hardware revisions

4.3. Performing a Measurement

Refer to the ProDAQ 3416 User Manual for the information which are required to setup the measurement. The example window of the waveform taken during the measurement is shown in Figure 21.

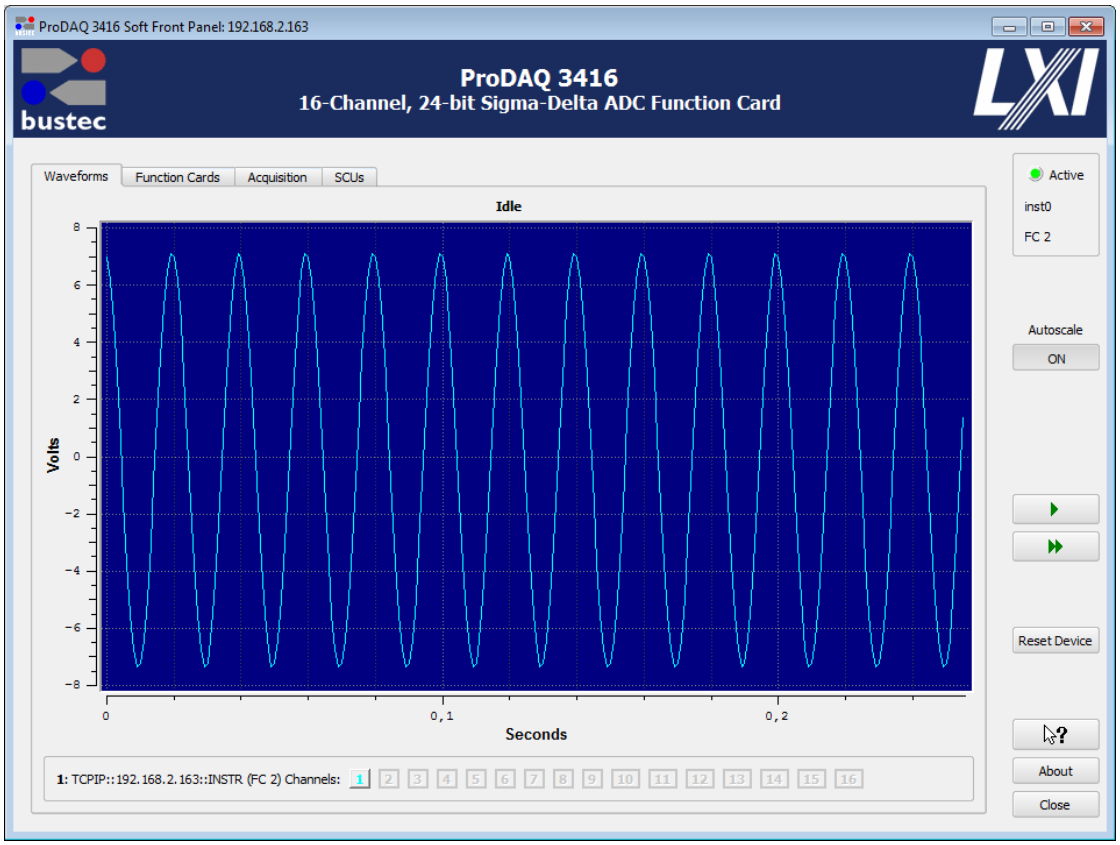

Figure 20 – An example of 3416/5828 Waveforms window

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5. Programming the ProDAQ 5828

This chapter shows how to program the ProDAQ 5828 signal conditioning card using the VXI*plug&play* driver. Complete examples can be found in the “Examples” subdirectory of the driver. All functions are explained in detail in the help file coming with the driver.

5.1. VXI*plug&play* Driver Organization

The VXI*plug&play* driver is organized in a hierarchical manner to allow the user to quickly choose the function calls to solve the task at hand without being confronted with unnecessary details. Besides the standard connection/disconnection and utility functions it contains different levels of functionality which provide single functions or sets of functions to solve a particular data acquisition task:

Function Tree Layout:
ProDAQ 5828 Isolation Amplifier Signal Condition Unit

Initialization	bu5828_init
Hardware Configuration	
Set Channel Configuration	bu5828_setChanConfig
Get Channel Configuration	bu5828_getChanConfig
Utility Functions	
Read Temperature	bu5828_readTemperature
Reset	bu5828_reset
Error Message	bu5828_error_message
Device Serial Number	bu5828_serialNumber
Revision Query	bu5828_revision_query
Get Function Card Last Error	bu5828_getFCLastError
Close	bu5828_close

Figure 21 – VXI*plug&play* Driver Organization

The section **Hardware Configuration** contains high-level functions to configure the card. The section **Utility Functions** contains utility functions that can be used together with the high-level functions.

The following paragraphs will explain the usage of the high level functions.

5.2. Connecting to the Function Card and Signal Conditioning Card

The ProDAQ 5828 driver utilizes the ProDAQ 3416 driver to access the signal conditioning card. Therefore first the ProDAQ 3416 driver need to be initialized and connected to the correct function card (the one connect via cable to the ProDAQ 5828) before the ProDAQ 5828 driver can be initialized.

To initialize the ProDAQ 3416 driver and connect to the ProDAQ motherboard or function card carrier, the standard VXI*plug&play* initialization function **bu3416_init()** is used (see Figure 22,①). (Please refer to the VXI*plug&play* standard VPP-4.3, section 4.3 for a detailed description of the address string.) After initializing the driver and connecting to the motherboard or carrier, the driver must be told which one of the function cards to work with. This is done by the function **bu3416_fcSelect()**. It takes as an argument the session established via the function **bu3416_init()**, the function card number and a boolean value specifying whether to reset the selected function card (see Figure 22, ②).

```
#include <visa.h>
#include <bu3416.h>
#include <bu5828.h>

main (int argc, char **argv)
{
    ViStatus status;
    ViSession session_3416;
    ViSession session_5828;
    ViChar descr[256];

#ifndef USE_PARAMINIT
①   /* connect to a ProDAQ motherboard in a VXIbus system */
    if ((status = bu3416_init("VXI0::2::INSTR", VI_TRUE, VI_TRUE, &session_3416)) != VI_SUCCESS)
    {
        viStatusDesc (session_3416, status, descr);
        printf ("Error: bu3416_init() failed due to %s\n", descr);


        return -1;
    }
②   /* use function card in position/slot 1 */
    if ((status = bu3416_fcSelect(session_3416, 1, VI_TRUE)) != VI_SUCCESS)
    {
        viStatusDesc (session_3416, status, descr);
        printf ("Error: bu3416_fcSelect failed due to %s\n", descr);

        return -1;
    }
#else
    /* OR: connect to a 3416 in position 1 in a LXI function card carrier */
③   if ((status = bu3416_paramInit("TCPIP::192.168.168.63::INSTR",
                                    1, VI_TRUE, VI_TRUE, &session_3416)) != VI_SUCCESS)
    {
        viStatusDesc (rm_session, status, descr);
        printf ("Error: bu3416_paramInit() failed due to %s\n", descr);


        return -1;
    }
#endif
④   /* connect to the 5828 controled by the 3416 */
    if ((status = bu5828_init(session_3416, VI_TRUE, VI_TRUE, &session_5828)) != VI_SUCCESS)
    {
        viStatusDesc (session_5828, status, descr);
        printf ("Error: bu5828_init() failed due to %s\n", descr);


        return -1;
    }
    /* ... */
```

Figure 22 - Connecting to The ProDAQ 3416 and ProDAQ 5828

For your convenience, the driver contains a new function called **bu3416_paramInit()**, which combines the functionality of the **bu3416_init()** and **bu3416_fcSelect()** functions by extending the argument list of the standard initialization function with a parameter specifying the function card number (see Figure 22,③).

For the driver functions to work properly, you will either have to use the function **bu3416_paramInit()** to open a session with the device, or you will have to call the function **bu3416_fcSelect()** after calling the function **bu3416_init()** and <u>before</u> any other driver function is called.

Now you can connect to the ProDAQ 5828 as well by using the function **bu5828_init()** with the session handle to the ProDAQ 3416 returned by the functions **bu3416_init()** or **bu3416_paramInit()**. As with the ProDAQ 3416 init function you have the choice whether to check the ID of the signal conditioning card to connect to as well as to reset the card (see Figure 22, ④). The function returns a new session handle, which must be used with all ProDAQ 5828 driver functions

To close the driver sessions with the ProDAQ 5828 and the ProDAQ 3416, the standard VXIplug&play functions **bu5828_close() and bu3416_close()** must be used, preferably in this sequence.

NOTE

Please note that only code snippets are shown here in the manual. For the complete example, refer to the 'Examples' folder in the drivers installation directory.

5.3. Hardware Configuration

To measure correctly, an application need to configure both cards, the ProDAQ 3416 as well as the ProDAQ 5828.

5.3.1. ProDAQ 3416 Channel Configuration

The input multiplexer and gain stages on the ProDAQ 3416 function card are configured using the function **bu3416_setChanConfig()**. It takes as arguments the session to the instrument, a channel number, a selection for the input multiplexer and a value for the gain setting. The channel number has to be an integer number in the range of 1...16 to select one of the channels or 0 for applying the configuration to all channels. Predefined macros from the include file *bu3416.h* can be used (**bu3416_CHAN_1** to **bu3416_CHAN_16** or **bu3416_CHAN_ALL**). The input multiplexer can be set to either connect the channel's input to the front panel connector or to the internal voltage reference bus. The selection can be made by using an integer value of 0 (front panel connector) or 1 (voltage reference bus) or again by using a macro predefined in *bu3416.h* (**bu3416_CH_FP** or **bu3416_CH_VREF**). The gain can be set in steps of 1, 2, 5 between 1 and 2000 by either using valid integer numbers (1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000) or by using the predefined macros **bu3416_GAIN_1** to **bu3416_GAIN_2000** (for more information, refer to the ProDAQ 3416 User Manual).

5.3.2. ProDAQ 5828 Channel Configuration

The ProDAQ 5828 allows to configureits gain stage via the driver function **bu5828_setChanConfig()**. It takes as an input the instrument session, a channel number and the gain. As for the ProDAQ 3416's **bu3416_setChanConfig()** function, the channel number has to be an integer number in the range of 1...16 to select one of the channels or 0 for applying the configuration to all channels. Predefined macros from the include file *bu5828.h* can be used for all the settings. The gain can be set to values of 1, 10, 100, by using the macros **bu5828_GAIN_1** to **bu5828_GAIN_1000**.

5.4. Calibration

ProDAQ 5828 is factory calibrated during production test and any other calibration options are not available for the user.

Note

ProDAQ 5828 calibration coefficients values are stored in the driver and automatically applied to ProDAQ 3416.

5.5. Performing a Measurement

To perform measurements, the appropriate ProDAQ 3416 driver function must be used. In the example the function **`bu3416_acquireWaveform()`** is used to acquire 128 Samples at speed of 1000 Samples/sec from channel 1 (see Figure 23, ②). To do the same on multiple channels, the function **`bu3416_acquireWaveforms()`** can be used. For continuous acquisition, functions like **`bu3416_startAcquisition()`**, **`bu3416_stopAcquisition()`** etc must be used (for more information, refer to the ProDAQ 3416 user manual and driver documentation).

```
{
    ViReal64 dblBuf[128];

    /* initialization and data acquisition */

    /* … */

①   /* configure the ProDAQ 5828, gain 10 */
    if ((status = bu5828_setChanConfig (session_5828, bu5828_CHAN_1,
                                        bu5828_GAIN_10,)) < VI_SUCCESS)
    {
        bu5828_error_message (session_5828, status, descr);
        printf ("Error: bu5828_setChanConfig() failed due to %s\n", descr);

        return -1;
    }

②   /* acquire 128 Samples at 1000 Samples/sec */
    if((status = bu3416_acquireWaveform (session_3416, bu3416_CHAN_1, bu3416_CH_FP,
                                         bu3416_GAIN_2, VI_FALSE, 1000.0, 128,
                                         dblBuf, VI_NULL)) < VI_SUCCESS)
    {
        bu3416_error_message (session_3416, status, descr);
        printf ("Error: bu3416_ acquireWaveform() failed due to %s\n", descr);

        return -1;
    }
```

Figure 23 – Connecting to The ProDAQ 3416 and ProDAQ 5828

6. VXI*plug&play* Driver Functions

Introduction

This instrument driver provides programming support for ProDAQ 5828 Isolation Amplifier SCU Unit. It contains functions for opening, configuring, taking measurements from, and closing the instrument.

Assumptions

To successfully use this function card, it must be installed onto a ProDAQ VXIbus motherboard or a ProDAQ LXI function card carrier. The ProDAQ motherboard must in turn be installed in a VXIbus system which is connected via a suitable slot-0 controller to your computer. The LXI function card carrier must be connected via network to your computer. A suitable VISA library must be installed on your computer.

Error and Status Information

Each function in this instrument driver returns a status code that either indicates success or describes an error or warning condition. Your program should examine the status code from each call to an instrument driver function to determine if an error occurred.

The general meaning of the status code is as follows:

Value	Meaning
0	Success
Positive Values	Warnings
Negative Values	Errors

The description of each instrument driver function lists possible error codes and their meanings.

Function Tree Layout:

Class/Panel Name:	**Function Name:**
Initialization	bu5828_init
Hardware Configuration	
Set Channel Configuration	bu5828_setChannelConf
Get Channel Configuration	bu5828_getChannelConf
Utility Functions	
Read Temperature	bu5828_readTemperature
Reset	bu5828_reset
Error Message	bu5828_error_message
Device Serial Number	bu5828_serialNumber
Revision Query	bu5828_revision_query
Get Function Card Last Error	bu5828_getFCLastError
Close	bu5828_close

6.1. VXI*plug&play* Driver Function Details

The following functions are in alphabetical order.

6.1.1. bu5828_close

```
    ViStatus bu5828_close (ViSession instrumentHandle);

Purpose

    This function closes the instrument and frees the resources allocated by
    the call to the initialization function bu5828_init().

    This function must be called once for every instrument handle returned by
    the initialize function, prior to terminating the application program.


Parameter List

    instrumentHandle

        Variable Type       ViSession

        The Instrument Handle is used to identify the unique session or
        communication channel between the driver and the instrument.

        If more than one instrument of the same model type is used, this
        handle will be used to differentiate between them.

Return Value

        If the function was successful, it will return a status of
        VI_SUCCESS, otherwise it will return a warning or error code.
        Passing the status code to the function "bu5828_error_message" will
        return a string describing the warning or error.

        A driver function can return three different types of warnings or
        errors. The function "bu5828_error_message" will handle all three
        types of warning/error codes by passing them to the appropriate
        function if necessary ("bu3100_error_message" or "viStatusDesc"), to
        return the correct warning/error message.

        VISA Warnings/Errors:
        See section 3.3 of the VPP 4.3.2 document for a complete list of
        VISA status codes and their values. The VPP 4.3 document contains
        detailed descriptions of all VISA functions and the status codes
        returned by each of them.

        BU3100 Warnings/Errors:
        These are warning or error codes returned by the common motherboard
        interface library, which are used by the 5828 driver to access a
        ProDAQ motherboard. Warnings returned by the library will be in the
        range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to
        0xBFFC0900. They are defined in the include file bu3100.h.

        BU5828 Warnings/Errors:
        Warning codes returned by the 5828 driver functions will be in the
        range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range
        0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file
        bu5828.h.
```


6.1.2. bu5828_error_message

```
ViStatus bu5828_error_message (ViSession instrumentHandle,
                               ViStatus errorReturnValue, ViChar errorMessage[]);
```

Purpose

Converts a numeric error code, returned by one of the functions of this driver into a descriptive error message string.

Parameter List

instrumentHandle

Variable Type ViSession

The Instrument Handle is used to identify the unique session or communication channel between the driver and the instrument.

If more than one instrument of the same model type is used, this handle will be used to differentiate between them.

errorReturnValue

Variable Type ViStatus

Accepts the error code, returned by one of the functions in this instrument driver. See bu5828.h for error codes.

errorMessage

Variable Type ViChar[]

Upon return from the function, this parameter holds a text error message which corresponds to the error code.

The VISA Warnings and VISA Errors are described in section 3.3 of the VPP 4.3.2 document and Appendix B of VPP 4.3.

Return Value

If the function was successful, it will return a status of VI_SUCCESS, otherwise it will return a warning or error code. Passing the status code to the function "bu5828_error_message" will return a string describing the warning or error.

A driver function can return three different types of warnings or errors. The function "bu5828_error_message" will handle all three types of warning/error codes by passing them to the appropriate function if necessary ("bu3100_error_message" or "viStatusDesc"), to return the correct warning/error message.

VISA Warnings/Errors:
See section 3.3 of the VPP 4.3.2 document for a complete list of VISA status codes and their values. The VPP 4.3 document contains detailed descriptions of all VISA functions and the status codes returned by each of them.

BU3100 Warnings/Errors:
These are warning or error codes returned by the common motherboard interface library, which are used by the 5828 driver to access a ProDAQ motherboard. Warnings returned by the library will be in the range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to 0xBFFC0900. They are defined in the include file bu3100.h.

BU5828 Warnings/Errors:
Warning codes returned by the 5828 driver functions will be in the range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range 0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file bu5828.h.

6.1.3. bu5828_getChannelConf

```
    ViStatus bu5828_getChannelConf (ViSession instrumentHandle, ViInt16 channel,
                                    ViInt16 *gain);

Purpose

    This function returns the gain configuration of the specified channel.



Parameter List

    instrumentHandle

        Variable Type       ViSession

        The Instrument Handle is used to identify the unique session or
        communication channel between the driver and the instrument.

        If more than one instrument of the same model type is used, this
        handle will be used to differentiate between them.

    channel

        Variable Type       ViInt16

        This parameter specifies which channel configuration will be get.

        Possible values are:

        bu5828_CH_1 to bu5828_CH_16   1-16

    gain

        Variable Type       ViInt16 (passed by reference)

        This parameter returns value of the gain.

        Possible values are:
        bu5828_GAIN_1           1        -  gain 1
        bu5828_GAIN_10          10       -  gain 10
        bu5828_GAIN_100         100      -  gain 100
        bu5828_GAIN_1000        1000     -  gain 1000

Return Value

        If the function was successful, it will return a status of
        VI_SUCCESS, otherwise it will return a warning or error code.
        Passing the status code to the function "bu5828_error_message" will
        return a string describing the warning or error.

        A driver function can return three different types of warnings or
        errors. The function "bu5828_error_message" will handle all three
        types of warning/error codes by passing them to the appropriate
        function if necessary ("bu3100_error_message" or "viStatusDesc"), to
        return the correct warning/error message.

        VISA Warnings/Errors:
        See section 3.3 of the VPP 4.3.2 document for a complete list of
        VISA status codes and their values. The VPP 4.3 document contains
        detailed descriptions of all VISA functions and the status codes
        returned by each of them.

        BU3100 Warnings/Errors:
        These are warning or error codes returned by the common motherboard
        interface library, which are used by the 5828 driver to access a
        ProDAQ motherboard. Warnings returned by the library will be in the
        range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to
        0xBFFC0900. They are defined in the include file bu3100.h.

        BU5828 Warnings/Errors:
        Warning codes returned by the 5828 driver functions will be in the
        range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range
        0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file
        bu5828.h.
```


6.1.4. bu5828_getFCLastError

```
ViStatus bu5828_getFCLastError (ViSession instrumentHandle,
                                ViStatus *fcErrorCode);
```

Purpose

The last error code returned by the function card driver which controls the ProDAQ 5828. Useful in the event of the error bu5828_MASTER_ERR in response to the ProDAQ 5828 driver function call.

Parameter List

instrumentHandle

Variable Type ViSession

The Instrument Handle is used to identify the unique session or communication channel between the driver and the instrument.

If more than one instrument of the same model type is used, this handle will be used to differentiate between them.

fcErrorCode

Variable Type ViStatus (passed by reference)

Last error code returned by the function card driver which controls the ProDAQ 5828. This code is related to the function card driver and should be passed only to bu3416_error_message() when using the ProDAQ 3416 as the master card.

Return Value

If the function was successful, it will return a status of VI_SUCCESS, otherwise it will return a warning or error code. Passing the status code to the function "bu5828_error_message" will return a string describing the warning or error.

A driver function can return three different types of warnings or errors. The function "bu5828_error_message" will handle all three types of warning/error codes by passing them to the appropriate function if necessary ("bu3100_error_message" or "viStatusDesc"), to return the correct warning/error message.

VISA Warnings/Errors:
See section 3.3 of the VPP 4.3.2 document for a complete list of VISA status codes and their values. The VPP 4.3 document contains detailed descriptions of all VISA functions and the status codes returned by each of them.

BU3100 Warnings/Errors:
These are warning or error codes returned by the common motherboard interface library, which are used by the 5828 driver to access a ProDAQ motherboard. Warnings returned by the library will be in the range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to 0xBFFC0900. They are defined in the include file bu3100.h.

BU5828 Warnings/Errors:
Warning codes returned by the 5828 driver functions will be in the range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range 0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file bu5828.h.

6.1.5. bu5828_init

```
    ViStatus bu5828_init (ViSession masterHandle, ViBoolean IDQuery,
                          ViBoolean resetDevice, ViSession *instrumentHandle);

Purpose

    Initializes the instrument and returns an "Instrument Handle".  The
    instrument handle must be used with all of the other functions of this
    driver.

    The initialize call allows the instrument to be queried to ensure that it
    is a Bustec data acquisition system. It also resets the module to the
    power-up state if the "Reset" parameter is True (ON).

    This function interrogates the motherboard registers to ascertain in
    which locations there are function cards fitted and then checks those
    locations to identify the type of function card fitted.

    Note that for each "bu5828_init()" call, a new unique instrument handle
    is returned. Thus, if four calls are made to the initialize call in
    succession, four unique instrument handles will be returned.

    For each instrument handle returned by the "bu5828_init()" function, the
    "bu5828_close()" function should be called to free up the resources
    allocated by "bu5828_init()". The call(s) to "bu5828_close()" should be
    made before the application program terminates.

Parameter List

    masterHandle

        Variable Type       ViSession

        This control specifies the instrument handle of the master ProDAQ
        3416 function card.
        The VXI Plug&Play driver of the master function card should be
        initialized prior to this function call.

    IDQuery

        Variable Type       ViBoolean

        Specifies whether to send an ID Query to the instrument during the
        initialization procedure.

         Valid Range:   1 = Yes
                        0 = No

         Default Value: 1 - Yes

        NOTE: Under normal circumstances the ID Query ensures that the
        instrument initialized over the bus is the type supported by this
        driver. However, circumstances may arise where it is undesirable to
        send an ID Query to the instrument. In those cases, set this control
        to Skip Query and this function will initialize the bus and the
        command arrays in the driver, without doing an ID Query.

    resetDevice

        Variable Type       ViBoolean

        Specifies whether the instrument is to be reset to its power-on
        settings during the initialization procedure.

         Valid Range:   1 = Yes
                        0 = No

         Default Value: 1 - Yes

        NOTE: If you do not want the instrument reset, set this control to No
        while initializing the instrument.

    instrumentHandle

        Variable Type       ViSession (passed by reference)
```



```
The Instrument Handle is used to identify the unique session or
communication channel between the driver and the instrument.

If more than one instrument of the same model type is used, this
handle will be used to differentiate between them.

NOTE: A new (unique) handle will be returned EACH time the initialize
function is called. The bu5828_close() call should be used for EVERY
handle returned by the bu5828_init() function.


Return Value

If the function was successful, it will return a status of
VI_SUCCESS, otherwise it will return a warning or error code.
Passing the status code to the function "bu5828_error_message" will
return a string describing the warning or error.

A driver function can return three different types of warnings or
errors. The function "bu5828_error_message" will handle all three
types of warning/error codes by passing them to the appropriate
function if necessary ("bu3100_error_message" or "viStatusDesc"), to
return the correct warning/error message.

VISA Warnings/Errors:
See section 3.3 of the VPP 4.3.2 document for a complete list of
VISA status codes and their values. The VPP 4.3 document contains
detailed descriptions of all VISA functions and the status codes
returned by each of them.

BU3100 Warnings/Errors:
These are warning or error codes returned by the common motherboard
interface library, which are used by the 5828 driver to access a
ProDAQ motherboard. Warnings returned by the library will be in the
range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to
0xBFFC0900. They are defined in the include file bu3100.h.

BU5828 Warnings/Errors:
Warning codes returned by the 5828 driver functions will be in the
range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range
0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file
bu5828.h.
```

6.1.6. bu5828_readTemperature

```
    ViStatus bu5828_readTemperature (ViSession instrumentHandle,
                                     ViReal64 *temperature);

Purpose

    This function reads the temperature from the onboard ProDAQ 5828
    temperature sensors.

Parameter List

    instrumentHandle

        Variable Type       ViSession

        The Instrument Handle is used to identify the unique session or
        communication channel between the driver and the instrument.

        If more than one instrument of the same model type is used, this
        handle will be used to differentiate between them.

    temperature

        Variable Type       ViReal64 (passed by reference)

        This control returns the temperature from onboard temperature sensor
        in degrees Celsius.

Return Value

        If the function was successful, it will return a status of
        VI_SUCCESS, otherwise it will return a warning or error code.
        Passing the status code to the function "bu5828_error_message" will
        return a string describing the warning or error.

        A driver function can return three different types of warnings or
        errors. The function "bu5828_error_message" will handle all three
        types of warning/error codes by passing them to the appropriate
        function if necessary ("bu3100_error_message" or "viStatusDesc"), to
        return the correct warning/error message.

        VISA Warnings/Errors:
        See section 3.3 of the VPP 4.3.2 document for a complete list of
        VISA status codes and their values. The VPP 4.3 document contains
        detailed descriptions of all VISA functions and the status codes
        returned by each of them.

        BU3100 Warnings/Errors:
        These are warning or error codes returned by the common motherboard
        interface library, which are used by the 5828 driver to access a
        ProDAQ motherboard. Warnings returned by the library will be in the
        range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to
        0xBFFC0900. They are defined in the include file bu3100.h.

        BU5828 Warnings/Errors:
        Warning codes returned by the 5828 driver functions will be in the
        range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range
        0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file
        bu5828.h.
```


6.1.7. bu5828_reset

```
    ViStatus bu5828_reset (ViSession instrumentHandle);

Purpose

    This function resets the function card to its power-on state.


Parameter List

    instrumentHandle

        Variable Type       ViSession

        The Instrument Handle is used to identify the unique session or
        communication channel between the driver and the instrument.

        If more than one instrument of the same model type is used, this
        handle will be used to differentiate between them.

Return Value

        If the function was successful, it will return a status of
        VI_SUCCESS, otherwise it will return a warning or error code.
        Passing the status code to the function "bu5828_error_message" will
        return a string describing the warning or error.

        A driver function can return three different types of warnings or
        errors. The function "bu5828_error_message" will handle all three
        types of warning/error codes by passing them to the appropriate
        function if necessary ("bu3100_error_message" or "viStatusDesc"), to
        return the correct warning/error message.

        VISA Warnings/Errors:
        See section 3.3 of the VPP 4.3.2 document for a complete list of
        VISA status codes and their values. The VPP 4.3 document contains
        detailed descriptions of all VISA functions and the status codes
        returned by each of them.

        BU3100 Warnings/Errors:
        These are warning or error codes returned by the common motherboard
        interface library, which are used by the 5828 driver to access a
        ProDAQ motherboard. Warnings returned by the library will be in the
        range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to
        0xBFFC0900. They are defined in the include file bu3100.h.

        BU5828 Warnings/Errors:
        Warning codes returned by the 5828 driver functions will be in the
        range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range
        0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file
        bu5828.h.
```

6.1.8. bu5828_revision_query

```
ViStatus bu5828_revision_query (ViSession instrumentHandle,
                                ViChar driverRevision[],
                                ViChar instrumentFirmwareRevision[]);
```

Purpose

Returns information about the hardware and software revisions.

Parameter List

instrumentHandle

Variable Type ViSession

The Instrument Handle is used to identify the unique session or communication channel between the driver and the instrument.

If more than one instrument of the same model type is used, this handle will be used to differentiate between them.

driverRevision

Variable Type ViChar[]

Returns the instrument driver revision.

instrumentFirmwareRevision

Variable Type ViChar[]

Returns firmware revision string.

Return Value

If the function was successful, it will return a status of VI_SUCCESS, otherwise it will return a warning or error code. Passing the status code to the function "bu5828_error_message" will return a string describing the warning or error.

A driver function can return three different types of warnings or errors. The function "bu5828_error_message" will handle all three types of warning/error codes by passing them to the appropriate function if necessary ("bu3100_error_message" or "viStatusDesc"), to return the correct warning/error message.

VISA Warnings/Errors:
See section 3.3 of the VPP 4.3.2 document for a complete list of VISA status codes and their values. The VPP 4.3 document contains detailed descriptions of all VISA functions and the status codes returned by each of them.

BU3100 Warnings/Errors:
These are warning or error codes returned by the common motherboard interface library, which are used by the 5828 driver to access a ProDAQ motherboard. Warnings returned by the library will be in the range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to 0xBFFC0900. They are defined in the include file bu3100.h.

BU5828 Warnings/Errors:
Warning codes returned by the 5828 driver functions will be in the range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range 0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file bu5828.h.

6.1.9. bu5828_serialNumber

```
ViStatus bu5828_serialNumber (ViChar subversion[], ViInt32 *serialNumber,
                              ViSession instrumentHandle);
```

Purpose

This function returns the ProDAQ 5828 device subversion and serial number.

Parameter List

subversion

Variable Type ViChar[]

This parameter returns the ProDAQ 5828 subversion in the form of a string, i.e., "AA" or "AB".

serialNumber

Variable Type ViInt32 (passed by reference)

This parameter returns the serial number of the ProDAQ 5828.

instrumentHandle

Variable Type ViSession

The Instrument Handle is used to identify the unique session or communication channel between the driver and the instrument.

If more than one instrument of the same model type is used, this handle will be used to differentiate between them.

Return Value

If the function was successful, it will return a status of VI_SUCCESS, otherwise it will return a warning or error code. Passing the status code to the function "bu5828_error_message" will return a string describing the warning or error.

A driver function can return three different types of warnings or errors. The function "bu5828_error_message" will handle all three types of warning/error codes by passing them to the appropriate function if necessary ("bu3100_error_message" or "viStatusDesc"), to return the correct warning/error message.

VISA Warnings/Errors:
See section 3.3 of the VPP 4.3.2 document for a complete list of VISA status codes and their values. The VPP 4.3 document contains detailed descriptions of all VISA functions and the status codes returned by each of them.

BU3100 Warnings/Errors:
These are warning or error codes returned by the common motherboard interface library, which are used by the 5828 driver to access a ProDAQ motherboard. Warnings returned by the library will be in the range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to 0xBFFC0900. They are defined in the include file bu3100.h.

BU5828 Warnings/Errors:
Warning codes returned by the 5828 driver functions will be in the range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range 0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file bu5828.h.

6.1.10. bu5828_setChannelConf

```
    ViStatus bu5828_setChannelConf (ViSession instrumentHandle, ViInt16 channel,
                                    ViInt16 gain);

Purpose

    This function configures the gain of specified channel or all 16
    channels.

Parameter List

    instrumentHandle

        Variable Type       ViSession

        The Instrument Handle is used to identify the unique session or
        communication channel between the driver and the instrument.

        If more than one instrument of the same model type is used, this
        handle will be used to differentiate between them.

    channel

        Variable Type       ViInt16

        This parameter specifies which channel will be configured.

        Possible values are:

        bu5828_CH_1 to bu5828_CH_16   1-16

        or

        bu5828_CH_ALL   0   All available channels will be configured
                            with the same parameters.

    gain

        Variable Type       ViInt16

        This parameter specifies value of the gain.

        Possible values are:

        bu5828_GAIN_1           1        -  gain 1
        bu5828_GAIN_10          10       -  gain 10
        bu5828_GAIN_100         100      -  gain 100
        bu5828_GAIN_1000        1000     -  gain 1000


Return Value

        If the function was successful, it will return a status of
        VI_SUCCESS, otherwise it will return a warning or error code.
        Passing the status code to the function "bu5828_error_message" will
        return a string describing the warning or error.

        A driver function can return three different types of warnings or
        errors. The function "bu5828_error_message" will handle all three
        types of warning/error codes by passing them to the appropriate
        function if necessary ("bu3100_error_message" or "viStatusDesc"), to
        return the correct warning/error message.

        VISA Warnings/Errors:
        See section 3.3 of the VPP 4.3.2 document for a complete list of
        VISA status codes and their values. The VPP 4.3 document contains
        detailed descriptions of all VISA functions and the status codes
        returned by each of them.

        BU3100 Warnings/Errors:
        These are warning or error codes returned by the common motherboard
        interface library, which are used by the 5828 driver to access a
        ProDAQ motherboard. Warnings returned by the library will be in the
        range 0x3FFC0800 to 0x3FFC0900 and errors in the range 0xBFFC0800 to
        0xBFFC0900. They are defined in the include file bu3100.h.
```



```
BU5828 Warnings/Errors:
Warning codes returned by the 5828 driver functions will be in the
range 0x3FFC0B00 to 0x3FFC0FFF and error codes in the range
0xBFFC0B00 to 0xBFFC0FFF. They are defined in the include file
bu5828.h.
```

7. Specifications

Available Versions

Versions	5828-AA 16-channel Isolation Amplifier Signal Conditioning Card

Signal Conditioning

Input Coupling	DC
Input ranges	±10V, ±1V, ±0.1V, ±0.01V
Gain	1, 10, 100, 1000
Gain Error	Gain 1, ±0.03% typical, ±0.05% max.
Offset Error	Gain 1, ±0.5mV typical, ±1.4mV max.
Input Bias Current	±25nA typical
IMRR	Gain 1: -120dB typ. at 50Hz, -100dB typ. at 1kHz Gain 10: -130dB typ. at 50Hz, -120dB typ. at 1kHz
Effective Input Noise 20kHz Bandwidth	Gain 1: 140µVrms Gain 100: 5µVrms
Gain Nonlinearity	±0.005% typical
THD	Gain 1: -75dBc typical (1Vrms) Gain 100: -65dBc typical
SNR	Gain 1: 88dB typical, 80dB min. Gain 100: 64dB typical, 62dB min.
SINAD	Gain 1: 65dB typical, 63dB min. Gain 100: 62dB typical, 59dB min.
Crosstalk, ch. to ch.1kHz	-96dB typical
Slew Rate	2V/µs typical
Full Power Bandwidth	50 kHz
Input Protection	±30VDC

Maximum Working Voltage

Maximum working voltage is the highest r.m.s. value of the AC or DC voltage across the particular isolation barrier which is allowed to occur during operating conditions. The maximum working voltage includes usable signal voltage plus the common mode voltage with respect to the ground.

Isolation	**Maximum Working Voltage**
Channel to Earth	350 V_{RMS} Category II, pollution degree 2
Channel to Channel	350 V_{RMS} Category II, pollution degree 2

Caution

When hazardous voltages (higher than 42.4 V_{AC} peak or 60 V_{DC}) are present on any channel, all channels are considered hazardous. Ensure that external wiring or any circuits connected to the device are properly insulated from human contact.

Environmental Specifications

Temperature	5 °C to +40 °C (operational) -40 °C to +70 °C (storage only)
Humidity	5% - 95% (non-condensing)
Warm-up Time	30 minutes minimum.
Recommended Calibration Period	Annual
Maximum altitude	2000 meters

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