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## 2. Introduction

The Beam BMeasure-125i unit is a flexible and powerful IoT data acquisition system for data capture,

data logging and control in the laboratory, industrial and remote sensing arenas. It is based around an 8 channel, fully differential, synchronous sampling, 24 bit ADC that can sample at speeds up to 128 ksps. Multiple units can be connected together to provide more synchronously sampled channels.

Operating as a data acquisition unit the system can capture the data from 8 analogue and 8 digital channels to a host computer over the USB, Ethernet, Wifi or RS-485 interfaces. Operating as a data logger, the system can autonomously sample and store the data to internal non-volatile FLASH storage or external Micro SDCARD for later data retrieval.

Data can be scaled and offset to floating point values with channel names and measurement units configured. The system is also able to perform a degree of processing on the raw sample data stream. This includes calculating the RMS, Mean, PeakHigh and PeakLow values for all of the channels over a set time period. Alarms can be triggered when a channels value goes out of range etc.

The unit is low power and has flexible power supply inputs. Options include 5-24V DC input, USB-5V, power over Ethernet and battery operation for remote monitoring applications. A 3G/4G mobile communication option is also available for such remote sensing applications (Contact us for more information).

IoT MQTT direct cloud access via the Internet is a configurable feature. The system also supports custom on-board programs allowing the unit to perform autonomous control functions for many uses. Please contact us for further information.

The unit can be configured to capture signals at up to 128 ksps. This is useful for acoustic, vibration and general electronic signal capture. It can also sample down to 1 sample per day for lower speed measurements such as temperature, humidity or other similar slow changing parameters.

### 3. Safety Instructions

This section contains important safety instructions that you must follow when operating the BMeasure-125i. Please read the following before using this equipment.

#### 3.1. Intended Purpose

- The BMeasure-125i is intended for capturing, processing, logging and communicating signals from low voltage sensors.

#### 3.2. Operating Environment

- Location: Installed in a dry location.
- Relative humidity: 15 to 85%
- Operating Temperature range: -10 to +40 degrees C
- Pollution Degree: The BMeasure-125i is designed to operate at pollution degree 2.

#### 3.3. Power Supplies

The unit should be supplied with electrical power by one of the following means:

- An isolated 5 – 24V DC power supply through the DC power input connector. Current must be limited provide to a maximum of 12W. The recommended power source is a DC power input at 12V and current limited to 1A.
- A 5V USB power supply with a 2 Amp current limit.
- A 50V Power over Ethernet supply with a 200 mA current limit.

#### 3.4. Isolation and Grounding

The unit is designed to directly measure voltages of up to  $\pm 30$  Volts. When connecting to systems that operate with higher voltages careful consideration needs to be made of the isolation and grounding of the overall measuring system.

#### 3.5. Storage Environment

- Location: Indoors or waterproof enclosure.
- Relative humidity: 15 to 85%
- Storage Temperature range: -40 to +85 degrees C

## 4. Operational Modes

The BMeasure-125i is a flexible and powerful measuring system. It can operate in one of three major modes:

- **Host Controlled Mode:**

In this mode the BMeasure unit is controlled by a host computer over one of its communication interfaces such as USB. A user or program running on the host can instigate measurements and capture data from the system. The digital IO lines can be read or written to, the relays can be operated and the switch inputs read etc. In effect it can act like a high specification data acquisition plug in card with the benefits of no card bus plug in or software driver issues, has remote location ability, supports multiple units per host computer etc. A set of host applications and an API access library is provided allowing easy control from C++, Python or Matlab programs.

- **Autonomous Mode:**

In this mode the unit has been programmed to take measurements periodically on its own. The results of the measurements can be logged into its data log store. If a network communication interface is available it can communicate measurements to a cloud server and send alarm conditions. Portions of, or all of, the stored data files can be downloaded over the network.

- **Program Mode:**

In this mode the system can run simple custom programs locally. This is an extended form of the autonomous mode that allows the user to program a measurement sequence and carry out simple actions based on the results of these. For example this could be used in a test environment to provide a go/no-go result. Please contact us for information on customisation services.

For some applications, such as laboratory use with high speed acoustic sensors or other such fast varying signals, the unit will be used with sample rates of up to 128 ksps. In this case the raw data stream would likely be stored in a host computers file for later processing or perhaps processed on the fly by a host computer. Typically the Host Controlled mode would be used for this type of application or perhaps the Autonomous data logging mode. The host interface would need to be able to keep up with the data rate needed. For 128ksps a 40 Mbits/s near real time interface is needed so this would normally rule out Internet connections and certainly most typical cloud communications schemes.

For many other applications a much slower sample rate, perhaps around 1 sps is needed, such as for temperature sensors. In this case the measurements can be processed internally and perhaps sent over the Internet to a cloud computer using the MQTT protocol for example. The system supports the processing of the raw sample data to provide RMS, Mean, PeakHigh and PeakLow values for each of its channels over a programmable period.

## 5. Data Acquisition

The BMeasure-125i unit is a flexible unit that can perform analogue signal sampling at up to 128 ksps. This fast sampling speed is ideal for fast changing measurements such as acoustic, vibration etc. However it is overkill for slower changing measurements such as temperature for which one sample per second or lower is best.

As well as providing the raw data at the full sampling speed the BMeasure-125i is able to process these fast data streams to produce measurements at slower rates. The fast sampled data is filtered and processed over a programmable time to produce the Processed Data. The effective oversampling and filtering used can often increase the effective ADC resolution and hence signal to noise ratio. The processed data yields the following parameters for each analogue channel:

<i>Parameter</i>	<i>Description</i>
Mean	The mean value of the raw data samples
RMS	The root mean square amplitude of the raw data samples
PeakHigh	The peak positive going signal level
PeakLow	The peak negative going signal level

These parameters are produced at the Processed Data sample rate. This can be programmed as desired or can be the time between measurement requests from an external system.

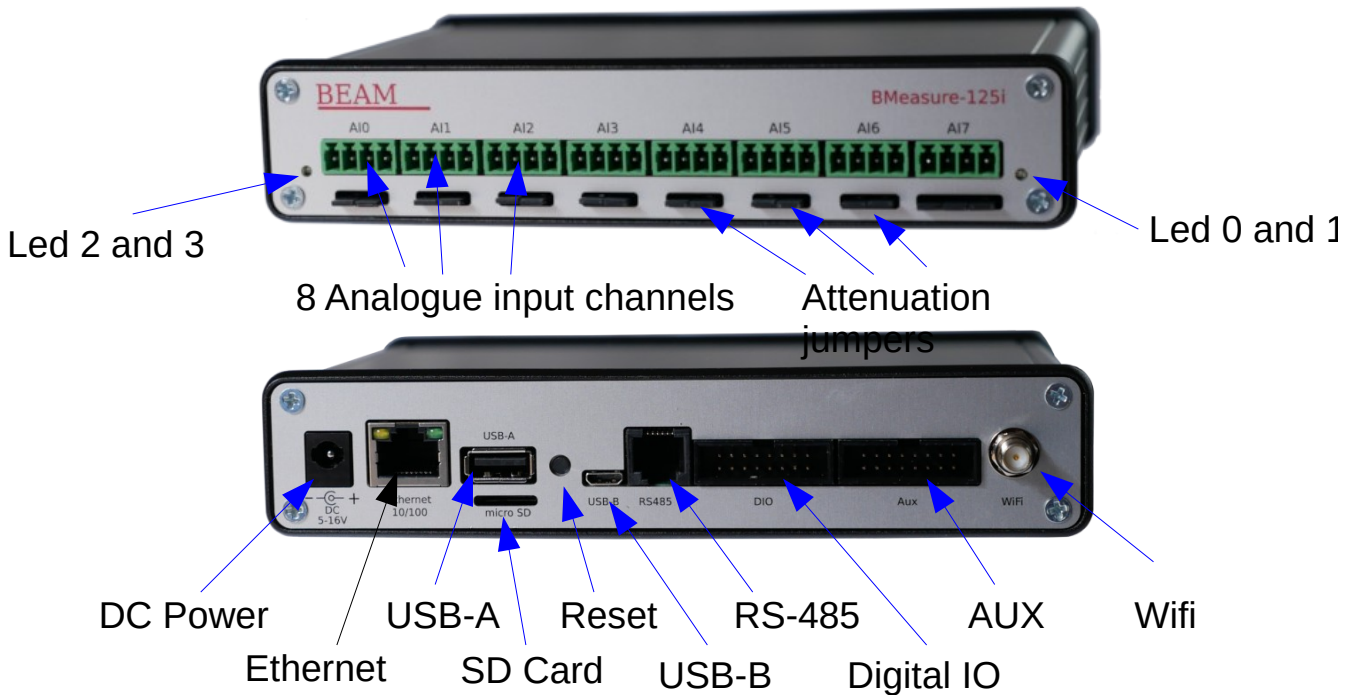
The values can be accessed using the BMeasure-gui application, the bmeasure-lib host API or the HTTP interface.

## 6. Basic Usage

The BMeasure-125i is a flexible measurement tool that can be used in a wide variety of applications. It is like a Swiss army knife of data acquisition, logging and control for a variety of applications where up to a 128ksps sample rate is sufficient. This manual will cover some basic measurement scenarios to help you become familiar with the device's functionality and our WEB based resources at <https://www.beam.ltd.uk/products/bmeasure-125i/> provide further information.

Usage will generally be explained by reference to using the system in a Host Controlled Mode via the **bmeasure-gui** user interface application although the functionality is also available using the command line and API libraries as well.

Please see the section: [7. Host Software Installation](#) for information on installing the host software.



## 6.1. Powering the Unit

The unit can be powered from the following sources:

- **USB-B Connector:**  
A USB 2.0 lead can connect to a host computer directly or via a powered USB hub. For stand alone operation a 5V USB battery supply may also be connected to this connector.
- **DC Jack:**  
This input supports a voltage of between 5 and 24 Volts.
- **Ethernet PoE (IEEE 802.3af):**  
The unit can be connected to a Power over Ethernet switch to provide its operational power.
- **RS-485:**  
Two lines of this 6 wire interface can be used to supply a voltage of between 5 and 24 Volts.

## 6.2. Connecting to the Unit

The unit can be connected to a host computer via one of the following interfaces:

- **USB-B 2.0:** This provides both power and communications abilities. It offers a 480 Mbits/s interface when plugged into a USB 2.0 or greater host or USB hub. This interface can handle BMeasure-125i data capture across all inputs at the full 128 ksp/s.
- **Ethernet 10/100:** This provides communications abilities and can also provide power. It offers a 100 MBits/s interface when plugged into a suitable 100 Mbps or faster Ethernet switch and host Ethernet port. This interface can handle capture at the full 128 ksp/s.
- **WiFi:** This interface provides communications at up to 10 Mbps depending on the WiFi operating distance, the amount of WiFi traffic present and the receiving WiFi units capabilities. Because of the limited data bandwidth, in a data streaming mode the unit will need configuration to capture at

a maximum speed of 16 kbps assuming a good Wifi signal with low sharing of the 2.4 GHz Wifi frequencies in use.

## 6.3. Connecting Sensors

Various sensors can be connected to the analogue inputs. Please refer to the Analogue inputs and Sensor interfacing sections of this manual for more details.

## 7. Host Controlled Mode: Capturing Data with *bmeasure-gui*

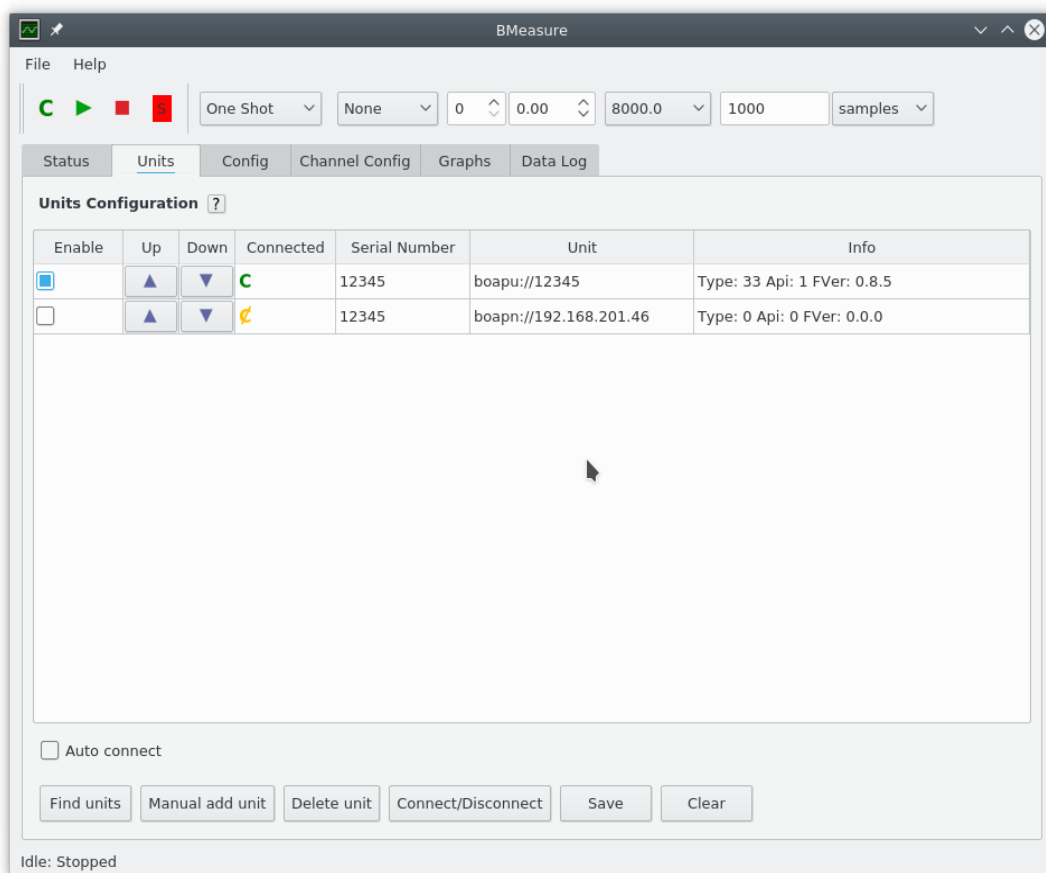
This section assumes the unit is connected to a host PC via the USB interface and uses the *bmeasure-gui* application to demonstrate a host computer driving the data capture process.

Once the BMeasure host software has been installed and a BMeasure unit is plugged in via a USB port or connected to the Ethernet LAN then the *bmeasure-gui* program can be started from the system's desktop menus or command line.

For experimenting with the unit the internal AWG signal generator can be fed into analogue channel 7's input. Make sure all jumpers are installed in the AI7's jumper block and enable the AWG to produce, say, a 100Hz sine signal and 5V amplitude.

### 7.1. Selecting the BMeasure unit or units

The system supports multiple BMeasure units that can be either used individually or linked together to perform a synchronous capture of up to 32 analogue and 32 digital channels.



When the *bmeasure-gui* application starts you can scan the USB bus and local Ethernet and Wifi



networks for any BMeasure units and list any found using the “Find Units” button. These units can then be enabled for use using the Enable checkbox. If more than one unit is to be used in a synchronised fashion then multiple units can be enabled. They will need a synchronisation cable connected between them for this purpose and the first (top) unit in the unit list will be used as the master unit.

Before using a single or group of units it is necessary to *Connect* to the units using the “C” button on the toolbar or the “Connect/Disconnect” button.

If the *Auto connect* checkbox is checked then the program will automatically connect to the enabled units when the application is started.

The *Save* button saves the units configuration for the next run of bmeasure-gui.

## 7.2. Performing a Data Capture

Once unit or units are connected, data capture can be started using the toolbar green triangular “Run” button. The measurement process can be configured using the toolbar parameters or via configuration parameters located in the “Measurement Config” option in the “Config” tab. Parameters available include:

- **Measure Mode:** This sets the overall measurement mode. It can be one of the following:
  - **One Shot:** Captures a single set of samples defined by the smallest of the “Chunk Duration” or “Capture Duration” parameters and after the trigger if this is configured.
  - **Repeat:** This performs multiple One Shot data captures of “Chunk Duration” triggering at the start of each separate capture if triggering is configured. If the “Repeat Period” parameter is non zero, then the system will wait this number of seconds between each capture.
  - **Continuous:** Captures samples continuously until the number of samples in “Capture Duration” have been sampled. If “Capture duration” is 0 then the unit will continuously capture until stopped. The unit will display “Chunk Duration” samples at a time in graph displays. Triggering, if set, will only occur at the start of the continuous capture.
- **Trigger Mode:** This enables triggering and the selection of a positive or negative going trigger.
- **Trigger Channel:** This defines the channel number to trigger from.
- **Trigger Level:** The signal level at which the trigger will occur. Set this to 0.5 for digital channels.
- **Trigger Delay:** The delay after the trigger event to start capturing and perhaps storing data.
- **Sample Rate:** The sample rate.
- **Chunk Duration:** Duration of each chunk captured and displayed. This can be entered as the number of samples or a time.
- **Capture Duration:** In Repeat or Continuous modes this defines to total number of samples to be captured. This can be entered as the number of samples or a time.
- **Repeat Period:** In repeat mode this sets the time, in seconds, between each repeated capture of a set of samples.
- **Data Processing:** When enabled the unit will calculate the RMS, Mean, PeakHigh, PeakLow and possibly the Power values of the raw data samples. These will be calculated over the period as defined in the “Data Process Duration” parameter. The results can be displayed or saved to a file.
- **Data Process Duration:** When data processing is enabled, the raw data samples are processed over the process duration period and will yield a set of processed data sample. The fastest rate supported is 10Hz. The resulting processed data samples can be displayed (in the Processed TAB)

and/or saved to a file.

- **Description:** This provides the ability to enter a short description for the measurement that will be stored in the data files.

There are three buttons that are used to set different standard configurations:

- **Set fast raw data mode:** This sets the sampling rate to 128000 SPS and performs a one shot data capture of 1000 samples.
- **Set processed data mode:** This sets the sampling rate to 1000 SPS and performs a one shot data capture of 1000 samples processing them to yield one set of processed data samples. So 1 second overall sampling time.
- **Set continuous processed data mode:** This sets the sampling rate to 1000 SPS and performs a continuous data capture processing 1000 samples at a time to yield one set of processed data samples every second.

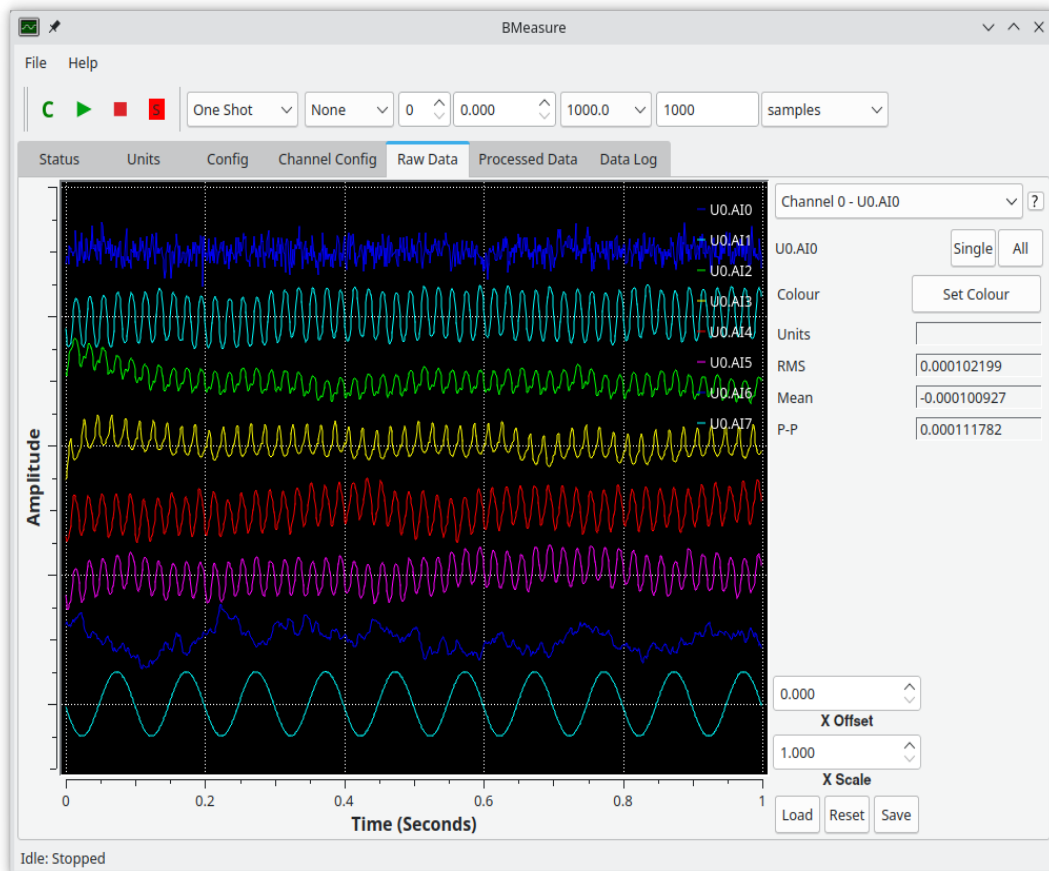
The **Save** button saves the settings into the BMeasure unit.

The **Read** button reads the settings from the BMeasure unit.

The Measuring Status icon on the toolbar indicates the status of the measurement by changing its text and colour. Red with an “S” means stopped, Yellow with a “T” is awaiting a trigger and Green with an “R” is capturing data.

## 7.3. Viewing Waveform Data

The Graphs tab enables the viewing of the captured data in graphical form from one or more channels.

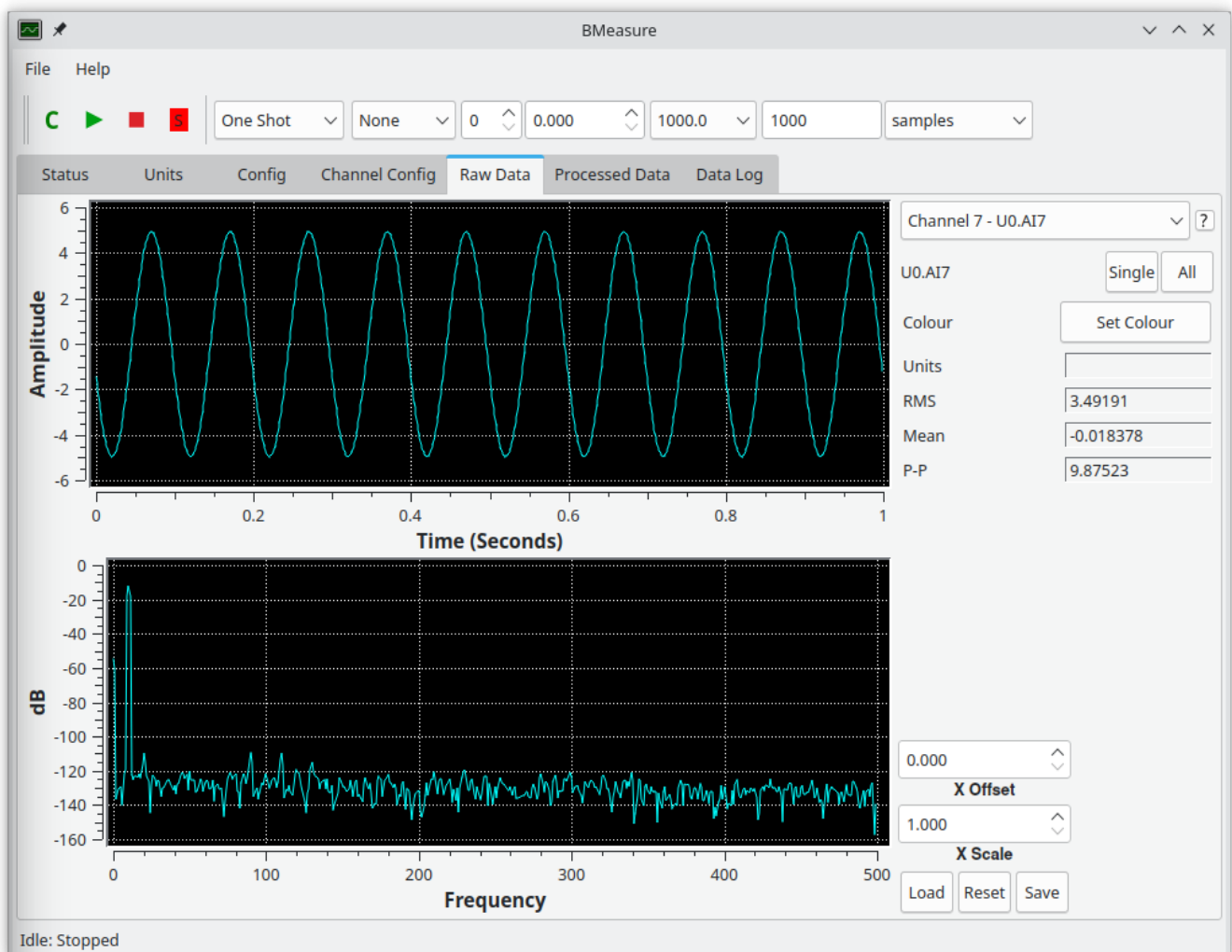


When showing more than one channel the graph display is as shown above. By default each channel is offset vertically by its channel number with channel 0 being at the top and autoscaled to fit in a +- 1 space. The amplitude parameters RMS, Offset and Peak to Peak are shown in the right hand panel along with display controls. At the top of this panel is a channel selector that allows the control and data for a particular channel to be viewed or measurement values for all data channels.

By default the amplitude is autoscaled, but the “Auto” toggle can be used to enable manual offset and scale on each channel. The knob like controls can be moved by clicking and dragging them around or once selected the mouse wheel or keyboard arrows will change the value. For the amplitude Y axis there is a Y Offset and Y Scale control per channel. The colour of each trace can be changed with the “Set Colour” button.

There is an X Scale and X Offset that applies to all of the channels. Underneath these are buttons to Load, Reset and Save the settings.

If the “Single” button is clicked the defined channel will be shown on its own with an FFT power spectrum displayed.



The upper graph shows the time domain captured sample values while the lower graph show the frequency spectrum in dB.

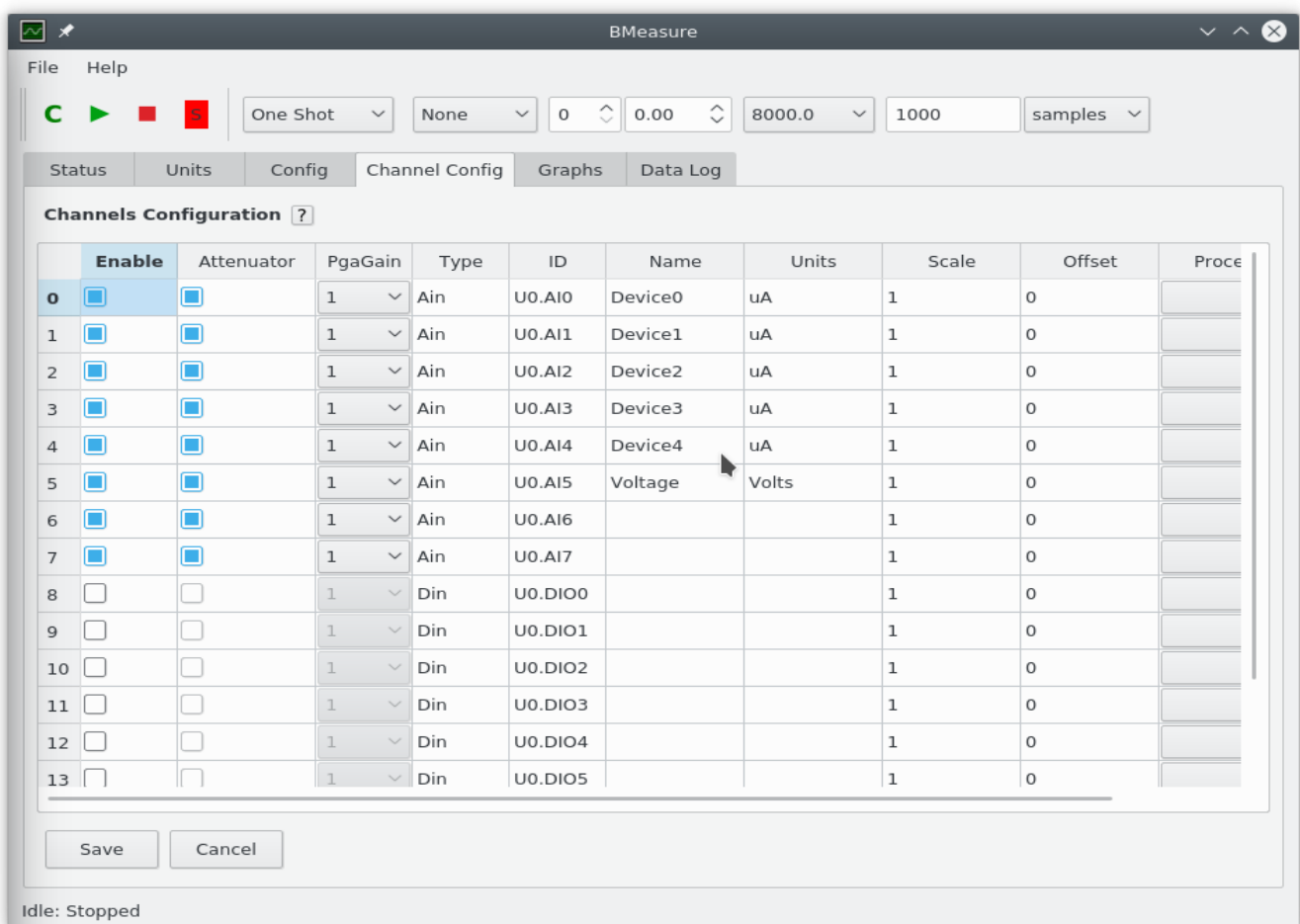
## 7.4. Storing the data in a file

When operated via USB or Ethernet the *bmeasure-gui* application can save the live captured data directly to a file. Using the **bmeasure-gui**, the configuration for file operations can be found under the “Config” tab’s “Measurement File Save Config” area. Tick the “Save data to file” checkbox in the “Measurement Config” items to save data. The “File name” field supports an optional variable `%{datetime}` that can be included in the file name to date and time-stamp the files. File types supported are:

- `csv_with_header` – comma separated values with initial column header.
- `csv` – comma separated values.
- `bmeas` – BMeasure native format. Access to data via a supplied API library and programs.
- `tdms` – National Instruments (Technical Data Management Streaming)

## 7.5. Channel Configuration

The BMeasure units capture channels can be configured from the Channel Config tab.



The Channels configuration is saved in the BMeasure units non volatile memory when the Save button is clicked. The following parameters are provided:

- **Enable:** Enable this channel for display. All channels data is always saved regardless of this

setting.

- **Attenuator:** This check box should be ticked when the channels jumpers are installed to include a 10x attenuation on the input signal.
- **PgaGain:** This sets the channels front end amplifiers gain to 1, 2, 4 or 8. This is useful when signals smaller than the ADC's normal full scale range are being measured.
- **Type and ID:** These read only fields define the channels type and internal ID.
- **Name:** This provides a user configurable name for the channel.
- **Units:** This allows the user to specify the SI units of the measured data.
- **Scale:** By default the unit is calibrated to provide channel data scaled to the voltage seen at its inputs. The Scale parameter allows the user to scale this value based on the sensor and any pre-processing circuits.
- **Offset:** This allows the user to offset the channels data as needed. This offset is applied before the Scale value.
- **Process:** This is set to one of several possible data processing algorithms. These include platinum resistance temperature sensor linearisation etc.

The digital input channels are also configured here but do not have the attenuator or PgaGain options.

## 7.6. General Configuration

The Config tab allows various configuration parameters to be viewed and changed. There are a number of separate sections. These include:

- **Measurement Config:** This set of parameters define a measurement.
- **Measurement File Save:** These parameters define the file and its format to save captured data to on the host computer.
- **AWG Config:** This defines the configuration of the internal arbitrary waveform generator that outputs its signal onto the two analogue output channels.
- **BMeasure-125i General Config:** These parameters define the run time mode of the BMeasure-125i unit. It also provides functions to perform a factory reset, calibrate the DC offsets on the analogue channels and set the units time from that of the host computer.
- **BMeasure-125i Network Config:** These parameters define Ethernet network settings.
- **BMeasure-125i Wifi Config:** These parameters define Wifi network settings.
- **BMeasure-125i Firmware:** This provides information on the various firmware components within a BMeasure-125i unit as well as the units time.
- **BMeasure-125i Alarms:** These parameters define Alarm settings.
- **BMeasure-125i MQTT:** These parameters define The MQTT server parameters.

## 7.7. Other Modes

This section has provided an overview of the usage of a BMeasure unit in a typical host controlled mode. It can also be used in a standalone data logging mode and in a standalone control mode. See the other sections in this manual and on our website for more information on these mode and for more detail of the units capabilities. The [BMeasure-gui-manual.pdf](#) manual provides more detail on the operation of the BMeasure-gui application and is available directly from the BMeasure-gui application.

## 8. Host Software Installation

The host software is available for Linux and Microsoft Windows platforms. It has three main components:

- **bmeasure-gui:** A graphical application to control and view sampled data of one or more BMeasure units.
- **bmeasure-cmd:** A simple command line program to control and download sampled data of one or more BMeasure units.
- **bmeasure-data:** A simple command line program to view meta data in a BMeasure bmeas format data file and convert its contents to another format.
- **bmeasure-lib:** An API library that can be used by a program to control and capture sampled data from one or more BMeasure units. This has C++, Python and Matlab interfaces.

### 8.1. Installation on Linux Systems

Currently supported are Redhat, Centos and Fedora RPM based systems and Ubuntu DPKG systems. To install the software, download the appropriate latest RPM from our release directory and install with your package manager of choice. A simple command line install for a Fedora 37 system would use “dnf” as follows:

```
dnf install bmeasure-1.1.1-1.beam.fc37.x86_64.rpm
```

Once installed there will be a menu entry to the *bmeasure-gui* application in the desktop’s Electronics menu. The BMeasure programs will be installed in /usr/bin so so you can run the *bmeasure-gui* and *bmeasure-cmd* programs from a command shell window.

### 8.2. Installation on Microsoft Windows Systems

64bit versions of Microsoft Windows 10 are supported. To install the software download and execute the appropriate latest *bmeasure-<version>-win64-setup.exe* installation file from our release directory.

Once installed there will be a BMeasure folder within the applications menu and a link to the *bmeasure-gui* application on the desktop. The default path for installation is “C:/Program Files/BMeasure”. The path to the BMeasure program directory will be set so you can run the *bmeasure-cmd* and *bmeasure-data* programs from a command prompt window.

## 9. BMeasure-lib Host API Library

As part of the host software, we provide a C++ and Python3 compatible API library to allow host programs to access BMeasure-125i units. The *bmeasure-lib* documentation provides information on this.

## 10. HTTP WEB HTML and JSON-RPC API

The BMeasure-125i provides a conventional HTTP protocol API interface over the network interfaces via the network ports 80 and 433. This interface can be accessed using a conventional WEB browser to configure BMeasure-125i units and read data from them. The JSON-RPC API provides a simple method of fetching the Processed Data data from the systems for simple slow speed applications. This API’s is documented in the BMeasure-http-api manual.

## 11. Autonomous Mode

In this mode the BMeasure-125i unit can be configured to startup and run continuous measurements

storing the data into its FLASH data log and/or communicating its measurements to a host over the local network or Internet.

## 12. Program Mode

In this mode the BMeasure-125i unit can be configured to startup and run an internal program to perform measurements, process the results and communicate its measurements or flag events to a host over the local network or Internet.

Please contact Beam for more information on writing custom firmware for this purpose.

## 13. Alarms

There are 8 alarms that can be configured, one for each analogue input channel. Each alarm can be set to trigger on an input channel going above or below a programmed level. Once an alarm has been triggered it stays set until cleared.

When an alarm is triggered it will send an appropriate MQTT message if an MQTT server has been configured. An alarm can also drive one of the digital IO lines high or low or operate one of the two relays. The processed data contains information on the state of the alarms for each channel.

The alarm configuration page has one row per each of the 8 possible alarms, one for each analogue input channel. Each as the following settings:

- **Mode:** This specifies the mode of this alarm It can be set to
  - **Off:** Disables this alarm
  - **High:** Triggers when the measured value is greater than the “Level High” programmed value.
  - **Less:** Triggers when the measured value is less than the “Level Low” programmed value.
  - **Range:** Triggers when the measured value is outside the specified range specified in the “Level High” and “Level Low” range.
  - **Magnitude:** Triggers when the magnitude of the measured value (both positive and negative) is greater than the value specified in the “Level High” programmed value.
- **Level Low:** Low alarm point value.
- **Level High:** High alarm point value
- **Output Mode:** This sets the output mode of the alarm.
  - **None:** drives no outputs, but will send MQTT messages if MQTT is configured,
  - **DIO High:** Sets the programmed digital output channel high on an alarm.
  - **DIO Low:-** Sets the programmed digital output channel low on an alarm.
  - **Relay On:** Enables the relay number as set in the “Output Channel” field
  - **Relay Off** - Disables the relay number as set in the “Output Channel” field.
- **Output Channel:** The DIO output channel or relay number to set on the alarm being triggered.

An alarm condition can be cleared using the bmeasure-gui program, the BMeasure API, the HTTP/HTML WEB interface or the HTTP/JSON interface.

## 14. MQTT Cloud Access

The system can send messages to a MQTT (MQ Telemetry Transport) server to be configured to receive alarms and/or data. It has the following configurable parameters:

- **MQTT Mode:** This sets the MQTT mode.
  - **Off:** - Disables MQTT,
  - **On Alarm:** - Sends an MQTT message when an alarm is triggered or cleared.
  - **On Data:** Sends a packet of data when available (typically once per second).
- **MQTT Server:** This is the host name or IP network address of the MQTT broker server.
- **MQTT Server Port:** This is the network port of the MQTT broker server to use. By default this is 1883.

The MQTT Configuration page has a **Save** button to save the configuration and a **Cancel** button to reset the changes made.

## 15. Connections

### 15.1. Power Supply

#### 15.1.1. DC Power Supply

The DC jack socket accepts a 5.5 mm diameter barrel with 2.1 mm diameter pin DC jack plug. The unit will accept a DC voltage between 5 Volts and 24 Volts on this connector. The typical operating power is below 2W. Power can be provided by a AC/DC mains power adapter or a suitable current limited battery pack. The recommended input power limit is 12W.

The unit supports the use of a latching DC power plug, the Cliff FC6814785 <http://www.cliffuk.co.uk> . These plugs can be purchased with pre-moulded cable.

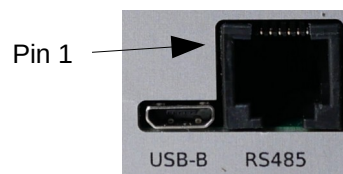
#### 15.1.2. USB Power Supply

The Micro USB-B connector can supply 5 Volt DC power to the unit. A typical operating current is below 400 mA. This enables the unit to be run from a standard PC's USB-A connector, the only connection being USB. For unattended logging applications a USB battery power unit can be connected.

#### 15.1.3. Power Over Ethernet (PoE) Power Supply

The system supports powering using the power over Ethernet via the RJ45 Ethernet connector. A suitable IEEE 802.3af PoE compliant network switch should be used to provide this power.

#### 15.1.4. RS-485 Power Supply



Pins 1,2 and 5,6 are used to provide power to the unit. A power limited DC supply of between 5 volts and 24 Volts, maximum power 12W can be connected to these pins:



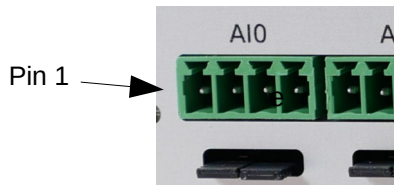
<i>Pin</i>	<i>Name</i>	<i>Description</i>
1	Power	DC Power input 5 – 24 Volts
2	Power	DC Power input 5 – 24 Volts
3	D-	RS-485 D+ signal
4	D+	RS-485 D- signal
5	Ground	Power and signal ground
6	Ground	Power and signal ground

The connector in the BMeasure unit is a RJ12 Cat3, 6P6C modular Jack Amphenol 54601-906WPLF. Suitable plug-in connectors are RJ12 Plugs 6P6C selected for cable type.

## 15.2. Analogue Inputs

The unit has 8 analogue input channels (AI0-AI7). Each input has a 4 pin connector that has fully differential input signals along with ground and a +5V power line. The input system allows many different types of sensor such as platinum resistance temperature sensors, thermistors, thermocouples, strain gauges, vibration sensors, audio signals etc. to be directly connected to the system. A conventional 3.81mm (Wurth 691361300004 ) plug-in screw terminal connector can be used to directly interface to some sensor types wires. Dedicated measurement probes and a customisable PCB/wire interface connector allowing components to be added to the front end analogue electronics are also available.

Note that the analogue inputs are not isolated. The ground connection is connected to the USB and other power sources ground line and the case. When powering with a DC jack AC supply, the Power over Ethernet supply, a battery or another such source and using Ethernet as the communications system the units ground can be floating.



<b>Pin</b>	1	2	3	4
<b>Signal</b>	Gnd	AI-	AI+	+5V

The analogue inputs have two jumper selectable ranges, a direct to ADC  $\pm 1.25$  Volt range high impedance input offering the best performance and an attenuated  $\pm 12.5V$  range with a  $180\text{ k}\Omega$  input impedance. The jumpers are situated beneath each analogue input port:

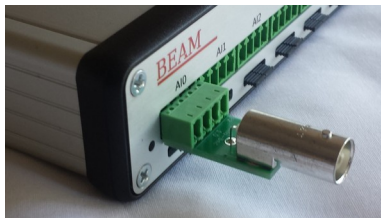
<i>Input Channel</i>	<i>Jumper Configuration</i>
AI0-AI6	No jumpers installed: input $\pm 1.25V$ Both installed: $\pm 12.5V$

AI7	No jumpers input: $\pm 1.25V$ Jumpers one and two installed: $\pm 12.5V$ . Jumper three routes the AWG output AO0 into the input AI7.
-----	---------------------------------------------------------------------------------------------------------------------------------------------

As well as the jumper selectable attenuator, the analogue input system has a programmable gain pre-amplifier with 1x, 2x, 4x and 8x gains adapting the analogue input range to optimise ADC resolution. This gain is selectable under software control.

These ranges can be extended with passive or active front-end circuits on a small PCB that can be plugged in to each port.

Note that the Common Mode voltage between 0V and the ADC inputs should be limited to a maximum of 1.25V or 12.5V depending on the jumper setting. The system is protected for around a  $\pm 40$  Volts input on these pins.



An optional front-end plug-in BNC adapter for BNC leads and oscilloscope probe usage is available.

Analogue input channel 7 has an extra jumper position to the right. This will enable the output of analogue output 0 to be fed directly into analogue input channel 7. This is for special purposes including LCR component bridge measurements and transfer function measurements. It allows the signal from analogue output channel to be sent through a component, component bridge or system and the result fed back to an analogue input channel such as AI0. The measurement system can now use the actual measured output signal from AI7 in conjunction with the AI0 signal to perform accurate transfer function measurements.

The internal circuits of the analogue input stages are shown below. See the section [9. Sensor Interfacing](#) for more information on connecting various sensor types.

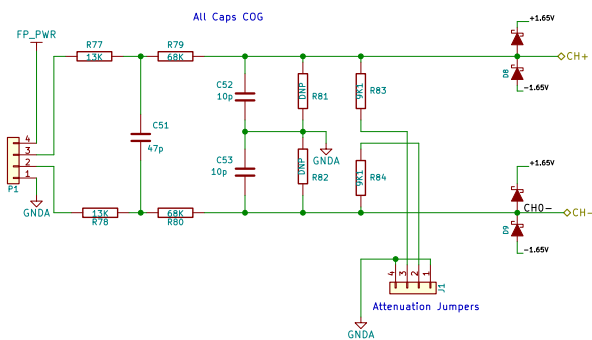


Figure 1: Analogue Input Stages 0 - 6

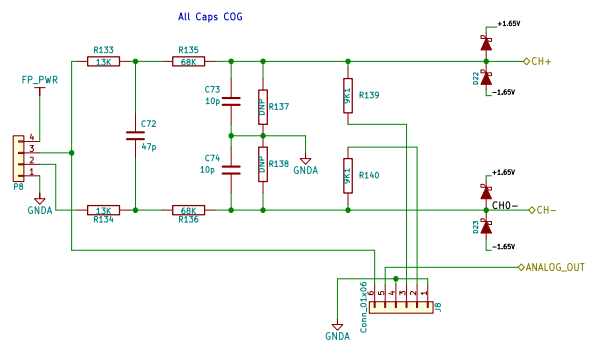
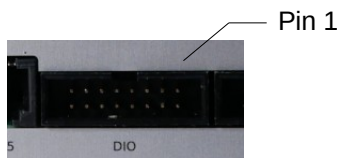


Figure 2: Analogue Input Stage 7

## 15.3. Digital Input/Output

An 8 x 2, 2.54mm IDC connector provides 8 programmable digital IO lines. These 0 – 3.3V input, 0 –



3.3V output lines can be programmed as inputs or outputs and have a range of functions. The lines have a 100Ω output impedance and a high input impedance. Two +3.3V power output pins can be used to power external low power circuitry (< 200mA).

<i>Digital Input/Output Connector</i>								
	Pin Number							
Top Row	15	13	11	9	7	5	3	1
Bottom Row	16	14	12	10	8	6	4	2

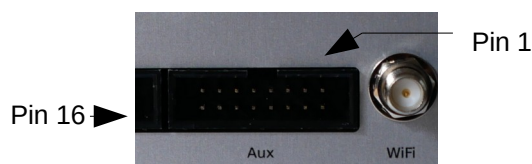
DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1	DIO0
Gnd	Gnd	Gnd	Gnd	Gnd	Gnd	+3.3V	+3.3V

The digital IO core functions provided include:

- Simple digital inputs captured and data logged.
- Digital I/O used as trigger inputs for sampling and control.
- Digital outputs controlled by a host system or by a local program.
- Multi-unit synchronisation. The upper 4 digital lines can connect two or more BMeasure-125i units (up to 4) together to provide a high number of synchronously sampled ADC channels.

If unit synchronisation is required the DIO4, DIO5, DIO6, DIO7 and associated grounds should be connected in daisy chain fashion to all of the units. This can be done with an 8 way 0.1” IDC cable connecting these pins. The length of cable should be kept as short as possible.

## 15.4. Auxiliary Connector



The 8 x 2, 2.54mm IDC auxiliary connector provides some dedicated functions including relay outputs, arbitrary waveform analogue outputs and switch detection inputs.

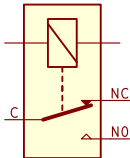
<i>Auxiliary Connector</i>								
	Pin Number							
Top Row	15	13	11	9	7	5	3	1
Bottom Row	16	14	12	10	8	6	4	2

R1NO	R1NC	R1C	SW2	SW1	+5V	AO1	AO0
------	------	-----	-----	-----	-----	-----	-----

R2NO	R2NC	R2C	Gnd	Gnd	AGnd	AGnd	AGnd
------	------	-----	-----	-----	------	------	------

### 15.4.1. Relays

There are two 24 Volt, 1 Amp rated relays (R1,R2) in the unit. These are intended for simple control applications. These have change over contacts and are available on the Auxiliary Connector. They can be operated from a host computer or from an internal program.



<Relay Number>NO	Normally open contact
<Relay Number>NC	Normally closed contact
<Relay Number>C	Common Contact

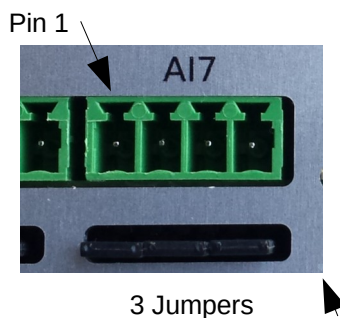
### 15.4.2. Switches

The two switch inputs (SW1,SW2), on the Auxiliary Connector, accept either switch-to-ground switches or 0 to 24 Volt DC inputs. They can be read by a host computer or by an internal program.

### 15.4.3. Analogue Outputs

Two analogue outputs are provided, AO0 and AO1 providing  $\pm 5V$  arbitrary waveforms with an output impedance of  $100\Omega$ . The signals are accessed via the Auxiliary connector on the rear of the unit.

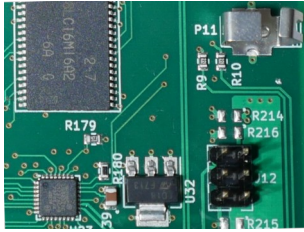
The analogue output AO0 can also be routed to analogue input AI7 (via an installable jumper). This can be used for special purposes including LCR component bridge and transfer function measurements. With this jumper installed AIO is routed to to connector AI7 pin 3 (AI7 still operates as an input enabling the AO0 output to be monitored. AI7 pin one (GND) and pin two (-vin) should normally be connected together externally).



To enable the  $\pm 5V$  arbitrary waveform output to the AI7 connector insert all three jumpers.

Pin 3 = A00  
Pin1 = GND

It is possible to route signal AO0 to all of the front panel connectors. In this instance the AO0 signal replaces the normal +5V output on **ALL** connectors AI0 – AI7. This configuration may be used to drive bridge based measurement sensors or used for other applications. To configure this option the unit must be opened and the jumper J12 moved. Note that one option is to route the DC input voltage, which could be 24V, to the input connectors. This is for very special purposes and you will have to be careful with items connected to the analogue connectors in this case.



Jumper		Signal on AI0-AI7 Pin 4
5	6	AI0
3	4	+5V
1	2	DC-IN (5 to 24 Volts)

## 15.5. USB-B

This micro-USB connector provides a non-isolated, High Speed (480 Mbps) USB 2.0 interface. It will also operate in USB 2.0 Full Speed (12 Mbps) mode if the host only supports that speed although data capture maximum sample rate will be restricted in this case.

The unit can be powered via a 5V USB 500mA supply from this connector. Additional power may be required if the user utilises the BMeasure-125i external power ports.

## 15.6. USB-A

This is provided for future use. Use includes Mobile 3G/4G modem and USB Mass storage connection. The maximum available power is 5V @ 500mA.

## 15.7. Ethernet Network Interface

The RJ45 connector provides an isolated 10/100 Mbits Ethernet interface connection. Speed is auto-negotiated on connection. The port supports an isolated Power over Ethernet (PoE 802.3 af) input enabling the unit to be remotely powered.

## 15.8. RS-485 or CAN Bus

The units supports control via an RS-485 compatible interface. Its expected to be the final item on the bus and has a factory fitted 120Ω line termination impedance. Connection is via RJ12 6p6c connector.

<i>Pin</i>	<i>Name</i>	<i>Description</i>
1	Power	DC Power input 5 – 16 Volts (Must be current limited 1A)
2	Power	DC Power input 5 – 16 Volts (Must be current limited 1A)
3	D-	RS-485 D+ signal
4	D+	RS-485 D- signal
5	Ground	Power and signal ground
6	Ground	Power and signal ground

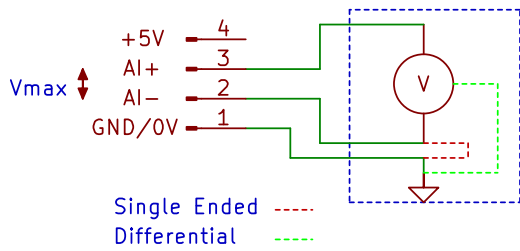
There is a special manufacturing option of implementing a CAN Bus interface on this port. Contact us for more information.

## 16. Sensor Interfacing

The following section illustrates how to connect various sensor types to a BMeasure unit. Many sensor types can be directly connected with minimal external components.

Each analogue input channel can support +5V powered interface adapters allowing complex input requirements to be supported. Please contact Beam for more details.

## 16.1. Voltage



Basic connection for the measurement of voltage is shown in the diagram.

Each analogue input pin (AI-,AI+) has a maximum common mode range of  $\pm 1.25\text{V}$  (no jumpers installed ) or  $\pm 12.5\text{V}$  (jumpers installed).

<i>Input Ranges – No Jumpers Installed</i>		
<i>Configuration</i>	<i>Input Pin</i>	<i>Acceptable Input Voltage</i>
Differential Signal Pk-Pk = 5V	AI-	-1.25V to +1.25V
	AI+	-1.25V to +1.25V
Pseudo Differential Signal Pk-Pk = 2.5V	AI-	Connected to GND. (Directly or via resistive element)
	AI+	-1.25 to +1.25V

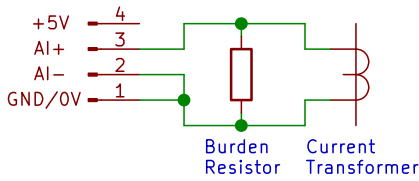
<i>Input Ranges – Jumpers Installed</i>		
<i>Configuration</i>	<i>Input Pin</i>	<i>Acceptable Input Voltage</i>
Differential Signal Pk-Pk = 50V	AI-	-12.5V to +12.5V
	AI+	-12.5V to +12.5V
Pseudo Differential Signal Pk-Pk = 25V	AI-	Connected to GND. (Directly or via resistive element)
	AI+	-12.5 to +12.5V

<i>Unipolar – No Jumpers Installed</i>		
<i>Configuration</i>	<i>Input Pin</i>	<i>Acceptable Input Voltage</i>
Signal Pk-Pk = 1.25V	AI-	Connected to GND. (Directly or via resistive element)
	AI+	0 to +1.25V

Note that to reduce ground loop noise the AI- input can be connected to the items under test and the BMeasure units ground connected via a low value resistor to the units ground.

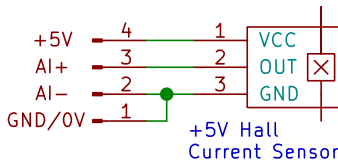
## 16.2. Current

### 16.2.1. AC current transformer



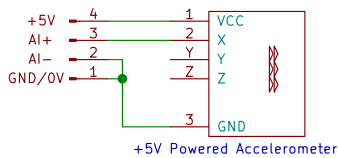
For the measurement of AC current a simple measurement current transformer and burden resistor can be used. Some current transformers have an inbuilt burden resistor.

## 16.2.2. AC/DC Hall Effect

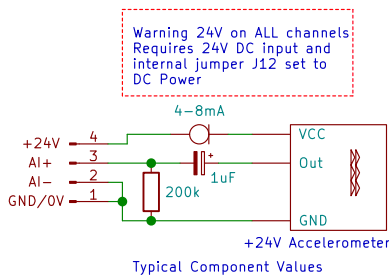


Where DC and AC currents require measurement a hall effect current sensor can be used. A 5V powered unit can be simply connected as shown.

## 16.3. Vibration



Analogue output vibrations sensors such as those based on the ADXL335 are available as modules accepting a 5V power input directly. Such devices can be easily connected to the BMeasure unit.



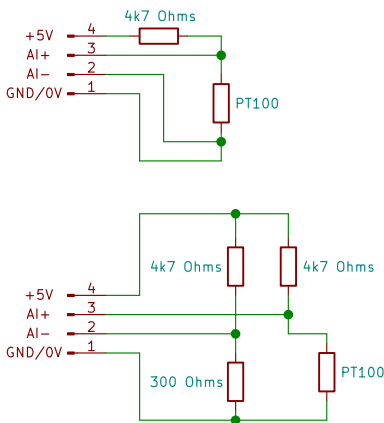
24V Constant current vibration sensors can be connected with minimal circuitry. 24V can be supplied by the analogue input connector directly from the BMeasure if the supplied power to the unit is 24V via the DC jack. An internal jumper J12, must be set-up to feed this 24 Volt supply to all of the analogue input connectors.

Plugin modules for the BMeasure are available to simplify sensor connections on a per channel basis. Please contact for details on current availability.

**WARNING: All 8 analogue input channels will supply 24V**

## 16.4. Temperature

### 16.4.1. Platinum Resistance PT100

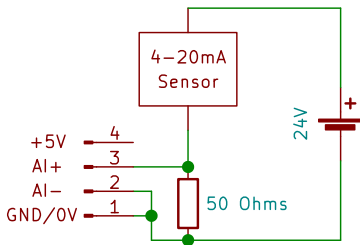


The platinum resistance sensor type PT100 is commonly used for measurements in the  $-200^{\circ}\text{C}$  to  $500^{\circ}\text{C}$  range. In this range the resistance of the sensor changes from around 18.4 Ohms to 281 Ohms.

The simplest circuit to connect up is to use a single resistor of 4700 Ohms 0.1% in series with the sensor as shown in the diagram. A bridge circuit as shown can be used to mitigate variations in the +5V supply.

The BMeasure offers linearisation and scaling for a number of standard configurations.

## 16.5. Generic 4-20mA



Sensors operating on the 4-20mA current system can be connected using a single sense resistor. For the  $\pm 1.25\text{V}$  input range a  $50\Omega$  resistor can be used.

It is possible to provide 24V at each analogue input connector by using a 24V DC input to power the BMeasure and setting an internal Jumper to route 24V rather than +5V to the input connectors of ALL channels. This may be of interest if a number of 4-20mA sensors need to be connected.

## 16.6. Other Sensor types

Many other sensor types can be directly connected to the unit. We also offer simple input adapter boards with extra amplification, current sources and different connector styles and provide a PCB template for your own designs. See our website for more details.

## 17. SD-Card Interface

The BMeasure-125i unit includes a 4 GByte eMMC FLASH device for data log storage. In addition the microSD card slot provides removable storage capacity. The system will support SDHC microSD cards of up to 64 GBytes size.

## 18. Network Interface

The BMeasure-125i supports TCP/IP networking over the Ethernet and Wifi interfaces. The TCP/IP port numbers used are:

Port Range	Usage
80	HTTP web interface for status
40358	BMeasure communications

### 18.1. HTML/HTTP Web Interface

The system implements a simple web access using the HTTP protocol on port 80. This interface supports the viewing of the system status, configuration and performing unit self tests.



The web interface can be accessed over the Ethernet or Wifi interfaces.

## 19. Using Multiple Units

A control host can control a number of BMeasure units either separately or as a synchronised set of units behaving like a larger number of channels BMeasure system. Up to 4 BMeasure units can be connected together to provide up to 32 channels of analogue and 32 channels of digital inputs. Every unit should be connected to the host via a USB cable or an Ethernet cable.

To synchronise units (up to four supported) a digital input/output sync cable should be fitted. This connection utilises four of the digital I/O lines. The cable is easily made by using an 8 way ribbon cable connecting the pins 8 to 16 together on each unit.

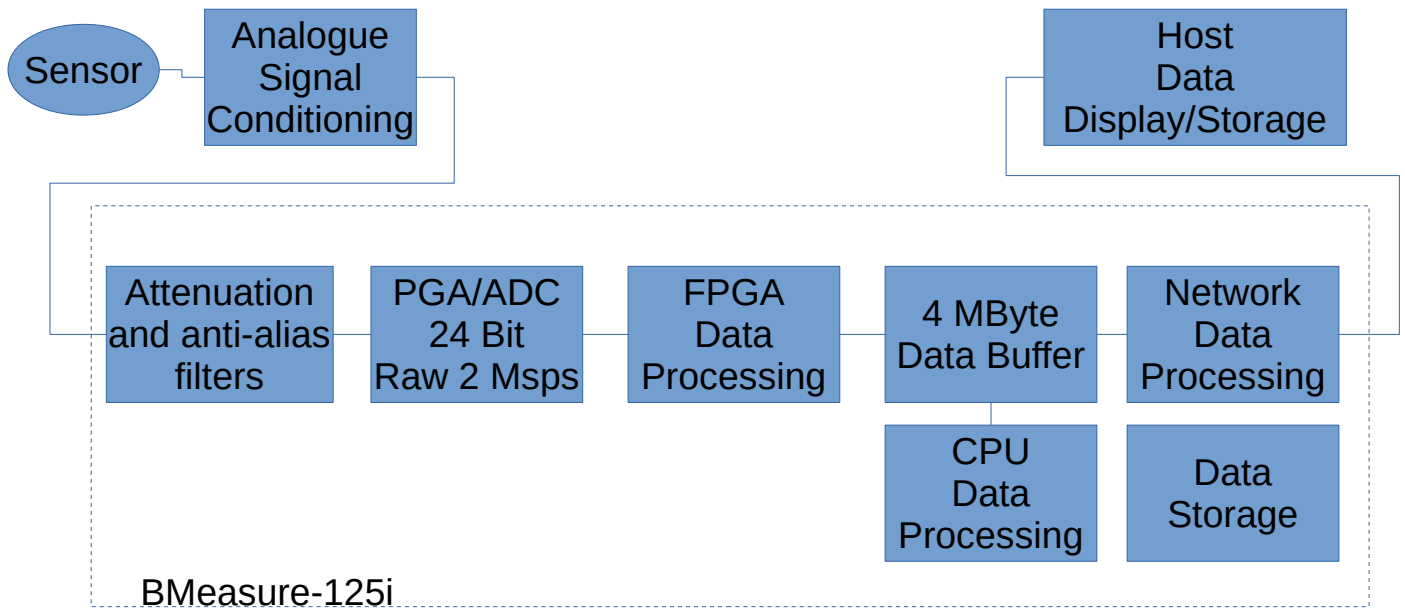
<i>Pin Number</i>	<i>Connector Unit 1</i>	<i>Connector Unit 2</i>	<i>Connector Unit 3</i>	<i>Connector Unit 4</i>
16	DIO7	DIO7	DIO7	DIO7
15	GND	GND	GND	GND
14	DIO6	DIO6	DIO6	DIO6
13	GND	GND	GND	GND
12	DIO5	DIO5	DIO5	DIO5
10	GND	GND	GND	GND
9	DIO4	DIO4	DIO4	DIO4
8	GND	GND	GND	GND
7	Not Connected	Not Connected	Not Connected	Not Connected
6	Not Connected	Not Connected	Not Connected	Not Connected
5	Not Connected	Not Connected	Not Connected	Not Connected
4	Not Connected	Not Connected	Not Connected	Not Connected
3	Not Connected	Not Connected	Not Connected	Not Connected
2	Not Connected	Not Connected	Not Connected	Not Connected
1	Not Connected	Not Connected	Not Connected	Not Connected

To use these multiple units with the bmeasure-gui program, simply select the “Multi connect” checkbox and enable all of the desired units in the Units tab with the master unit (any unit can be the master) at the top of the list and connect. The bmeasure-gui program will instruct the BMeasure units to drive or receive the synchronisation signals to/from the digital IO synchronisation pins.

The system will now control all of the data gathering channels and collate the data packets received into multi channel data blocks for processing or storage in a data file. Triggering is best performed on the channels of the master unit, but any units channel can be selected for triggering.

## 20. BMeasure Signal Path

The following diagram describes the signal processing path within a BMeasure-125i unit and a host computer.



1. **Sensor:** Any type of real-world measurement device that provides an analogue voltage or current signal can be used.
2. **Analogue Signal Conditioning:** This may or may not be needed depending on the sensors actual output. It can be a BMeasure plug-in module or an users specific external circuit.
3. **ADC:** The BMeasure uses an Analogue device AD7771 delta sigma 24 bit ADC with internal PGA. This samples the 8 channels synchronously (8 \* ADC's) at 2 MHz and then filters and down converts the data samples to a 24 bit digital signal stream.
4. **FPGA:** The small FPGA provides overall ADC sampling clock, timing, interconnections between the CPU, ADC, DigitalIO etc. It has a large degree of uncommitted logic and DSP processing blocks for custom signal processing. It collates the ADC and DigitalIO data and sends blocks of data to the CPU.
5. **CPU:** This processes the data as needed and routes it to the local FLASH data log storage or to a host via the USB or Network connections.
6. **Network Processing:** This handles the network protocols including secure TLS streams as configured.
7. **Host:** The host can be a locally connected computer or a remote cloud server. Note the BMeasure-125i can also operate standalone if configured to do so.

## 20.1. Real-time performance

The BMeasure-125 unit can sample and transmit data captured at a programmable sample rate of up to 128 ksps. At this rate the communications data stream is about 4 MBytes/s (40 MBits/s). The BMeasure unit has 4 MBytes of internal RAM to buffer this data (about 1 seconds worth at 128 ksps). The network/USB interface and host computer needs to be able to keep up with this data rate in real-time for the length of the measurement in progress.

## 21. BMeasure-lib API Library

Details regarding how to configure and control a BMeasure unit via the Application Programming

Interface (API) software can be found at <https://www.beam.ltd.uk/files/products/bmeasure-125i/doc/>

## 22. HTTP/JSON-RPC API

Details regarding how to configure and control a BMeasure unit via the JSON-RPC Programming Interface (API) software can be found at <https://www.beam.ltd.uk/files/products/bmeasure-125i/doc/>

## 23. Calibration

The BMeasure units are calibrated in the factory. If re-calibration is required please contact the factory.

## 24. Further Information

The online version of this manual is being updated as new features are added to the BMeasure-125i device. Please see the latest version of this manual and our other WEB resources at: <http://www.beam.ltd.uk/products/bmeasure-125i/> for more information.

## 25. Specifications

<b>Power Supply</b>		<b>Analogue output</b>	
DC Jack input	5 to 24 Volts, 0.5 Amps	Output voltage	±5 Volts
USB-B	5 Volts, 0.5 Amps	Output impedance	100 Ohms
Battery (via USB-B)	5 Volts, 0.5 Amps	Max Sample rate	125 ksps
Battery (via DC Jack)	5 to 24 Volts, 0.5 Amps	<b>Communications</b>	
RS-485	5 to 24 Volts, 0.5 Amps	USB 2.0	Mini-B high speed (480 Mbps)
PoE (Option)	48 Volts, 0.060 Amps	Ethernet	RJ45, 10/100 Mbps
<b>ADC Performance</b>		RS-485	RJ12, 1Mbps
Resolution	24 bits	Wifi	Wi-Fi b/g/n. 10Mbps
Max Sample rate	Up to 128 ksps	<b>Storage</b>	
SNR/dynamic range at 32 kSPS	107 dB	Datalog storage eMMC FLASH	4 GBytes
THD	-109 dB	<b>Misc</b>	
FSR INL	±8ppm	Analogue Connectors	4 pin 3.81mm screw terminal
Offset error	±15uV	<b>Physical</b>	
Input voltage range1	±1.25 Volts	Case dimensions	170 mm x 117 mm x 35 mm
Input impedance range1	> 10 MOhm	<b>Environment</b>	
Input voltage range2	±12.5 Volts	Operating temperature range	-18 to +40 degrees C
Input impedance range2	180 kOhm	Storage temperature range	-18 to +50 degrees C
Input protection	±30 Volts	Relative humidity	15 to 85%
<b>Digital IO</b>		Core Standards	IEC61010-1:2010, IEC61326-1:2012, IEC61000, IEC61557-8
Input Voltage	0 – 3.3 Volts	CE	
Output Voltage	0 – 3.3 Volts		
Input impedance	> 1M Ohm		
Output impedance	100 Ohm		
Max Sample rate	128 ksps		

**26. Notes**

## EC Declaration of Conformity

We: **Beam Limited**

Of: **Unit 3, Northavon Business Centre, Dean Road, Yate, Bristol, BS37 5NH, UK.**

declare that the below mentioned product:

Type of Product: Instrument

Model: **BMeasure-125i**

are herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to Radio Equipment Directive (2014/53/EU) and Low Voltage Equipment Directive (73/23/EEC and 93/68/EEC).

For the evaluation regarding Electromagnetic Compatibility and Low Voltage Equipment Directive, the following standards were applied:

<b>Info</b>	<b>Document</b>
Low Voltage Directive. Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements	EN 61010
Electrical equipment for measurement, control and laboratory use	EN61326-1: 2013
Emissions AC Port	EN55011:2009 +A1: 2010
Radiated Emission	EN55011:2009 +A1: 2010
Harmonic Currents	EN61000-3-2: 2014
Flicker	EN61000-3-3: 2013
Immunity ESD	EN61000-4-2:2009
Immunity E-Field	EN61000-4-3:2006 +A1:2008 +A2:2010
Electrical Fast Transients	EN61000-4-4: 2004 +A1:2010
Surge Immunity	EN61000-4-5:2006
Conducted RF Immunity	EN61000-4-6:2009
Magnetic Immunity	EN61000-4-08:2009
Voltage Dip/Interruption	EN61000-4-11:2004
Electromagnetic Compatibility (EMC) standard for radio equipment and services	EN301 489-1 V2.1.1
Radiated RF emission	EN55032:2015
Harmonics	EN6100

<b>Info</b>	<b>Document</b>
Radio Equipment Directive	EN300 328 V2.1.1