VibWire-108

8 Channel Vibrating Wire Sensor Interface

User Guide & Installation Manual

Version 1.17

Last updated 01/03/2023

WARRANTY

Keynes Controls Ltd warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 12 months from the date of purchase. If the unit should malfunction, it must be returned to Keynes Controls for evaluation, freight prepaid. Upon examination by Keynes Controls Ltd, if the unit is found to be defective, it will be repaired or replaced at no charge.

However the WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration., improper specification misuse outside of the companies Control.

Components which wear or become damaged by misuse are not warranted. This includes batteries, fuses and connectors.

Models VibWire-108-SDI12 and VibWire-108-485 are fully integrated into the Keynes Controls Free Q-LOG Data Acquisition & Display Software. Copies of this software can be downloaded from the company website.

Release Information

This manual refers to products sold and supplied after August 2015.

Calibration Factors Processing

All of the Keynes Controls Vibrating Wire Sensor Interfaces use the following calibration equations to convert frequency into SI units:

$$\mathbf{X = A + Bd + Cd^2 - D(T-T_0)}$$

where d = F^2 / 1000 (Digits) in Hz^2
and D = Thermal Expansion Coefficient
T = Temperature in Deg C read by the instrument
T_0 = Sensor Calibration Temperature from the datasheet

The instrument is capable of processing the standard calibration equation using frequency measurements made using Hz and Digits.

A = Constant B = Linear Term C = Quadratic Term D = Thermal Expansion Coefficient

Vibrating Wire Standard Equation

Keynes Control uses the following equation to determine ‘Digits in all our products. This is a commonly used unit with vibrating wire sensor calculations.

$$\text{Digits} = \frac{\text{Frequency}^2}{1000} \qquad \frac{(\text{Hz})^2}{1000}$$

TESTED

Conducted RF Emissions: EN 55011: 2016
Radiated Emissions EN 55011: 2016 A2

Introduction

The following document is the User Manual for the VibWire-108 range of instruments.

The User is expected to have some prior knowledge of the SDI-12, RS-485 or Modbus network and protocols since this manual is not meant as a teaching aid for network applications.

The VibWire-108 family of vibrating wire sensor interfaces have been designed to interface vibrating wire sensors from any manufacture to a data logger, PC data acquisition system, or SCADA applications.

The principle operating feature of the VibWire-108 is its ability to accurately measure and report the vibrating wire sensor frequency. The instrument uses an auto-resonance technique to energize the sensor coil and adjusts the ping frequency automatically to follow the sensor operation.

The auto-resonance feature enables the frequency component of a vibrating wire sensor to be automatically configured by the instrument.

Hardware Options

VibWire-108-RS485	with RS-485 network option
VibWire-108-SDI12	with SDI-12 network option
VibWire-108-Modbus	with RS-485 Modbus option
VibeWire-108-Analog	with analogue output option

Static Measurement Applications

The VibWire-108 is ideally suited to static measurement applications.

Applications requiring samples rates of 1 - 10 Samples/Sec then a new Keynes Controls product the VibWire-301 will be required.

Dynamic Measurements

Dynamic measurements are best undertaken using the single channel VibWire-301 version instruments.

Configuration

For SDI-12, RS485 and Modbus network devices the frequency input configuration settings for each of the Vibrating Wire sensors connected to the devices are automatically assigned.

Only the model VibeWire-108-Analog instrument of the VW-108 range requires any VW sensor frequency configuration and this is only when the analogue output representation of the input signal is being assigned.

SI Units

The VibWire-108 can be set-up to supply results directly in units of Hz, Digits (Hz^2) , and Engineering units. The vibrating wire sensor engineering unit conversion is carried out using the industry standard quadratic equation expansion.

The VibWire-108 uses the Steinhart-Hart equation, or Thermistor Beta value to give values in Deg C, or these results can also be supplied in raw mV format.

Temperature Corrected Readings

The VibWire-108 supports temperature compensated frequency readings. The temperature compensation is carried out only when the vibrating wire sensor calibration temperature T0 is set into the device calibration factors.

Note. Some sensor manufacturers do not supply this value and a value of 25 Degree Celsius should be used for **T0.**

Features

- 8 x 4 Wire Vibrating Wire Sensor Inputs
- Resolves the VW signal to less than 0.01 Hz (industry standard 0.1 Hz)
- Gas Discharge Tube Sensor Protection
- Real-time Frequency Display - 5 digit
- Audible Output
- Auto Resonance VW Excitation
- Analogue Output 0- 2 V DC - Temperature and Frequency
- SDI-12 / RS485 / Modbus-485 Digital Network Support
- Automatic VW sensor configuration
- Digital communications to remove noise sources and errors.
- Temperature Compensated Frequency Readings.
- Output - Frequency, Digits, SI Units, Temp Deg C
- Steinhart-Hart Thermistor Linearisation Support
- Integrated Polynomial Linearisation - Quadratic Support direct from VW Sensor Calibration Data Sheet.

Field Operations

All of the VibWire-108 family of interfaces contain a real-time 5 digit, 7 segment LED display that can be used to show real-time sensor frequencies for the vibrating wire sensors, and to configure the most commonly used features of the instrument. This feature is useful when configuring and testing sensors in the field.

Terminal Port

The VibWire-108 supports a terminal port configuration and upgrade facility. The terminal port can be used by any industry standard terminal emulator software such as the Microsoft Hyperterminal or Token-2. The terminal port enables the complete configuration of the instrument without any prior programming knowledge.

All of the VibWire-108 interfaces can be configured to provide measurements in engineering units (SI).

9600 Baud, 8 data bits, 1 stop bit, No parity.

Fully Integrated Data Recording Solutions

The VibWire-108 can be connected to any suitable third party data logger or communication system supporting SDI-12, RS-485 or Modbus operations. Simple industry standard commands are used to make a reading and acquire data.

The Modbus network protocol is supported for easy integration into SCADA applications.

The keynes Controls USB-485-Pro dongle can be used to connect a instrument to a Windows PC running SCADA Modus applications software

Q-LOG

The VibWire-108 is fully integrated into the free Keynes Controls Q-LOG data recording and display software. The Q-LOG software enables simple creation of PC based data recording and display solutions, with little or no programming experience.

The Q-Log software can be downloaded for free

http://keynes-controls.com/Download/QLogSetup50_21may2020.zip

Additional Information

The Q-LOG software supports virtual comm port network operations and as such enables remote network connection across a local area network, or via Wi-Fi Connection.   The VibWire-108-485 supports 3rd party RS485 network accessries such as RS485-Wi-Fi Converters.

Care & Maintenance

The VibWire-108 family of products have been designed for long term operation and so will operate reliably for many years as long as the instrument is not misused and operated as shown in the manual..

Step 1

Remove any signal cables and terminal blocks from the instrument.

Step 2

Clean the 4 and 5 way plug and sockets using ionized water to remove the buildup of any dirt or foreign bodies that build up on the termination pins. It is essential to remove any grease that can cause corrosion to the pins.

Step 3

Allow the sockets to dry out before connecting any signal cables.

Description	
Operating temperature	–10 to 60 °C
Storage temperature	–10 to 85 °C
Operating humidity	10 to 90% RH, non-condensing
Storage humidity	5 to 95% RH, non-condensing

Default Factory Settings

All instruments are set for	No of Channels = 8	Temp = 8
Default ID = 0	Models VibWire-108-SDI12, VibWire-108-RS485, VibWire-108-Modbus	
SI Units	Vibrating Wire Sensor (Hz) - Temperature (Deg C)	

All sensor input channels can be User configured to give output values in SI Units by using the terminal port menu system. See Page 34 for additional details.

Required Software

The VibWire-108 requires a terminal software package supporting VT100 emulation only.

Recommended software: Microsoft Hyper-terminal, Token2

Q-LOG Software

The Q-Log data acquisition and display software has been designed to operate with the Keynes Controls USB-SDI12 and USB-RS-485 media converters. Suitable 3rd party devices can be used but these are not tested by Keynes.

Q-Log enables the VibWire-108 to operate with a PC or laptop and give the User access to the data in a familiar Windows

The Q-LOG software can be downloaded at:

http://keynes-controls.com/Download/QLogSetup50_21may2020.zip

Youtube: https://youtu.be/pxOO7UZbX5g

Device Operation

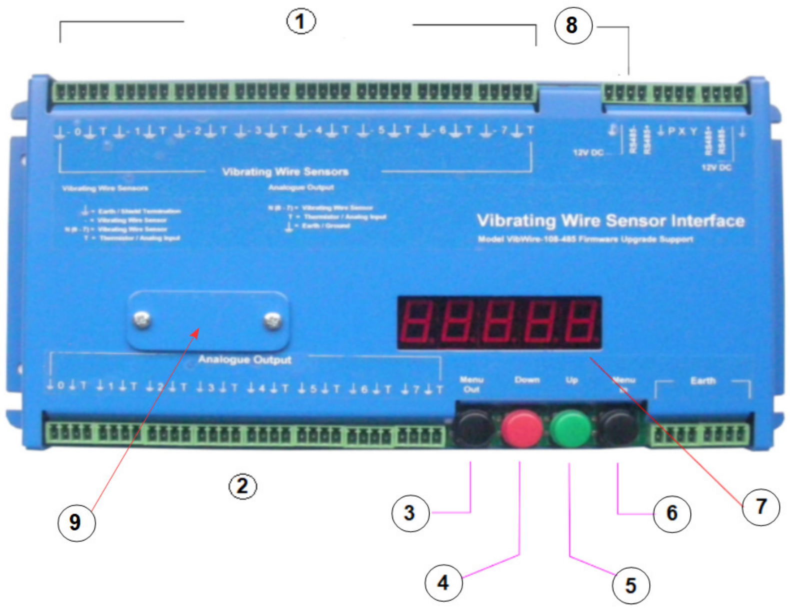
The VibWire-108 operates as a stand-alone 8 channel vibrating wire sensor interface. The number of channels scanned are set into the instrument using the on board menu system and keyboard. The instrument can be set to scan from 1 to 8 channels, The lower the number of channels scanned then the faster the sample rate,

The Q-LOG Windows software does not control the scanning of the instruments. it only interprets the measurements. Take care to match the number of sensors scanned on an instrument, to the correct configuration in Q-LOG. For example an instrument set to scan 4x Frequency and 4x Temperature must have the same configuration in Q-LOG otherwise the measurements may be mis-interpreted.

The VibWire-108 automatically resets to the network operation after a time-out period of 10 minutes and so prevents a User leaving in the wrong mode of operation. This feature ensures the instrument is always ready for operation and is useful for widely distributed applications and systems deployed in hard to reach locations.

Front Panel Features

Figure 2



1	**Sensor Inputs 1 x 8 4 Wire**	**2**	**Analogue Output Channels 0-2 V DC**
3	**Menu Out Button**	**4**	**Menu Up Button**
5	**Menu Down Button**	**6**	**Menu In Button**
7	**7 Segment Display**	**8**	**Digital Network Port**
9	**Terminal Port Cover**		

Data Logger Commands

The VibWire-108 instruments can be used with SDI12 and RS454 compatible data recorders.

Start Measurement Commands

The following commands are used to make measurements under a command of an SDI12 compatible data logger.

Frequency Channels 0 - 3	D0!	where 0 = zero.
Frequency Channels 4 - 7	D1!	
Temperature Channels 0-3	D2!	
Temperature Channels 4-7	D3!	

Send Measurement Commands

where 0 = zero.

Frequency Channels 0 - 3	M0!	returns ID+Chan-0 Frequency + Channel 1 Frequency + Channel-2 Frequency + Channel-3 Frequency
Frequency Channels 4 - 7	M1!	returns ID+Chan-4 Frequency + Channel-5 Frequency + Channel-6 Frequency + Channel-7 Frequency
Temperature Channels 0-3	M2!	returns ID+Channel-0 Temperature + Channel 1 Temperature + Channel-2 Temperature + Channel-3 Temperature
Temperature Channels 4-7	M3!	returns ID+Channel-4 Temperature + Channel-5 Temperature + Channel-6 Temperature + Channel-7 Temperature

Table 1

Youtube Training Video

1. Power Connection and Initialisation

2. Keyboard Operations

3. Set ID Number

Instrument Power On

The instructions are the same for all models.

Step 1 - Power on the VibWire-108. The HELLO message will be displayed on the instrument as shown in Figure 3.

Fig 3

Step 2 - The display will default to '**0**' on the LED display.

The instrument will wait until a start measurement command is received before a measurement is made

Power can also be applied to the instruments by using the 0 V / Gnd and 12 V DC pins of any of the network ports see Figures 10 and 11 on page 10.

Initialisation Message

Fig 4

Figure 4 opposite shows the initialisation message on the 7 segment display as the instrument is first powered on.

Start of the Keyboard Menu System

All the menu options available using the keyboard are accessed from the bASIC message.

To select the different software features of the instrument press the "**Up and Down**" to select the different menu options

Menu Item Selection

In order to select the different options available within the menu system press the "**Menu In**" button. See Page 35 Figure 70.

SDI12 Network Accessories

Fig 7

Part Number USB-SDI12-Post

1 = 12 V DC
2 = 0V / Gnd
3 - SDI12 Data

Part Number USB-SDI12-Pro

USB to USB-A Cable

Connection to a PC

All of the models of USB media converter are connected directly to a USB port on a Windows laptop.

SDI-12 Network Operation

The SDI-12 multi-drop network requires only 3 wires to be connected between instruments for the communication of data. This ensures that the installation and use of the SDI-12 network is a very simple operation. The VibWire-108 is powered by the SDI-12 network +12V and 0V supply operations. The SDI-12 network only goes active during a measurement operation and is switched off at any other time. The SDI-12 network is typically controlled by the data recorder.

Keynes Controls offers a range of USB-SDI12 media converters that can be used to connect the instrument to a Windows PC.

The VibWire-108 supports enhanced SDI12 Address mode and supports greater than 10 devices on a network.

PC Data Acquisition System based upon SDI12 Digital Network

The simplest form of network application consists of a Windows PC, Free issue Q-LOG software, USB-SDI12 media converter,

Part No. USB-SDI12-Pro / USB-SDI12-Post Isolated SDI12 to USB media converter
The media converter can power a single instrument directly from a PC USB Port

Model: VibWire-108-SDI12 8 channel Vibrating Wire Sensor Interface with SDI12 digital network.

Software: Q-LOG Windows Software - Free Issue Data Display, Configuration and Logging Software.

Earth Connection

All of the earth connections within the instrument are connected in common.
Ensure that a good Earth connection is made and fitted to each instrument in order that the lightning protection discharge tubes will operate.

Lightning protection is provided for all Vibrating Wire sensor inputs and between the network power connections.
The protection system will not prevent damage to an instrument for a direct strike.

The earth sheath for the sensor cables should be terminated to a common point along with that of the instrument.
This will prevent earth current loop effects from corrupting measurements.

Network Connections

Figures 10 and 11 below show the network port connections for the SDI12 and RS485 version instruments.

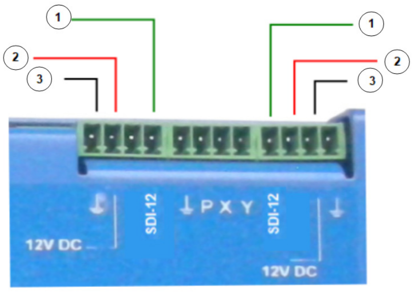


Fig 10

SDI-12 Network Connection

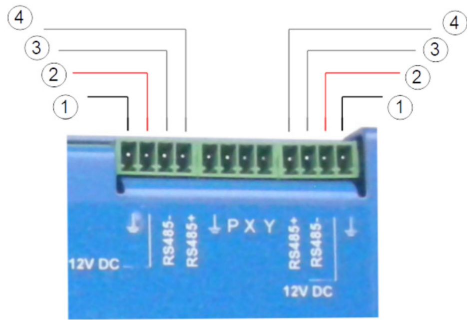


Fig 11

RS-485 Network Connection

SDI12 Network Connection

1 = SDI12 Data   2 = +12 V DC   3 = Gnd

RS485 Network Connection

1 = Gnd / 0 V   2 = +12 V DC   3 = - RS485   4 = + RS485

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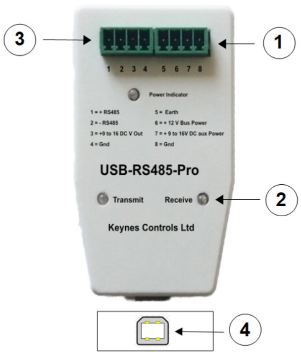

Part Number USB-485-Pro Media Converter

The VibWire-108-485 can be directly connected to, and powered by the USB-RS485-Pro media converter. A single instrument can be directly connected to the network port of the media converter and is powered directly from the PC.

When multiple instruments are used then the external power supply port will be required.

1 = External Power Supply Port
2 = Network Data Transmission Indicator
3 = RS485 network Port
4 = USB type A External Port

Advanced Network Application

For applications requiring large numbers of sensor input channels then the RS485 network should be used.

The RS485 can support up to 30 instruments on a single network string.

Part Number: **VibWire-108-485**

Fig 12

PC Data Acquisition System based upon the RS485 Digital Network

The simplest form of network application consists of a Windows PC, Free issue Q-LOG software and a USB media converter as shown in Figure 13 below.

Part No. USB-485-Pro Isolated 485 to USB media converter
The media converter can power a single instrument directly from a PC USB Port

Model: VibWire-108-485 8 channel Vibrating Wire Sensor Interface with 485 digital network.

Software: Q-LOG Free Issue Windows Software for Configuration, Data Display and Data Recording.

MODBUS 485

The USB-485-Pro converter can be used with Modbus instruments over the RS485 network as well as by direct 485 network operations

The Modbus version instruments cannot have the network speed adjusted.

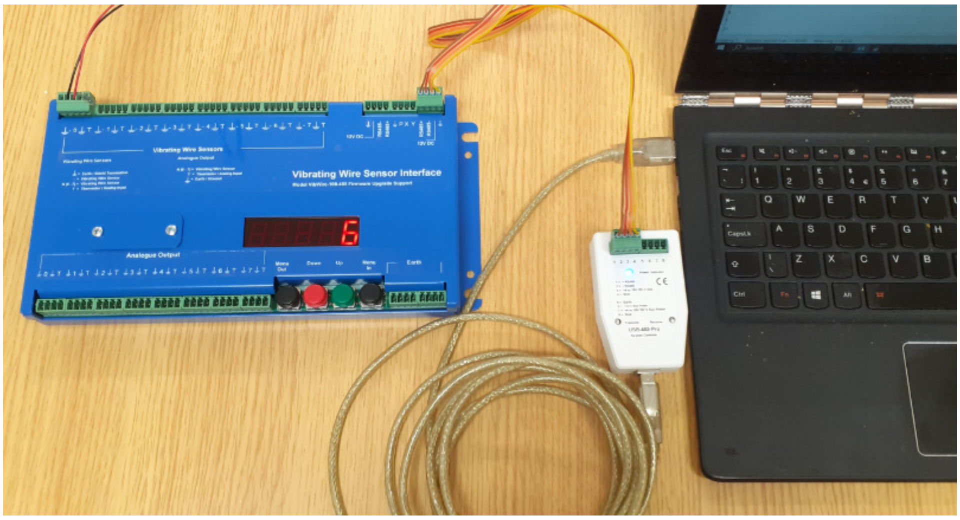

Fig 13

Technical Specifications

The technical specification for the different models is shown below.

All of the VibWire-108 family of products use the same terminal port setting for configuration operations.

Measurement Data	
Number of channels	8 x 4 Wire VW Inputs - User Selectable
VW sensor coil resistance	to 2 K Ohm (standard):- other ranges on request
Distance of VW sensor to interface	0 .. 10 Km depending on cabling.
Frequency range	400 - 6 KHz (standard) Other ranges on request
Frequency Resolution Accuracy	32 bit resolution 0.001 Hz
Long term stability	± 0.05 % FS max / year
Temperature range	- 50 to 70 Deg C
Temperature resolution	0.1 ºC +/- 0.2 Deg Thermistor 10 K Ohm standard 3.3 K Ohm on request
Temperature accuracy	± 0.2 ºC / 0.2 ºF SDI-12
Thermistor measurement	A half bridge ratio-metric measurement. Value returned in mV. Is used for temperature compensation on VW measurements using Steinhart-Hart thermistor equation or beta value.
Thermistor excitation	2.5 V DC 50 ppm /Deg C
Input resistance	10 K Ohm 0.1 % Completion resistor (Standard) 3.3 K Ohm on request
Units	Freq (Hz), Digits (Hz^2), SI Units, Temperature Deg C, mV
Display only - Resolution	5 digit - 0.1 Hz
Electrical Data	
Voltage supply	**SDI-12** 10.5 to 16V DC
Current compensation SDI-12 Option only	Typical values are @ 12 V DC Excitation
Idle mode	1.2 mA
Active / measurement	8 mA data transmission 58 mA including frequency display These values may change slightly between sensors. Use figures as a guide only.
Measuring time	
warm up	500 ms
response	3 seconds per channel depending on the VW sensor being used (Typical)
Length of data lines	
SDI-12	0 .. 100 m
SDI-12 Address mode	Supports enhanced addressing 0 .. 9 A .. Z
General Data	
Dimensions (mm)	L =260 W = 127 D = 38
Material	Powder coated aluminum
SDI-12 Digital Port	SDI-12, 1200 Baud, 7 bit, N stop bit, Even Parity - other speeds on request.
RS-485 Digital Port (Factory Default setting(Optional from keyboard	1200 Baud, 7 bit, Even parity, 1 stop bit. 9600 Baud, 7 bit, Even parity, 1 stop bit.
CE Conformity	CE conformity according to EN 61000-6
Weight	400 g
Communications	
Terminal Port	9 Way Male - 9600 Baud 8 data, No Parity, 1 stop bit, No Flow control - DTE
SDI-12 Digital Port	1200 Baud, 7 bit, N stop bit, Even Parity - other speeds on request
RS-485 Network Settings	1200 Baud, 7 data bit, N stop bit, even parity
RS-485 Network Settings - Modbus	9600 Baud, 8 data bit, 1 stop bit, even parity

Table 2

VibWire-108 Digital Communications

The instructions below detail the operations to follow to operate the VibWire-108 across both the SDI-12 and RS-485 serial networks.

Recommended Test

Use a single instrument only when undertaking initial measurements with a VibWire-108 on the RS-485 or SDI-12 network. This simplifies the software and will speed up the understanding of the command used to obtain data. It is very easy to test the results measured across the RS-485 and SDI-12 network with the ones shown on-board frequency display of the unit.

The results obtained across the RS-485 and SDI-12 network will be the same as those shown on the display for a specified channel.

The default instrument address for a unit straight out of the box is 0. Any result from the instrument will be a random number when no sensors are installed.

Test Measurement - SDI12 Commands

All of the VibWire-108 models support the SDI12 industry standard command set. Prefix the commands with a % sign when communicating using a terminal emulator across the 485 network.

Issue command **0M!** to start measurement operations. The VibWire-108 will scan all channels
0D0! returns items of data *0+ Freq Chan 0 + Freq Chan 1 + Freq Chan 2 + Freq Chan 3*

RS485 Command

Issue command %**0M!** to start measurement operations. The VibWire-108 will scan all channels
%**0D0!** returns items of data *0+ Freq Chan 0 + Freq Chan 1 + Freq Chan 2 + Freq Chan 3*

Ensure that each instrument used on a network has a unique ID number assigned within its configuration in order to correctly identify the data that is being recorded.

Start-up and Scan Time

Typically the VibWire-108 takes 1 second to boot, followed by 3 seconds to complete the scan for each sensor. The actual response time for the instrument is dependent upon the number of sensors fitted and can be interrogated using the **aM** command **!,** See details in Table 1.

The number of channels scanned can be User Defined from the device keyboard menu system. See details on page 17.

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RS-485/ SDI-12 Commands

The commands used by instruments on the SDI-12 and RS485 network are the same. Use a % prefix symbol when using the RS485 version instruments

In the following commands **'a'** and **'b'** are the address of the instrument and can only be integers 0 to 9 or the characters a - z.

Where

'ttt' represents a time in seconds (0 to 999 seconds)
'n' or 'nn' represents a number of channels (00 to 99 channels)
\r and **\n** are the Carriage Return and Line Feed characters - ASCII 13 and 10.

Sending measurements over the SDI-12 or RS-485 network

All of the VibWire-108 models use the **SERAL** option to assign the data transmission operations across the digital network. A 10 minute time-out feature ensures that the instruments cannot be left displaying real-time frequency results.

For Modbus operations the instrument scans automatically at the pre-set sample time as soon as power is applied, see Page **38** for further details.
The Modbus ID is set exactly the same as for the SDI-12 and normal RS-485 operations.

Sending Measurements across a Network

This is the same operation for the SDI12, 485 and Modbus version instruments.

To activate the analogue output channels on the VibWire-108.

1. Starting at

Fig 14

2. Select “**Menu In**” button

Fig 15

3. Use the Up & Down Keys to select the option “**SERAL**” option

Once the “**SErAL**” option is selected the “**Menu Out**” key to store the new configuration into the instrument.

4. The VW-108 will return to the display

The instrument will now send measurements across the digital network..

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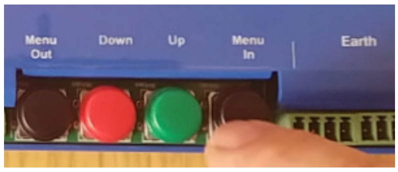
Figure 15 shows the display message used to show that measurements are to be sent across a network..



Model VibWire-108-485 Network Speed Adjustment

These instructions are the Model: VibWire-108-485 only.

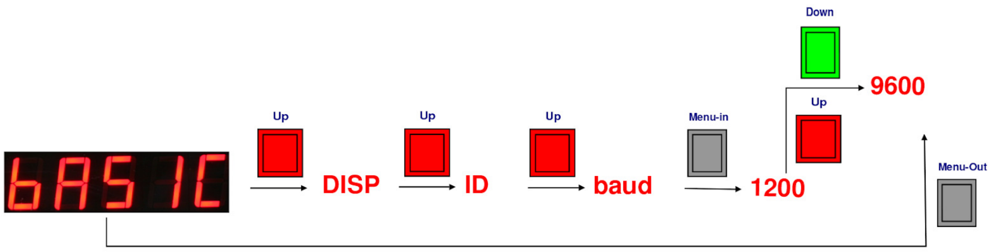


Fig 18

Follow the keyboard sequence shown in Figure 18.

Press the '**Menu Out**' button in order to store the baud rate setting into the instrument.

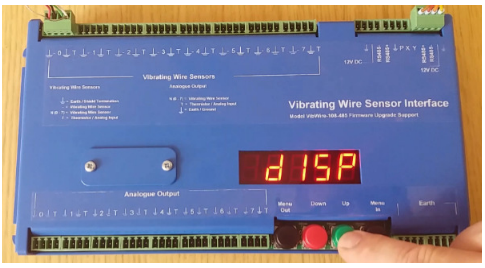


Fig 19

dISP display on the VibWire-108

Fig 20

Baud Rate Setting

Figure 20 opposite is used on model VibWire-108-485 only.

This instrument supports 9600 and 1200 Baud network operations.

To select the network speed options press the "**Menu-in**" key. The instrument has two network speed options for operation on a RS485 network.

Figure 21 below shows the 1200 Baud Even Parity setting and Figure 22 the 9600 no parity setting.

Fig 21

Fig 22

Use the green and red Up and Down keynes to select the desired network speed

Press the "Menu-out" button to store the setting into the instrument.

Channel Scanning Selection

The instrument can be set to scan from 1 to 8 sensor channels. It takes approximately 3 seconds to complete a sensor scan. The lower the number of channels instilled then the faster the individual instrument scan time will be.

The number of sensor channels to be scanned is assigned on the VibWire-108 itself. This feature is common to all models.

Q-LOG Instrument Scan

The Q-LOG software can only read measurements sent across a network and set calibration factors.

In order for Q-LOG software to understand the meaning of the measurements being sent across the network, the number of channels assigned to be scanned by an instrument should match the device setup in QLOG.The Q-LOG software only reads the data being sent across the network and cannot be used to set the number of sensor channels to be scanned on an instrument.

Example

A VibWire-108 is set to scan 4 sensors only. The Vibrating wire sensors have to be fitted to channels 0 to 3.

The instrument CHANNELS = **4F 4T**   Q-LOG Device Setup VW108 4Freq 4Temp

The options available are:

VW108 Scan Mode	Q-LOG Device Setup
8S 8T	8 X Frequency + 8 X Temperature
7S 7T	7 X Frequency + 7 X Temperature
6S 6T	6 X Frequency + 6 X Temperature
5S 5T	5 X Frequency + 5 X Temperature
4S 4T	4 X Frequency + 4 X Temperature
3S 3T	3 X Frequency + 3 X Temperature
2S 2T	2 X Frequency + 2 X Temperature
1S 1T	1 X Frequency + 1 X Temperature

Table 3

Example 8 Channel Scan Hardware and Q-LOG Software

Figures 23 and 24 show the instrument scan and Q-LOG software configuration setting in order to scan 8 vibrating wire sensors and read the measurements Q-LOG.

Fig 23

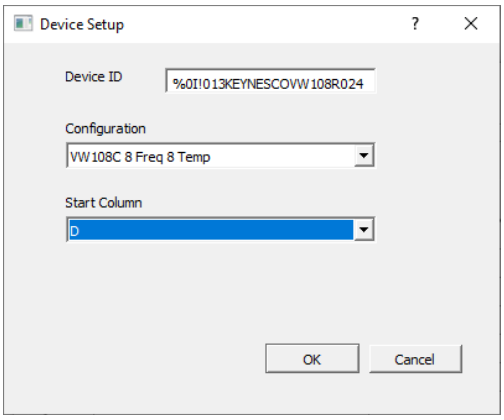


Fig 24

Figure 23 above shows the setting required to make a VibWire-108 scan 8 sensor channels.

The Q-LOG software is set to read and display 8 channels of vibrating wire sensor measurements

Setting the Number of Channels to be Scanned using the Device Keyboard.

The following instructions are the same on all models of this instrument.

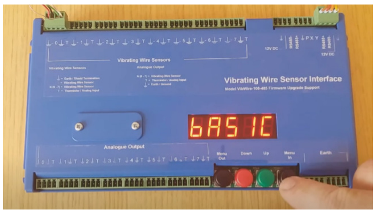


Fig 25

Starting menu

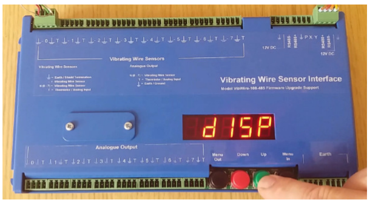


Fig 26

Press the green **"Up"** key

The dISP message will appear

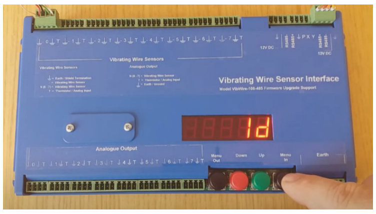


Fig 26

Repeat the operation.

Press the green **"Up"** key

The Id message will appear

Fig 27

Repeat the operation.

Press the green **"Up"** key

The bAUd message will appear

Fig 23

Fig 28

Channel Scan Selection Menu

Press the green **"Up"** key

The CHAnS message will appear.

Press the **Menu-in** key to reach the channel scan selection options. The default is **8S 8T**

Use the green **Up** button or red **Down** button to select the number of channels to scan.

Storing Parameters into the Instrument

Once the number of channels to be scanned has been selected then to store the new setting into the instrument press the "**Menu-out**" button.

The list of channel scanning options are shown in Table 3 on page 16. Figures 30 to 33 show some of the options available.

Instrument Channel Scan Options Display

Figure 30 opposite shows a VibWire-108 set to scan 8 x frequency and 8 x temperature sensor inputs.

8 Channel Scan

A VibWire-108 will take approximately 24 seconds to scan all 8 sensor channels.

Figure 31 opposite shows a VibWire-108 set to scan 4 x Frequency and 4 x Temperature sensor inputs.

4 Channel Scan

A VibWire-108 will take approximately 12 seconds to scan the 4 sensor channels.

Figure 32 opposite shows a VibWire-108 set to scan 3 x Frequency and 3 x temperature sensor inputs.

3 Channel Scan

A VibWire-108 will take approximately 9 seconds to scan the 3 sensor channels.

Figure 33 opposite shows a VibWire-108 set to scan 2 x Frequency and 2 x Temperature sensor inputs.

2 Channel Scan

A VibWire-108 will take approximately 6 seconds to scan the 2 sensor channels.

Q-LOG Instrument Scan Operation

Once the instrument has been identified on a network then the number, and type of sensor to be scanned be assigned into Q-LOG.

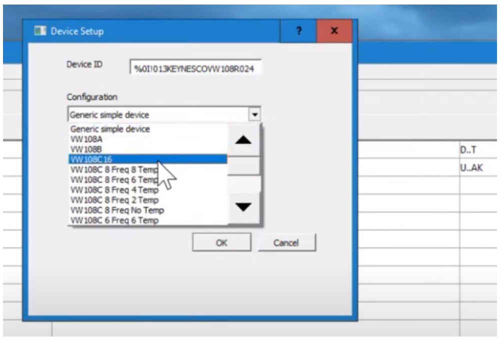


Fig 34

1, Select the “Setup Button” See Figure 48 on Page 21 for further details.

The following menu list will appear.

2. Select the Sensor Scan option that matches the VibWire-108 being configured.

Example

8 Sensors scanning for Q-LOG must match 8 sensors scanning on the instrument.

The Scan options can be seen in Table 2.

The Q-LOG software only interprets the measurements sent out across a network. It cannot be used to set the number of channels that the instrument should scan. The number of scanned channels has to be assigned using the keyboard and menu system shown on the seven segment display.

Example 8 Channel Scan Hardware and Q-LOG Software

Figures 35 and 36 show the instrument scan setting and Q-LOG software configuration in order to scan 8 vibrating wire sensors and read the measurements Q-LOG.

Fig 35

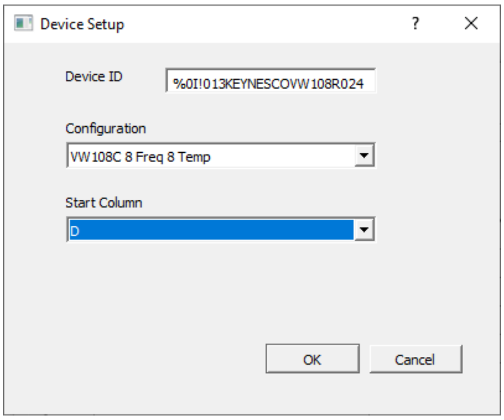


Fig 36

Figure 35 above shows the setting required to make a VibWire-108 scan 8 sensor channels.

The Q-LOG software is set to read and display 8 channels of vibrating wire sensor measurements

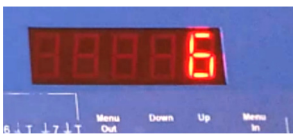
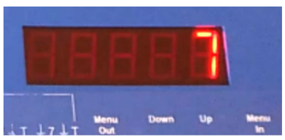
Instrument Scan Indicator

The 7 segment display identifies the channel currently being scanned as shown in the images below.




Figures 37 to 40 show the Channel Scan Indicator for sensor channels 0 to 3.



Figures 41 to 44 show the Channel Scan Indicator for sensor channels 4 to 7.

Setting the Device ID Number using the device keyboard

The youtube video links below demonstrates the setting of the device ID number using the keyboard and also using the Q-LOG Windows Software. This operation is identical for all models of the device.

YOUTUBE DEMO

1. https://youtu.be/3cst_smq7L8
2. https://youtu.be/BJUJfSg090U - Q-LOG Multi Instrument Demo

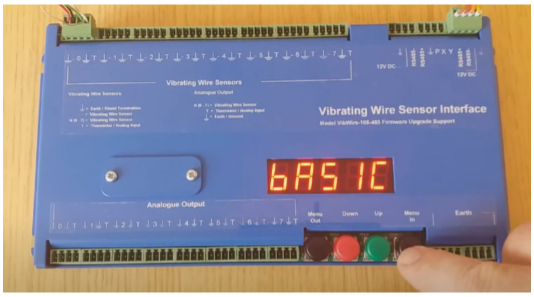


Fig 45

Menu System Navigation

The Menu-In and Menu-out keys are used to select the main category menu items such as

1. ID Number
2. Scanning Options

The **Up** and **Down** keys are used to select the avail options for the menu items.

such as the different ID numbers for a device,

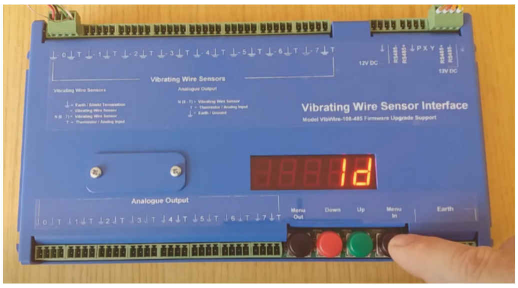


Fig 46

Select the "**Menu-in**" Key until the Id message appears on the display as shown in Figure 46 opposite

Select the "Menu-In" key a second time and the current instrument Id number will be displayed.

Figure 47 below shows the current Id number of the instrument as 1

FURTHER NOTE

The Windows Q-LOG Software can be used to identify and adjust the current instrument ID Number. Each instrument must have a unique ID number assigned.

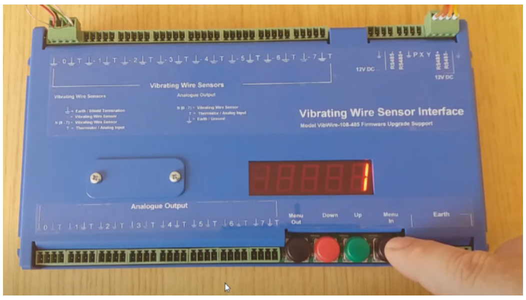


Fig 47

Step 3

Use the "Up" and "Down" buttons to select the device ID number.

Selecting the "**Up**" key will increment the ID.

Selecting the "**Down**" key will decrement the ID number.

Each instrument on the network, regardless of it being SDI12 or RS485 requires a unique ID number to be assigned.

Store the new ID number into the instrument by pressing the "**Menu-out**" button.

Q-LOG Software - Setting the Instrument ID Number

The VibWire-108 instrument is offered with a free applications software named Q-LOG. This software can be used to configure most, but not all of the device configuration settings, make test measurements and to display and store measurements. It is offered free and without restriction.

Q-LOG can be used to assign the instrument ID number .

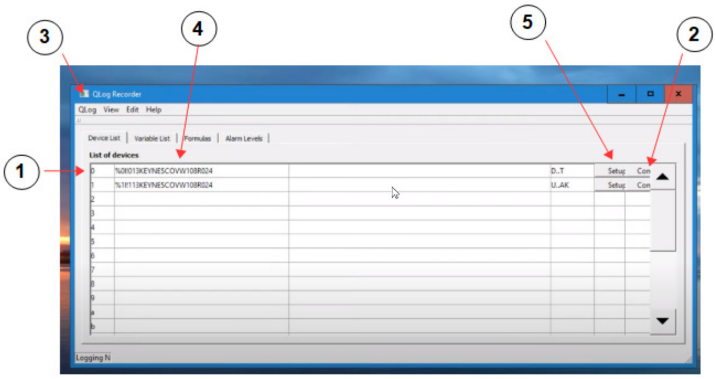


Fig 48

Figure 48 opposite shows the default Q-LOG application software Window that identifies instruments on a RS485 or SDI12 digital network.

The instruments shown have ID numbers 0 and 1.

Q-LOG Features

1 = ID Number
2 = Configure Sensors Button
3 = Main Menu Items Tab
4 = Instruments identified on a network.
5 = Setup Button - Instrument Scan Options

Item 2 - Configure Sensors Button

Select Option 2 to bring up the Sensor Configuration Menu. It is into this Window that all of the sensor calibration parameters are assigned. Default temperature sensor calibration parameters are built into the Q-LOG software, however the User can adjust these parameters.

Q-LOG Change ID Number

The Q-LOG software can be used to display and adjust an instrument ID number. The ID number is the address of the unit on a network.

1 = Q-LOG Menu **2 = Change Address Menu Option** **3 = Auto Assign Menu Option**

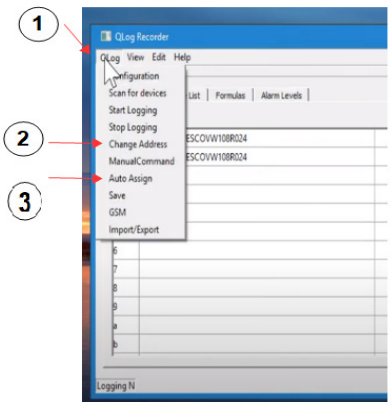


Fig 49

Select Instrument for address change

From the Menu system that is displayed select ‘**Change Address**’ option.
Enter the new ID number and press ‘**Set**’ option.

The status indicators on the Keynes media converters will flash to show data sent out to the instruments.

Select the “**Scan for devices**” menu option and the instrument will appear at the new ID number on the device list.

TECHNICAL NOTE

Ensure that no two sensors on a network have the same ID number.

Select the “**Auto-assign**” menu option to tidy up the results file layout.

A demonstration for changing an instrument ID number USING Q-LOG can be seen on youtube:

See link: https://youtu.be/BJUJfSg090U

Writing Configuration Factors into the VW-108 using Q-LOG Software

Each sensor channel is fully configurable and gives the User the ability to set calibration factors for both the vibrating wire frequency and temperature components of a sensor, The sensor input channels can be individually configured to report frequency in Hz , Digits and Engineering units.

The temperature sensors can be configured to give results in Degree Celsius and mV.

Sensor Calibration Factors and Setup for Channels 0 and 1

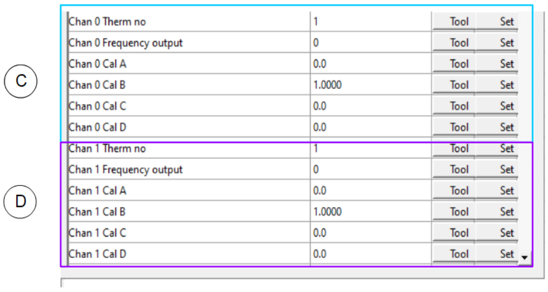


Fig 50

C = Channel 0 Sensor Calibration Factors.

D = Channel 1 Sensor Calibration Factors.

Thermistor Selection

Thermistor type 1 has been selected.

Frequency Units

Frequency Output Type 0 for Hz has been selected.
Raw frequency results are unscaled returned by the instrument for these channels.

Sensor Calibration Factors and Setup for Channels 2 to 4

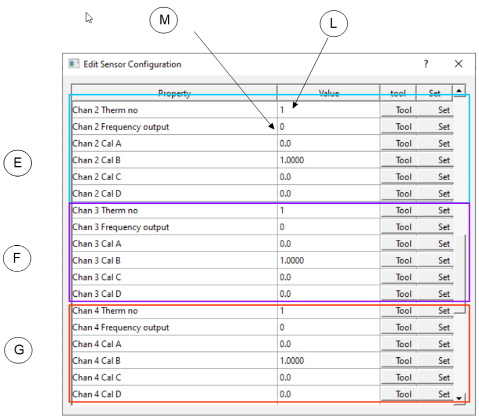


Fig 51

E = Channel 2 Sensor Calibration Factors.

F = Channel 3 Sensor Calibration Factors.

G = Channel 4 Sensor Calibration Factors.

Thermistor Selection

L = Thermistor type selection.

In order to report temperature readings then the thermistor type option has to be set

Therm no: Integer : Value 1 or 2 only

M = Frequency Output Type

0 = Hz 1 = Digits 2 = Engineering Units

Sensor Calibration Factors and Setup for Channels 5 to 7

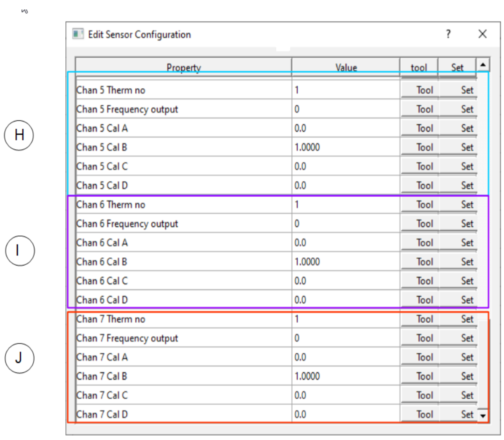


Fig 52

H = Channel 5 Sensor Calibration Factors.

J = Channel 6 Sensor Calibration Factors.

G = Channel 4 Sensor Calibration Factors.

Thermistor Selection

Thermistor type 1 has been selected.

Frequency Units

Frequency Output Type 0 for Hz has been selected.

Raw frequency results unscaled returned by the instrument for these channels

Frequency Output Types: 0 = Hz, 1 = Digits, 2 = Engineering Units

Thermistor Calibration Factors

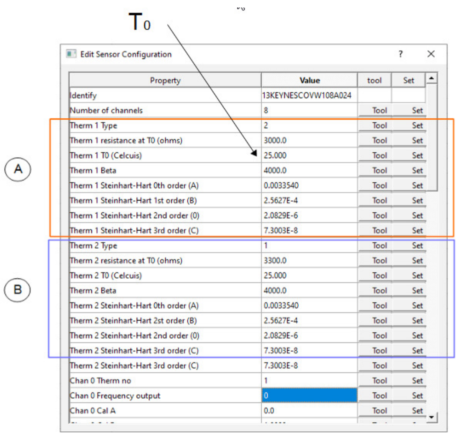


Figure 53

The VibWire-108 supports two User Defined thermistor type sensor configuration settings.

The menu shown in Figure 53 opposite shows the Window in Q-LOG where the calibration settings for the thernistors are found and assigned.

The parameters can also be found and adjusted using the terminal port menu system, see additional details on page 35 of the manual.

Type in the new parameters from a calibration data sheet and press the “Set” button to write the new value into the instrument. Should a Keynes Controls media converter be in use then the status lights will illuminate to show that the parameters have been sent to the device,

A = Thermistor Type 1 Settings
B = Thermistor Type 2 Settings

Factory Default Settings

Figure 53 shows the default parameters factory set and can be used by most third party sensors without any adjustment.

All the calibration factors can also be assigned using the **Terminal Port Menu System.**

Adjusting a Calibration Factor using Q-LOG Software

1. Select the Cell to adjust using the mouse pointer.
2. Type the new value into the chosen cell. The cell will change colour indicating that a value has been updated.
3. Press the ‘Set’ button to store the vale into the instrument.

Should a Keynes Controls media converter be used to communicate with an instrument then the User will observe the Status LED indicators flash.

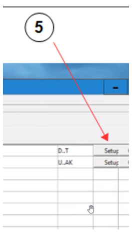


Fig 54

5 = Set Button QLOG

Temperature Compensated Measurements

To activate the temperature compensated readings the thermistor calibration parameter T_0 and the thermal expansion parameter D have to be assigned in the calibration factors.

Figure 53 above shows where the T_0 Calibrated Sensor Temperature is assigned in the Q-LOG Software.
T_0 parameter is found defined on most Vibrating Wire Sensor Calibration Data sheets.

In case of the parameters T_0 and R_0 have both been assigned then the calculation using T_0 is used as it gives the most accurate results.

When T_0 is not assigned or equals to zero then temperature compensated results are not calculated.

Temperature Calculation Options

The thermistor linearisation options available by the VibWire-108 instruments are Beta Value and Steinhart-hert.

Common VW Sensor Thermistor Part Number

YSI	**44005**
Vishay	**1C 3001 B3**
RS Part no:	**151-215**

The part numbers are for 3K Ohm thermistor commonly used by most different VW sensor manufacturers to measure temperature

The sensors give 3K Ohm resistance at 25 Deg C

The most common material used in these sensors uses material type F from GE sensing.

For lower accuracy temperature readings or when the calibration factors are not known then the thermistor Beta value, T_0 and R_0 parameters can be assigned.

SDI-12 Version Instrument Supported Commands

The following commands are supported by the VibWire-108 SDI-12 model

Description	Master	VibWire-108 Response
Acknowledge active	a!	a\r\n
Send ID:	aI!	a13KEYNESCOVibWire-1080001\r\n
provided to complement SDI-12 protocol		Part Description assigned by Keynes
Address Query	?!	a\r\n
identifies instrument address and commonly used on single instrument operations only.	Used to make command set SDI-12 compatible	Where a = ID number 0 - 9 (standard) / (a..z) Enhanced SDI-12 0 - 9 / a - z for RS485
Change Address:	aAb!	b\r\n
used to change instrument address from **a** (initial) to **b** new ID for network operations	a = initial address b = new address	**a : b** = number 0 - 9 or a - z
Start Measurement	aM!	a0268\r\n
instruct an instrument to make measurement	a = address of instrument example 0M! starts scan for ID 0	instrument with address a returns 8 x vibwire & 8 x temp after 60 seconds
Concurrent measurement:	aC!	a0268\r\n
Used for starting a measurement for all instruments on a network at the same time.	start measurement instrument address a	initial response only after receipt of instruction and no response when data is ready to be sent.
This command frees RS-485 bus for other devices		
Send data	aD0! aD1! aD2! or aD3!	+xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n
data returned aND! = Vib + Vib + Therm + Therm and has same format for each command	aD0! = channel 0 and 3 VibWire Sens aD1! = channel 4 and 7 VibWire Sens aD2! = channel 0 and 3 Therm/analog aD3! = channel 4 and 7 Therm/analog	
Thermistor 1 & 2	VibWire-108 supports 2 thermistor types	
Thermistor Type 1 Temperature sensor settings	aXT1RE! aXT1T0! = 25	Resistance at 25 Deg C T0 - generally 25 Deg C
Parameters from the sensor calibration sheet	aXT1BET!	Beta Value
Steinhart-Hart Parameters Thermistor resistance/temp calculation	aXT1ST0! aXT1ST1! aXT1ST2! aXT1ST3!	A in Steinhart-Hart B in Steinhart-Hart C in Steinhart-Hart D in Steinhart-Hart
Thermistor Type 2		
Temperature sensor settings Parameters from the sensor calibration sheet	aXT2RE! aXT2T0! = 25 aXT2BET!	Resistance at 25 Deg C T0 - generally 25 Deg C Beta Value
Steinhart-Hart Parameters Thermistor resistance/temp calculation Page 36 shows sample calibration data sheet	aXT2ST0! aXT2ST1! aXT2ST2! aXT2ST3!	A in Steinhart-Hart B in Steinhart-Hart C in Steinhart-Hart D in Steinhart-Hart
VW Sensor Input Channel Settings	aXCH0FN! F = Frequency type N = VW Channel 0 .. 7	0 = output in Hz 1 = output in digits = F^2/1000 2 = use formula A + B*digits + C*digits^2 + D*temperature digits = Frequency^2 in units of Hz^2
Thermistor Type The VW108 supports 2 different thermistor types for temperature measurement.	aXCH0TN! = Thermistor type where a = ID T = Thermistor Type N = Thermistor Channel Input = 0..7	0 = Voltage ratio 1 = Type 1 thermistor (use XT1RE etc. as above) 2 = Type 2 thermistor 11 = Type 1 resistance ratio, output Rt/R25 12 = Type 2 resistance ratio, output Rt/R25 99 = Output mV at terminal
Thermistor Temperature Calculation	aXT1TYn! a = ID n = integer 0 .. 2	0 = resistance ratio - thermistor data sheet (Rt/R25) 1 = Beta value calculation 1/T = 1/T0 + log(r)/Beta where r = Rt/R25 2 = Steinhart-hart equation $1/T = A + B(\ln R_t/R_{25}) + C(\ln R_t/R_{25})^2 + D(\ln R_t/R_{25})^3$

Table 3

RS-485 Version Instrument Supported Commands

The instrument commands for the RS-485 and SDI-12 versions of the instrument are identical except for the "%" prefix at the start of the command. See Table 4 below.

Description	Master	VibWire-108 Response
Acknowledge active	%a!	a\r\n
Send ID:	%aI!	a13KEYNESCOVibWire-1080001\r\n
provided to complement SDI-12 protocol		Part Description assigned by Keynes
Address query	%?!	a\r\n
identifies instrument address and commonly used on single instrument operations only.	Used to make command set SDI-12 compatible	Where a = number 0 - 9 for SDI-12 0 -9 letters a - z for RS485 A - Z
Change Address:	%aAb!	b\r\n
used to change instrument address from an (initial) to b new ID for network operations	a = initial address b = new address	a : b = number 0 - 9 or a - z
Start Measurement	%aM!	a0268\r\n
instruct an instrument to make measurement	a = address of instrument example 0M! starts scan for ID 0	instrument with address a returns 8 x vibwire & 8 x temp after 60 seconds
Concurrent measurement:	%aC!	a0268\r\n
Used for starting a measurement for all instruments on a network at the same time. This command frees RS-485 bus for other devices	start measurement instrument address a	initial response only after receipt of instruction and no response when data ready to be sent.
Send data	%aD0! aD1! aD2! or aD3!	+xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n
data returned aND! = Vib + Vib + Therm + Therm and has same format for each command	aD0! = channel 0 and 3 VibWire Sens aD1! = channel 4 and 7 VibWire Sens aD2! = channel 0 and 3 Therm/analog aD3! = channel 4 and 7 Therm/analog	
Thermistor 1 & 2	VibWire-108 supports 2 thermistor types	
Thermistor Type 1 Temperature sensor settings Parameters from the sensor calibration sheet	%aXT1RE! %aXT1T0! = 25 %aXT1BET!	Resistance at 25 Deg C T0 - generally 25 Deg C Beta Value
Steinhart-Hart Parameters Thermistor resistance/temp calculation See page 36	%aXT1ST0! %aXT1ST1! %aXT1ST2! %aXT1ST3!	A in Steinhart-Hart B in Steinhart-Hart C in Steinhart-Hart D in Steinhart-Hart
Thermistor Type 2 Temperature sensor settings Parameters from the sensor calibration sheet	%aXT2RE! %aXT2T0! = 25 %aXT2BET!	Resistance at 25 Deg C T0 - generally 25 Deg C Beta Value
Steinhart-Hart Parameters Thermistor resistance/temp calculation See page 36	%aXT2ST0! %aXT2ST1! %aXT2ST2! %aXT2ST3!	A in Steinhart-Hart B in Steinhart-Hart C in Steinhart-Hart D in Steinhart-Hart
VW Sensor Input Channel Settings	%aXCH0FN! F = Frequency type N = VW Channel 0 .. 7	0 = output in Hz 1 = output in digits = F^2/1000 2 = use formula A + B*digits + C*digits^2 + D*temperature digits = Frequency ^{2} in units of Hz^2
Thermistor Type The VW108 supports 2 different thermistor types for temperature measurement.	%aXCH0TN! = Thermistor type where a = ID T = Thermistor Type N = Thermistor Channel Input = 0..7	0 = Voltage ratio 1 = Type 1 thermistor (use XT1RE etc. as above) 2 = Type 2 thermistor 11 = Type 1 resistance ratio, output Rt/R25 12 = Type 2 resistance ratio, output Rt/R25 99 = Output mV at terminal
Thermistor Temperature Calculation	%aXT1TYn! a = ID n = integer 0 .. 2	0 = resistance ratio - thermistor data sheet (R_t/R_{25}) 1 = Beta value calculation $1/T = 1/T_0 + \log(r)/Beta$ where $r = R_t/R_{25}$ 2 = Steinhart-hart equation $1/T = A + B(\ln R_t/R_{25}) + C(\ln R_t/R_{25})^2 + D(\ln R_t/R_{25})^3$

Table 4

Examples Of Using RS-485/SDI-12 Commands

The following examples show how to undertake the various tasks needed to set up and make readings across the RS-485 and SDI-12 networks. The command structure between the SDI-12 and RS485 models is essentially the same except all RS-485 commands use the '%' sign at the start of all instructions.

The SDI-12 network only supports up to 10 instruments with address range: 0 to 9 unless otherwise stated.

Changing the ID Number (address) using a command

The following example demonstrates how to change the instrument ID number from the default factory setting 0 to 5.

Use the command '**aAb**!' where a = Start ID b = Final ID

SDI-12 master sends:	**'0A5!**'	Instrument responds	**5\r\n**	Return New Line	(5 representing new ID number)
RS-485 master sends	'%**0A5**!	Instrument responds	**5\r\n**	Return New Line	(5 representing new ID number)

ID Number Query

This command has been included to remain compatible with the SDI-12 and should be used for single instrument operations only. Useful command when identifying ID numbers for instruments to be deployed on a multi-instrument network.

The example below is to show the ID number of a single instrument

Use the command **'?!'** .

The '?!' command only works when a single instrument is in operation.

master sends: '**?!'** Instrument responds 3**\r\n** Return New Line (3 is the ID number)

Start measurements for Instruments on a network

The following example shows how to start measurements on instruments with ID numbers 2, 7, and 9 respectively.

For this example the instruments are instructed to start readings one at a time and the network is not freed up until each instrument responds that the readings are being undertaken.

The instruments will start their measurement operations but will not send data across the network until instructed to do so.

Use the command '**aM**!' where a = Instrument ID Number
Use the command '%**aM**!' for RS-485 network operation

Examples of use.

The following example is based upon a simple application of 3 x VibWire-108 units connected together on a local SDI-12 network. Unit 1 with address 2 is configured for 4 vibrating wire sensors, Unit 2 with address 7 is configured to scan 6 sensors, and finally Unit 3 has been configured to scan 8 sensors.

master sends:'2M!'	Instrument responds followed by	**'20144\r\n'** **'2\r\n'**	indicated readings available after 60 secs when the measurement is completed
7M!		**'70206\r\n'** **'7\r\n'**	indicated readings available after 20 seconds after the measurement instruction is sent.
9M!		**' 90268\r\n'** **' 9\r\n'**	indicated readings available after 26 seconds after the measurement instruction is sent.

Instrument Identifier

Each instrument deployed on the multi-drop network must have a unique instrument identifier set in order to identify specific instrument on the network:

For the RS-485 network this identifier is in the range: **0-9 / a-z.**
For the SDI-12 network then the ID number is in the range 0..9 - Additional ID numbers are supported: **a .. z.**

For Modbus operations the ID number is currently limited to **1 .. 32.**

Start Measurement Commands

There are 2 separate commands supported by the VibWire-108 for initiating measurements across an RS-485 network and are named '**aM!**' and '**aC**!'. Tables 3 and 4 include the complete description of the commands used by the VibWire-108 models.

The **'aM**!' starts a measurement and responds as soon as the data is ready to be transmitted from the instrument. This command returns all instrument sensor inputs as a string

The '**aC**!' command starts concurrent operations that are used to initiate measurements upon multiple instruments deployed across the network. The 'aC!' command frees the network bus so that other devices can operate freely.

Advice on the choice of Measurement Commands

The VibWire-108 supports both the individual and concurrent measurement commands.

Keynes recommends using individual start measurement commands where there are large distances between devices and the network cable installation quality is poor. Should there be substantial voltage losses on the supply cable then the additional load of a lot of sensors scanning simultaneously may cause errors with some instruments being unable to operate correctly.

For fast results and small scale systems then the concurrent start measurement command can be used.

Possible Network Problems

Most common network problem occurs for instruments connected to the SDI-12 network.

Should a larger than expected load be put onto a network then the voltage drop between 0 V and SDI-12 12 V supply line can cause the instrument to malfunction. A high load can simply be caused by excessive current being drawn by too many instruments on a network.

Pluck Control options can be seen on page 43.

Start measurements using the Concurrent Command

The VibWire-108 supports the aM! and aC! measurement commands. The concurrent measurement 'aC!' command differs from the 'aM!' command as it frees the network after the initial command response to allow other devices to operate.

The 'aC!' command initiates the measurement cycle within the instrument to start reading from the sensors; however the data still has to be requested from the VibWire-108 before being sent across the network.

Example of concurrent measurements for instruments with ID numbers 1, 6, and 7 respectively.

For this example the instruments are instructed to start readings one at a time and the network is not freed up until each instrument responds that the readings are being undertaken. The instruments will start their measurement operations as soon as the command is received but will not send data across the network until instructed to do so.

Use the command '**aC**!'   where a = Instrument ID Number.

master sends: '**1C**!' - 4 sensors   Instrument responds   **'10144\r\n**'   indicated readings available after 14 secs
The network is free for other devices as soon as this response is returned.

'**6C!**' -3 sensors   **'60113\r\n'**
'**7C!**' - 5 sensors   **'70175\r\n'**

Read measurement values from the VibWire-108

No matter which instruction 'aM!' or 'aC!' is used to initiate measurement operations for the VibWire-108 has to be instructed to send data when it becomes available. It takes the instrument approximately 30 seconds to make sensor values available after being instructed to make a measurement.

The vibrating wire frequency input data values are in **Units Hz, Digits . SI**

The **Temp values** input are in **Units Deg C.**

Use the command:
'**aD0**!' -- Vibrating Wire inputs 0 - 3
'**aD1!**' -- Vibrating Wire inputs 4 - 7
'**aD2**!' -- Temp 0 - 3 (Deg C)
'**aD3**!' -- Temp 4 - 7 (Deg C)

Instrument responds: '**a**+xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n'   xxxx.x is the format of the number returned - 1 decimal place

for example to read all the sensor data back from an instrument with ID = 4

master sends: '**4D0**!'   Instrument responds: **'4+0025.3+0024.4+0024.3+0025.7**'   Vibrating wire data
'**4D1**!'   Instrument responds: '**4+0024.5+0026.0+0017.8+0000.0'**   0000.0 is returned when no sensor installed

Temperature Data Format

For an instrument with 7 VW sensors installed.

'**4D2!**'   Instrument responds: '**4+0025.6+0025.1+0024.9+0021.7**'   shows results with only 7 temperature values Deg C
'**4D3!**'   Instrument responds: '**4+0024.9+0026.8+0025.9+0000.0**'

No Data is available   Instrument responds   'a\r\n'   or this example '**4\r\n**'

Note. The temperature values are in Deg C.

Note. The individual Vibrating wire sensor inputs can be configured to return SI units using the terminal port menu system.

Setting Temperature Unit Type (Deg C / mV)

The following example shows how to set the temperature sensor output for an instrument with ID=0 for Channel 2 into Deg C.

aXCHcTN,n
- **c: channel number 0..7**
- **n: 1 or 2 = thermistor selection in Celsius**
- **n: 0 = voltage ratio**
- **n: 9 = millivolts**

0XCH2TN1   Select Thermistor type 1 for channel 2.   -   The setting of a thermistor into type 1 ensures the temperature values are in Deg C.

Connection to an Analogue Data Acquisition System

The following details show how to configure the VibWire-108 analogue outputs to operate with an analogue input data acquisition system or logger unit.

Part Number : **VibWire-108-Analog**.

Technical Specification Analogue Output Ports

8 x 0 - 2.5V DC single ended analogue output ports - 16 bit DAC
8 x Thermistor Outputs - 3.3 K Ohm completion resistors

Theory of Operation

The VW-108 can be connected to an external data acquisition system or data logger using the analogue output ports fitted onto the instrument. In order that the correct values can be interpreted by the logger/acquisition system they are first scaled into a suitable analogue signal by the VW-108 before being passed on for measurement. Each output channel can be uniquely configured to support any manufactured sensor.

When defining the operation of the analogue output each channel has to have the sensor operating characteristics defined. For the VW-108 this means that the minimum operating frequency and span are set into the instrument.

Once the operating frequencies for the sensor are assigned the instrument scales the measured sensor frequency over the range 0V = minimum frequency and 2.5V = maximum frequency.

Connection to an Analogue Input or Data Acquisition System

The analogue output ports are single ended and as such, care should be taken when connecting to a differential input channel.

- Sense = 0V (single ended) or -Vin (Differential Input)
+ Sense = +Vin

VibWire-108 Analogue Port Configuration

Low Frequency := 500 - 3000 Hz defined in 100 Hz intervals
Range := 100 Hz steps.

Starting Analogue Output Ports

To activate the analogue output channels on the VibWire-108

1. Starting at

Fig 55

2. Select “**Menu In**” button

3. Use the Up & Down Keys to select the option “**Analg**”

“**Serial C0d C1d C2d C3d C4d C5d C6d C7d**” are the other options available

Once the “**Analg**” output is selected the “**Menu Out**” key has to be pressed to confirm this option.

4. The VW-108 will return to the display

and now the analogue output channels for the instrument are now activated.

Each of the vibrating wire sensor inputs can be individually configured. Setting the analogue output channel is only needed when using the instrument with an external data logger or analogue acquisition system and is not required when measurements are to be made across the SDI-12 and RS485 networks

Optimising the Analogue Output Settings

Example 1

The VibWire-108 contains 8 independently configurable analogue output ports and they are used to represent the output signal from the sensor.

Each analogue output is of the range 0 - 2.5V DC and any analogue output must scale a result to within this range Care should be taken to ensure that the output signal is scaled as close as possible to sensor range

For example, Channel 0 is used to output a signal from a sensor with operating range of 1452 - 3176 Hz

It is not possible to set the output range of the DAC directly to represent the absolute range of the sensor and so it must be set to cover the sensor range with the minimum overlap in order to obtain the highest resolution.

a range of

0V = 1400 Hz & **2.5V = 3200 Hz** **so CH0 LF = 1400** and **CH0 RA** = **3200 - 1400** = **1800 Hz**

will give the highest resolution for this example

DAC Resolution output port = 16 Bit so Frequency Resolution = 1800 / 65536 = 0.03 Hz

In practice accuracy of around 0.5 Hz can be achieved when connecting the VW-108 to an analogue data acquisition system after allowing for the losses due to the Digital-analogue and Analogue-digital conversion process.

Only when operating the VibWire-108 with an active analogue output port need the operating characteristics for the vibrating wire sensor be defined.

For general purpose operations the analogue output should be set to represent the full operating range of the sensor.

Connection to an Analogue Input Data Acquisition Unit

Example 2

A vibrating wire pressure sensor with operating frequency 400 Hz to 1000 Hz connected to channel 5 on the VW-108 and the analogue output is to be connected to an AquaDAT Sensor interface.

CH5 LF = 400 CH5 RA = 600 (where range = 1000 - 400) and CH(0-7).RA is the range parameter.

the AquaDAT input channel range is to be set to 2.5 V

therefore 0V = 400 Hz and 2.5V = 1000 Hz

The AquaLOG will auto-range to optimise the signal measurement

The data logger will scale the results over the full range Resolution = 600/65536 = 0.01 Hz

In practice an measurement accuracy of 0.05 Hz will be achieved after allowing for losses in the analogue conversion process.

Unit Conversions

Celsius to Fahrenheit **(˚C × 9/5) + 32 =°F**
Fahrenheit to Celsius (˚F - 32) x 5/9 =°C

Example: Convert 26° Celsius (a nice warm day) to Fahrenheit

First: 26°×9/5 =234/5 =46.8

Then: 46.8 + 32 = 78.8° F

Real-time Frequency Display

All of the VibWire-108 models contain a 5 digit 7 segment display and this can be used to display the instantaneous frequency from any of the individual vibrating wire sensor inputs.

Vibrating wire sensors can be deployed a considerable distance from the VibWire-108 interface and may well be embedded into a structure. To ensure that the sensors are operating correctly, simply observe the sensor operating frequency on the 7 segment display and then confirm the result is within the operating range as specified by the manufacturer.

When operating in a real-time mode the instrument frequency display responds instantly to effects upon the sensor.

To use the VibWire-108 as a real-time frequency display follow the instructions below:

Configure a Real-time Sensor Display

To display real time sensor frequency on the instrument seven segment display.

1. Starting at

2. Select “**Menu In**” button

3. Use the Up & Down Keys to select the Sensor Input Channel.
“**C0d C1d C2d C3d C4d C5d C6d C7d**” are the other options available.

4. Select the “**Menu Out**” key to store the sensor input channel to be displayed within the seven segment display.

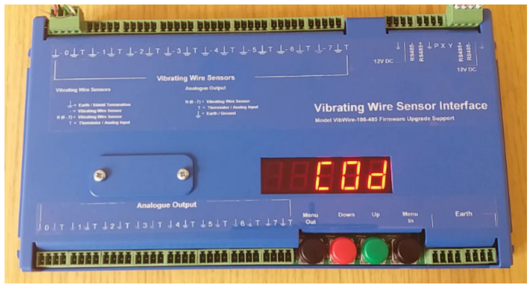


Fig 58 Real-time Display.

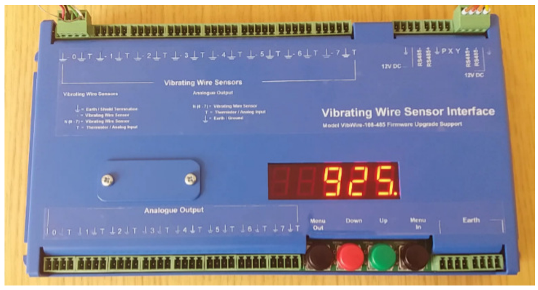


Fig 59 Real-time Sensor Frequency.

Digital Network Selection

The seven segment display shown in Figure 61 demonstrates the menu that is used to set the instrument to send measurements across a network. The instrument will default to this operating mode after 20 minutes So long as the instrument is powered on then measurements will be sent across a network.

The operation is the same on all models of the instrument but is mainly used with the SDI12 and RS485 models.

To set the VibWire-108 to send measurements across a network then

Fig 60

1. Select the "**Menu-in**" key

Fig 61

2. Using the Menu-In and Menu-out keys move up and down the menu options until the SErAL option is displayed

3. Press the "**Menu-out**" key

The instrument is now configured to send values across the chosen network.

4. The instrument will go back to the **bASIC** display..

The instrument will send measurements upon receiving the network commands.

Sensor Problems

Should a clean ping not be heard when the vibrating wire sensor is being sampled by the instrument the following guide should help.

1) Should there be only random noise on the speaker for the defined channel then check the wiring and circuit resistance.
The most common error is an open circuit. Locate and fix the broken cable.

2) If a ping can be heard but it is faint then the sensor cable may be too long, or a too high cable resistance is being used causing degradation of the signal amplitude. Finally the gauge sensitivity may be too low.

3) If the ping is not a pure tone then the gauge is possibly faulty.
The gauge may have become damaged during installation.

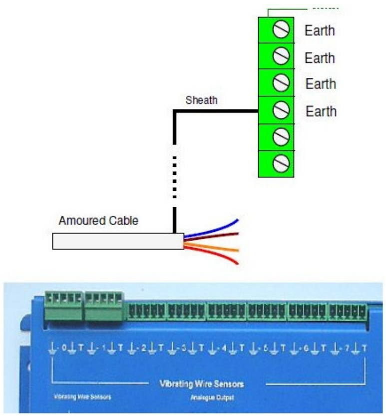
4) If a low frequency hum is heard then noise pickup can be a problem. If the gauge cabling is routed near a transformer, electric motor, high current power cables, etc, then relocate or reorient the gauge for minimum pickup. Ensure that only shielded cable is used and that the shielding is terminated at a single point to prevent capacitive pickup

Vibrating Wire Sensor Installation

The vibrating wire sensors are connected directly into the VW Sensor Input channels as shown below. The instrument contains a completion resistor for the thermistor sensor enabling the temperature reading to be made along with the vibrating wire sensor readings. The VibWire-108 can be used with many different thermistors used within the vibrating wire sensors.

Connection to the instrument is as follows:

Figure 63



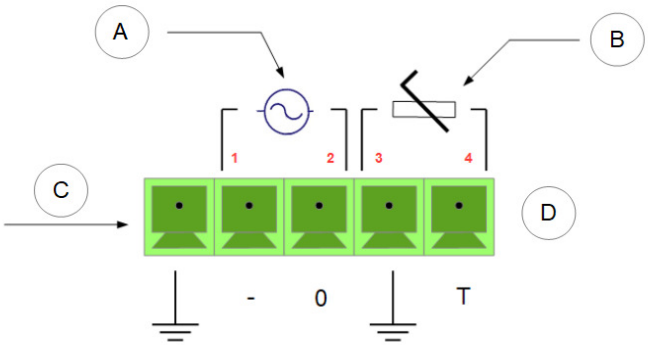


Fig 64

Sensor Port Connections

A	Frequency Input Port	**B**	Thermistor / Temperature Sensor Port
C	Earth / Shield	**D**	5 way connector

Sensor Pin-out = 2 and 3 for frequency signal wire from the sensor
= 3 and 4 Thermistor sensor wire

Common Earth Points

In order to ensure that there are sufficient points to terminate sensor sheathing when armored cable is used to connect a sensor to the VibWire-108 the following terminal points are internally wired in common:

Earth
Earth
Earth
Earth
Gnd

.

Any earth Sheathing from armored cable etc.. can be connected to any of the terminals mentioned above for ease of installation.

Lightning Protection

The lightning protection within the VibWire-108 cannot protect the instrument from a direct lightning strike. It is used to protect the instrument from local ground strikes close to the sensors and cabling.

All of the sensor inputs are protected by transorb and gas discharge tubes. The transorb are high capacitance devices and are not used on all systems as they can distort low level signals to a point where the instrument can not be accurately measured. The transorb does protect the instrument at lower levels than the gas discharge tube, and starts to become active around 12V.

The gas discharge tube protection activates at around 92V DC and resets instantaneously after the lightning strike effect has died away.

Figure 63 above shows the VibWire-108 connected to a system earth using the Earth terminators mounted adjacent to the power

Terminal Port Setup and Operation

The following Youtube video shows how to configure the terminal port.

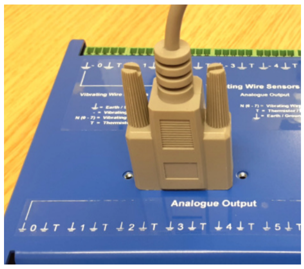
Youtube

https://youtu.be/3cst_smq7L8

Fig 65

USB-RS232 Converter

Null modem cable



Models **VibWire-108-SDI12**, **VibWire-108-RS485**, and **VibWire-108-Modbus** can be configured using the instrument terminal port.

The following instructions are for the Microsoft Windows Operating system.

Step 1:

Connect the PC/Laptop to the VibWire-108 using the USB-RS232 interface and null modem cable as shown above. The terminal port is configured as a 9-way DTE device.

Step 2:

Plug the USB-RS232 adapter into the PC/Laptop.

From the operating system control panel select the "**device manager**" option. A Window similar to that shown opposite will appear.

Select the 'Ports (COM & LPT)' option from the menu list to identify the Comm port number used by the USB-RS232 interface.

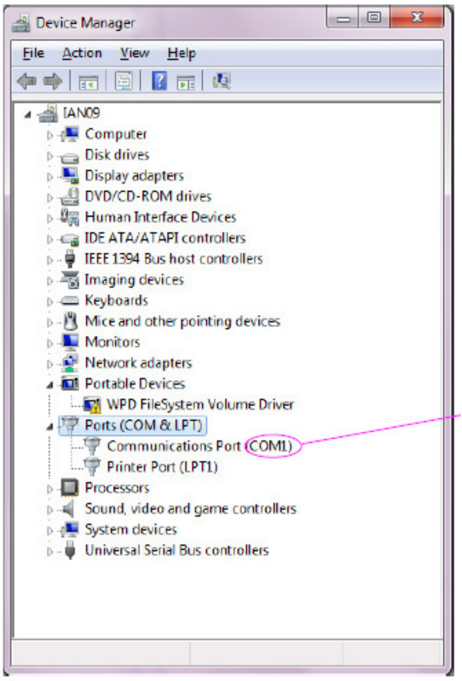
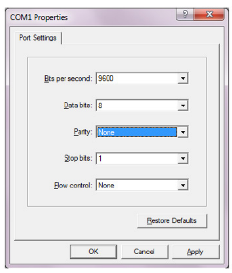


Fig 66

Comm Port in use
by the USB-RS232 media converter

Microsoft Hyperterminal - Connect To Window



Microsoft Hyperterminal - Com Port Properties Window

Menu System

The menu system can be accessed and used by any modern terminal emulator software such as Microsoft Hyper-terminal or Token-2 etc. The terminal software has to be **VT100** compatible to operate correctly. The example Windows above, are taken from the Hyper-terminal software, however the communication port settings are the same no matter which package is used.

Step 3

Start the Terminal emulator software and configure the communications port to **9600 Baud, 8 data bits, 1 stop bit, No parity**.

The Comm port number used by the USB-RS232 media converter is shown in the Windows 'Device Manager' Window.

Terminal Port Operation

The terminal port built-in to the VibWire-108 enables the instrument to be easily configured using the built in menu system to set all the calibration parameters. There is no driver software required with this device apart from a terminal emulator package, which is frequently a feature included in most operating systems. Each VW sensor input channel can be individually configured using details taken directly from a sensor calibration data sheet.

Terminal Port Menu System

The following procedure is for the **VibWire-108-SDI12**, **VibWire-108-RS485**, and **VibWire-108-Modbus** models only.

Main Menu

1 System Maintenance
2 Thermistor type 1
3 Thermistor type 2
4 Diagnostics
5 Channel 0
6 Channel 1
7 Channel 2
8 Channel 3
9 Channel 4
A Channel 5
B Channel 6
C Channel 7
U Up. T Top

Fig 67

Figure 66 opposite shows the Main Terminal Port Menu available in all instruments.

Setup the Terminal Emulator Software such as Hyper-terminal to operate as specified on Page 33 Figure 58.

Make sure the RS232 media converter COM port has been correctly identified.

Press the **Esc** key and the menu system opposite will appear.

The menu system allows the device to be configured.

Menu System - Vibrating Wire Frequency Setup

The examples below show the configuration for the frequency component of a vibrating wire sensor.

Worked examples can be found on pages 46 and 50.

Sample Vibrating Wire Sensor Configuration

Channel 0

1 Frequency proc	2
2 Thermistor type	1
3 Cal A	-1.26E+02
4 Cal B	6.52E-02
5 Cal C	3.42E-07
6 Cal D	-1.40E-02
U Up. T Top.	

Fig 68

Definitions

Calibration Equation X = Cal **A** + Cal **B.** d + Cal **C**. d2 – **Cal D**.t

t = temperature;

Gage Factor P = G(R0-R1)
= G.R0 - G.R1

Uses P = G. **Cal B** **where G = Gauge Factor in Digits Hz^2**

R1 = Current sensor reading in Digits
R0 = Initial sensor reading from the start

Frequency Process Options

0 = Hz **1** = Digits Hz^2 **2** = Engineering Units

The example shown in Figure 68 above shows the Frequency proc = 2 which means that the instrument will return the measurements for Channel 0 in Engineering Units.

Where the terms from the Calibration Equation are shown below:

Cal A = Constant term
Cal B = Linear term
Cal C = Quadratic Term

Cal D = Thermal expansion

Menu System - Temperature Sensor Settings

The following instructions are common for all models of the instruments.

The factory preset temperature sensor calibration settings work for most third party vibrating wire sensors.

Summary

The VibWire-108 supports two indiviual thermistor configurations that can be preset into the device.

Thermistor Calculation Options: **Steinhart-Hart and Beta Value**

Thermistor type 1

1 Type	1
2 Resistance at T0 (ohms)	3000
3 T0 (Celsius)	25
4 Beta	5234
5 Steinhart-Hart 0th order (A)	3.35E-3
6 Steinhart-Hart 1st order (B)	2.56E-4
7 Steinhart-Hart 2nd order (C)	2.08E-6
8 Steinhart-Hart 3rd order (D)	7.30E-8

U Up. T Top.

Fig 69

Steinhart-Hart Temperature Calibration Factors.

Steinhart-Hart Calculations are the most accurate process for determining temperature from a thermistor sensor built into a vibrating wire sensor.

Figure 69 shows a sample setup for Channel 0. The instrument will return data values in engineering units,

Assign Steinhart-Hart Calculation Option

Menu option '**1**' is set 1 as shown opposite,

The instrument will use Steinhart-Hart calibration factors A B C and D as shown in the menu system opposite.

Any Beta value that is shown in the menu system will be ignored.

Thermistor type 1

1 Type	2
2 Resistance at T0 (ohms)	3000
3 T0 (Celsius)	25
4 Beta	5234
5 Steinhart-Hart 0th order (A)	0.0
6 Steinhart-Hart 1st order (B)	0.0
7 Steinhart-Hart 2nd order ©	0.0
8 Steinhart-Hart 3rd order (D)	0.0

U up. T Top.

Figure 70

Beta Value Temperature Calibration Factors.

The beta value calculation is normally less accurate for converting thermistor temperature reading into Degrees Celsius.

Assign Steinhart-Hart Calculation Option

Menu option '**2**' is set 1 as shown opposite, ,

Figure 70 opposite shows the Beta value assigned to the temperature calculations.
The Beta value of 5234 will be used to determine the temperature value.

Any Steinhart-Hart factors will be ignored.

To adjust a parameter simply type in the new value and press the return key. The new parameter will be stored directly into the instrument.

USB to SDI12 Media Converter

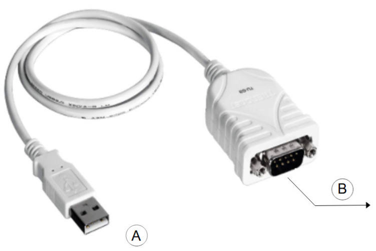


Fig 71

A = USB Connector

B = 9 Pin D Connector

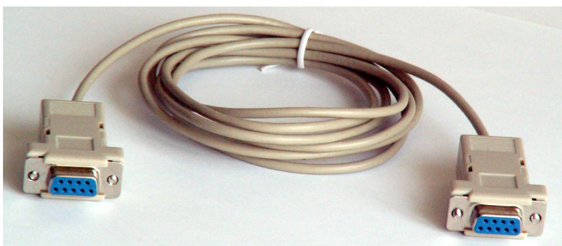


Fig 72 - NULL Modem Cable (Crossover Cable)

Modbus Supported Instrument

Part Number: **VibWire-108-Modbus**

The VibWire-108 supports Modbus protocol across the RS-485 digital network and acts as a slave unit only.
The layout of the registers used to hold the sensor data values is shown in the tables below.

The VibWire-108-Modbus version cannot currently cannot operate within Q-LOG software and requires Modbus Client software to operate.

Model: VibWire-108-485

The **VibWire-108-Modbus** version instrument will start the channel scan sequence automatically as soon as power is applied. The scan period is set using the built in menu system accessed via the keyboard. See Page 34 for details.

Unlike the other versions of the instrument the VibWire-108-Modbus version instruments update the Modbus registers upon detecting a change in a sensor operating frequency or temperature measurements and waits for the command to send measurements to the network from the master unit.

Modbus - Factory Set Parameters

Modbus version instruments are:

8 x VW Channels: Units Hz   8 x Temperature Sensor: Units Degree Celcuis – Modern sensors SI Units Degree Celsius

The device input channels can be individually configured to give results in SI Units using the terminal port menu system. See details on page 22. Instruments shipped after this date will have the temperature sensor input ports pre-set into SI Units

Device Configuration

The **VibWire-108-Modbus** has the calibration factors for the sensors installed via the terminal port. See page HHH for details. The same procedure for assigning calibration factors is used throughout the VibWire-108 range..

The number and type of sensor inputs to scan is assigned from the keyboard using the menu system. See page HJG for more details.

Scanning The Instrument

The VibWire-108-Modbus scans automatically after power- on and updates the Modbus registers upon detecting a change in the sensor signals.

The User can select from scan period of:

30 Sec, 1 MIN, 1 HR, 6 HR, 24 HR

The following Modbus command is used to get data from the VibWire-108

Read Input Registers (FC=04) command

Selecting the Register Type

All of the registers shown below are available from a single instrument. Choose the Modbus registers that best suit the SCADA software operations. High resolution 32 bit values give frequency results to 0.1 Hz.

32 Bit Integer results start at address 256.

32 Bit Floating Point Registers

The tables below show how the registers holding the VibWire-108 32 bit - floating point data is stored.

Address: 0..40 – Unused registers return 0.

Address Offset	Parameter	Description
0	Chan-0 Freq	High order word
1		Low order word
2	Chan-1 Freq	High order word
3		Low order word
4	Chan-2 Freq	High order word
5		Low order word
6	Chan-3 Freq	High order word
7		Low order word
8	Chan-4 Freq	High order word
9		Low order word
10	Chan-5 Freq	High order word
11		Low order word
12	Chan-6 Freq	High order word
13		Low order word
14	Chan-7 Freq	High order word
15		Low order word

Table 5

	2 Bytes	2 Bytes
Floating Point Data Value	High Word	Low Word

Address Offset	Parameter	Description
16	Chan-0 Temp	High order word
17		Low order word
18	Chan-1 Temp	High order word
19		Low order word
20	Chan-2 Temp	High order word
21		Low order word
22	Chan-3 Temp	High order word
23		Low order word
24	Chan-4 Temp	High order word
25		Low order word
26	Chan-5 Temp	High order word
27		Low order word
28	Chan-6 Temp	High order word
29		Low order word
30	Chan-7 Temp	High order word
31		Low order word
32	Number of Modbus read attempts	High order word
33		Low order word
34	Number of Scans	High order word
35		Low order word

Table 6

16 Bit Integer Registers

The tables below show how the registers holding the VibWire-108 16 bit Integer data is stored.

Address: 128..148 – Unused registers return 0.

Address Offset	Parameter	Description
128	Chan-0 Freq	Integer Word
129	Chan-1 Freq	Integer Word
130	Chan-2 Freq	Integer Word
131	Chan-3 Freq	Integer Word
132	Chan-4 Freq	Integer Word
133	Chan-5 Freq	Integer Word
134	Chan-6 Freq	Integer Word
135	Chan-7 Freq	Integer Word
136	Chan-0 Temp	Integer Word
137	Chan-1 Temp	Integer Word
138	Chan-2 Temp	Integer Word
139	Chan-3 Temp	Integer Word
140	Chan-4 Temp	Integer Word
141	Chan-5 Temp	Integer Word
142	Chan-6 Temp	Integer Word
143	Chan-7 Temp	Integer Word

Table 7

Address Offset	Parameter	Description
144	Number of Modbus read attempts	Integer word
145	Number of Scans	
146-148	0	Integer Word

Table 8

	2 Bytes
Word Data Value	**Word**

Modbus Register Types

Address Range		Modbus Data Format
0 .. 40	30001+	Floating point format (Standard)
128 .. 148	30129+	16 bit
256 .. 296	30257+	32 bit
384 .. 424	30385+	32 bit high resolution

Table 9

32 Bit Integer Registers

The tables below show how the registers holding the VibWire-108 32 Bit data is stored

Address Offset	Parameter	Description
256	Chan-0 Freq	High order word
257		Low order word
258	Chan-1 Freq	High order word
259		Low order word
260	Chan-2 Freq	High order word
261		Low order word
262	Chan-3 Freq	High order word
263		Low order word
264	Chan-4 Freq	High order word
265		Low order word
266	Chan-5 Freq	High order word
267		Low order word
268	Chan-6 Freq	High order word
269		Low order word
270	Chan-7 Freq	High order word
271		Low order word

Table 10

Floating Point Data Value

2 Bytes	2 Bytes
High Word	Low Word

Address Offset	Parameter	Description
272	Chan-0 Temp	High order word
273		Low order word
274	Chan-1 Temp	High order word
275		Low order word
276	Chan-2 Temp	High order word
277		Low order word
278	Chan-3 Temp	High order word
279		Low order word
280	Chan-4 Temp	High order word
281		Low order word
282	Chan-5 Temp	High order word
283		Low order word
284	Chan-6 Temp	High order word
285		Low order word
286	Chan-7 Temp	High order word
287		Low order word
288	Number of Modbus read attempts	High order word
289		Low order word
291	Number of Scans	High order word
292-296	N/A	

32 Bit High Resolution Registers

Address Offset	Parameter	Description
384	Chan-0 Freq	High order word
385		Low order word
386	Chan-1 Freq	High order word
387		Low order word
388	Chan-2 Freq	High order word
389		Low order word
390	Chan-3 Freq	High order word
391		Low order word
392	Chan-4 Freq	High order word
393		Low order word
394	Chan-5 Freq	High order word
395		Low order word
396	Chan-6 Freq	High order word
397		Low order word
398	Chan-7 Freq	High order word
399		Low order word

Table 11

Floating Point Data Value

2 Bytes	2 Bytes
High Word	Low Word

Address Offset	Parameter	Description
400	Chan-0 Temp	High order word
401		Low order word
402	Chan-1 Temp	High order word
403		Low order word
404	Chan-2 Temp	High order word
405		Low order word
406	Chan-3 Temp	High order word
407		Low order word
408	Chan-4 Temp	High order word
409		Low order word
410	Chan-5 Temp	High order word
411		Low order word
412	Chan-6 Temp	High order word
413		Low order word
414	Chan-7 Temp	High order word
415		Low order word
416	Number of Modbus read attempts	High order word
417		Low order word
418	Number of Scans	High order word
419-424	N/A	

High Resolution Mode Modbus Operation

In high resolution mode the measured values are multiplied by a factor of 10.

Example Measured Reading **25373** True Vale = **2537.3** Hz
Temperature **278** True Value = **27.8** Hz

Modbus over 485 Network

The images below show the 485 network for Modbus operations.

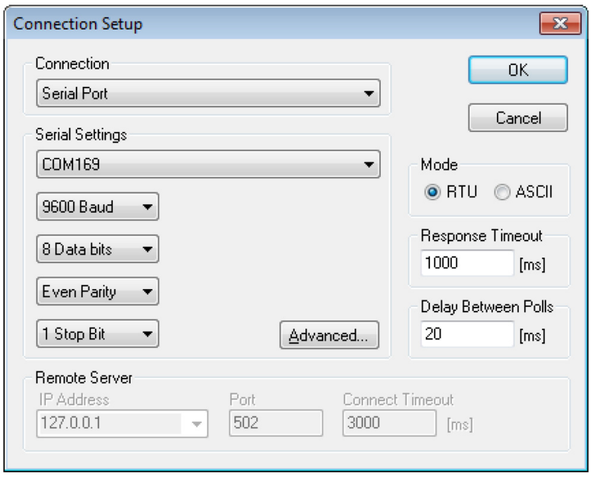


Fig 74

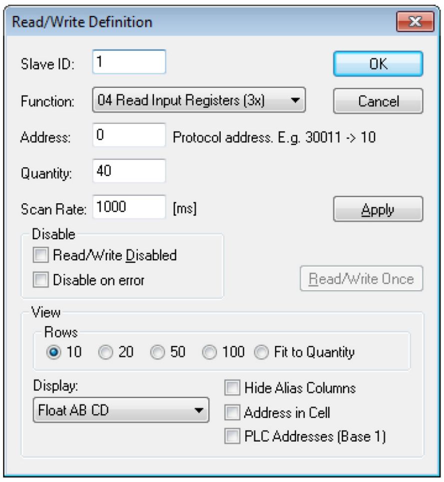


Fig 75

Modbus Operations

The model VibWire-108-Modbus will connect to any suitable Modbus system supporting RS-485 digital communications. This could be a plant wide SCADA solution or simply a stand-alone system running on a PC or laptop. So long as a suitable communications port is available then the instrument will communicate.

The Keynes model USB-485 media converter is shown in the documentation however any other similar device can be used with the instruments.

The VibWire-108-Modbus operates as a /slave system where the SCADA system or data recorder is the master,

Keyboard Menu System Options

The keyboard menu system has been designed to be easy to use. Use the menu keys

Move up and down the menu system until the desired parameter is shown in the display. Use the '**Up**' and '**Down**' keys to change the values. Once the new value is selected press the '**Menu Out**' button to store the new value.

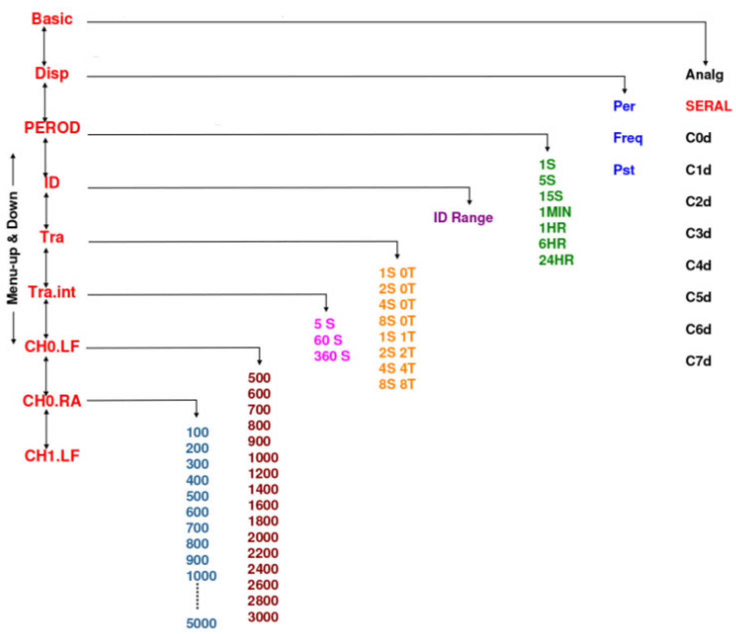


Fig 76

Top Menu Item

Fig 77

Use the **Up** and **Down** keys to access the main menu items such as **Disp, PEROD, ID, CHO.LF, CH0.RA.**

Select the **Menu-In** key to move through to the optional adjacent menu items..

Use the **Up** and **Down** keys to access sub menu items

The in-built keyboard enables the User to set up and adjust the operating charachetristics for an instrument such as the number of channels to scan etc..

The sensor calibration factors are entered using the terminal port or via Q-LOG as it is not practical to enter complex numbers using the four keyboard keys.

PEROD := Sensor Activation Period

Defines the sensor scan period for the instrument. The analogue output channels are updated after each scan.

1S, 5S, 15S, 1 min, 1Hr, 6Hr, 24Hr. 1S is only used for single channel operation.

ID := System identifier number

Each instrument requires a unique identification number that is required to locate a specific instrument upon a network.
integer of range 0 .. 32.

TRa := Transmission Data Options. (**Not used RS485/SDI-12**)

To optimise the network bandwidth in order to ensure the maximum number of sensors can be deployed the User is allowed to select the number and type of sensor inputs used on the VibWire-108 for data transmission across a network.

DISP := This option is used to select the type of engineering results that are shown on the 7 segment display.

Per = 1/ Freq = period of oscillation in mSec
Freq = XXXX.X in Hz - units changed by terminal
Pst = Percentage of range

	Definition	Menu-in / Menu-out
Basic		Analg, SERAL, COd, C1d, C2d, C3d, C4d, C5d, C6d, C7d
DISP	Display	Per, Freq, Pst
PEROD	Sensor Scan Period	1S, 5S, 15S, 1MIN, 1HR, 6HR, 24HR
ID	Network Address / ID Number	1..32
TRa	Number and type of sensor Input	1S 0T, 2S 0T, 4S 0T, 8S 0T, 1S 1T, 2S 2T, 4S 4T, 8S,8T
TRa.int	Device update rate	5 S, 60 S, 360 S
CH0.LF	Channel 0 Low Frequency	A
CH0.RA	Channel 0 Range	B
CH1.LF	Channel 1 Low Frequency	A
CH1.RA	Channel 1 Range	B
CH2.LF	Channel 2 Low Frequency	A
CH2.RA	Channel 2 Range	B
CH3.LF	Channel 3 Low Frequency	A
CH3.RA	Channel 3 Range	B
CH4.LF	Channel 4 Low Frequency	A
CH4.RA	Channel 4 Range	B
CH5.LF	Channel 5 Low Frequency	A
CH5.RA	Channel 5 Range	B
CH6.LF	Channel 6 Low Frequency	A
CH6.RA	Channel 6 Range	B
CH7.LF	Channel 7 Low Frequency	A
CH7.RA	Channel 7 Range	B

Table 13

Only available in the VibWire-108-Analog version instrument..

A = 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000 Hz
B = 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 Range in Hz

Real-time Display Options - Units Hz

Available in all versions of the VibWire-108 instruments.

C0d	Real Time Channel 0	**C1d**	Real Time Channel 1	**C2d**	Real Time Channel 2	**C3d**	Real Time Channel 3
C4d	Real Time Channel 0	**C5d**	Real Time Channel 1	**C6d**	Real Time Channel 2	**C7d**	Real Time Channel 3

Vibrating Wire Sensor Excitation Control

The pluck control system built into the VibWire-108 is a useful feature to activate upon observing unusual spikes in what should be steady state data values for sensors that change little over time.

Spikes in the Vibrating Wire Sensor Data

Depending on how well a vibrating wire sensor is made the sensor coil could become damaged, or if the sensor extreme physical shock once it is deployed. Damage to the sensor often means the coil seating has been damaged and the sensor can oscillate at a different harmonic than the designed fundamental frequency.

In order to obtain the correct sensor frequency in the face of oscillations from higher harmonics then the pluck control feature can be used.

Important Note

The '**Initial Pluck** ' defines the start frequency of the sensor scan. By default use the automatic sensor excitation '0' as this gives the best result for the majority of sensors.

The 'Initial Pluck' frequency is a global setting and is of use only then the same model of sensor is used on all sensor inputs.

Setting the Pluck Control

Go to the 'Pluck Control' menu as shown in Figure 79 below.

Select the channel to be configured.

Enter the '**Centre Frequency**' for the normal operation of the sensor.
Enter the '**Initial Pluck**' for the normal operation of the sensor.

The operating frequency for the VW sensor input is now limited to a minimum frequency of ½ of the 'Centre Frequency', and to a maximum of 2 x 'Centre Frequency'. This range removes the third harmonic oscillation which is a common cause of spikes in VW data.

Example

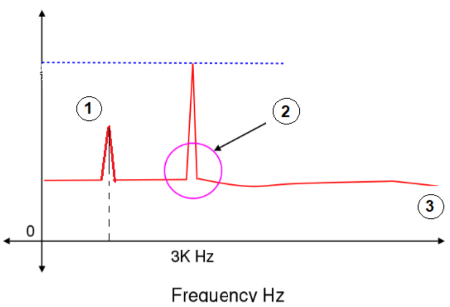


Fig 78

Example - Setup channel 0

Press item **'2'**

Set Frequency to '1000'

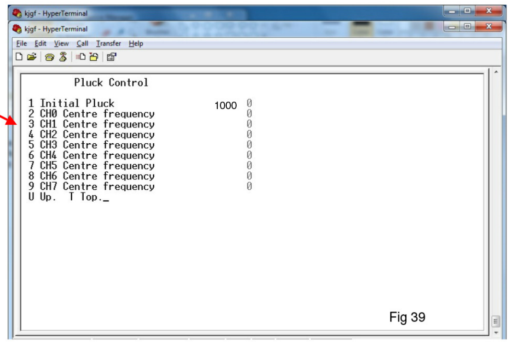


Fig 79 Pluck Control Menu

1 = Sensor Fundamental Frequency
2 = 3rd Harmonic Out of band Signal Component

Pluck Control Calculations

Table 14 below demonstrates sample pluck control settings

Center Frequency	Low Frequency	Centre Frequency	Max Frequency
800	400	800	1600
900	450	900	1800
1000	500	1000	2000
1200	600	1200	2400

Table 14

Low Frequency = Center Frequency / 2
Maximum Frequency = 2 x Center Frequency

The pluck control sets the range over which the instrument will respond. Any detected harmonics outside this range will be ignored.

Example. Center frequency - 1400 Hz

Low Frequency = 700 Hz Maximum Frequency = 2800 Hz

Device Firmware Upgrade Facility

Using the Terminal Port menu system

1. From the '**Main Menu**' select option 1 '**Systems Maintenance**'

2. The following menu will appear -

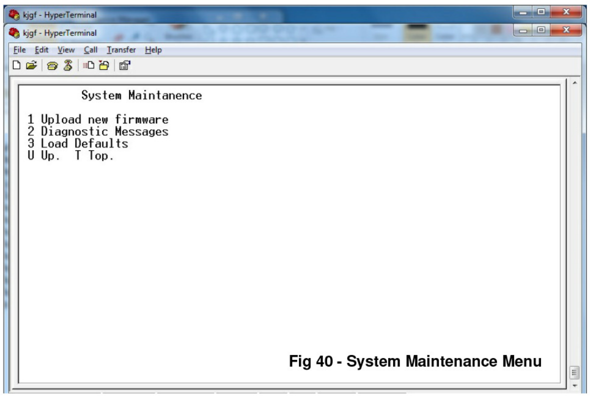


Fig 40 - System Maintenance Menu

Fig 80

3. Select option 1 '**Upload new firmware**'

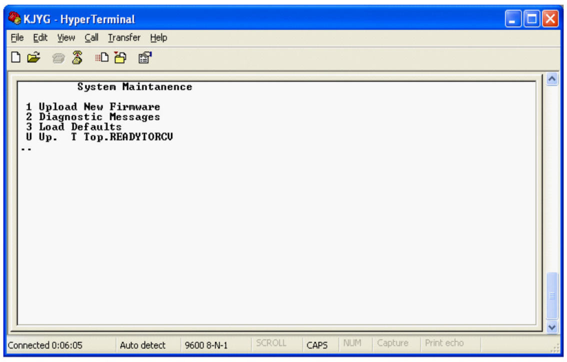


Fig 81

4. Using the HYPER-TERMINAL menu system

Select '**Transfer\Send Text File**' option.

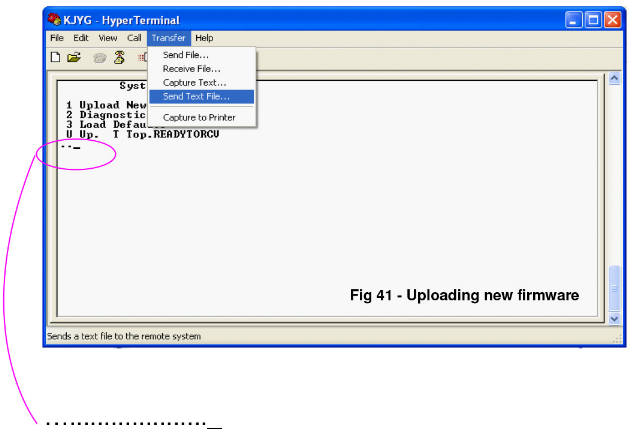


Fig 41 - Uploading new firmware

........................_

appears on the screen as the firmware loads into the sensor interface.

'**Burning**' message shows that
The firmware has been loaded correctly.

Fig 82

Firmware Update

Any new firmware is sent out from Keynes Controls technical support only. Only a competent software engineer should undertake this task.

Keynes Controls offer a back to base firmware upgrade service. A small cost is incurred if using this service.

Make sure the latest firmware which is in the form of a text data file, is stored into a suitable location.

Example firmware for this documentation is titled 'vw101.txt'

Once option '1' is selected then the 'Upload new firmware' Window, as shown opposite will appear.

Locate and select the new firmware data file.

Figure 82 opposite shows how the 'Hyper-terminal' software appears once the firmware file is selected and data is being sent to the sensor interface.

Figure 83 below shows the System Maintenance Window.

The 'Burning' message has to be displayed to show the new firmware has been loaded correctly.

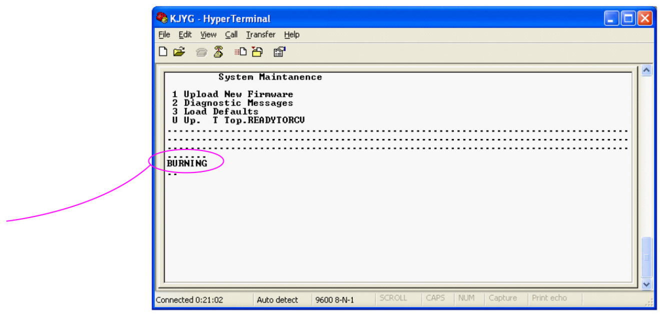


Fig 83 - Firmware upload successful

Terminal Port Menu Screens

Main Menu

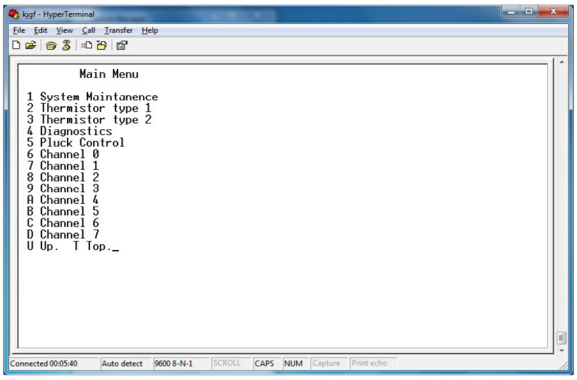


Fig 84

Default menu upon activating the terminal port..

Select the menu number to access the options.

Thermistor Type 1 Menu

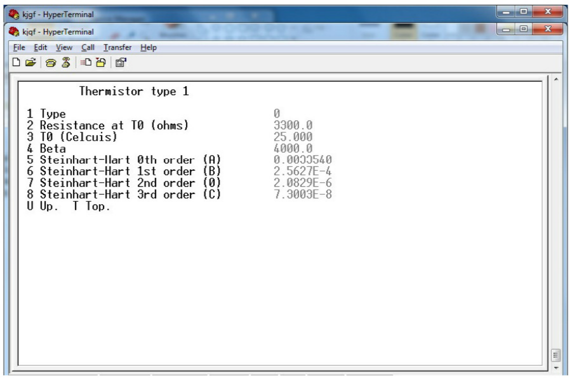


Fig 85

Thermistors sensor calibration factor setup menu.

Thermistor Type 1 Default Configuration Parameters

Pluck Control Menu

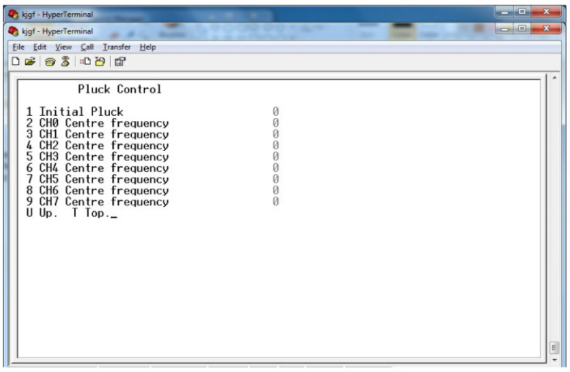


Fig 86

The pluck control menu system used to remove out of band harmonics from any device measuremnt.

Page 44 shows additional setup details.

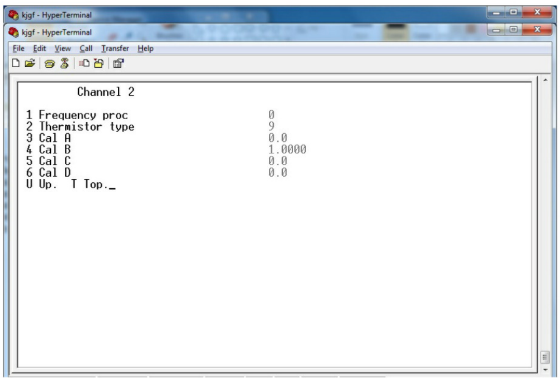


Fig 87

The image opposite shows the default Vibrating Wire Sensor input channel configuration menu system.

Option 1 ‘Frequency’ - Hz , Digits or SENSOR (SI units)

Repeat for each sensor input channel.

SAMPLE Vibrating Wire Piezometer Calibration Data Sheet

Encardio-rite Electronics Pvt. Ltd.
A-7 Industrial Estate, Talkatora Road, Lucknow, UP-226011 India
E-mail: geotech@encardio.com, lko@encardio.com; Website: www.encardio.com
Tel. +91 (522) 2661039/40/41/42 Fax +91 (522) 2662403

TEST CERTIFICATE
DWT Traceable to standard no. : J082301 T8F 281 TC

Customer	:			
P.O. No.	:			
Instrument	:	V W Piezometer	Date	: 02.02.2012
Serial number	:	xxxxx	Temperature	: 19°C
Capacity	:	350 kPa	Atm. Pressure	: 100 kPa

Input pressure (kPa)	Observed value Up1 (Digit)	Down (Digit)	Up2 (Digit)	Average (Digit)	End Point Fit (kPa)	Poly Fit (kPa)
0.0	6555.9	6556.9	6556.9	6556.4	0.0	0.3
70.0	6312.4	6312.6	6312.4	6312.4	69.3	69.5
140.0	6064.0	6064.3	6063.1	6063.5	139.9	140.1
210.0	5817.1	5818.4	5816.2	5816.7	210.0	210.1
280.0	5569.8	5570.7	5568.0	5568.9	280.3	280.3
350.0	5323.3	5323.3	5323.7	5323.5	350.0	349.8

Digit : $f^2/1000$

Linear gage factor (G) : 2.8388E-01 kPa/digit
(Use gage factor with minus sign with our read out unit Model : EDI-51V)

Thermal factor(K) : -0.087 kPa/°C

Polynomial constants :
A= -2.2253E-07 B= -2.8085E-01 C= 1.8512E+03

Pressure "P" is calculated with the following equation:

Linear : P(kPa) =G(R0-R1)+K(T1-T0)-(S1-S0)

Polynomial : P(kPa) = A(R1)² + B(R1) + C+K(T1-T0)-(S1-S0)

R1 = current reading & R0 is initial reading in digit.
S1 and T1 = current atmospheric pressure(kPa) and temperature (°C)

Readings at the time of shipment — Date

f	:	Hz
f^2	:	Digit
Temperature	:	°C
Thermistor	:	Ohm
Atm.pressure	:	kPa
Coil resistance	:	Ohm

(Zero conditions in the field must be established by recording the reading R0 (digit) along with temperature T0 (°C)and atmospheric pressure S0 (kPa) at the time of installation.If polynomial constants are used, determine value of 'C' as per § 6.2 of user's manual.)

Piezometer Calibration Setting - Worked Example

Worked Example

$$P(kPa) = A(R1)^2 + B(R1) + C + K(T1-T0) - (S1-S0)$$

Calibration Equation from the above data sheet.

where the output measurement will be in the Engineering Units of kPa

The parameters **SO** sensor calibration factor is shown at 100 kPa and is the barometric pressure at the time the sensor was calibrated.

S1 is the current barometric pressure in kPa at the sensor location that would have to be measured using an intelligent barometer such as the Keynes **Barom-SDI12** or **Barom-485** instruments that can return measurements in the same engineering units as the vibrating wire sensor. In this example the units being used are kPa.

In order to simplify the example then the barometric variation using the S0 and S1 terms are not going to be considered.

The correct calibration factors have to be identified from the calibration equation and written into the instrument.

Constant Terms

These terms are those that do not vary with time or pressure but remain constant in value.

C + K (T1-T0) where T0 =19 Degree Celsius

C + K.T0 are constant terms.

Using the values shown in Table 15 below, then the constant terms that will be entered into the instrument will be

C **+** **K. T0** = 1.8512E03 + (-0.087 * 19)
= 1852 - 1.653
= 1849.3

So the value **1849.3** is used as the Constant Term.

Figure 90 on Page 49 shows the Constant Value entered into Channel 2 Configuration settings using the Q-LOG Software.

Real-time Temperature Compensated Measurements

The VibWire-108 interface can be configured to return temperature compensated frequency measurements.

In order to undertake this task the Thermal Expansion Parameter has to be assigned.

Figure 89 below shows the Thermal Expansion coefficient assigned into the Q-LOG software,

Should the Thermal Expansion Parameter not be assigned or set to 0 then the temperature correction is not used.

The Thermal Expansion Parameter value from the data sheet above

= **- 0.087**

Understanding the Parameters

Using the sample equation above

The values shown in Table 15 below have been taken from the sensor datasheet on Page 47 and show the Frequency Component Calibration Factors and their definition.

A = Quadratic Term	B = Linear Term	C = Offset	K = Thermal Expansion	T0 = Sensor Calibration Temperature
-2.2253E-07	-2.8085E-01	1.8493E03	= -0.087	= 19

Table 15

Each of the eight sensor channels can be individually configured.
The Q-LOG Software and Terminal Port Menu system use the same calibration factor order.

Main Menu

1 System Maintenance
2 Thermistor type 1
3 Thermistor type 2
4 Diagnostics
5 Channel 0
6 Channel 1
7 Channel 2
8 Channel 3
9 Channel 4
A Channel 5
B Channel 6

Channel 2

1 Frequency proc	2
2 Thermistor type	1
3 Cal A	1.8493E03
4 Cal B	-2.8085E-01
5 Cal C	-2.2253E-07
6 Cal D	-0.087

Figure 88

The menu system shown in Figure 88 is configured for temperature compensated measurements.

Calibration Factor D has been set.

Q-LOG Software - Frequency Component Calibration Parameter Settings

The example below shows Channel 2 Frequency Calibration Factors configuration in the Q-LOG software.

When writing new calibration factors into the instrument press the Set Button to store them into the instrument.

Q-LOG Software Channel 2 Sensor Calibration Window

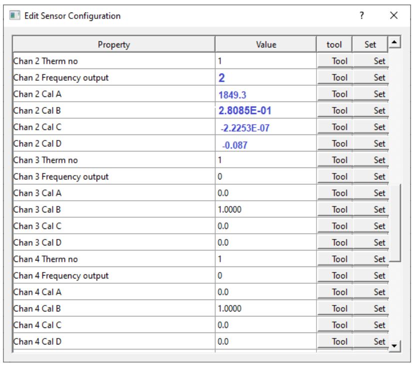
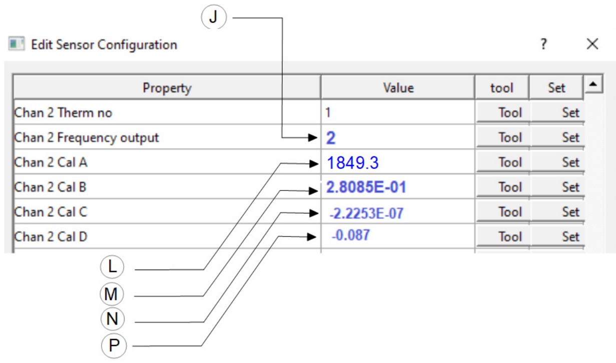


Fig 89 **Q-LOG Software Channel 2 Sensor Calibration Window**

Figure 90



J	Engineering Units	L	Constant Coefficient	M	Linear Term
N	Quadratic Term	P	Thermal Expansion		

Table 16

The sensor calibration temperature is shown to be 19 Degrees Celsius. In practice the Constant term used as

Terminal Port Settings - worked example

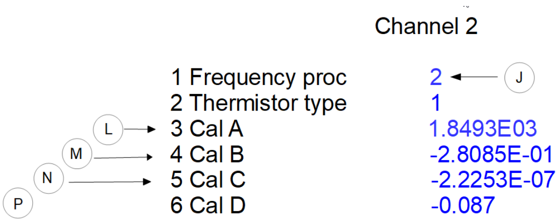


Figure 91 opposite shows the terminal port menu system frequency component calibration settings for the Piezometer vibrating wire sensor on Page 47.

In order to send measurements in Engineering units then the Process Option 2 is set.

Table 16 shows the definitions for the different Calibration Factors.

Thermistor Temperature Settings

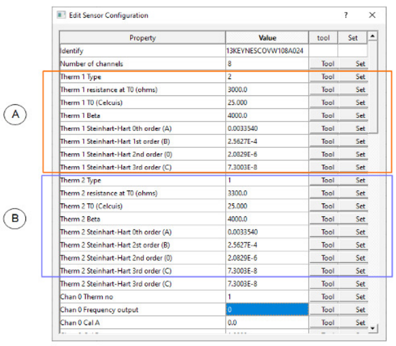


Figure 92

Figure 92 opposite shows the Q-LOG Thermistor calibration settings for the temperature sensor used in Channel 2 of the example,

A VibWire-108 supports two separate thermistor temperature sensor type

The example above shows sensor type 1 defined for use with the vibrating wire sensor.

When possible use the Steinhart-Hart Thermistor Calibration Factors when available.
.

Channel two of the VibWire-108 instrument will measure and report temperature corrected pressure readings.

Displacement Sensor Calibration Factors - Worked Example Calibration

The following example uses the Digits frequency measurement parameter in the calculation

Worked Example

VIBRATING WIRE INSTRUMENTS CALIBRATION CERTIFICATE

Instrument Type : Displacement Transducer
Instrument Range : 0.00 to 50.0 mm
Gauge Factors in mm
Period Gauge Factor K = 92.1053900
Thermal Expansion Coefficient : **0.009612**
Linear Gauge Factor (G) : (mm/digit) -0.0092090
Polynomial Gauge Factor A: **0.000000024979750**
Polynomial Gauge Factor B: **0.0089750451**
Polynomial Gauge Factor C: **28.976750**

Serial No. : 012453
Calibration Date. : 14th March 2014
Ambient Temp. : 23 Deg C
Barometric Pressure : 1015 mb
Calibrator Personnel : Ian Thomas
Calibration Equipment :
Digital micrometer with scale
VibWire-108 sensor interface
Regression Zero: 3185.7

Reading (Period)	Digits $F^2/1000$	Calculated (Linear)	Error %FS (Linear)	Linear Increment	Applied (mm)	Calculated (Polynomial)	Error %FS (Polynomial)
5610.9	3176.4	-0.088	-0.18	0.0	0.00	0.023	0.05
5182.9	3722.6	4.943	-0.11	546.2	5.00	4.987	-0.03
4840.0	4268.8	9.974	-0.05	546.2	10.00	9.966	-0.07
4555.8	4818.0	15.032	0.06	549.2	15.00	14.988	-0.02
4316.6	5366.8	20.087	0.17	548.8	20.00	20.021	0.04
4112.2	5913.5	25.123	0.25	546.7	25.00	25.049	0.10
3937.9	6448.8	30.053	0.11	535.3	30.00	29.987	-0.03
3782.8	6988.5	35.024	0.05	539.7	35.00	34.981	-0.04
3643.9	7531.2	40.023	0.05	542.7	40.00	40.017	0.03
3521.8	8062.5	44.917	-0.17	531.3	45.00	44.961	-0.08
3409.0	8604.8	49.912	-0.18	542.3	50.00	50.022	0.04

Formulae: **Linear** $E = G(R_1 - R_0)$
Polynomial $E = AR_1^2 + BR_1 + C$
Offset $C = -(AR_0^2 + BR_0)$

These equations give displacement only without any temperature compensation.

Soil Instruments Piezometer Set-up

The calculations are in Digits so the instrument has to **Freq Proc = 1**
All calculations will now use the measured sensor frequency in Digits and not Hz.

To use the Polynomial Calibration Equation see the Configuration below

Main Menu

1 System Maintenance
2 Thermistor type 1
3 Thermistor type 2
4 Diagnostics
5 Channel 0
6 Channel 1
7 Channel 2
8 Channel 3
9 Channel 4
A Channel 5
B Channel 6

Channel 0

1 Frequency proc	1
2 Thermistor type	1
3 Cal A	28.976750
4 Cal B	-8.9750E-03
5 Cal C	2.4979E-09
6 Cal D	-0.009612

Linear Formula Calculation

Where R_0 = is the initial zero reading of the sensor..
From the table above R_0 = 3176.4

R_1 = Current Sensor Frequency - in **Digits.**

Displacement Calculations using the Linear Formula only

$E = G(R_1 - R_0)$ Linear Displacement Formula

G = Linear Gauge Factor **= 0.009209**

R_0 = 0 mm Sensor Frequency in Digits

Constant Term = - G.R_0 = 0.0092090. 3176.4
= **2.925E01**

Linear Term = G = **0.009209**

The Calibration factors are

1 Frequency proc	1
2 Thermistor type	1
3 Cal A	-2.925E01
4 Cal B	9.209E-3
5 Cal C	0.0
6 Cal D	0.0

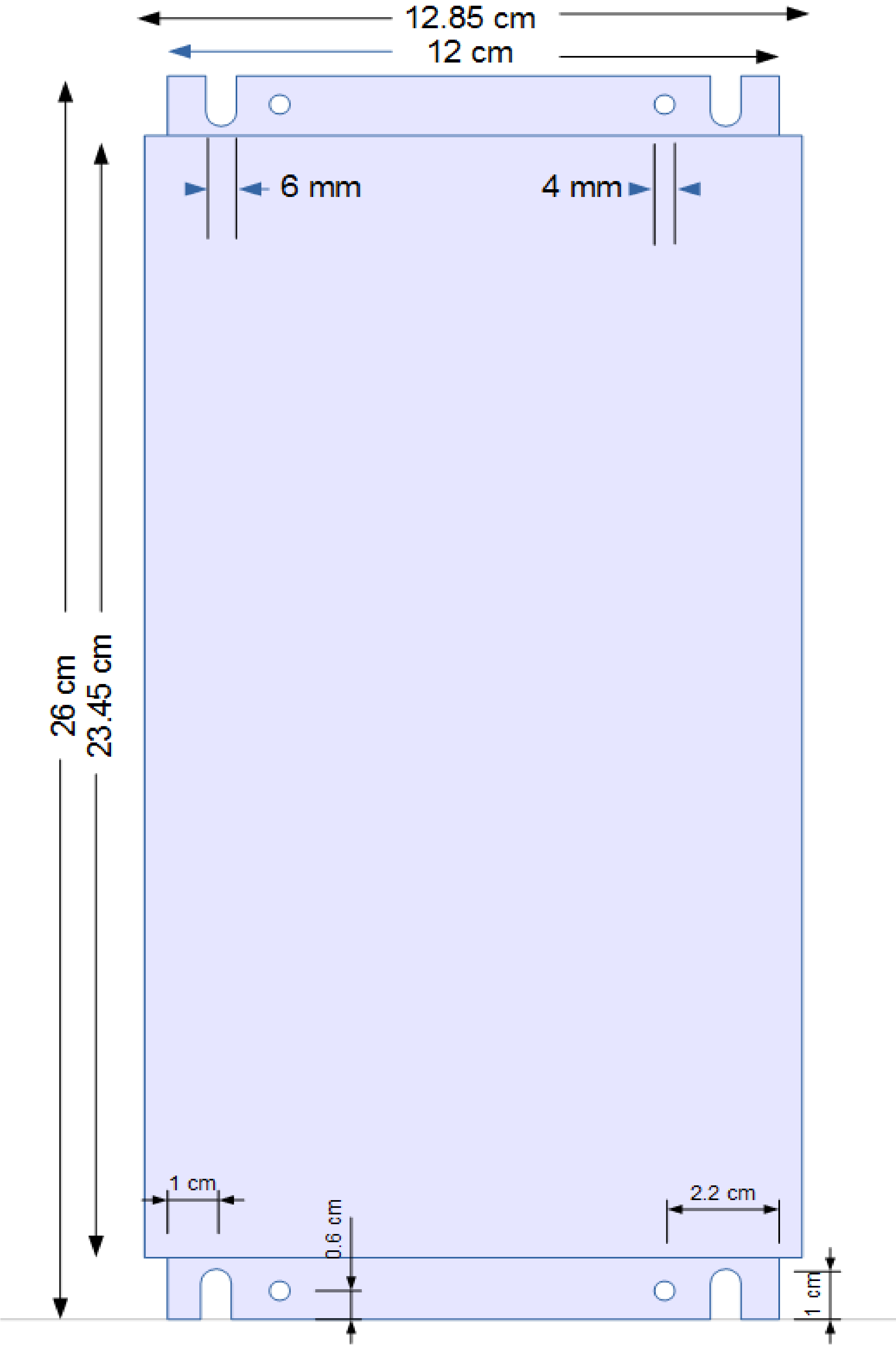
No temperature compensation has been used in this example.

Polynomial Calibration Equation Coefficients

A = Quadratic Term	B = Linear Term	C = Offset	K = Thermal Expansion	T0 = Sensor Calibration Temperature
2.4979E-09	**8.9750E-03**	**28.976750**	**-0.009612**	**23**

Dimensions of the VibWire-108 Back Mounting Panel

The image below shows the dimensions of the back mounting panel for the VibWire-108 range of vibrating wire sensor interfaces.



Further Information Menu System Options

VibWire-108 Menu Items	Translated Text	Comments
Main Menu	**Main Menu**	
1 System Maintenance	1 System Maintenance	
2 Thermistor type 1	2 Thermistor type 1	
3 Thermistor type 2	3 Thermistor type 2	
4 Diagnostics	4 Diagnostics	
5 Channel 0	5 Channel 0	
6 Channel 1	6 Channel 1	
7 Channel 2	7 Channel 2	
8 Channel 3	8 Channel 3	
9 Channel 4	9 Channel 4	
A Channel 5	A Channel 5	
B Channel 6	B Channel 6	
C Channel 7	C Channel 7	
U Up. T Top	U Up. T Top	

Thermistor type 1

VibWire-108 Menu Items		Translated Text	
1 Type	1	1 Type	1
2 Resistance at T0 (ohms)	3000	2 Resistance at T0 (ohms)	3000
3 T0 (Celsius)	25	3 T0 (Celsius)	25
4 Beta	5234	4 Beta	5234
5 Steinhart-Hart 0th order (A)	3.35E-3	5 Steinhart-Hart 0th order (A)	3.35E-3
6 Steinhart-Hart 1st order (B)	2.56E-4	6 Steinhart-Hart 1st order (B)	2.56E-4
7 Steinhart-Hart 2nd order (C)	2.08E-6	7 Steinhart-Hart 2nd order (C)	2.08E-6
8 Steinhart-Hart 3rd order (D)	7.30E-8	8 Steinhart-Hart 3rd order (D)	7.30E-8
U Up. T Top.		U Up. T Top.	

Vibrating Wire Frequency Component Calibration

1 Frequency proc	1	1. **Frequency Process Option**
2 Thermistor type	1	2. **Thermistor type**
3 Cal A	-2.925E01	3. **Calibration Factor A**
4 Cal B	9.209E-3	4. **Calibration Factor B**
5 Cal C	0.0	5. **Calibration Factor C**
6 Cal D	0.0	6, **Calibration Factor D**

Key Terms

Up	**Up**
Down	**Down**
Menu-in	**Menu in**
Menu-out	**Menu Out**

Storing Calibration Factors Worked Example

The Q-LOG software can be used to write sensor configuration values into models VibWire-108-SDI12, VibWire-108-485 and VibWire-108-Analog.

The example below shows how to write calibration factors for a KDE-V150 type vibrating wire displacement sensor into a VibWire-108 t8 channel sensor interface using the Q-LOG software.

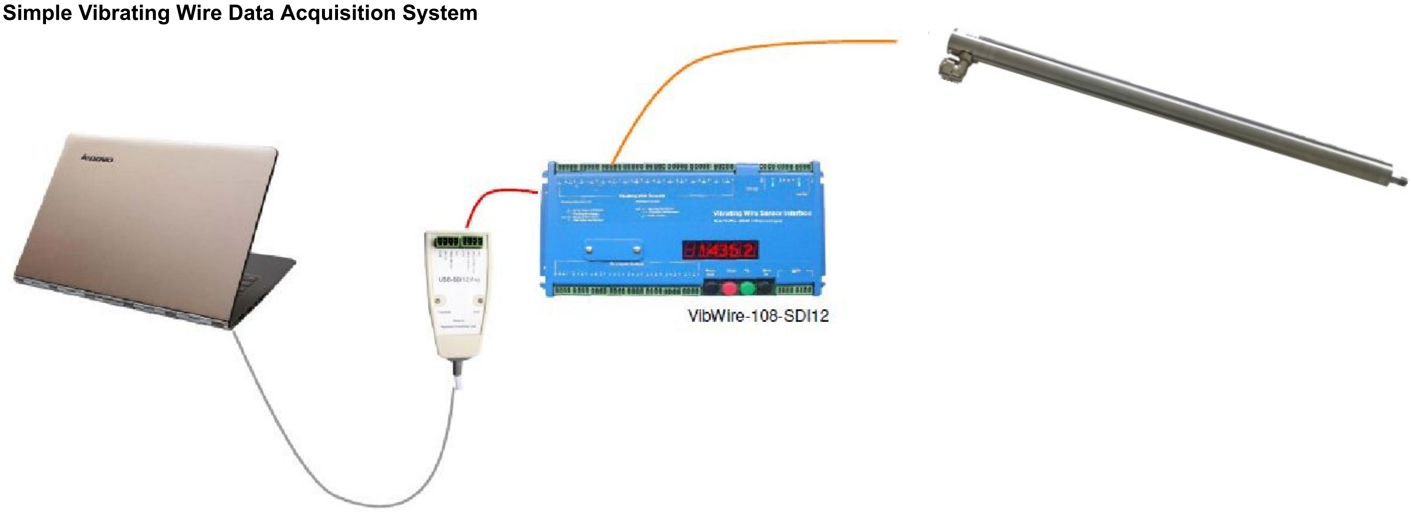
Basic System Setup

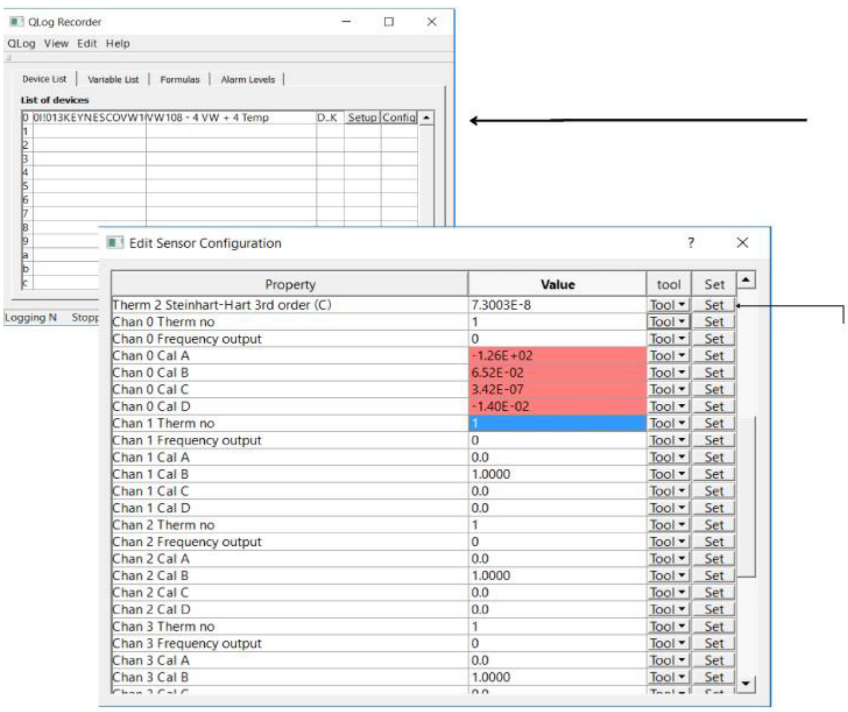
A VibWire-108-SDI12 is connected to a Windows PC using a USB-SDI12-Pro media converter.

The example presumes that the USB-SDI12-Pro is already installed and the Q-LOG is already up and running.

.

Simple Vibrating Wire Data Acquisition System





Q-LOG Software

A single VibWire-108 unit has been identified with ID=0 on the network.

The example shows a VibWire-108 configured to operate with 4 x 4 Wire inputs (4 x Frequency + 4 x Temperature inputs)

Press the **'Set'** button to write new parameters into the sensor interface.

Changed Cells

The cells that have been changed will be highlighted by having a red background.

The cell background will go clear once the new values have been written into a sensor interface.

For further information contact:

sales@keynes-controls.com

Appendix B- Vibrating Wire Total Pressure Cell - Calibration Sheet

SAMPLE

VW TOTAL PRESSURE CELL

Model	VWTPC-4000	Cal date	04/07/2017	SN.	8233
Serial		Baro	1008.8	Readout No.	14002
Works ID	G3 11 92	Temp °C	20	RO Cal Date	17/01/2017

Applied pressure		Readings [digit]			Calculated Pressure		Error % fso	
psi	kPa	1 up	1 down	avg.[digit]	lin.[kPa]	polyn.[kPa]	linear	polynomial
0.000	0.000	8940.1	8935.4	8937.7	-0.19	0.06	-0.11%	0.04%
5.004	34.500	8263.8	8259.4	8261.6	34.46	34.41	-0.02%	-0.05%
10.007	69.000	7586.8	7582.6	7584.7	69.15	68.95	0.09%	-0.03%
15.011	103.500	6911.5	6907.9	6909.7	103.75	103.55	0.15%	0.03%
20.015	138.000	6240.4	6237.1	6238.7	138.14	138.09	0.08%	0.05%
25.018	172.500	5575.4	5574.0	5574.7	172.18	172.43	-0.19%	-0.04%

CALIBRATION FACTORS

Linear factor (k)

kPa per digit	psi per digit	mH_2O per digit
-0.051254234	-0.007434	-0.005226

Polynomial factors

	kPa	psi	mH_2O
A	1.70079E-07	2.4667E-08	1.7343E-08
B	-0.053722418	-0.007792	-0.005478
C			

Thermal factor (T)

kPa per °C	psi per °C	mH_2O per °C
0.344313957	0.04993676	0.035110

Thermal Factor

Note: Digits are $Hz^2 \times 10^{-3}$ units.

(please consult the User Manuals for conversion of alternative reading units)

Polynomial calculation [kPa] = A * (Reading)^2 + B * (Reading) + C + T * (Current Temp - Site Zero Temp)

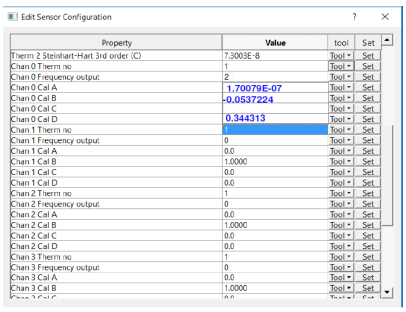
C = -A*(Site Zero Reading^2) - B*(Site Zero Reading)

Linear calc = k (kPa) * (Current Reading - Site Zero Reading) + T * (Current Temp - Site Zero Temp)

Q-LOG Software

The image below shows the Q-LOG Sensor setup Window for defining the VW Total Pressure Cell operations. The Q-LOG software can handle both polynomial and Digits processing to convert frequency values into SI units.

Channel 0 of a VibWire-108 unit is set to convert frequency measurement to SI unit of KPa. Polynomial Linearisation is used.


Edit Sensor Configuration

Property	Value	tool	Set
Therm 2 Steinhart-Hart 3rd order (C)	7.3003E-8	Tool	Set
Chan 0 Therm no	1	Tool	Set
Chan 0 Frequency output	2	Tool	Set
Chan 0 Cal A	1.70079E-07	Tool	Set
Chan 0 Cal B	-0.0537224	Tool	Set
Chan 0 Cal C		Tool	Set
Chan 0 Cal D	0.344313	Tool	Set
Chan 1 Therm no	1	Tool	Set
Chan 1 Frequency output	0	Tool	Set
Chan 1 Cal A	0.0	Tool	Set
Chan 1 Cal B	1.0000	Tool	Set
Chan 1 Cal C	0.0	Tool	Set
Chan 1 Cal D	0.0	Tool	Set
Chan 2 Therm no	1	Tool	Set
Chan 2 Frequency output	0	Tool	Set
Chan 2 Cal A	0.0	Tool	Set
Chan 2 Cal B	1.0000	Tool	Set
Chan 2 Cal C	0.0	Tool	Set
Chan 2 Cal D	0.0	Tool	Set
Chan 3 Therm no	1	Tool	Set
Chan 3 Frequency output	0	Tool	Set
Chan 3 Cal A	0.0	Tool	Set
Chan 3 Cal B	1.0000	Tool	Set

Channel 0 (Units kPa)

1 Frequency proc	2
2 Thermistor type	1
3 Cal A	1.70079E-7
4 Cal B	-0.0537224
5 Cal C	
6 Cal D	-0.344313
U Up. T Top.	

Channel 1 (Units psi)

1 Frequency proc	1
2 Thermistor type	1
3 Cal A	-2.4667E-08
4 Cal B	
5 Cal C	
6 Cal D	0.04993676
U Up. T Top.	

Barometric Correction

For applications where local barometric correction is required, then the Keynes Controls Barom-SDI12 or Barom-485 instruments should be used. These instruments are intelligent and can be set to supply pressure measurements in many different types of engineering units.

Part No: Barom-SDI12

