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nanoDAQ
Pressure Scanner
Acquisition System

INSTALLATION
AND
OPERATING MANUAL

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Visit the Chell website at:
http://www.chell.co.uk

900196-1.3

Please read this manual carefully before using the instrument.

⚠ **Use of this equipment in a manner not specified in this manual may impair the user's protection.**

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ECO : 2221 Date: 05/05/2016

Chell's policy of continuously updating and improving products means that this manual may contain minor differences in specification, components and software design from the actual instrument supplied.

CONTENTS

1 Description

1.1 General

The nanoDAQ is a self contained acquisition system and combined pressure scanner that acquires and transmits data to a host via Ethernet or a CAN bus. It is the newest version of the popular Chell microDAQ acquisition system.

By default the nanoDAQ comes with two 16 channel Digital Thermal Compensation (DTC) microscanners, arranged side by side to give 32 channels of acquisition.

The nanoDAQ addresses the scanner at a defined rate, acquires the output and applies a pressure and thermal calibration to derive the engineering units.

The nanoDAQ also has a hardware trigger like the Mk3 CANdaq system, to give some time determination to the data acquired.

This manual revision covers firmware version 1.1.3.

2 Specification

2.1 Power Supply:

Line voltage:	8-24 VDC
Absolute Max. Line voltage	25VDC
Consumption:	Max 4VA
With a 64 channel scanner:	

2.2 CAN specifications:

CAN type	2.0B
CAN baudrate	Configurable from 1M, 500K, 125K and 100K.
Programmable variables:	
Address 0x?nn	Most significant programmable device ID
Address 0xn?n	Next most significant programmable device ID
BRP	CAN bus timing
TSEG1	CAN bus timing
TSEG2	CAN bus timing
SJW	CAN bus timing

2.4 Ethernet Specifications:

TCP/IP	10Mb/s & 100Mb/s via Auto Negotiation TCP & UDP protocols supported

2.5 Operating conditions:

Operating temperature range:	+5°C to +90°C
Storage temperature range:	-20°C to +90°C
Maximum Relative humidity:	95% at 50°C (non condensing)

2.6 Measurement specifications:

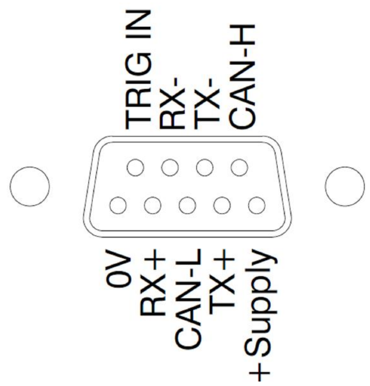
System accuracy:	±0.06% FS
Resolution:	16 Bit
Theoretical Maximum Measurement Speed: (actual data output is limited by chosen comms available bandwidth)	See table below:

Scanner Acq. Freq.	Max Data Rate
70KHz	4000
50KHz	3000

All measurements are in measurements / channel / second.

3 Installation and Interconnections

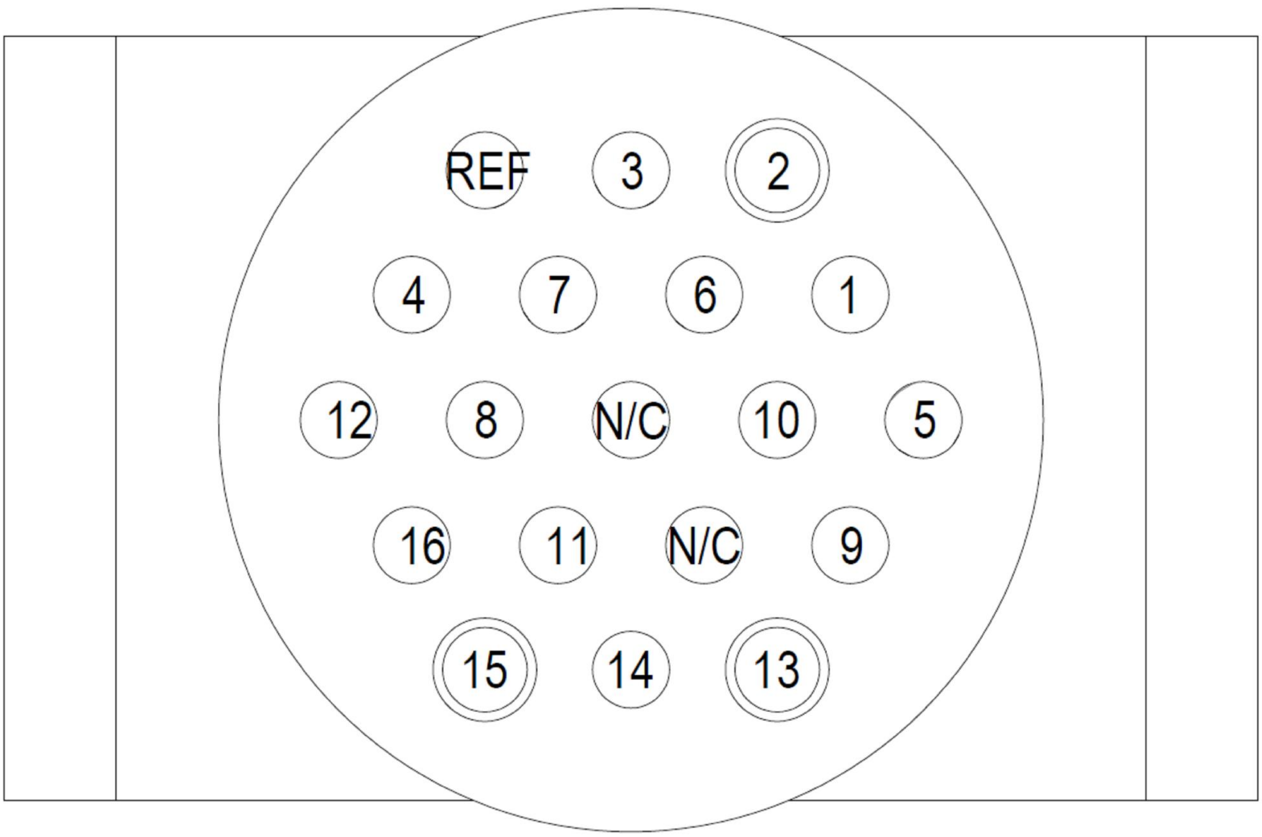
3.1 Connector – Mating connector: 9 way micro-d (Male)



Hot plugging the power to the nanoDAQ at the connector can cause permanent damage to the unit. Always switch the power at the power supply source.

3.2 Pneumatic Connection - Mating Connector: 19 way QDCM-1901010101

Gasket: QDCM-190000100
Replacement manifold: 70197513



4 Operation of the instrument

4.1 Connecting up the nanoDAQ.

The nanoDAQ has one connector and cable which supplies the unit with power and also provides CAN and Ethernet comms. Ensure all the connections are made before powering up the nanoDAQ. **The nanoDAQ should not be hot plugged with the power connector. Doing so can cause permanent damage to the unit. Always switch the power at the power supply source.**

Upon power up, the blue LED will light constantly while the nanoDAQ boots up. This boot-up period will vary depending on the type of scanner and the number of channels. The boot up time is also influenced by the Ethernet initialisation process. This process requires a valid network connection to perform auto negotiation and link check status. If there isn't a valid connection the process waits until either a network is found or the timeout occurs. This timeout is configurable via setup and ranges from 0 to 30 secs per check (2 checks).

When the nanoDAQ has finished booting, the blue LED will flash at a constant rate to show that the system is running (unless auto hardware trigger enable has been set – see later).

4.3 Re-zeroing the nanoDAQ.

Before any measurements are made, the nanoDAQ should be re-zeroed. The nanoDAQ may need further re-zeroing if the unit or scanner should be subject to significant thermal variations.

The nanoDAQ is re-zeroed by sending the appropriate command over the CAN or Ethernet link via the Chell software or via the embedded webserver. The system will then average a number of zero readings and perform a re-zero. Naturally, there should be no pressure applied to the ports of the scanner when a re-zero is being performed.

When a re-zero is being performed, the red LED will light momentarily.

4.4 Hardware Trigger

The nanoDAQ features a hardware trigger to enable the user to synchronise multiple nanoDAQ's and to calculate the timing of the measurements made. The hardware trigger takes the form of a pulse train. Each time the nanoDAQ receives a positive edge, it will generate a set of measurements for all the channels configured in the system.

4.4.1 Hardware Trigger Input.

The hardware trigger input is a 5V TTL square wave pulse train. Minimum frequency 2Hz and maximum frequency 4KHz (32 channel scanner, real world application – theoretical maximum is determined by the preconfigured scanner acquisition frequency and external comms bandwidth, etc.

4.4.2 Timing Information

The hardware trigger allows the user to calculate the time of each measurement. For example if the hardware trigger were running at 100Hz then the user would receive 100 measurements per channel per second. The first pulse would generate the first set of measurements and 10ms later the second pulse would generate the second set and so on. When the hardware trigger is activated, the nanoDAQ will wait for the first pulse. The time that this first pulse is generated can be measured by the user and therefore the time of the first set of data and all subsequent sets can be determined. For more details on hardware trigger timing a technical paper is available – Chell document no. 900118 (this paper was developed for the CANdaq but applies to the nanoDAQ as well).

4.4.3 Software Control

The hardware trigger mode is activated by the T command over the CAN or Ethernet interfaces. The T command can be used to enable the hardware trigger that will cause the nanoDAQ to stop free-running and wait for the first pulse. The disable command will return the nanoDAQ to free-running. The command structure is as follows:

Command	Interface	On / Off
T01	CAN	Off
T11	CAN	On
T02	Ethernet	Off
T12	Ethernet	On

The hardware trigger can also be set to auto enable on power up which means that the nanoDAQ will not go into free-running mode after initialisation and will instead wait for the first hardware trigger pulse. In this instance the blue LED will not flash at a constant rate after initialisation and will actually turn off. This feature can be enabled/disabled from the embedded webserver configuration.

5 nanoDAQ Configuration Webserver

5.1 Introduction.

The nanoDAQ web Configuration provides the means of setting up and demonstrating the nanoDAQ unit from a standard PC with an Ethernet port and browser.

The webserver is divided by tabs into five areas of functionality, namely 'Setup', 'Live Data', 'DTC Information', 'Timestamp', 'Advanced' and 'Factory Tools'.

'Setup Parameters' provides the means to set nanoDAQ's main operating parameters. The unit's function may be checked and demonstrated using 'Live Data' to show the pressure scanners raw readings and nanoDAQ's calibrated output. 'DTC Information' provides a means for interrogating the DTC electronics in the attached microscanners – the user having access to identification information and both excitation and temperature voltages for both microscanners. 'Advanced' provides setup for the all other parameters that may require tweaking on a per application basis. Timestamp provides some options for configuring the timestamping feature of the nanoDAQ. 'Factory Tools' provides some functionality to read DTC coefficients and current scanner values and change the MAC address of the Ethernet hardware. This tab is password protected and therefore not readily available to everyone and further detail is beyond the scope of this document.

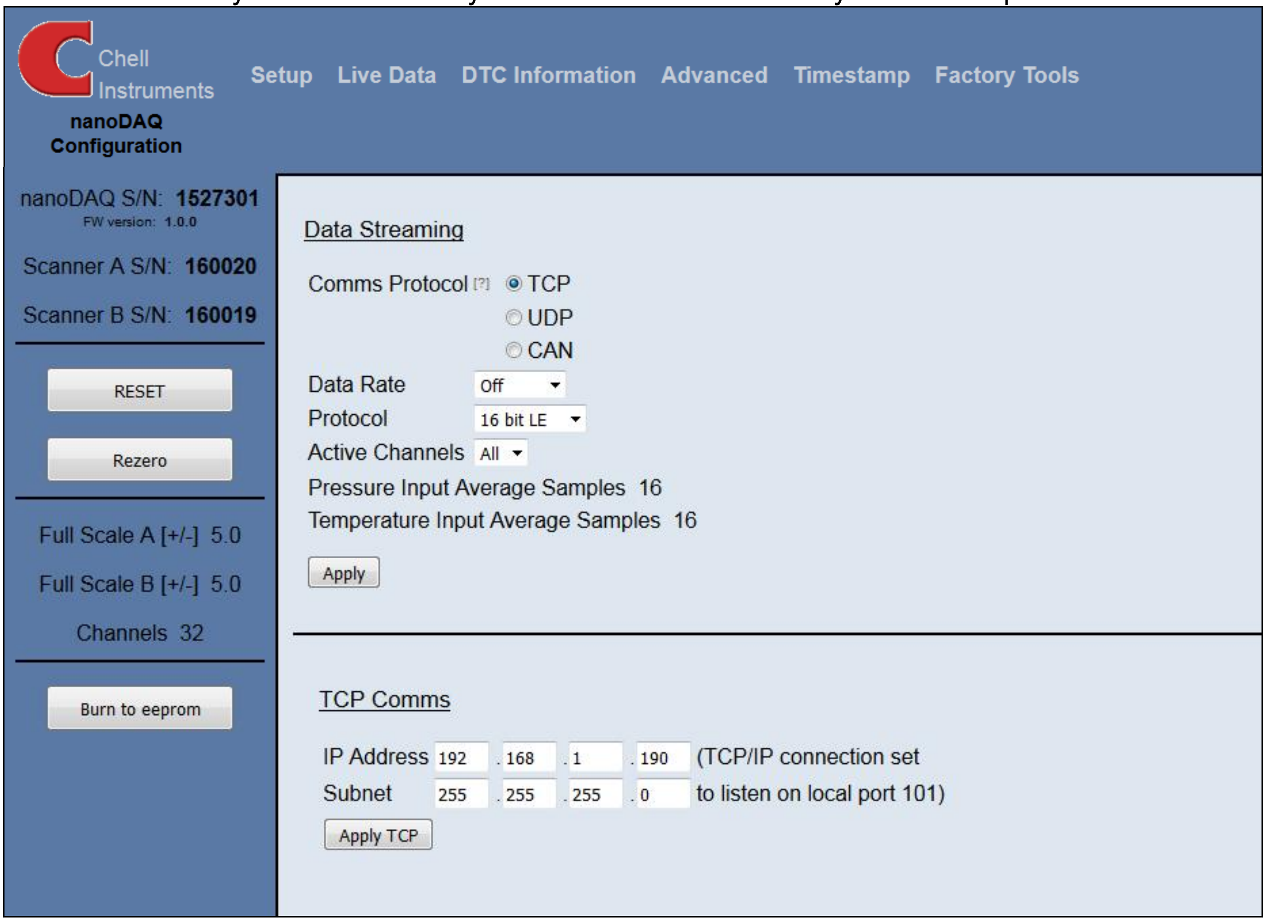


Figure 5.1, Main Setup page

5.2 Common Controls Sidebar

Figure 5.1 above shows the first page viewed when navigating to the webserver. It includes the common controls sidebar and the main group of setup parameters. The sidebar provides information on the nanoDAQ unit and its built in scanners, including serial numbers and current firmware revision along with the configured scanner fullscales and total channels. The function of the common controls is detailed in the subsequent table (Table 5.1)

Control	Function
'RESET' button	Resets the nanoDAQ, similar to power cycling the device. Use to activate new settings and/or rebuild calibration tables.
'Rezero' button	Starts a nanoDAQ rezero operation.
'Burn to eeprom" button	Burns all changes made to the local settings into the eeprom

Table 5.1, Common sidebar control functions.

5.3 The 'Setup Parameters' Page

5.3.1 Introduction

The 'Setup Parameters' page shows all of the nanoDAQ's main operating parameters. Setup Parameters is divided into different categories by function, and each category is detailed separately in the following.

5.3.2 Data Streaming

The ‘Data Streaming’ section allows the user to change settings that affect all three communication protocols, and allows the user to choose the protocol that is to be used, along with the data transfer rate and the amount of channels.

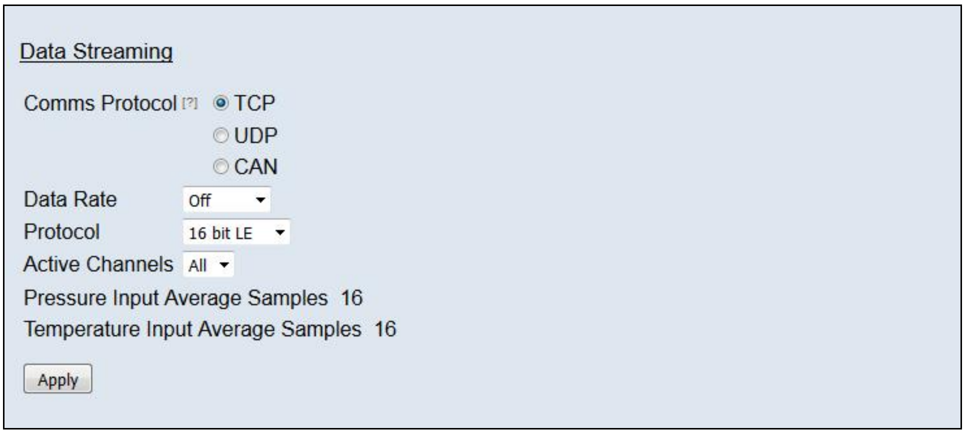


Figure 5.2, Data Streaming group

Control	Function
‘Comms Protocol’ radio button	Chooses the communication protocol that is to be used. This button changes what options are available below it.
‘Data Rate’ option list	Selects the rate at which the nanoDAQ will automatically transmit data after reset.
‘Protocol’ option list	Selects the format that the data will be transmitted as, options are 16 bit LE, 16 bit BE for all protocols and eng. units as an extra option for TCP and UDP Comms.
‘Active channels’	Selects the number of active channels, either All, 16 or 32.
‘Apply’ button	Applies the changes made to the local settings memory.
Pressure Input Average Samples	Displays the number of samples used for deriving the average pressure.
Temperature Input Average Sample	Displays the number of samples used for deriving the average temperature.

Table 5.2, Data Streaming settings.

Note that selecting Engineering Units for a protocol will cause the scanner addressing rate to be reduced; it is better to scale calibrated 16 bit data to engineering units within the client software.

It should also be noted that changing the data rate also changes the Pressure and Temperature input averaging samples to optimum settings based on scanner multiplexer frequency and the requested data rate.

The max measurement per channel per second=multiplexers speed / num channels
Averaging required = max measurement per channel / requested data rate

The average required is then dropped to the next value down in the averaging index. An averaging of 1 is equal to off.

So if the scanner multiplexer frequency is 50kHz and the data rate selected is 1Khz then the Pressure and Temperature input average samples will be 2.

5.3.3 TCP Parameters

The TCP communication protocol parameters are shown in Figure 5.3. This only shows if the TCP radio button is selected in the datastreaming section. The options in this section control the nanoDAQs IP address and subnet mask. Note nanoDAQ's active TCP listening port is fixed at 101.

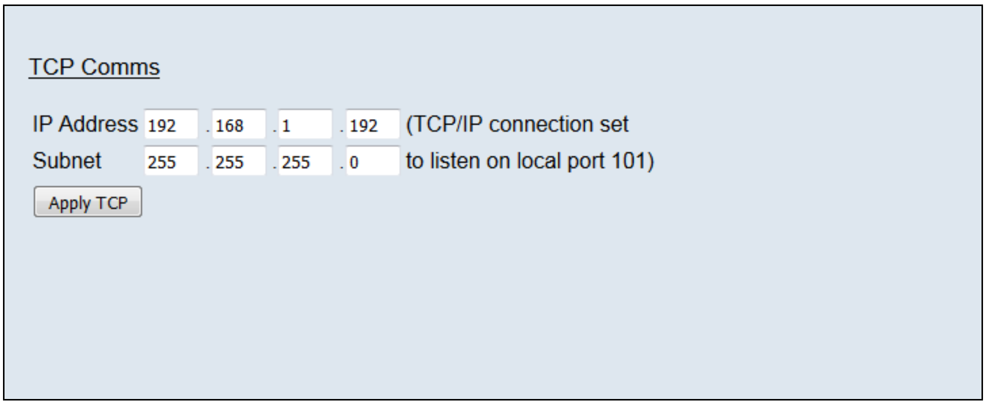


Figure 5.3, TCP Comms group

'IP Address'	IP address allocated to nanoDAQ on the user's network.
'Subnet'	Subnet mask as set on the user's network.
‘Apply TCP’	Applies the settings to the local memory

Table 5.3, TCP Comms group settings

5.3.4 UDP Parameters

The UDP section (figure 5.4) holds all the settings specific to UDP. In UDP mode each acquisition cycle (of ‘x’ number of channels) is packed as a separate UDP packet with a four byte representation of the nanoDAQ serial number at the start of the packet. These are attempted to be sent out at the required rate but with no checking for reception or validity of data.

It is also possible to change the output data packet format to IENA specification format by using the check box.

Note that the nanoDAQ’s local IP address is the same setting as from the TCP Comms group and the nanoDAQ’s local UDP port is also fixed at 101.

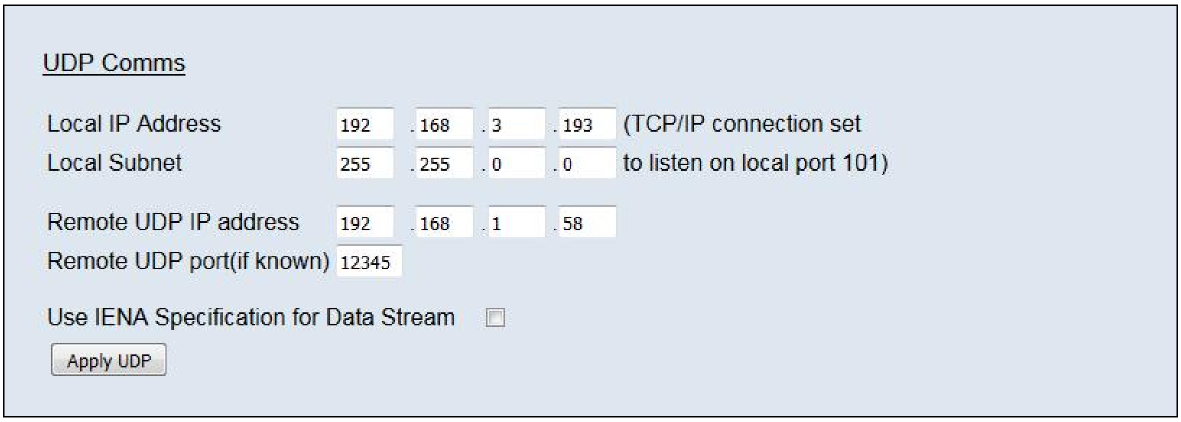


Figure 5.4, UDP Comms group

Local IP address and subnet	This displays the IP address of the nanoDAQ, this is the same as in the TCP comms section.
Remote UDP IP address.	Address of remote connection to nanoDAQ. If set then the nanoDAQ can be set to auto stream data to that remote host on boot up (after initialisation)
Remote UDP port.	Port of remote connection to nanoDAQ. If set then the nanoDAQ can be set to auto stream data to that remote host on boot up (after initialisation)
Use IENA Specification for data stream	Changes the format of data output packets to IENA specification.
'Apply'	Applies the settings to the local settings memory

Table 5.4, UDP Comms group settings

5.3.5 CAN Parameters

The CAN communication settings are shown in Figure 5.5. Options are available to set the base message ID number may be selected, and the offset from this base number for the reception of user commands over CAN, and whether an acknowledgement of these user commands is sent on the next higher message number. Data may be transmitted on either multiple messages, or alternatively on a single message ID, with a selectable delay between messages.

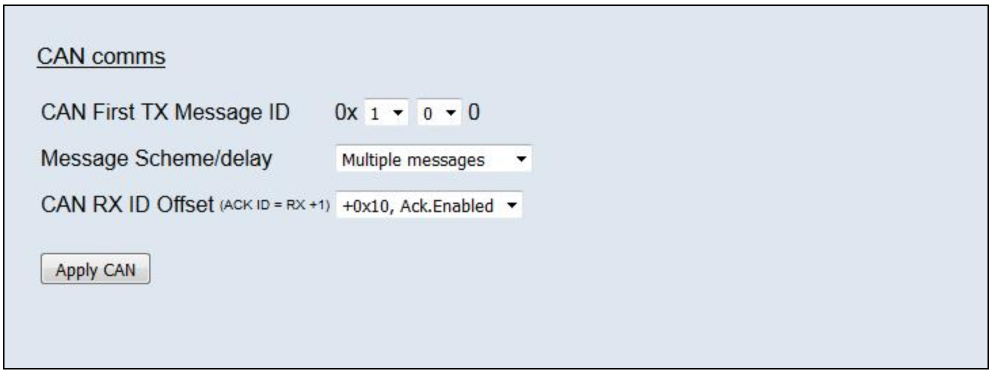


Figure 5.5, CAN Comms group

'CAN First TX Message ID'	nanoDAQ uses standard CAN message arbitration id's, and the unit is assigned the most significant 2 digits of the Hex base address. For the digits 0x1A for example, data for the first 4 channels will be sent on 0x1A0, the next 4 on 0x1A1, etc.
Message scheme/delay	Select 'Multiple Messages' for the 4 channels per message, multiple message scheme. Alternatively data may be packed 3 channels per message + identifier byte, with a selectable delay between messages.
'CAN RX ID Offset'	Selects the hex offset from the base message ID where nanoDAQ will receive incoming user commands (see user command document). If 'Ack. Enabled' is selected, the unit will acknowledge the reception of a correctly formatted command on the message ID calculated as Base ID + RX Offset + 1
'Apply'	Applies the settings to the local settings memory

Table 5.5, CAN Comms group settings.

5.4. ‘Live Data’ Page

Figure 5.6 shows the 'Live Data' page of the webserver, for a 32 channel pressure scanner.

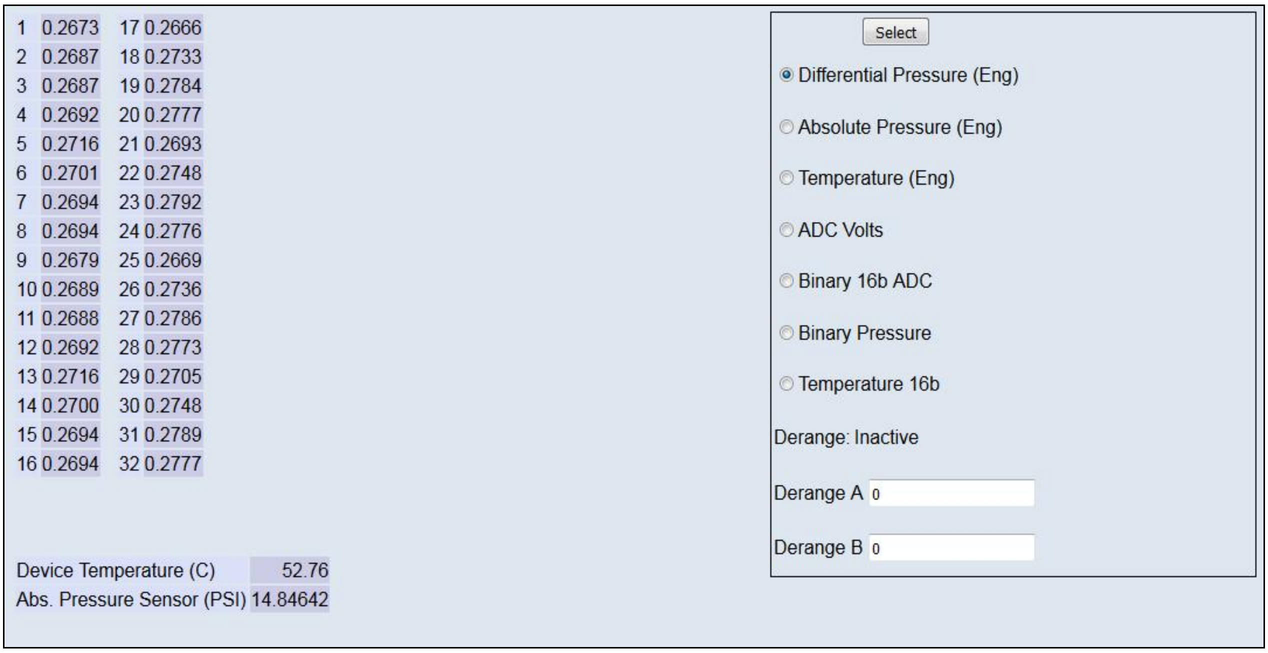


Figure 5.6, Live Data Page

The live data page is a means to demonstrating the correct operation of nanoDAQ and testing the unit's calibration. A value label is shown for each channel with 1-16 representing the first microscanner in the nanoDAQ (Scanner A on the Common Controls Sidebar) and 17-32 representing the second microscanner (Scanner B). The nanoDAQ also has a miniature absolute pressure sensor onboard, with its own temperature sensor. This provides a means to see the current atmospheric pressure (in PSI) and also the internal temperature of the nanoDAQ (Please note that if the nanoDAQ is using manifolds without an absolute pressure port present, then the absolute pressure reading cannot be guaranteed as the port is effectively blanked.

The type of value shown in the labels may be selected by means of the option buttons in the righthand frame. These are as follows:

• Differential Pressure (Eng)	Calibrated engineering units pressure value scaled to known scanner full scale.
• Absolute Pressure (Eng)	As above, but represented as an absolute pressure, using Abs. Pressure Sensor reading as a base.
• Temperature (Eng)	Calibrated engineering units temperature value (DTC)
• ADC Volts	Raw 16bit ADC readings scaled as a voltage
• Binary 16b ADC	Raw 16bit ADC readings
• Binary Pressure	Calibrated 16bit pressure value
• Temperature 16b	Calibrated 16bit temperature value

Values are updated automatically, once every 500ms, with the default view being Differential Pressure (Eng). Use the Select button to start showing values from one of the other selectable options.
The ‘Derange’ Active/Inactive is decided on the advanced page - the value of this constant may either be typed into the text boxes for the appropriate scanner, or reading the DTC header for the appropriate scanner will automatically fill in these values.

5.5. 'DTC Information' Page

The 'DTC Functions' page gives the user access to some information regarding the attached DTC microscanners. The scanner voltages for temperature and excitation may be read and also the information contained in the scanner header may be displayed. Note that there are two 'identical' sections, one for each connected microscanner.

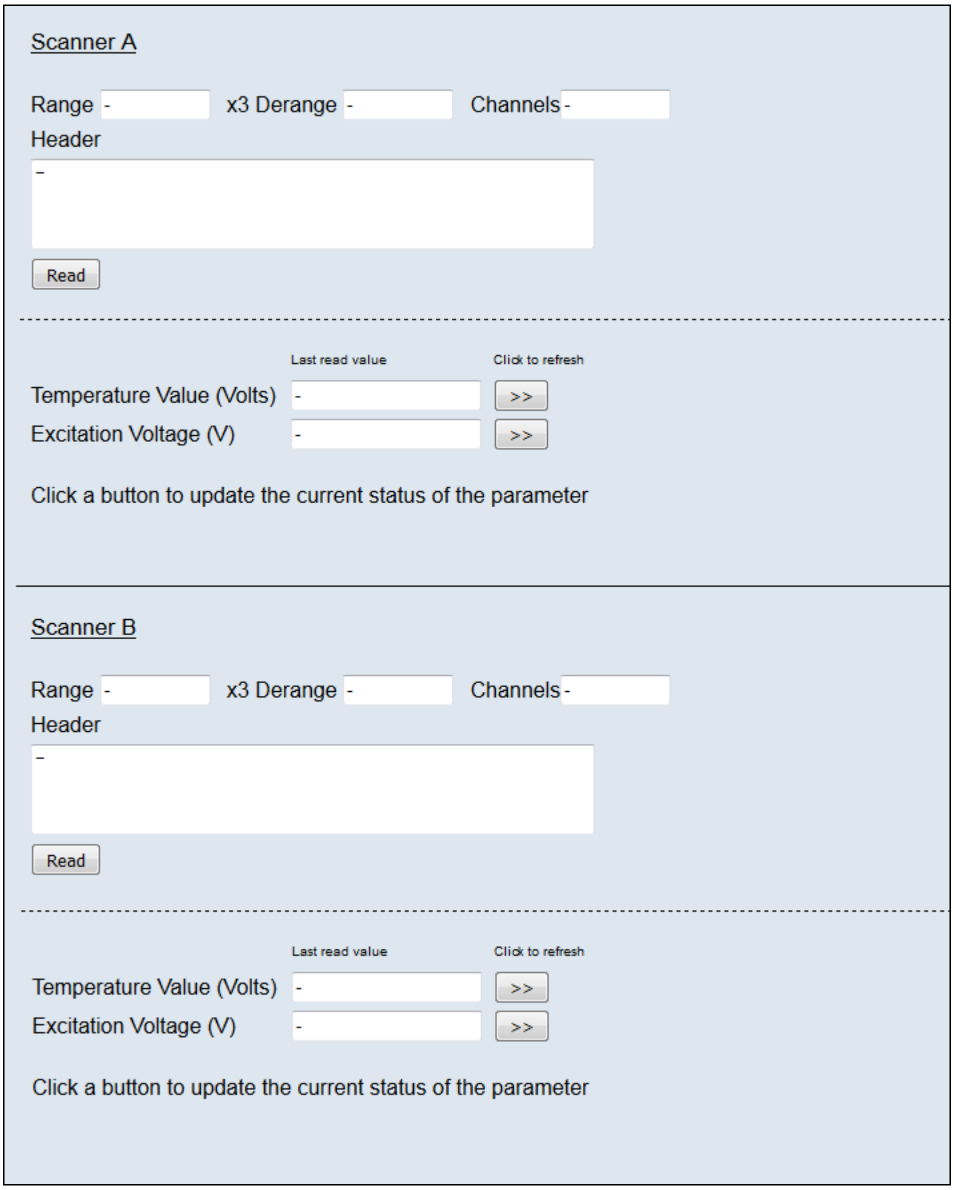


Figure 5.7, 'DTC Information' Page

Control	Function
'Range' label	Shows the floating point value for the range contained within the scanner.
'x3 derange' label	Shows the floating point value for the sensitivity derange constant contained within the scanner.
'Channels' label	Shows the floating point value for number of scanner channels.
'Read' button	Interrogates the microscanner for its header information and splits out the scanner full scale, number of channels and the deranging factor to update the labels. Also shows the rest of the header, including the scanner model, serial number and date of manufacture.
'Temperature (V)' label and button	Click '>>' to read the current temperature voltage from the scanner.
'Excitation (V)' label and button	Click '>>' to read the current excitation voltage from the scanner.

Table 5.7, 'DTC Information' Page controls

5.6. ‘Advanced’ Page

The advanced tab contains extra options that users may find useful for more exact configuration but are not compulsary.

5.6.1 Filtering

The nanoDAQ has settings to allow the user flexible control over the data throughput of the device. Averaging options include impulse filters for noise reduction and rolling averages for the pressure and temperature inputs. These are adjusted automatically by changing the automatic data rate on the main setup parameters tab, but may be subsequently tweaked here if required. The other setting determines whether calibration temperature compensation is switched off, or on continuously. Table 5.8 details the function of the signal parameter option controls.

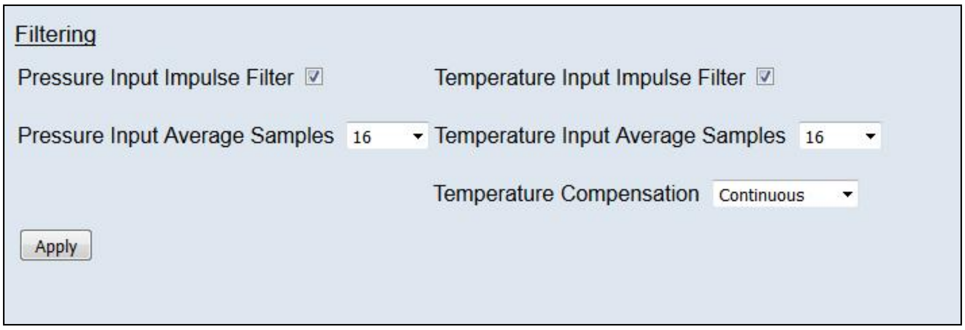


Figure 5.8 Filtering group

Control	Function
'Pressure Input Impulse Filter'	Check box to apply impulse filter to pre calibration data - will remove single impulse noise events in the pressure data.
'Temperature Input Impulse Filter'	As above but with temperature data.
'Pressure input average samples'	Selects the number of samples for a moving average of pre calibration pressure data.
'Temperature input average samples'	As above but with temperature data.
'Temperature Compensation'	Selects the temperature compensation scheme for the calibration. 'Continuous' repeatedly rebuilds the calibration data on a channel by channel basis without interrupting the flow of data. 'With zero only' rebuilds the table when a user rezero is issued, after the rezero has been actioned.
‘Apply’	Applies the settings to the local settings memory

Table 5.8, Filtering group settings

5.6.2 Advanced communication settings

The nanoDAQ has extra communication variables that may help get a more precise connection between the nanoDAQ and the PC.

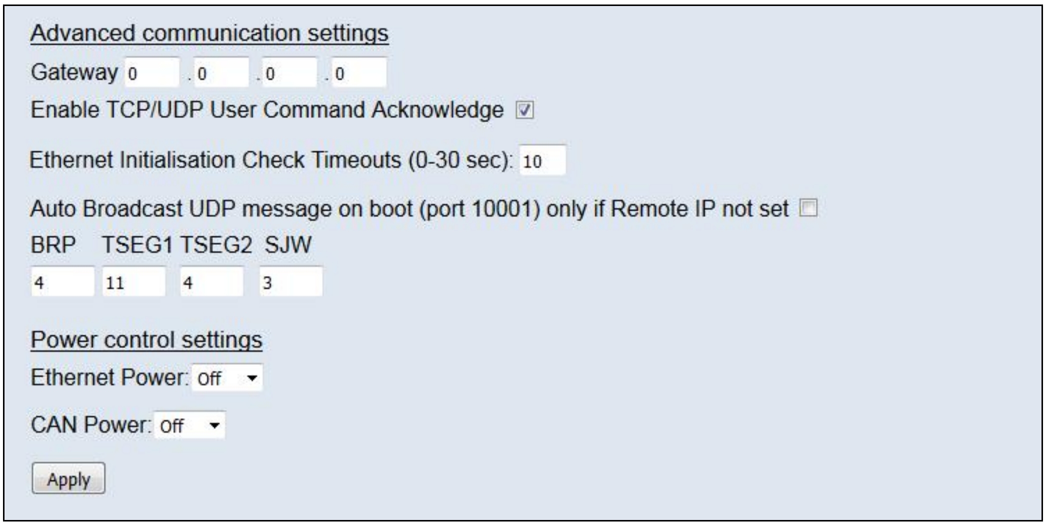


Figure 5.9 Advanced comms group

Control	Function
Gateway	Allows the nanoDAQ gateway address to be changed.
Enable TCP/UDP User Command Acknowledge	Turns on or off acknowledge bytes from commands sent via TCP or UDP.
Ethernet Initialisation Check Timeouts	At bootup the Ethernet module performs two checks for auto negotiation and link check status. This timeout can be controlled via this text box. If Ethernet comms are not going to be used then this value can be set at 0 to speed up startup time.
Auto Broadcast UDP message on boot	If checked, auto broadcasts a UDP message on port 10001 on startup which details the nanoDAQs serial number, IP address, etc. in an ASCII, comma separated list. (should not be used if remote UDP address/port has beenconfigured and auto streaming has beenset – via TCP rate on Standard tab)
BRP, TSEG1, TSEG2, SJW	Register values for the CAN module within the nanoDAQs microcontroller.
Ethernet power	Turns the Ethernet power Phy to ‘Off’, ‘On’ or ‘Auto’. This can be used to save power and reduce device temperature.
CAN power	Turns the CAN transceiver to ‘Off’, ‘On’ or ‘Auto’. The can be used to save power and to reduce device temperature.

Table 5.9 Advanced comms settings

5.6.3 Miscellaneous

The remaining parameters are edited via the Miscellaneous group shown in Figure 5.10. The nanoDAQ contains DTC microscanners which automatically select the full scales and channels but those values can be temporarily changed here for testing purposes. The microscanners options of sensistor and gain configuration may also be selected from this tab. The scanner acquisition frequency can be toggled between 50KHz & 70KHz.

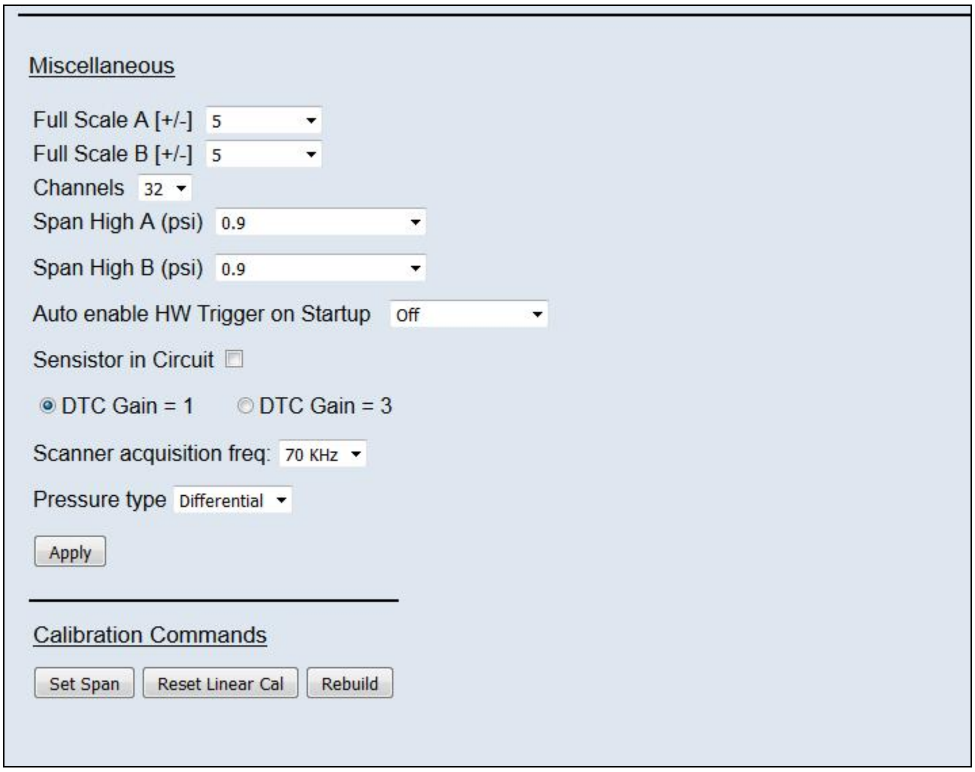


Figure 5.10, Miscellaneous group.

'Full Scale A' dropdown	This dropdown overrides the selection of scanner A's full scale operating pressure. The value affects the display of live engineering values.
'Full Scale B' dropdown	This dropdown overrides the selection of scanner B's full scale operating pressure. The value affects the display of live engineering values.
'Channels' dropdown	The number of channels on the attached scanner can be overridden from this drop down.
'Span High A'	Sets the value of pressure for the 'high' point in the linear span and zero calibration. Valid values range from 0.144PSI (3"WC) to 90PSI. Typically this value should be set to 90% of the scanner A's full scale value, if possible.
'Span High B'	Sets the value of pressure for the 'high' point in the linear span and zero calibration. Valid values range from 0.144PSI (3"WC) to 90PSI. Typically this value should be set to 90% of the scanner B's full scale value, if possible.
'Auto enable HW trigger on startup' dropdown	If set to anything other than Off, the nanoDAQ will immediately switch to hardware trigger mode, waiting for the first trigger pulse, after initialisation. The dropdown indicates the comms protocol used to send acquired data during triggering.
'Sensistor in circuit'	If checked, keeps the sensistor in circuit for the scanner – this setting applies to both microscanners at the same time. In normal operation this control should be left unchecked.
'DTC gain = 1/3'	Selects the deranging function of the microscanner if the '3' option is selected, otherwise defaults to the standard range of the scanner. This setting applies to both microscanners at the same time.
'Scanner acquisition freq'	Selects the acquisition frequency of the scanner, either 50 KHz or 70 KHz
"Pressure type"	Currently this setting determines whether a 16bit scaled absolute pressure value is attached to the start of a data stream cycle.
'Apply'	Applies the settings to the local settings memory

Set span	Perfoms a span calibration on all channels
Reset linear cal	Clears the span calibration on all channels
‘Rebuild’ button	Force a calibration table rebuild.

Table 5.10, Miscellaneous group settings

5.6.4 Span and Zero Coefficients

For information only, the Span and Zero coeffecients for the linear cal. are displayed as a separate group at the bottom of this page.

Span and Zero Coefficients

	Span	Zero		Span	Zero
1	1.000000	0	17	1.000000	0
2	1.000000	0	18	1.000000	0
3	1.000000	0	19	1.000000	0
4	1.000000	0	20	1.000000	0
5	1.000000	0	21	1.000000	0
6	1.000000	0	22	1.000000	0
7	1.000000	0	23	1.000000	0
8	1.000000	0	24	1.000000	0
9	1.000000	0	25	1.000000	0
10	1.000000	0	26	1.000000	0
11	1.000000	0	27	1.000000	0
12	1.000000	0	28	1.000000	0
13	1.000000	0	29	1.000000	0
14	1.000000	0	30	1.000000	0
15	1.000000	0	31	1.000000	0
16	1.000000	0	32	0.000000	0

Table 5.11 Span and Zero Coefficients group

5.7 Timestamp

This page allows the user to edit the timestamp settings of the microDAQ. This timestamp will alow the user to get millisecond level accuracy timestamps on the data packets. If the timestamp is enabled it will have an affect on the maximum transmission rate.

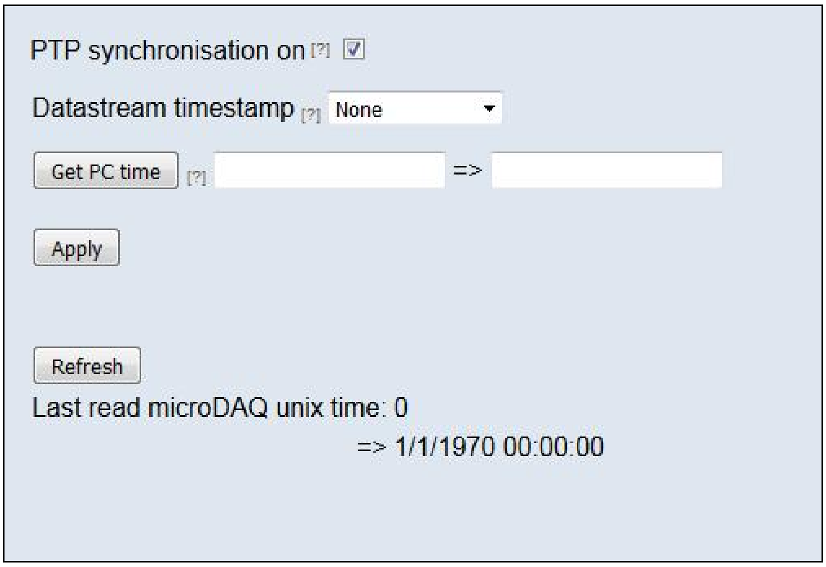


Figure 5.11, Timestamp

'PTP synchronisation on' checkbox	This allows the user to select whether any timestamps that may be added to the datastream are PTP synchronised or not. Please note this will only work if there is a PTP grandmaster on the same network as the microDAQ
'Datastream timestamp' dropbox	The user can use this to select where the timestamp is positioned in the datastream, either none which will turn the timestamp off, start of cycle which will place a timestamp at the beginning of all the channels and every channel which will read the timestamp for every channel. It should be noted that the latter 2 options will reduce the maximum transmission speed datastream.
'get PC time'	This button allows the user to get the timestamp from the PC time of the PC they are using. This can be used as a base time for the timestamps if the user is not using PTP. In the first box it will show the timestamp and in the second box it displays the timestamp converted date/time to make it easier to understand. NOTE the user has to click apply to send the timestamp to the nanoDAQ
'Apply'	This button will apply the settings chosen on this page.
'Refresh'	This allows the user to refresh the displayed value of the last read timestamp from the microDAQ.
'last read microDAQ unix time'	The top line shows the current time in the microDAQ in

Table 5.12, Timestamp

6. Service and Calibration

6.1 Service

There are no user serviceable parts inside the instruments. Should any difficulties be encountered in the use of the nanoDAQ, it is recommended that you contact Chell Instruments Ltd for advice and instructions.

6.2 Calibration

Calibration is recommended on an annual basis and Chell Instruments Ltd. provides a fully traceable facility for this purpose.

6.3 Adjustment

There are no user adjustments in the instrument. The user is strictly forbidden from removing the covers without invalidating Chell's obligations under both Warranty and COSSH.

6.4 Cleaning

A dirty instrument may be wiped clean with a soft cloth that has been sprayed with a proprietary 'foaming cleaner', then wiped dry immediately.

Under no circumstances should the instrument be wetted directly or left damp.