VibWire-301

Single Channel Vibrating Wire Sensor Interface

DIN rail Mounted VibWire-301 Sensor Interface

User Guide & Installation Manual

Version 4.0

Last updated 8/12/2022

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.

The VibWire-301 is 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.

Standard Vibrating Wire Sensor Equations

The following equations and Coefficients shown in these equations are used in the device menu system and calibration factors.

Vibrating Wire - Digits

Keynes Control uses the following equation to determine 'Digits in all our products.

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

Vibrating Wire Calibration Factors

The VibWire-301 use the following calibration equation to convert frequency into SI units:

$$X = A + Bd + Cd^2 - Dt$$

where d = measured frequency in Digits.
and D = Temperature Correction Coefficient
t = temperature in Deg C

Where A = Constant   B = Linear term   C = Quadratic terms and all frequency values are in Digits. The parameter D is for thermal expansion.

The terms A..D are the menu items assigned into the VW-301 to configure the frequency sensor input into engineering units.

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Introduction

The following document is the User Manual and installation guide for the VibWire-301 vibrating wire sensor interface..

The User is expected to have some prior knowledge of the use of sensors operated on the SDI-12 or RS-485 digital networks. This manual is not meant as a teaching aid for network applications.The VibWire-301 has been designed to interface vibrating wire sensors from any manufacturer to a Data Logger, PC Data Acquisition System, or SCADA applications.

The principle operating feature of the VibWire-301 is its ability to accurately measure and report the vibrating wire sensor frequency. The instrument uses an auto-resonance technique to energise the sensor coil and adjusts the ping rate automatically to follow the sensor operation. The auto-resonance feature enables the sensors to be automatically configured as the instrument adjusts the coil excitation to maximise the signal to noise ratio without excessive strain put to the sensor coil.

Stand-alone Operation

The VibWire-301 can act as a stand-alone trigger to an external device when using its in-built analogue output ports. It can be used to switch on indicator lights or trigger an alarm. The software in the device is embedded and once configured can be left alone to operate once power is applied. The current loop outputs can be connected to panel meters to provide real-time process applications.
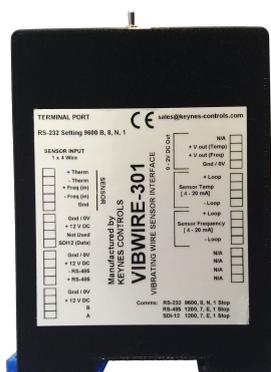
Figure-1 VibWiew-301
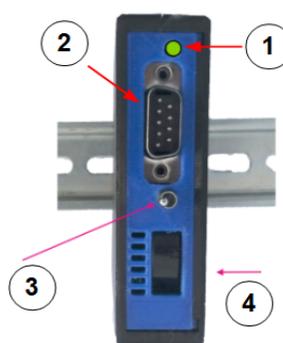
1 = LED Status Light   2 = Terminal COM Port
3 = Speaker On/Off Switch   4 = Sensor Ceramic Speaker

Figure-2   Device mounted on a DIN Rail

Dynamic & Static Measurement Applications

The VibWire-301 is capable of both static and dynamic measurement operations. The high speed measurement ability of the device makes it an ideal partner for large scale dynamic measurements.

Configuration

The VibWire-301 can be configured using the in-built terminal port menu system, or using the Q-LOG Data Display and Configuration Software..

The Q-LOG software enables the device to be configured, and test measurements made in a Windows environment without any programming experience required. The Q-LOG software can be used to display measurements and store results. A series of panel meters can be used to show real-time results.

Network Status LED

The device has a built-in LED network indicator observable on the front panel. The LED indicator flashes in a set pattern to show the mode of operation.

The network type is configured using the terminal menu system built into the device.

SI Units

The VibWire-301 can be set-up to supply results directly in units of Hz, Digits and SI (Engineering) units.

The device uses the Steinhart-Hart thermistor equation to give temperature values, as measured using the built in vibrating wire sensor temperature sensor in Deg C. Temperature measurements can be supplied in mV if required.The VibWire-301 has the calibration factors for the most common temperature sensors. User defined sensor calibration factors can be stored into the instrument.

Technical Specifications

The technical specification for the different models is shown below.

All of the VibWire-301 family of products use the same terminal port setting for configuration operations.

Physical Size (Excluding boot cover)	Height 120 mm - Width 100 mm - Depth 22 mm
Weight	65 g
Power Supply	8-15 V DC
Communication Ports	1 x RS-485 Slave - 9600 Baud, 8 data, 1 stop, no parity
	1200 Baud, 7 data, 1 stop, even parity
	1 x SDI-12 - 1200 Baud, 7 data, 1 stop, even parity
Terminal Port	1 x RS232 9600, 8 data, 1 stop, no
External Power Supply	10 - 15V DC @ 100 mA min specification
Vibrating Wire Measurements	
Analogue Input	24 Bit Sigma Delta
	Differential Coil (V+) and Coil(V-) for direct connection of sensor, excitation and resonant frequency measurement. Digital signal processing for excellent noise rejection.
Sensor Excitation	Auto-resonance - Fully automatic frequency excitation
Operating Frequency	400 - 15 KHz
Measurement Resolution	0.01 Hz RMS - 20 to 70 Deg C
Measurement Accuracy	± 0.014% of reading - 20 to 70 Deg C
SI Units	Hz, Digits (Hz^2/1000), Eng Units (Quadratic Cal Factors)
Temperature Measurements	Used for temperature compensated vibrating wire measurements, and stand-alone temperature sensors for Geotechnical applications.
Analogue Input	24 Bit Sigma Delta
Analogue Output (Frequency, Temp)	0 - 2 V DC Scaled to represent output levels.for Frequency and Temperature.
Current Loop Isolation	500V DC
4-20 mA Loop	1 x Frequency
-Powered.	1 x Temperature
Measurement Range	- 50 to 100 Deg C
Measurement Accuracy	± 0.25 % of reading - 20 to 70 Deg C
Output	Temperature - Deg C
	Frequency (Hz), Digits, SI Units
Temperature Sensor	Steinhart-Hart factors: A B C & D
Cal Factors	Quadratic Equation, Beta Value
Expansion Options	1..32 - 2 Wire Freq inputs
1 x MUX-16/32 expansion unit	1..32 - Temp (thermistor) inputs
	1..16 - 4 Wire vibrating wire sensor inputs
Scan Rate: Dynamic	10 - 20 Samples/ Sec (9600 B RS-485) - 50 Hz Analog Out
	2 Sec/Chan - using expansion module
	250 ms update to screen
16 x 4 Wire Mode	3 Sec/Chan
32 x 2 Wire	1 minutes
Storage temperature	>5 Deg C

Table 1

System Test: Power-On Sequence

Power on the VibWire-301 unit using an external power supply. See Figures 8 and 9 on Page 8.
The LED status indicator will illuminate and after several seconds will start to flash repeatedly.

Factory Default Setting

The Status LED indicator will flash slowly, but repeatedly every second indicating that the device is set to the SDI-12 network.

When factory Preset the SDI12 ID = 0

Alternative Output Port Identification

Full network indicator identification pattern is shown on Page 24.

The device remembers any previous pre-set output port option, and will illuminate the status LED indicator with the appropriate indicator pattern.

Features

- 1 x 4 Wire Vibrating Wire Sensor Input - Expands to 16 x 4 wire or 32 x 2 Wire Inputs
- Resolves the VW signal to less than 0.01 Hz (industry standard 0.1 Hz)
- Gas Discharge Tube Sensor Protection
- Audible Output
- Auto Resonance Sensor Excitation (Minimum Sensor Stress)
- RS-232 / SDI-12 / RS485 / Modbus over RS-485 Network Support
- Firmware Upgrade facility
- Automatic VW Sensor Configuration - No prior sensor operating characteristics need to be known.
- Digital Communications to remove noise sources and errors.
- Fully integrated into the Keynes Controls Q-LOG Software for easy configuration.
- Output - Frequency, Digits, SI Units, Temp Deg C
- Thermistor Linearisation Support.

Simple Installation

The VibWire-301 is simple to install on industry standard DIN rail.

Fully Integrated Data Recording Solutions

The VibWire-301 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 measurements.

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

Q-LOG - Free Data Acquisition Software

The VibWire-301 is fully integrated into the free Keynes Controls Q-LOG data recording and display software. The Q-LOG application software enables simple creation of PC based data recording and display solutions, with little or no programming experience.

The Q-LOG software is often used to test out the sensor interfaces before a site installation, this gives the User every confidence that the hardware is operating correctly before site installation or connection to a stand-alone data recorder.The software supports all of the Keynes Controls products and can be used with third party devices. The User manual demonstrates how 3rd party devices can be added to the software.

All of the Keynes Controls sensor interfaces can be simply combined into single data geotechnical data system,

Q-LOG Software Download

The Q-LOG software can be downloaded at:
http://keynes-controls.com/Download/QLogSetup50_21may2020.zip

 Show Comm port and SDI-12 network configuration in QLog software. Network scan and device identification
Youtube: https://youtu.be/pxOO7UZbX5g

Care & Maintenance

The VibWire-301 has 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 deionized water, or Isopropanol 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 = 1 Temp = 1
Default ID = 0 Sensor Network Type	Vibrating Wire Sensor (Hz) - Temperature (Deg C) SDI-12

Table 2

All sensor input channels can be User configured to give output values in SI Units by using the terminal port menu system. See Page 22 for additional details.

Required Software

The VibWire-301 requires a terminal software package supporting VT100 emulation only.

Recommended software: Microsoft Hyper-terminal,   Token22
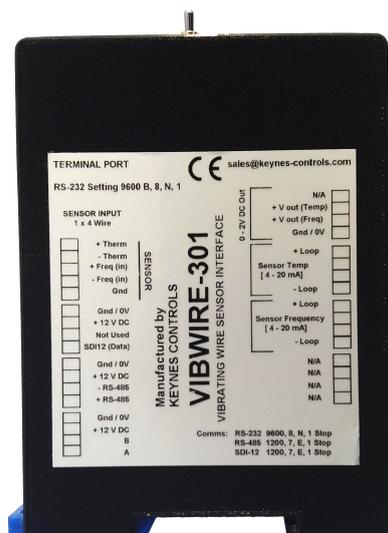
Device Layout
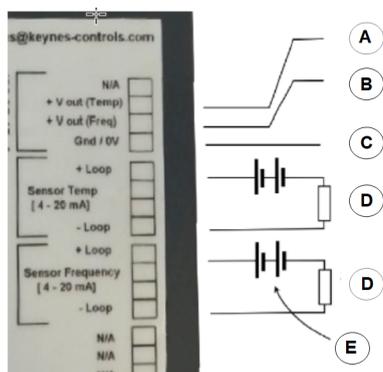
Figure-3

Device Communications & Sensor Ports

Figure-3 opposite shows the communications and sensor ports built into the VibWire-301.

The device supports directly 1 x 4 Wire port and can be expanded by the use of the MUX-16/32 expansion unit to:

16 x 4 Wire
32 x 2 Wire (32 x Frequency / 32 x Temperature)

A = 0-2 V DC (Temperature)	**B** = 0-2 V DC Frequency)
C = Gnd / 0V	**D** = Loop Sense Resistor
E = Loop Power Supply	

Analogue Signal Ports

The image opposite shows the connections used for the 4-20 mA Current Loops and the Analogue Output Ports.

See Page 36 Figure 46 and 47 for the 4-20 mA current loop wiring diagrams.

See Page 33 Figures 42 and 43 for the 0 to 2V DC output wiring diagrams.

Figure-5 - VibWire-301 mounted on DIN Rail

The VibWire-301 shown fitted onto industry standard TS35 (EN 50023) Top hat Section DIN RAIL

DIN Rail Mounting

The VibWire-301 is very simple and user-friendly to install, and can enable systems integrators to create an extremely cost-effective and space-saving solution for all manner of applications and industries.

Top hat rail IEC/EN 60715
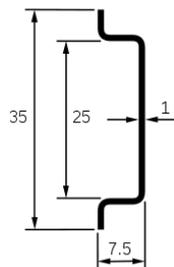
Figure-6 DIN Rail

USB to RS232 Converter
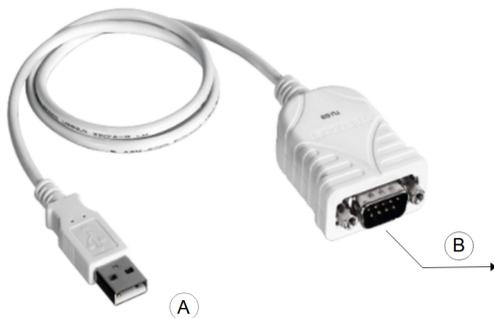
Figure-6 opposite shows USB to RS232 converter.

Ensure the cable uses the FTDI genuine chip set.

Typically the Microsoft operating system auto detects the USB converter and automatically loads the correct device driver.

A = USB Connector   B = 9 PIN D Connector

Powering the Device

The VibWire-301 can be powered by an external power supply using the power supply operations of the SDI-12 and RS-485 port.

The images below show the power supply connection options. When powered by the digital networks the VibWire-301 is only active during a measurement operation and powered off the rest of the time.

External Power Supply Connection

A = +12 V DC Power Supply
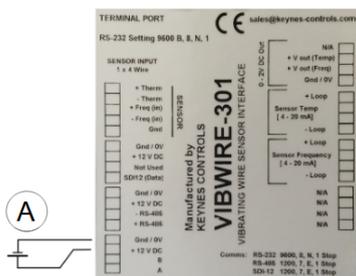
Figure-7
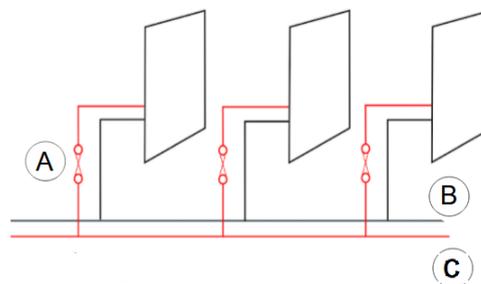
Figure-8

Figure-7 Label	Figure-8 Labels
	A = 100 mA Fuse
A = + 12 V DC Supply	B = 0 V / Ground
	C = + 12 V DC Supply

Connecting Multiple Devices to a Power Supply

The image below demonstrates how multiple devices should be connected to a single common power supply.
Individual fuses should be used to protect the VibWire-301 instruments as shown below. **Fuse rating recommendation is 100 mA**.

Fuse Specification :- 100 mA. See MF-R010 - PPTC Resettable Fuse, Through Hole, MF-R Series, or similar.

SDI-12 and RS485 Power Supply Connection

The VibWire-301 can be powered by connecting an external power supply to the network power supply connections as shown in Figures 9 and 10 below.

A = + **12 V DC (Network Power)**   B = 0 V / Ground

4 Pin SDI-12 Port   **4 Pin RS485 Port**

Figure-9

Figure-10

Device Power by Optional USB Media Converter

The Keynes Controls USB to SDI12, or USB to RS845 media converters can be used to power the VibWire-301 directly from the PC USB port.

Simply install the device and connect to the device as shown below.

When using the USB-SDI 12/485-pro media converter to directly power the VibWire-301 units, limit the number of instruments that can be powered on to 2 units at any one time. Additional instruments can be added to the network, however Keynes Controls recommends that an external power supply be attached to the media converter. See Figure-11 below.

Once power is applied to the device then it can be configured using the terminal port menu system, or via the Q-LOG software in a Windows environment.
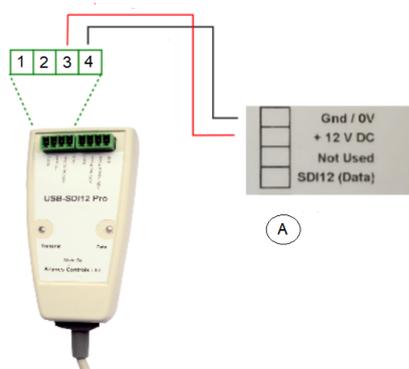
The Keynes Controls range of USB media converters can power a VW-301 directly from a PC USB Port without the use of an external power supply.

A = VW-301 SDI12 Port

USB Media Converter

1 = Not Required
2 = Not Required
3 = 12 V DC Power
4 = 0 V / Ground

Figure 11

External Power Supply connection to the USB-SDI12/485 Media Converter

Figure-12 below demonstrates how to connect an external 12 V DC power supply to the USB media converter.
Use an external power supply when there are more than 2 devices directly connected to the media converter.
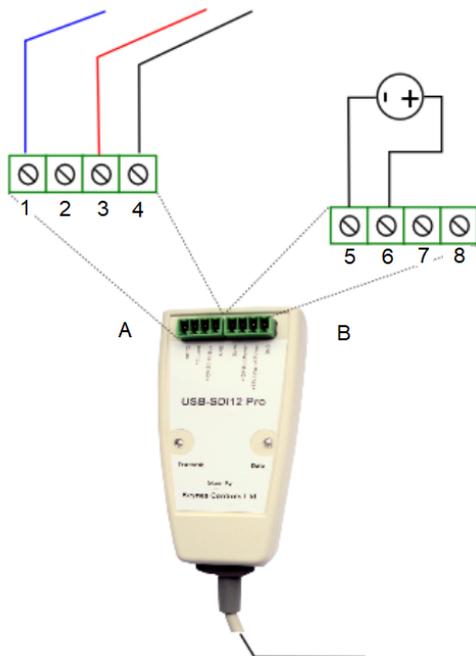
The media converter connects

A = Sensor Connection Port

1 = SDI12 Data
2 = Not Used
3 = SDI-12 Network +12 V DC Power
4 = 0 V / Ground

B = External Power Supply

5 = 0V / Gnd
6 = + 12 V DC
7 = Not Used
8 = Not Used

An external power supply is to be used when multiple instruments are to be connected to the media converter.

Figure 12

PC Data Acquisition System

The VibWire-301 can be directly connected to a Windows PC USB Port using a Keynes Controls media converter, or any suitable 3rd party equivalent product.

The instrument can be combined with any combination of intelligent sensors, or systems in order to create monitoring systems suitable for many different tasks.

The VibWire-301 contains both the SDI12 and RS-485 digital network ports. For stand-alone applications the RS-485 network offers the most flexible solution allowing for greater network string length and number of sensors than is available than using SDI-12 network. The SDI-12 network is ideal for low power simple measurements using a stand-alone logger.

When being used on a plant wide SCADA system then Modbus over RS-485 should be used. The VibWire-301 can be used with many different 3rd party SCADA systems so long as Modbus is supported

When used with a Microsoft Windows PC, the Q-LOG software can be used to create a complete data recording system without the User requiring any programming experience.

The instrument can be connected onto industry standard wireless RS-485 networks when increased range is required, or when a wired solution is not practical.

The image below shows how the VibWire-301 is used with a media converter to create a PC based data recording system.
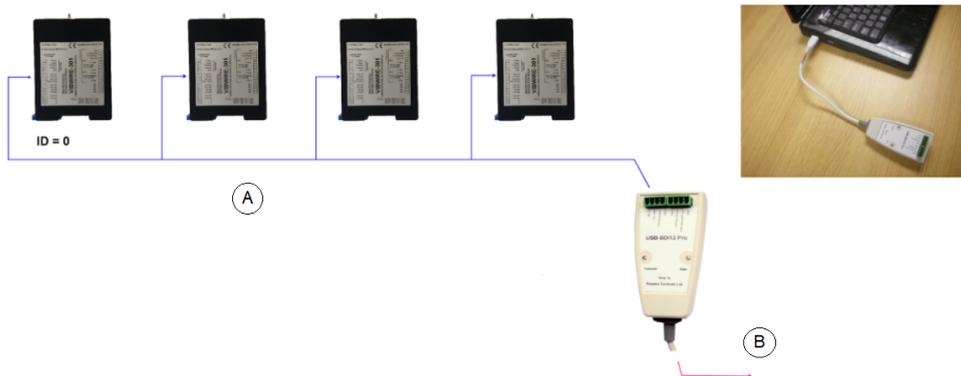
The image opposite demonstrates the use of the Keynes Controls USB-SDI12-Pro converter connected to a number of the VibWire-301 instruments.

A = SDI-12 Network
B = USB Port

The SDI-12 network supports up to 10 sensors each with an individual ID number in the range of 0 to 9.

Figure-13

The simplest and lowest cost PC based vibrating wire sensor application is undertaken with the VibWire-301, USB Media Converter and the free issue Q-LOG Data Acquisition Software.

The image below is taken from the Q-LOG software and demonstrates the Panel Meter display for the sensor results.
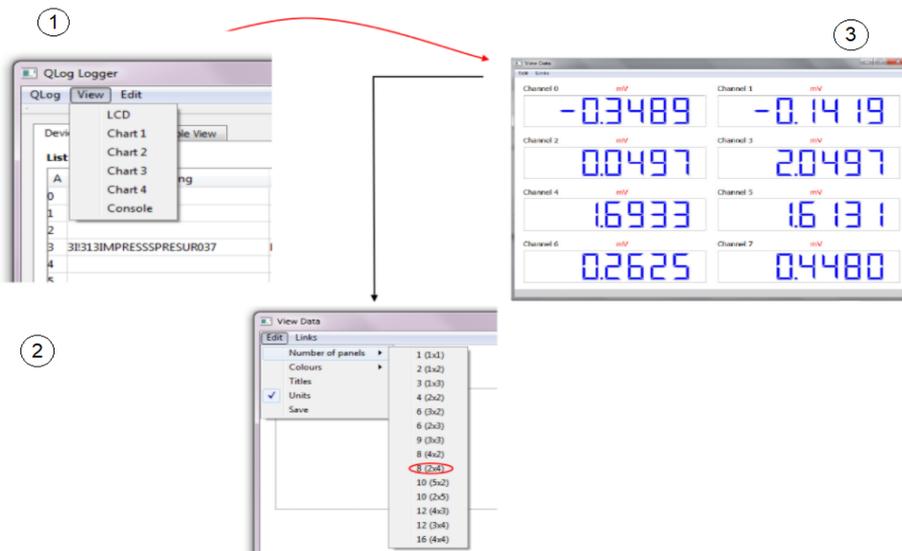
Q-LOG Windows

1 = View Tab.
2 = Number Of Panels Menu Option.
3 = 2 x 4 Panel Meter.

Figure 14

Q-Log Software Interface

The VibWire-301 is fully integrated into the free issue Q-LOG Data Acquisition and Display Software.

Fig 15 below shows how a VW-301 is identified on the Device List Window in the Q-LOG Software.

Q-LOG gives the User the ability to create a vibrating wire sensor test solution using any modern Windows laptop, and basic Stand-alone data recording solutions.

The Q-LOG software supports all of the Keynes Controls Sensor interfaces and can be configured for 3rd party devices. There is no restriction on its use. Do not use this software in life safety systems solutions.
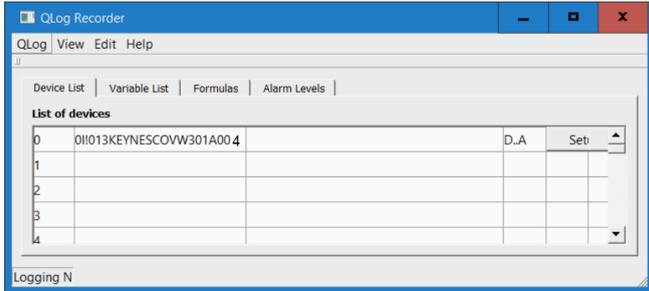
Figure-15

Demonstration Youtube Configuration Video

The videos are based upon using the Keynes Controls manufactured isolated media converters. In practice any suitable 3rd party media converter can be used with the VibWire-301.

Description:

 Show Comm port and SDI-12 network configuration in QLog software. Network scan and device identification.

Title: VW-301 QLOG Software clip v1

See: https://youtu.be/pxOO7UZbX5g

Description:

The QLOG software basic operations.with the VibWire-301 vibrating wire sensor interface.

Operations shown - Scan network - Sensor identification - Selection of the VW301 - Cell assignment- Start data acquisition operations. - Observing measurement values..

Title: VW-301 Qlog Basic Operations

See: https://youtu.be/gWV1D8KPPfc

Figure-16 shows a DIN rail mounted VibWire-301 Installation.

Basic Test System
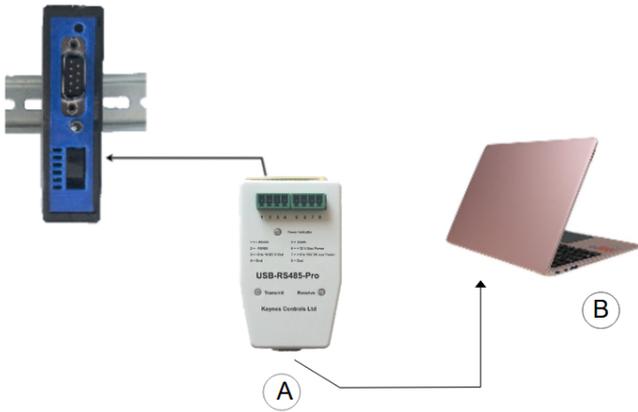
Figure-17

Figure 17 opposite demonstrates the simplest solution for connecting a VW-301 to a Windows PC in order to configure the device and make test measurements.

A = USB to SDI12 / USB to RS485 Media Converter

Part Numbers

USB-SDI12-Pro / USB-SDI12-Post   (SDI12 Network)
USB-495-Pro   (RS-486 network media converter)

B = Windows PC

Any suitable third party media converter can be used with the VW-301.

The Keynes Controls media converter range can also power the instrument from the PC USB Port.
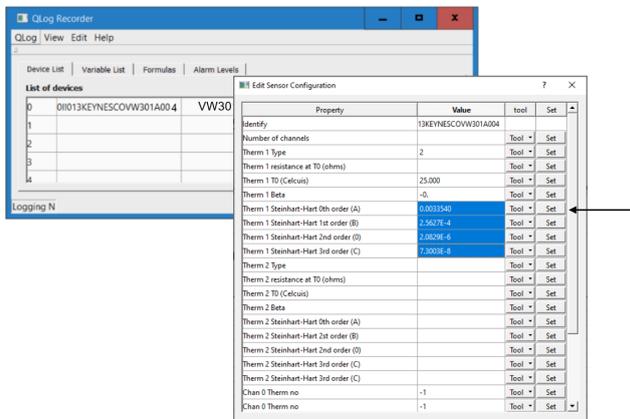
Q-LOG Software

A single VibWire-301 unit has been identified with ID=0 on the network.

The example shows the User writing temperature sensor calibration parameters into VibWire-301.

Enter the Calibration factor into the appropriate Value Cell

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

Changed Cells

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

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

Figure-18

Store Calibration Factors - VibWire-301 with Q-LOG

Calibration factors can be written straight into the VibWire-301 units when the device is connected to a digital network. Q-LOG gives the User a Windows platform for setting up a device without having to understand any programming on network operations. Q-LOG is the Keynes Controls free data logging and examination software.

The simplest configuration is to connect a VibWire-301 to a PC using the network media converter. The image below demonstrates how to set-up Channel-0 on a VibWire-301 unit using the Q-LOG Windows software, to use the displacement sensor calibration factors shown in the sample data sheet on page 43.

Figure-19 below shows the default temperature calibration factors built into the VibWire-301.
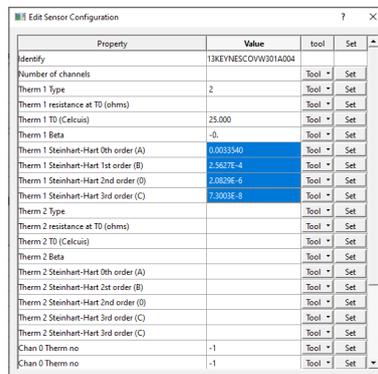
Figure-19A - Q-LOG Parameter Configuration Window

Displacement Sensor -Terminal Port Configuration

The terminal port setting shown below demonstrates temperature sensor configuration features of the Q-LOG software.

The sensor interface is set to give output measurement values in SI units of mm.

The calibration factors shown in the data sheet on page 43 are pasted into appropriate terminal menu locations:

'Polynomial Gauge Factor A' -1.26E+02 into **'Cal A'** menu option.

Keynes Controls - KDE-V150 Displacement Sensor Set-up

Frequency Input Configuration

VW Sensor Configuration

1 Frequency proc	SENSOR	Output in SI Units: mm
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	**-1.4-E-02**	
U Up. T Top.		

Q-LOG VW Sensor Configuration

Figure-19B

Figure 19B opposite demonstrates how the vibrating wire sensor part of the calibration factors are stored into the device using Q-LOG

The sensor calibration factors are highlighted in blue and are taken from the sample VW Displacement Sensor Calibration data sheet.

Type in the calibration factor and press the **'Set'** button.

Modbus Operation Mode

The Modbus network operation works differently than the SDI-12 and RS-485 network operations. The VibWire-301 will scan continually so long as power is applied. The device will update the Modbus registers as soon as a new sensor frequency reading is detected. The same operation happens for the temperature reading and operates independently of the frequency sensor readings.

Modbus - Factory Set Parameters

 (Instruments shipped until Dec 2017)

Modbus version instruments are:

1 x VW Channels: Units Hz   1 x Temperature Sensor: Units Deg C

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 of Deg C.

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-301 for initiating measurements across an RS-485 network and are named '**aM!**' and '**aC**!'. Table 1 includes a complete description of the commands used by the VibWire-301

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 'a**C**!' 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 VibeWire-301 supports both the individual and concurrent start 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.

aC! -- Concurrent start measurement command   aM! -- Sequential start measurement command.

Use the 'aM!' command when power management is essential.

Possible Network Problems

Should a larger than expected load be put onto the SDI-12 network then the voltage drop between 0 V and SDI-12 12 V supply can be as high, If this is the case then the instruments may not respond.

Vibrating Wire Standard Equation - Digits

Keynes Controls uses the standard equation shown opposite to calculate Results in Digits.

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

Terminal Port

The VibWire-301 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 menu system enables the complete configuration of the instrument without any prior programming knowledge. The device can be configured to provide measurements in engineering units Hz, Digits and (SI).

A = VW-301
B = Null Modem Cable
C = USB to RS232 Converter
D = PC USB Port
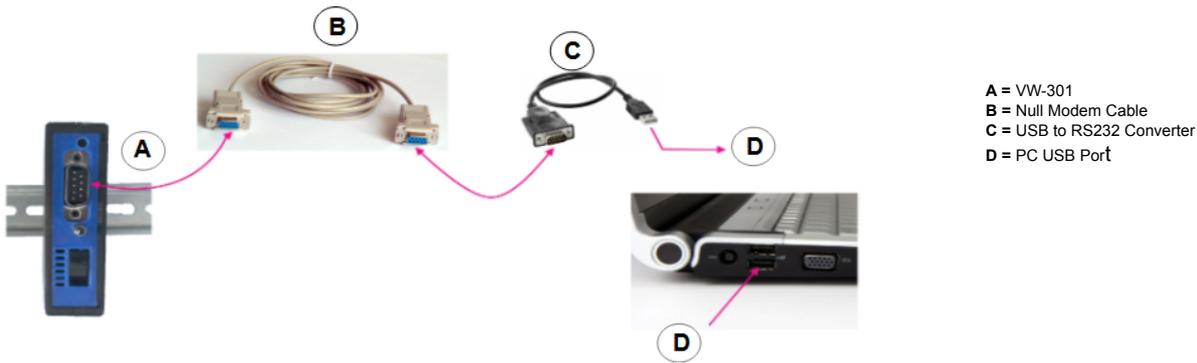
Figure-20

Terminal Port Settings

The VibWire-301 can be fully configured using the terminal menu system built into the device.

The following instructions are for the Microsoft Windows Operating system. Some Windows from different versions of the Windows Operating System may look slightly different from the example

Step 1:

Connect the PC/Laptop to the VibWire-301 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.
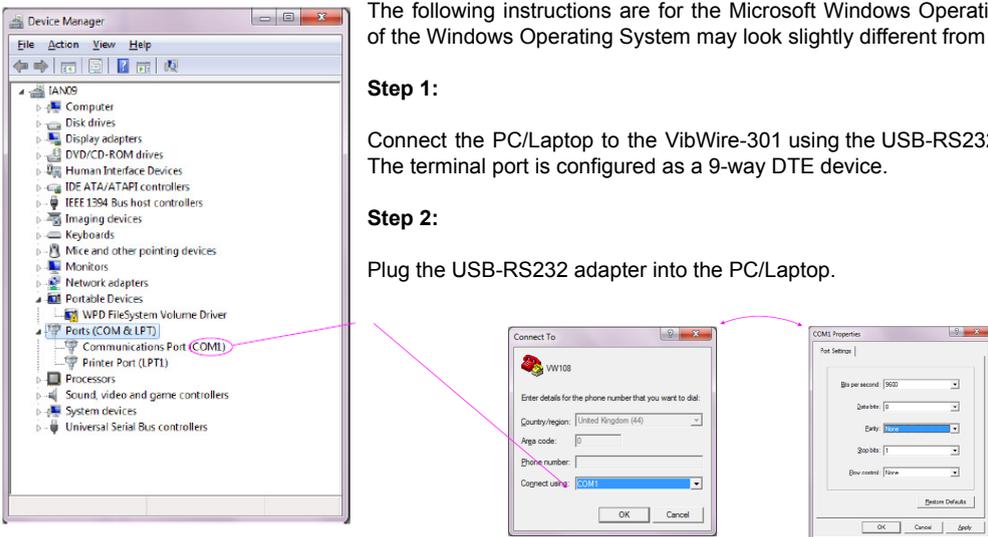
Terminal Port Settings

9600 B, 8 Data, No Parity, 1 Stop

Figure-21

Microsoft Hyperterminal - Connect To Window

Microsoft Hyperterminal - Com Port Properties Window

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.
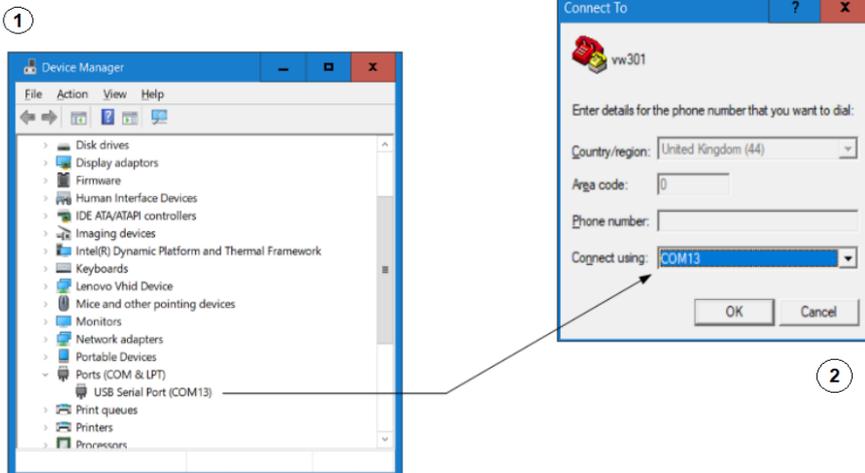
1 = Microsoft Windows Device Manager Window

2 = HyperTerminal Connect Window

HyperTerminal is no more than a popular free Terminal Emulator software.

Any similar Terminal Emulator Software can be used for configuration applications.

Figure-21 - COMM Port Identification Window

Null Modem Cable

A null modem cable is a RS-232 serial cable where the transmit and receive lines are crosslinked.

The null modem cable connects the VibWire-301 terminal RS-232 port to a USB-RS232 media converter or serial port on a PC

Figure-22   **Null Modem Cable**

Terminal Port Operation

The terminal port built-in to the VibWire-301 enables the instrument to be easily configured using the built in menu system to set all the calibration parameters.

There is no software required with this device apart from a terminal emulator package, which is frequently a feature included in most modern operating systems.

Once the device is connected to a suitable power supply, and the RS-232 media converter

1 Device Setup
2 Thermistor setup
3 Sensor Setup
4 4-20mA Frequency Output
5 4-20mA Temperature Output
6 0-2V Frequency Output
7 0-2V Temperature Output
8 System Maintanence
9 Exit
U Up. T Top.

Activating the Menu System

Once the terminal port is configured hit the '**Return**' key, or on some terminal software the **'Escape'** key.

See Youtube video   https://youtu.be/RiVu4nWX9g0   :- **ViBWire-301 Hyperterminal Setup**

https://youtu.be/vn7IjBEFjCs   :- **Terminal Port and sensor connections (hardware)**

Terminal Port Menu System

The menu system built into the VibWire-301 is shown below.

Main menu

```
1 Device Setup
2 Thermistor setup
3 Sensor Setup
4 4-20mA Frequency Output
5 4-20mA Temperature Output
6 0-2V Frequency Output
7 0-2V Temperature Output
8 System Maintanence
```

```
Device setup

Device Setup

1 Communication mode        1
U Up.  T Top.
```

Output Port Selection Menu

```
Communiucation Mode

Enter Communication mode

Modes: 1=4-20mA, 2=0-2V Analog, 3=SDI12, 4=RS485, 5=RS232 high speed

Current Value 1
```

Temperature Sensor Configuration Menu

```
Thermistor setup

1 Thermistor Type           STEINHART
2 Resistance at T0 (ohms)   3000.0
3 T0 (Celcius)              25.000
4 Beta                      -0.
5 Steinhart-Hart 0th order (A)  0.0033540
6 Steinhart-Hart 1st order (B)  2.5627E-4
7 Steinhart-Hart 2nd order (0)  2.0829E-6
8 Steinhart-Hart 3rd order (C)  7.3003E-8
U Up.  T Top.
```

TECHNICAL NOTE

Any parameter shown in the text colour is a factory set value and is factory set at the time orf manufacture.

These parameters should not be adjusted.

Vibrating Wire Sensor Configuration Menu

```
1 Frequency proc            HZ
2 Temperature output
3 Centre Frequency (Hz)     2000
4 First Ping (us)           5000
5 Cal A                     Constant
6 Cal B                     Linear Term
7 Cal C                     Quadratic Term
8 Cal D                     0.
U Up.  T Top.
```

(Frequency options Hz DIGITS or SENSOR2)

Enter Frequency proc

Frequency output: Hz , DIGITS or SENSOR

Current Value HZ

Frequency 4-20 mA Loop Output Menu

```
4-20mA Frequency Output

1 Value 4mA                 0.
2 Value 20mA                16000
3 DAC calibration 0         10922
4 DAC calibration 1         54613
```

Temperature 4-20 mA Loop Output Menu

```
4-20mA Temperature Output

1 Value 4mA                 -40.000
2 Value 20mA                120.00
3 DAC calibration 0         10922
4 DAC calibration 1         54613
U Up.  T Top.
```

Frequency 0-2 V DC Output Menu

```
0-2V Frequency Output

1 Value Low                 0.
2 Value High                16000
3 DAC FS output (mv)        2000
4 DAC calibration 0         0
5 DAC calibration 1         4000
U Up.  T Top.
```

Temperature 0-2 V DC Output Menu

```
0-2V Temperature Output

1 Value Low                 -40.000
2 Value High                120.00
3 DAC FS output (mv)        -0.
4 DAC calibration 0         0
5 DAC calibration 1         4000
```

SENSOR = Output in SI Units

Figure-23 - Menu System

Sensor Setup Menu

```
          Sensor Setup

1 Frequency proc              DIGITS
2 Centre Frequency (Hz)       800
3 First Ping (us)             5000
4 Cal A                       0.
5 Cal B                       1.0000
6 Cal C                       0.
7 Cal D                       0.
8 Stabalization after pluck (us)  5000
9 Sample number of pulses     10
U Up.  T Top._
```

The Sensor Setup menu defines the operation of the frequency measurement component of a standard vibrating wire sensor

8. Stabilization After Pluck

This parameter only defines the first pluck made to the sensor upon initialisation. The default factory set parameter will be suitable for most applications

Analogue Output Update Rate

The VibWire-301 has the ability to output the sensor frequency and temperature values represented by an analogue signal that can vary between 0 to 2 V DC The speed of the update is related to the operating frequency of the sensor. The higher the operating frequency of the sensor then the faster the VW-301 will respond to changes in the input signal.

The analogue output level is only adjusted upon the instrument detecting a frequency change on the incoming signal. The device will maintain the current analogue output level should no change be observed.

9. Sample number of pulses -- Defines the number of measurements averaged before returning a value.

For high speed update rates set the "**Sample number of pulses = 10". Should there be any spikes in the data then increasing this parameter to a higher value will be required.**

Network Communications

The following pages demonstrate the connections for the SDI-12 and RS-485 network connections.

SDI-12 Serial Network Connection

The following page describes connecting the VibeWire-301 to an SDI-12 network.
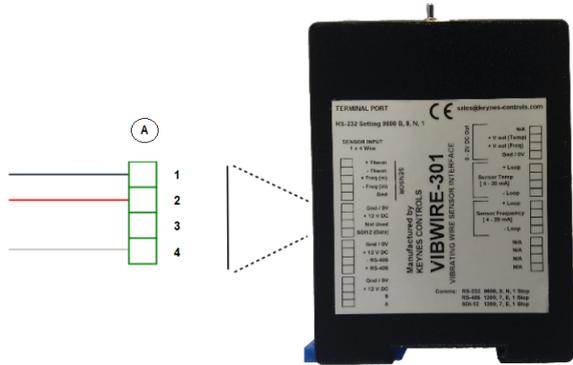
Figure-24

SDI-12 Network Advantages

The specification document describes a number of advantages including:

- Interchangeability of sensors without reprogramming of data acquisition devices
- Power Management
- Simple 3 wire network for easy installation and support.
- Applicability of training in SDI-12 to a variety of sensors, data recorders and PC based data recording solutions.
- 1 .. 10 devices on a single network.
- Up to a maximum network length of 100 m.

A = SDI12 Port

1 = 0V / Gnd	**2 =** Network + 12V DC
3 = Not Used	**4 =** SDI12 Data

RS-485 Serial Network Connections

4-Pin RS-485 Port

Gnd
+ 12V DC
- RS-485
+ RS-485
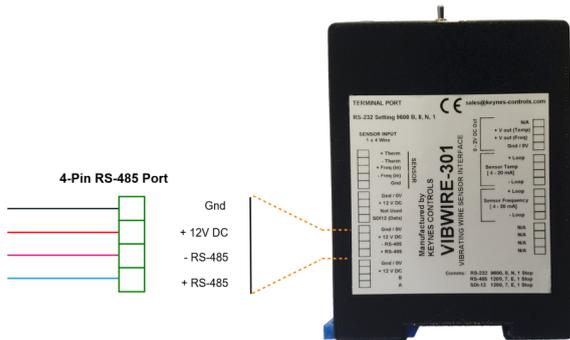
Figure-25

The image opposite shows the RS-485 network port and connections into the VibWire-301.

The RS-485 network can be used to obtain higher sample rates, and number of devices than can be achieved using the SDI-12 network.

- Ideal for concurrent measurement systems.
- Large network strings up to 1000m length.
- Higher operational speed at 9600 Baud (2018 models)

Powering the VibWire-301 using the USB-SDI12-Pro Media Converter

USB-SDI12-Pro

1 = SDI12 Data   5 = Earth
2 = Not Used   6 = + 12 V Bus Power
3 = +9 to 16 DC V Out   7 = + 9 to 16V DC aux Power
4 = Gnd   8 = Gnd

Transmit   Receive

Keynes Controls Ltd

Part No: USB-SDI12-pro- Isolated Media Converter

Fig 26 opposite shows the Keynes Controls manufactured USB to SDI12 media converter. This device is used with a Windows PC and is used to connect SDI-12 sensors to a PC.

The device isolates the SDI-12 network from the PC in order to prevent any damage to the PC should a fault condition occur on the network.

This device is commonly used in collaboration with the free issue Q-LOG Data Acquisition and Display Software. This device supports 3rd party devices so long as they support the SDI-12 network.

Maximum directly connected VIbWire-301 units = 2 with an external power supply.

Figure-26

Stand-alone Operation

The VibWire-301 can operate stand-alone and act as a sensor interface to loop powered process meters as shown in Fig 27 below.

A wide range of applications can be monitored with the device and when used with a process meter display unit, then simple permanent display solutions can be created. The process meter can be configured to convert the 4-20 mA loop current into engineering SI units such as pressure, load, water level etc..
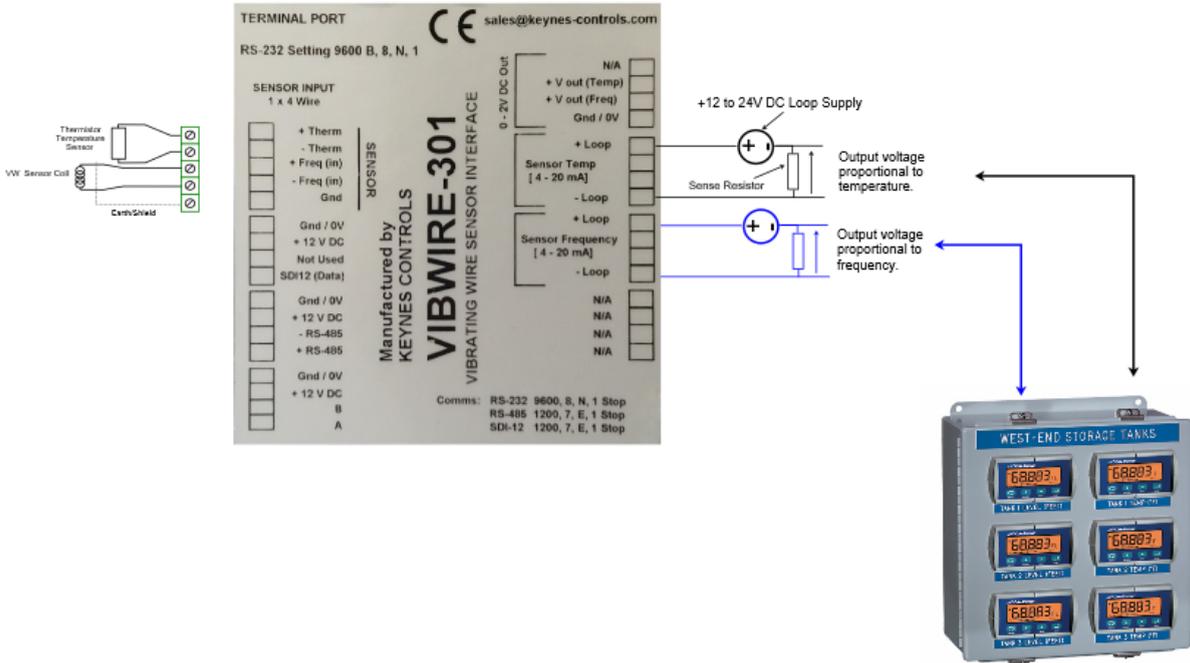
Figure-27

Process Meter

The process meter can be used to drive the 4-20 mA loop input within the VibWire-301 remotely. The current loop input can be used to power the device and return the process signal. The display on the Process Meter will display the current loop value in SI units in real-time.

The VibWire-301 can be configured to scale 4-20 mA loop in order to simplify any process control and measurement operations.

Fig 27 above shows the connections for a VibWire-301 with current loop outputs for the temperature and frequency signal components.

Each of the current loop outputs are individually isolated in order to minimise any earth loop noise problems.

Sensor Connection
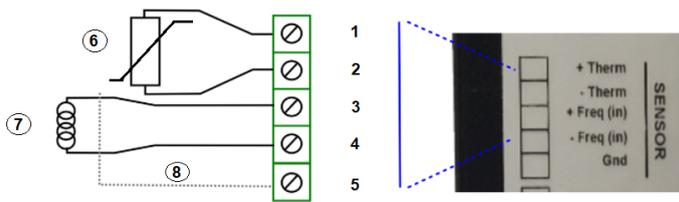
1 = + Therm	**2 =** - Therm
3 = + Frequency	**4 =** - Frequency
5 = Ground / Shield	
6 = Temperature Sensor	**7 =** Sensor Coil
8 = Sensor Earth / Shield	

Figure-28

Audio Output

The sensor operation can be examined using the speaker built into the device.

Activate the Speaker On / Off switch.

The speaker output should be clear and strong for a correctly installed sensor.

1 = Speaker On / Off Switch
2 = Ceramic Speaker

Figure 29

Sensor Problems

A vibrating wire sensor when working correctly should give a clear audio tone that can be monitored using the internal speaker unit.

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

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

4) Should a low frequency hum be 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'

Operating Mode Identification
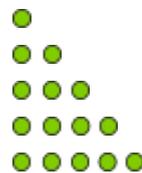
Status LED Flashes   **Operating Mode**

1 = 4-20 mA
2 = 0-2 V DC
3 = SDI-12
4 = RS485
5 = High Speed RS485

Figure-30

The VibWire-301 flashes the Status LED in quick succession to indicate the mode of operation of the device. A visual inspection is all that is required to identify the operating mode so long as the device is powered.

Insert Link LED status SDI0-12 onto youtube

Encardio Rite Pressure Sensor Configuration

Example.   The following polynomial equation is taken from the example Encardio-Rite pressure sensor calibration data sheet on Page 43.and is used to convert the measured frequency from the sensor into SI units. The output pressure is in units KPa.

P(KPa) = A(R1^2) + B(R1) + C + K(T1-T0) - (S1-S0)   [**Equation-1**] as defined by Encardio for this sensor.

Where

R1 = Current reading (digits)   R0 =Initial reading in digits

From the example Sensor Calibration Data Sheet, see Page 43, the calibration factors shown below can be found.

A = **-2.2253E-7**   B = **-2.8085E-01**   C= **1.8512E+03**   and Thermal Constant (K) = **-0.087** kPa/Deg C

P(KPa) = **-2.2253E-7**(R1^2) - **2.8085E-01**(R1) + **1.8512E+03**

Rewrite the Keynes Controls calibration equation as used by the VibWire-301

X = C(R1)^2 + B(R1) + A - Dt   [Equation-2]   Keynes Standard Equation rewritten to match Encardio Sensor

We remove the (S1 S0) terms as the value is considered to be 0 (no barometric change) between consecutive readings.

P(KPa) = -2.2253E-7(R1^2) - 2.8085E-01(R1) +   1.8512E+03

X =   C(R1)^2 + B(R1) + A

Quadratic   Linear   Constant
term   term   term
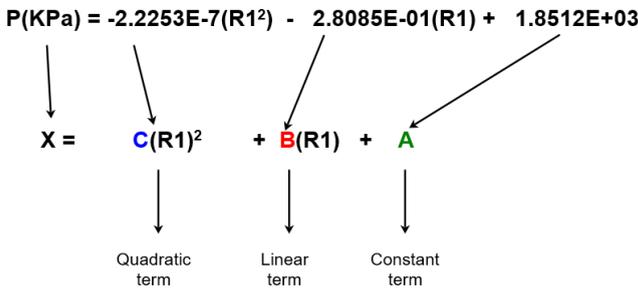
The Vibrating Wire Sensor Configuration Menu is set as shown below

1 Frequency proc	**DIGITS**
2 Temperature output	
3 Centre Frequency (Hz)	2000
4 First Ping (us)	5000
5 Cal A	**1.8512E+03**
6 Cal B	**-2.8085E-01**
7 Cal C	**-2.2253E-0**
8 Cal D	**0.087**
U Up. T Top.	

In this example note that Encardio defines the Quadratic term and Constant term calibration factors the opposite way round to the standard terms used by Keynes Control and built into the device menu system.

Note.

Care has to be taken to ensure that the quadratic and constant terms are correctly assigned otherwise the device will give the wrong answer.

Example. Vibrating Wire Strain Gauge Parameter Configuration

The following example demonstrates how to assign the correct calibration factors to the VibWire-301 to convert frequency into Microstrain for a vibrating wire strain gauge.

The factors shown below are taken from a 3rd party manufacturer's strain gauge calibration data sheet. Most sensor manufacturers provide strain gauge calibration information in a similar format to that shown below.

Calibration Factor Gauge #1:	0.000004300 inches/digit	0.358	microstrain/digit
Calibration Factor Gauge #2:	0.000004277 inches/digit	0.356	microstrain/digit
Calibration Factor Gauge #3:	0.000004280 inches/digit	0.357	microstrain/digit
Calibration Factor Gauge #4:	0.000004245 inches/digit	0.354	microstrain/digit
Calibration Factor Gauge #5:	0.000004265 inches/digit	0.355	microstrain/digit
Calibration Factor Gauge #6:	0.000004260 inches/digit	0.355	microstrain/digit

Factor(Average Calibration Factor), K: 0.000004271 inches/digit   0.356 microstrain/digit

The sensor manufacturer states

Microstrain = Reading (Digits) x G   where G = Gauge Factor   and Digits = $\dfrac{Frequency^2}{1000}$

The Vibrating Wire Sensor Configuration Menu is set as shown below

Where A = Constant   B = Linear term   C = Quadratic term   D is for thermal expansion.

And the frequency measurement must be set to DIGITS. See Page VV for further details of the menu option.

1 Frequency proc	**DIGITS**
2 Temperature output	
3 Centre Frequency (Hz)	2000
4 First Ping (us)	5000
5 Cal A	**0.0**
6 Cal B	**0.356**
7 Cal C	**0.0**
8 Cal D	**0.0**
U Up. T Top.	

The menu system has the sensor defined at a centre frequency of 2 K Hz and 1st ping in 5000 microseconds. These parameters need not be changed and are good for most sensors.

The equation: **Microstrain = Reading (Digits) x G**   has a linear term and so only menu item **6. Cal B** is set.

For the example above only the average Microstrain calculation has been used.

Example. Keynes Controls Vibrating Wire Displacement Sensor Configuration

The following example demonstrates how to configure the VibWire-301 to give an output in SI units of mm for a Keynes Controls manufactured displacement sensor. See the Calibration Data Sheet on Page 47.

1.   Ensure the VibWire-301 is operating in DIGITS (See Page 17 Figure-23 for the Sensor terminal port settings).

The Keynes Controls datasheet sheet for the vibrating wire displacement sensor uses the same coefficients as are defined in Equation-1 for the conversion of the vibrating wire sensor frequency into SI units. The sensor calibration factors shown in the device menu system as 'Cal-A', 'Cal-B' and 'Cal-C' represent the coefficients A, B and C in Equation-1

The sensor will be configured as shown below:

1 Frequency proc	**DIGITS**
2 Temperature output	
3 Centre Frequency (Hz)	2000
4 First Ping (us)	5000
5 Cal A	**1.8512E+03**
6 Cal B	**-2.8085E-01**
7 Cal C	**-2.2253E-0**
8 Cal D	**0.087**
U Up. T Top.	

Device Sensor Input Ports, Output Ports and Controls
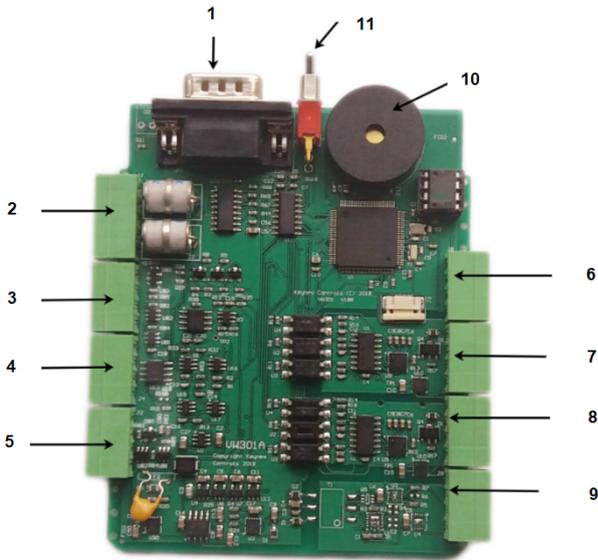
1 = 9 Pin D Connector RS232 Port
2 = 4 Wire Sensor Port
3 = SDI12 Port
4 = RS-485 Port
5 = Expansion Port
6 = Sensor 0 - 2 V DC Analogue Output Port
7 = Temperature Sensor Component 4-20 mA Loop
8 = Frequency Sensor Component 4-20 mA Loop
9 = Not Used
10 = Speaker
11 = Speaker On / Off Switch

Figure-31

Pin-Outs

Figure-32 below shows the Pin-Outs for the ports on the VibWire-301. This label is attached to the front of the unit.

Figure-32 Device Pin-outs

Vibrating Wire Sensor Problems

A vibrating wire sensor when working correctly should give a clear audio tone that can be monitored using the internal speaker unit.

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

1) If there is only random noise on the speaker then check the wiring and circuit resistance. The most common error is an open circuit.

Locate and fix the broken cable.

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

4) Should a low frequency hum be 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 Sensor Input channel 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. The VibWire-301 can be used with many different thermistors used within the vibrating wire sensors.

1 = + Therm	**2 =** - Therm
3 = + Frequency	**4 =** - Frequency
5 = Ground / Shield	

6 = Temperature Sensor	**7 =** Sensor Coil
8 = Sensor Earth / Shield	

Connection to the instrument is as follows:
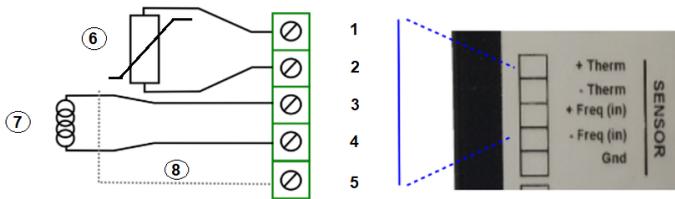
Figure-35

1.   Connect the vibrating wire signal component to the terminals labeled +Freq and -Freq.
       It does not matter which way round the frequency signal sensor cables are connected to the device.

2.   Connect the temperature sensor to the terminals labeled +Therm and -Thermo respectively.

So long as the VibWire-301 is powered on, activate the speaker switch and a clear sensor tone should be heard. Should no tone be heard simply check that the sensor wiring has been connected to the appropriate terminal. (See Figure-29 on page 20 for the speaker switch)

Lightning Protection

The lightning protection within the VibWire-301 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. The VibWire-301 is protected from lightning strikes using a gas discharge tube (GDT) fitted to the sensor input ports.

When a voltage disturbance reaches the GDT sparkover value, the device will switch into a virtual short, known as the arc mode. In the arc mode, the GDT practically shorts the line, diverting the surge current through the GDT to ground and removing the surge from the VibWire-301.

 For the lightning protection to operate the VibWire-301 must be connected to a good electrical earth.

Device Communications

The following section details the communication options available with the VibWire-301.

Page 18 Figure 24 shows the connections used for the SDI-12 network. Figure-25 shows the connections used for the RS-485 network.

SDI-12 Network Operation

The SDI-12 network consists of only three wires and is simple to install and maintain in the field. The SDI-12 network is used to power sensors and transmit the measurements to the host data logger or PC based data acquisition unit. The SDI-12 network is limited in speed, the number of sensors it can handle and in length. The maximum number of sensors is 10 and length to approximately 100 m.

Additional network range can be achieved using good quality network cable.

Data Recorder Connection

The image below shows how the VibeWire-301 are deployed when used with a low power SDI-12 based data recorder. A simple 3 wire network is all that is required to connect multiple devices together.
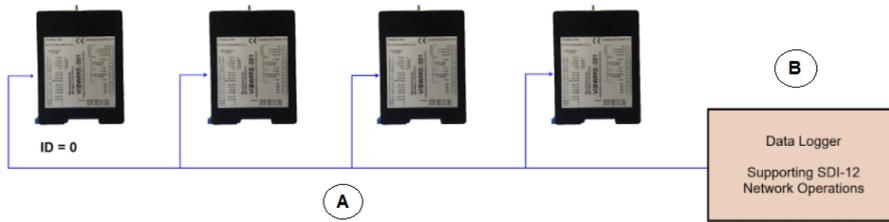
The VibWire-301 instruments are simply daisy chained together. 1 .. 10 Devices. 0 ..100 m.

SDI12 Data to SDI12 Data
+ 12 V to + 12 V DC
0 V to 0 V

A = SDI12 Network
B = Data Logger / Data Acquisition System

Figure 36

RS-485 Network

Up to a maximum of 32 instruments can be connected to a standard RS-485 network. The VibWire-301 can use the 485 Port to connect a range of accessories such as Wt-Fi and range extenders.
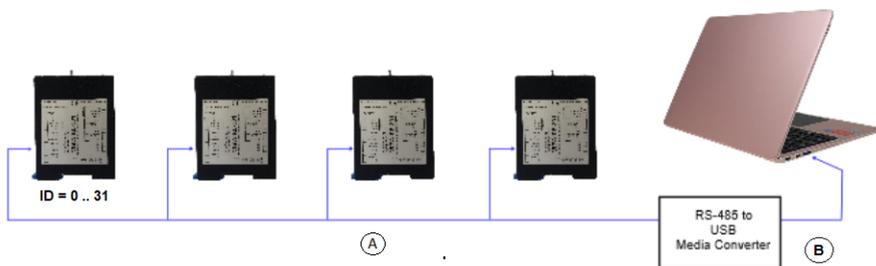
1 .. 32 Units
0 .. 1000 m Range
High Speed Acquisitions

Figure-38

Setting the Network Type

From the main menu select '1' Device Setup

The 'Output Port Selection' menu will appear as shown in the Menu below.

To select the Output Port enter mode number. **1=4-20mA, 2=0-2V Analog, 3=SDI12, 4=RS485, 5=RS232.**

The example shown below shows that the 4-20 mA port has been selected,

Setting the Network Type

From the main menu select '1' Device Setup.

1 Device Setup
2 Thermistor setup
3 Sensor Setup
4 4-20mA Frequency Output
5 4-20mA Temperature Output
6 0-2V Frequency Output
7 0-2V Temperature Output
8 System Maintanence
9 Exit
U Up. T Top.

Output Port Selection Menu

Communiucation Mode

Enter Communication mode

Modes: 1=4-20mA, 2=0-2V Analog, 3=SDI12, 4=RS485, 5=RS232 high speed

Current Value 1

Mode: 1 4-20mA loop output selected.

Start Measurements using the Concurrent Command aM!

The VibWire-301 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 'aM!' command is used to make measurements from devices in a sequential order across the network. Each device is instructed to make a measurement and return data before the next device is activated.

There is no limitation on the order issuing the aM! Command

Example of sequential measurements using the 'aM!' command 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 '**aM**!'   where a = Instrument ID Number.

master sends: '**1M**!' - 1 sensors   Instrument responds   **'101\r\n'**   indicated readings available after 1 secs

The network is free for other devices as soon as this response is returned.

1M! 1D0!
6M! 6D0!
7M! 7D0!

Read data values from the VibWire-301

No matter which instruction 'aM!' or 'aC!' is used to initiate measurement operations for the VibWire-301 has to be instructed to send data when it becomes available. It takes the instrument approximately 2 seconds, under standard operation to make sensor values available after being instructed to make a measurement.

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

The **temperature values** input are in **Units of Deg C.**

Use the command: '**aD0**!'   --   Frequency + Temperature (Deg C)

Instrument responds: '**a**+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+1524.4'.**   Vibrating wire data

The 'aM!' command is best used for low power, low sensor number applications.

Start Measurements using the Concurrent Command aC!

The VibWire-301 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. Concurrent measurements enable multiple instruments to respond faster to measurement commands on a network. The disadvantage of using the 'aC!' command is that there can be greater power loss on the power supply network lines, so good quality network cabling for long network strings should be used.

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-301 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**!' - 1 sensors   Instrument responds   '**102\r\n**'   indicated readings available after 2 second.
                                            The network is free for other devices as soon as this response is returned.

          '**6C!**' -1 sensors   '**602\r\n**'
          '**7C!**' - 1 sensors   '**702\r\n**'

The command structure

          1C!
          6C!
          7C!

Will start

Read data values from the VibWire-301

No matter which instruction 'aM!' or 'aC!' is used to initiate measurement operations for the VibWire-301 has to be instructed to send data when it becomes available. It takes the instrument approximately 2 seconds, under standard operation to make sensor values available after being instructed to make a measurement.

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

The **temperature values** input are in **Units of Deg C.**

Use the command: '**aD0**!'   --   Frequency + Temperature (Deg C)

Instrument responds: '**a**+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+01091.6+0024.4**'   Vibrating wire data single channel operation   '

SDI-12 Supported Commands

The following commands are supported by the VibWire-301 SDI-12 model

Description	Master	VibWire-301 Response
Acknowledge active	a!	a\r\n
Send ID:	aI!	a13 KEYNESCOVi Wire-3010001\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** (inital) 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!	a02\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!	+xxxx.x+xxxx.x\r\n
data returned aND! = Vib + Vib + Therm + Therm and has the same format for each command	aD0! = Freq+Temp VibWire-301 supports 2 thermistor types	
Thermistor 1 & 2		
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	aXT2RE! aXT2T0! = 25	Resistance at 25 Deg C T0 - generally 25 Deg C
Parameters from the sensor calibration sheet	aXT2BET!	Beta Value
Steinhart-Hart Parameters Thermistor resistance/temp calculation	aXT2ST0! aXT2ST1! aXT2ST2!	A in Steinhart-Hart B in Steinhart-Hart C in Steinhart-Hart
Page 36 shows sample calibration data sheet	aXT2ST3!	D in Steinhart-Hart
VW Sensor Input Channel Settings	aXCH0FN! F = Frequency type N = 1	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 $1/T = A + B(\text{Ln } R_t/R_{25}) + C(\text{Ln } R_t/R_{25})^2 + D(\text{Ln } R_t/R_{25})^3$

Table 2

RS-485 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 below

Description	Master	VibWire-301 Response
Acknowledge active	%a!	a\r\n
Send ID:	%aI!	a13KEYNESCOVibWire3011\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!	a02\r\n
instruct an instrument to make measurement	a = address of instrument example 0M! starts scan for ID 0	instrument with address a returns 1 x vibwire + 1 x temp after 2 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!	a+xxxx.x+xxxx.x\r\n
Data returned aND! = Data + Therm Frequency Result in Hz / Digits / SI Units	aD0! = Freq + Temp	
Thermistor 1 & 2	VibWire-301 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 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 $1/T = A + B(\operatorname{Ln} R_t/R_{25}) + C(\operatorname{Ln} R_t/R_{25})^2 + D(\operatorname{Ln} R_t/R_{25})^3$

Table 3

VibWire-301 Digital Communications

The instructions below detail the operations to follow to operate the VibWire-301 across both the SDI-12 and RS-485 digital networks.

Recommended Device Test Setup

Use a single instrument only when undertaking initial measurements on the RS-485 or SDI-12 network. This simplifies any third party software configurations and will speed up the understanding of the commands used by the device

Test Measurement

Factory Default ID = 0

Issue command **0M!**   to start measurement operations. The VibWire-301 will scan the sensor input/
          0D0!   returns items of data   *0+ Frequency + Temperature*

Ensure that each instrument used on a network has a unique ID number assigned, in order to correctly identify the measurements that are being recorded.

Command Structure & Operations across an RS-485 network

The VibWire-301 uses a command structure across the RS-485 network very similar to that used by the SDI-12 network in order to simplify the overall system operations. The VibWire-301 supports SDI-12,S485 and Mobus over R%S485 in a single device.

Both of the RS-485 and SDI-12 networks, by default operate at the same speed of 1200 baud. The RS-485 network speed can be increased using the terminal port menu system, see page XX.. Mobus communications over the RS-485 network are also assigned using the menu system. The network status indicator LED flash rate adjusts automatically to show the network type currently assigned.

Even though this is a relatively slow rate, as networks go, it is more than adequate for the small amounts of data transmitted by the instrument. No break characters are transmitted in an RS-485 command and any sent will be ignored by the instrument.

A short delay of approximately **10 ms** is added between a command received by VibWire-301 and its transmission of data since this delay is used to allow time for the host PC to turn off its transmitter when using soft-negotiation for data flow control operations. Under normal RS-485 data transmission operations the RTS line on the serial port is used for flow control operations.

Keynes Controls recommends an RS-485 interface with hardware negotiation used to control the VibWire-301 across a network.

Timing Constraints RS-485 / SDI-12 Network

There are no timing constraints for the transmission of instructions and receipt of data across an RS-485 network.

There is timing compared to the operations on an SDI-12 network. Any terminal program to be used with the SDI-12 network has to allow for the timing packets that are sent along the network. The terminal port feature built into the Q-LOG data acquisition software can be used to issue commands to sensors across the SDI-12 network.
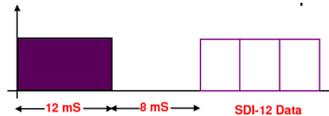
Figure 39 shows timing delay used on SDI-12 serial bus prior to sending data

12 mS   8 mS   SDI-12 Data

Start-up and Scan Time

Typically the VibWire-301 takes 1 second to boot, followed by 1 second to complete a sensor scan depending upon the sensor operating frequency..

RS-485/ SDI-12 Commands

The device supports the same commands for both the SDI-12 and 485 networks.

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.

Most Commonly Used Menu Items

The most commonly used features of the device are

1. Setting the device output - SDI12 / 485 or Analogue Outputs
2. Defining the output units - Hz / Digits / SI (Engineering Units)

This page demonstrates the most commonly defined features using the built in menu system.

Setting the Network Type

From the main menu select '1' Device Setup

The 'Output Port Selection' menu will appear as shown in the Menu below.

To select the Output Port enter mode number. **1=4-20mA, 2=0-2V Analog, 3=SDI12, 4=RS485, 5=RS232.**

The example shown below shows that the 4-20 mA port has been selected,

Setting the Network Type

From the main menu select '1' Device Setup.

1 Device Setup
2 Thermistor setup
3 Sensor Setup
4 4-20mA Frequency Output
5 4-20mA Temperature Output
6 0-2V Frequency Output
7 0-2V Temperature Output
8 System Maintanence
9 Exit
U Up. T Top.

Output Port Selection Menu

Communiucation Mode

Enter Communication mode

Modes: 1=4-20mA, 2=0-2V Analog, 3=SDI12, 4=RS485, 5=RS232 high speed

Current Value 1

Mode: 1   4-20mA loop output selected.

Selecting the VW sensor output units

Follow the menu system shown in Page 17. Using Option "3", the Main menu simply sets the output units for the frequency signal component.

Main Menu

1 Device Setup
2 Thermistor setup
3 Sensor Setup
4 4-20mA Frequency Output
5 4-20mA Temperature Output
6 0-2V Frequency Output
7 0-2V Temperature Output
8 System Maintenance
9 Exit
U Up. T Top.

The VibWire-301 supports output units of Hz, Digits (Hz^2), and SI units.

Connection to an Analogue Data Acquisition System

The following section details how to configure and optimise the VibWire-301 analogue output ports to operate with an analogue input data acquisition system, or stand-alone logger unit.

Technical Specifications - Analogue Output Ports

1 x 0 - 2.0V DC single analogue output ports - 16 bit DAC
1 x thermistor outputs - 3.3 KOhm completion resistors

Analogue Output - Theory of Operation

The VW-301 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-301 before being passed on for measurement.

When defining the operation of the analogue output each channel has to have the sensor operating characteristics defined. For the VW-301 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 2.0V = maximum frequency.

Digital VoltMeter Connection

The images below show how to connect a Digital VoltMeter (DVM) to the analogue output ports on the VibeWire-301.The DVM is to be set to input type volts.

Figure-40 Testing the Temperature Analogue Output

N/A
+ V out (Temp)
+ V out (Freq)
Gnd / 0V
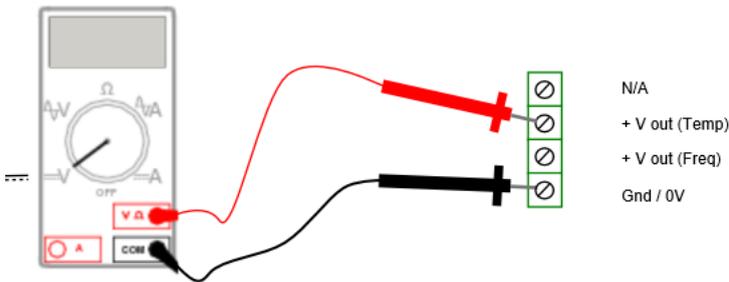
Figure-41 Testing the Frequency Analogue Output

N/A
+ V out (Temp)
+ V out (Freq)
Gnd / 0V
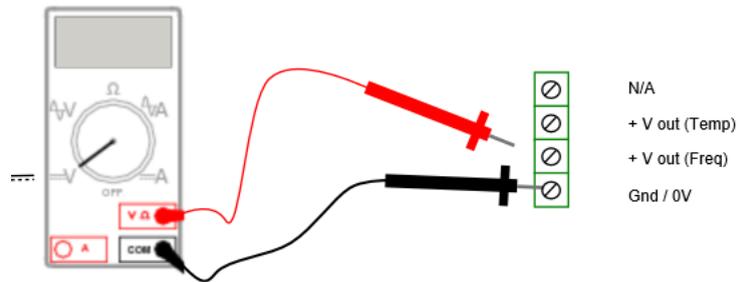
Analogue Output Port Connection

Figures 42 and 43 below show the connections to be used for the analogue output ports. The output level varies between 0 to 2 V DC.

Frequency

0 - 2 V DC

Analogue Output
(Temperature)

N/A
+ V out (Temp)
+ V out (Freq)
Gnd / 0V

Figure-42

Temperature

0 - 2 V DC

Analogue Output
(Frequency)

N/A
+ V out (Temp)
+ V out (Freq)
Gnd / 0V
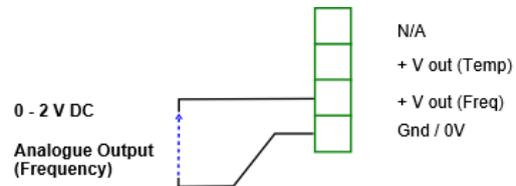
Figure-43

Factory Default Settins

0-2V Frequency Output

1 Value Low	0.0
2 Value High	16000
3 DAC FS output (mv)	2000
4 DAC calibration 0	0
5 DAC calibration 1	4000
U Up. T Top.	

Do not adjust these parameters

Only menu items 1 and 2 in the menu opposite have to be adjusted.

Value Low = The lowest sensor frequency.
Value High = The highest sensor operating frequency.

The output units can be Hz, Digits or SI (Engineering). and how this is set will be shown further into the video.

Voltage Output Port 0-2 V DC (Analogue)

The VibWire-301 supports 2 x independent voltage output ports. One output is to represent the frequency signal, and the other port is to represent the temperature signal. The analogue voltage output signal levels can be configured using the terminal port menu system, see Page 17.
Both of the frequency component analogue output, and the temperature output have to be configured to represent the full 4 wire sensor signal.

Worked Example

For a 100 mm range vibrating wire displacement sensor Low = 1150 Hz High = 2200 Hz. with the midpoint at 1675 Hz., 0 V = 0 mm and 2 V = 100 mm.

Operations

1. Ensure the device is set to 'Frequency Proc' = SENSOR   - (Output values are in SI Units)
2. Ensure the Vibrating Wire Sensor calibration factors are assigned.   Frequency and Temperature calibration factors.
3. **Communication Mode - 2=0-2V Analog**

Worked Example

The Sensor Setup menu below shows the calibration factors used to convert the raw sensor measurements into SI units.

Sensor Frequency   **Temperature Sensor**

Sensor Setup   **Thermistor setup**

1 Frequency proc	**SENSOR**		**1 Thermistor Type**	**STEINHART**
2 Temperature output			**2 Resistance at T0 (ohms)**	**3000.0**
3 Centre Frequency (Hz)	**2000**		**3 T0 (Celcius)**	**25.000**
4 First Ping (us)	**5000**		**4 Beta**	**-0.**
5 Cal A	**-1.26E2**		**5 Steinhart-Hart 0th order (A)**	**0.0033540**
6 Cal B	**6.25E-02**		**6 Steinhart-Hart 1st order (B)**	**2.5627E-4**
7 Cal C	**3.42E-07**		**7 Steinhart-Hart 2nd order (0)**	**2.0829E-6**
8 Cal D	**0.**		**8 Steinhart-Hart 3rd order (C)**	**7.3003E-8**
U Up. T Top			**U Up. T Top.**	

User Defined Sensor Calibration factors.

Factory Set Calibration Factors Thermistor type YSI 4144. This is a common temperature sensor used by many different sensor manufacturers. Do not adjust.

Setting the output channel levels is done using the Main Menu.

From the Main Menu select option '**6**' to assign the frequency output level, followed by option '**7**' to assign the temperature signal loop level for the 0-2 V DC output channels.

```
1 Device Setup                          --- Main Menu
 2 Thermistor setup
 3 Sensor Setup
 4 4-20mA Frequency Output
 5 4-20mA Temperature Output
 6 0-2V Frequency Output
 7 0-2V Temperature Output
 8 System Maintenance
 9 Exit
 U Up.  T Top.
```

Select option '**6**' to set the **0-2** V frequency analogue output level. The frequency and temperature analogue output ports are identified in Figure-31 on Page 23.

0-2V Frequency Output   0-2V Temperature Output

1 Value Low	**0.**		1 Value Low	**-40.00**
2 Value High	**100**		2 Value High	**120.00**
3 DAC FS output (mv)	**2000**		3 DAC FS output (mv)	-0.
4 DAC calibration 0	**0**		4 DAC calibration 0	0
5 DAC calibration 1	**4000**		5 DAC calibration 1	4000
U Up. T Top			U Up. T Top.	

Sample Output 1   Sample Temperature Output 1

Note: **1 Value Low   0 -- Represents 0 mm and 2 Value High   100 -- represents the 100 mm displacement**

For the temperature output levels

1 Value Low   0 -- Represents -40 Deg C and 2 Value High   120 -- represents the 120 Deg C.

Select option '5' from the Main Menu and assign the 4-20 mA temperature output levels as shown above.

Do not adjust the factory set calibration factors shown as items 4 and 5 in the '0-2V Frequency Output' menu system.

Optimising the Analogue Output Settings

Example 1

The VibWire-301 contains individually configurable analogue output ports for the sensor frequency and temperature signals. The analogue output range is 0 - 2.0V DC.Only the parameters Value Low and Value High need to be set.

Example - Analogue Output Port Settings

For example, a vibrating wire sensor with an operating range of **1200 - 1900** Hz is to be assigned to the analogue output port used to represent the frequency signal.

The terminal port menu system can be used to assign the sensor range parameters, see page 22..

The settings are:

Value Low = 1200 Hz & **Value High = 1900 2.0V = 1900 Hz.**

The analogue output port 0 V represents 1200 Hz and 2 V DC represents 1900 Hz.

will give the highest resolution for this example

DAC Resolution Output Port (16 bit DAC)   **Range / 65536 (Hz)**
= 700 / 65536
= 0/01 (Hz)

In practice accuracy of around 0.25 Hz can be achieved when connecting the VW-301 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-301 with an active analogue output port do 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.

Understanding the Analogue Output Port Settings
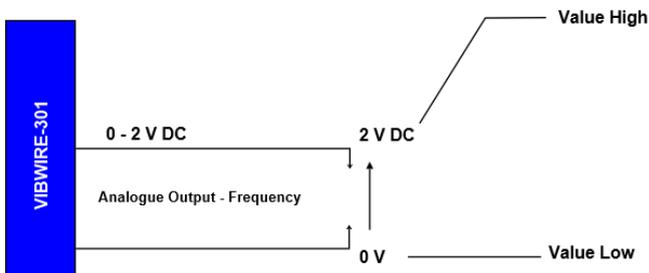
Figure-44

Value High can be in Hz, Digits and SI Units.

Value Low can be in Hz, Digits and SI Units.

The choice of units that the voltage level represents is set as the 'Sensor' setup option. See Page 17 Figure-23 .

An example for setting the Output Units type can be seen on Page 22.

Select

Enter Communication mode: 2=0-2V Analog.

To use the analogue output port.

4-20 mA Loop Power Supply

Connect the loop power supply as shown below.

Figure-45
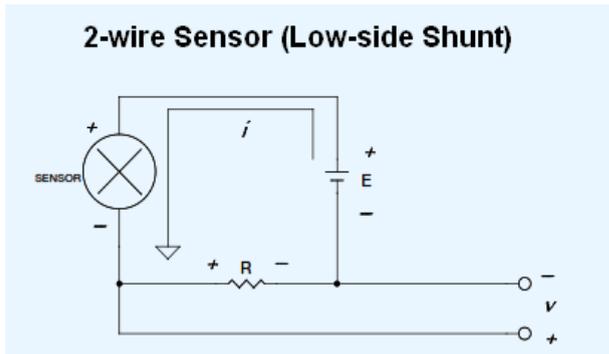
R = Sense Resistor (typically 200 Ohm)

Figure-46
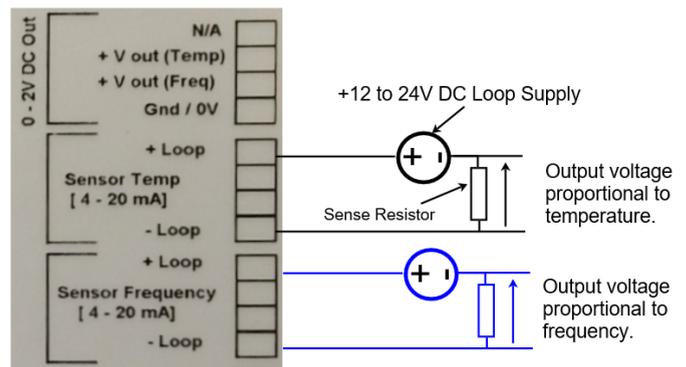
Problems with Current Loops

The VibeWire-301 contains 2 x current loop output ports, one for the frequency signal component and a separate port for the temperature signal. Each loop is individually isolated and configured. Keynes Controls recommends individual power supplies for the loops.

Watch Your Grounds (or use an isolated instrument)

Contrary to what many believe, ground potentials are almost never at the same level in many industrial locations, which is exactly where most 4-20 mA current loop instruments are used. Two or more grounds that are the *same* means that they are at the *same potential*.

A measurement between the grounds of the various instruments using a digital volt meter (DVM) on both its DC and AC settings will show zero volts, or very close to it. In reality, it is possible to measure at least several volts between the different earth points on a structure. When grounds that are not at the same potential are tied together (which you need to do to make a measurement), current flows through them, creating several possible measurement outcomes for non-isolated instruments:

1. The measurements are noisy.
2. The measurement can be inaccurate.
3. Irreparably damage the instrument.
4. Saturate the instrument so it is not possible to make any successful measurements.

To remedy these problems requires the following:

1. Use an isolated instrument for your 4-20 mA current loop measurements.

2. The VibWire-301 is opto-isolated for both the frequency and temperature sensor ports. This enables the instrument to ignore all other grounding issues in exchange for successful measurements in any situation.

3. Ensure that the loop power source is isolated. This means that its output ground (the one connected to the sensor) is not tied to its input ground (the one that connects to AC line power.) An isolated power source means that the output ground can be tied to another ground (like a non-isolated instrument) without consequence.

4. Power the instrumentation from a battery.

4-20 mA Loop Operation Problems

The current loop is powered on but the instrument does not do anything -- Why ?

A 4/20 mA loop consists of many parts, and any one of the parts can be a problem. The first step is to check the wiring. Ensure that contact is made and to the correct terminals. The positive side of the loop devices should be wired toward the positive side of the power supply, the negative toward the negative.

A digital multimeter is an invaluable tool in troubleshooting a 4/20 mA loop. Measure the voltage on the power supply to ensure that it powers up to the rated voltage. Measure the voltage across the transmitter to ensure that the voltage is larger than the minimum requirement and that the polarity of the voltage is correct as labeled on the transmitter. A frequent cause of loop failure is due to the transmitter being wired up backwards. Loop power should be 12 V.

Current loop Signal Format - 4-20 mA

The VibWire-301 supports 2 x independent current loop outputs. One output is to represent the frequency signal, and the other port is for the temperature signal. The current loop levels can be configured using the Terminal Port Menu System, see Page 17.

Both the frequency component current loop, and the temperature output signal loop have to be configured to represent the full 4 wire sensor signal.

Worked Example

For a 50 mm range vibrating wire displacement sensor Low = 1250 Hz High = 2100 Hz. with the midpoint at 1675 Hz.. where 4 mA = 0 mm and 20 mA = 50 mm

Operations

1. Ensure the device is set to 'Frequency Proc ='**SENSOR**'   - (Output values are in SI Units)
2. Ensure the vibrating wire sensor calibration factors are set.   Frequency and Temperature calibration factors.
3. **Communication Mode - 1=4-20mA**

Worked Example

The sample Sensor Setup menu below shows the calibration factors used to convert the raw sensor data into SI units.

Sensor Frequency		Temperature Sensor	
Sensor Setup		**Thermistor setup**	
1 Frequency proc	**SENSOR**	**1 Thermistor Type**	**STEINHART**
2 Temperature output		**2 Resistance at T0 (ohms)**	**3000.0**
3 Centre Frequency (Hz)	**2000**	**3 T0 (Celcius)**	**25.000**
4 First Ping (us)	**5000**	**4 Beta**	**-0.**
5 Cal A	**-1.26E2**	**5 Steinhart-Hart 0th order (A)**	**0.0033540**
6 Cal B	**6.25E-02**	**6 Steinhart-Hart 1st order (B)**	**2.5627E-4**
7 Cal C	**3.42E-07**	**7 Steinhart-Hart 2nd order (0)**	**2.0829E-6**
8 Cal D	**0.**	**8 Steinhart-Hart 3rd order (C)**	**7.3003E-8**
U Up. T Top		**U Up. T Top.**	

User Defined Sensor Calibration factors.

Factory Set Calibration Factors Thermistor type YSI 4144. This is a common temperature sensor used by many different sensor manufacturers.   Do not adjust these parameters.

Setting the Output Channel Levels

From the main menu select option '**4**' to assign the frequency output level, followed by option '**5**' to assign the temperature signal loop levels.

```
1 Device Setup                    ---- Main menu
 2 Thermistor setup
 3 Sensor Setup
 4 4-20mA Frequency Output
 5 4-20mA Temperature Output
 6 0-2V Frequency Output
 7 0-2V Temperature Output
 8 System Maintanence
 9 Exit
 U Up.  T Top.
```

Select option '**4**' to set 4-20 mA Frequency Output loop levels. The values for the 4 and 20 mA levels are set as shown 'Sample VW Sensor Configuration'

4-20mA Frequency Output			4-20mA Temperature Output		
1 Value 4mA	0.0	-- Represents 0 mm	1 Value 4mA	-40.000	(-40 Deg C)
2 Value 20mA	50.0	-- Represents 50 mm	2 Value 20mA	120.00	(+120 Deg C)
3 DAC calibration 0	10922		3 DAC calibration 0	10922	
4 DAC calibration 1	54613		4 DAC calibration 1	54613	
U Up. T Top.			U Up. T Top.		

 Sample VW Sensor Configuration   Sample Temperature Sensor Configuration

Select option '**5**' from the Main Menu and assign the 4-20 mA temperature output levels as shown in Sample Temperature Sensor Configuration menu above.

Do not adjust the factory set calibration factors shown as items 3 and 4 in the menu system.

Understanding Current Loop Settings

The image below demonstrates how the current loop levels are represented.

Frequency Component
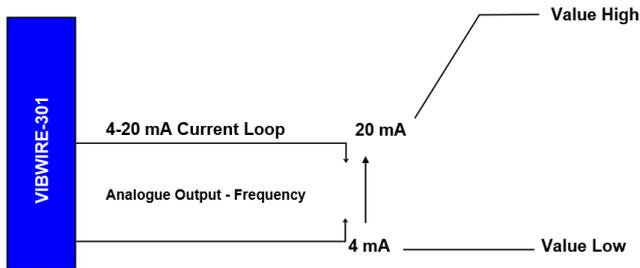
Figure-47

Value High can be in Hz, Digits and SI Units.

Value Low can be in Hz, Digits and SI Units.

The choice of units that the current loop level represents is set as the 'Sensor' setup option. See Page 17 Figure-23.

Select

Enter Communication mode: **1 = 4-20 mA**

To use the current loop port.

Important Note

The 'Thermistor Type' calculation option determines which calculation is used regardless of the calibration parameters that are set.

Temperature Sensor Configuration

The VibWire-301 uses the in-built temperature inside a VW sensor to make temperature measurements.

The menu system has two thermistor types predefined and stored within the instrument. The YSI 44005 sensor type is the most common industry standard sensor built into a vibrating wire sensor. This sensor is defined as '**Thermistor Type 1**'.

The menu system enables custom thermistor calibration parameters for both the VW sensor linearisation and temperature sensors to be configured. The thermistor resistance and therefore temperature is calculated using the Steinhart-Hart equation. The output temperature SI unit is Deg C.

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.

Should the temperature sensor calibration factors for a particular chosen sensor be unknown, then simply select the default values in the device.

Examples Of Using RS-485/SDI-12 Commands

The default factory network setting is SDI-12. With ID=0.

The following examples show how to undertake the various tasks needed to set up the instrument, and make readings across the RS-485 and SDI-12 networks. The command structure between the SDI-12 and RS485 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)

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-301 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	**'2001\r\n'**	indicated readings available after 1 secs
	followed by	**'2\r\n'**	when the measurement is completed

Note. For this command the RS-485 network will not become available until each instrument completes its measurement cycle**.**

Unit Conversions

Temperature

Celsius to Fahrenheit   **(˚C × 9/5) + 32 =°F**   1 degree Celsius = 274.15 kelvin
Fahrenheit to Celsius   (˚F - 32) x 5/9 =°C   1 degree Celsius = 0.8 degree Reaumur
          1 degree Celsius = 493.47 degree Rankine

Pressure

Common Pressure Unit Conversion Factors

1 atmosphere [standard] = 1 033.227 554 8 centimeter of water [4 °C]   1 centimeter of water [4 °C] = 7.735 502 475 meter of air [0 °C]
1 centimeter of water [4 °C] = 98.066 5 pascal   1 centimeter of water [4 °C] = 0.735 559 231 36 torr
1 centimeter of water [4 °C] = 0.098 066 5 kilopascal   1 kilopascal = 101.971 621 3 Water Column [millimeter]

Vibrating Wire Sensors

Keynes Controls manufactures some Vibrating wire sensors. Our instrumentation supports most manufacturers sensors and a small summary of these is shown below.

Vibrating Wire Displacement Sensor

Part Numbers

Model : KDE-V05	50 mm Displacement
Model : KDE-V10	100 mm Displacement
Model : KDE-V15	150 mm Displacement
Operating Frequency	1490- 2200 Hz (Typical)
Initial Frequency - non load	1389 Hz

Displacement ranges are available with ranges up to 150 mm

Resolution	0.025% of range
Accuracy	± 0.2% of range
Temperature effect	–0.014mm/°C (typical)
Operating temperature	–0.014mm/°C (typical –30 to +70°C

4 Core screened

Vibrating Wire Strain Gauge

Part Number :	**KDS-20-V-SW**
Gauge Type:	surface mounting strain gauge.
Gauge factor:	3.025 x 10-3 microstrain per Hz squared.
Measurement range:	> 3000 microstrain.
Resolution:	Generally better than 1 micro-strain.
Coil Resistance:	Approximately 100 ohms.
Operating temp range:	-200C to 800C.
Thermal coefficient:	11 ppm per 0C.

Vibrating Wire Joint Meter

Joint meters

Joint meters are available with ranges up to 100 mm

Resolution:	0.025% of range
Accuracy:	± 0.2% of range
Temperature effect:	–0.02mm/°C (typical)
Operating temperature:	–30 to +70°C
Cable:	2 Core screened

Vibrating Wire Sister Bar

Effective Gauge length:	50 mm (nominal)
De-bonded length:	175 mm
Overall length:	1.39 m
Standard diameter :	15 mm
Resolution :	0.5 micro-strain
Strain range:	2500 micro-strain
Thermal expansion:	12 ppm /deg C

Vibrating Wire Piezometer

Figure 35

Figure 36

Figure 37

Encardio-rite Vibrating Wire are well tested with the VibWire-301 and are the recommended sensor range for this product range.

Frequency signals i.e. those generated using vibrating wire sensors are particularly suitable for demanding environments such as that often occur within Civil Engineering Applications

Vibrating wire sensors ideally suit the harsh civil engineering environment since the signals are capable of long transmission distances without degradation, tolerant of wet wiring conditions and resistant to external electrical noise.

Specifications

Excitation:	Auto-resonance
Voltage Protection:	Semitron Bi-Polar 230 V
Thermistor:	3k Ohms at 25 ºC
Over-range:	minimum twice pressure
Resolution:	0.025% FSO (minimum)
Accuracy:	< 0.25 % FSO (see Notes)
Thermal Effect:	< 0.02% FSO /ºC
Operating range:	-20 ºC +100 ºC
Cable:	2 pair PVC outer sheath.
Typical range:	3500-2200 Hz
Nominal zero value:	3130 Hz

For additional details contact : Encardio-Rite Ltd India

Encardio-rite

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 -
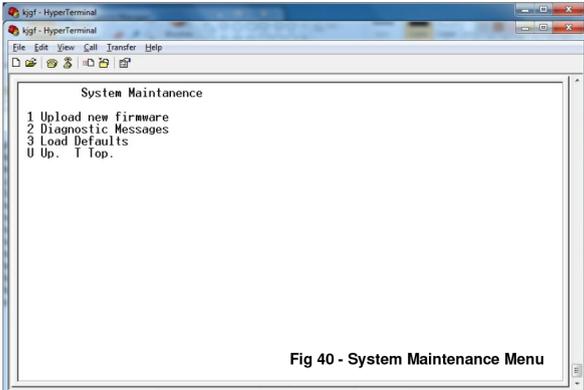
Fig 40 - System Maintenance Menu

3. Select option 1 '**Upload new firmware**'
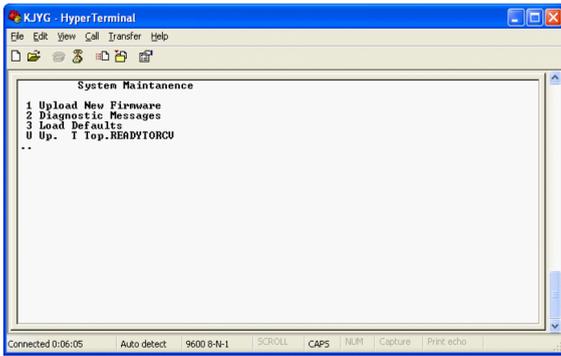
4. Using the HYPER-TERMINAL menu system

Select '**Transfer\Send Text File**' option.
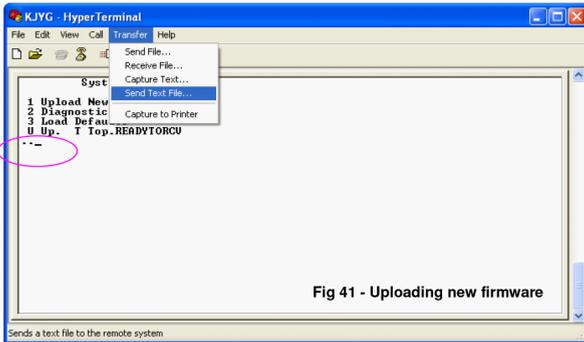
Fig 41 - Uploading new firmware

…………………………_

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

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

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 in 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.

Fig 41 opposite shows how the 'Hyper-terminal' software appears once the firmware file is selected and data is being sent to the sensor interface.

Fig 42 shows how the 'Hyper-terminal' emulator 'System Maintenance' Window will appear once the firmware has loaded into the sensor interface correctly.

The 'Burning' message has to be displayed to show the new firmware has been loaded correctly.
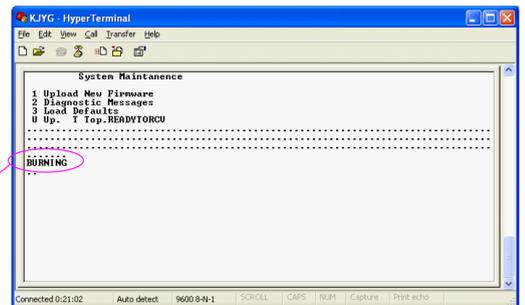
Fig 42 - Firmware upload successful

SAMPLE Vibrating Wire Sensor Calibration Data sheets

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)	Up1 (Digit)	Observed value 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	:	$P(kPa) = G(R_0-R_1) + K(T_1-T_0) - (S_1-S_0)$
Polynomial	:	$P(kPa) = A(R_1)^2 + B(R_1) + C + K(T_1-T_0) - (S_1-S_0)$

R_1 = current reading & R_0 is initial reading in digit.

S_1 and T_1 = 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

The terms K(T1-T0) are the temperature compensation terms for this sensor.

Temperature compensated readings only work if the thermsitor operation is defined.

(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.)

VIBRATING WIRE INSTRUMENTS CALIBRATION CERTIFICATE

Instrument Type : Displacement Transducer

Instrument Range : 0.00 to 50.0 mm

<u>Gauge Factors in mm</u>

Period Gauge Factor (K : 92.1053900

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

<u>Calibration Equipment</u> :
Digital micrometer with scale

VibWire-301 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	$E = G(R_0 - R_1)$
Polynomial	$E = AR_1^2 + BR_1 + C$
Offset	$C = -(AR_0^2 + BR_0)$

These equations give displacement only without any temperature compensation.

Where R_0 = is the initial zero reading at the time of installation.

R_1 = current reading Units $Hz^2/1000$ (Digits)

Piezometer Set-up

Main Menu	Frequency proc
1 System Maintenance	HZ **DIGITS** SENSOR
2 Thermistor type 1	
3 Thermistor type 2	where SI Units is by Quadratic Expansion
4 Diagnostics	
5 Channel 0	
U Up. T Top.	

Channel

1 Frequency proc	DIGITS
2 Thermistor type	1
3 Cal A	0.000000024979750
4 Cal B	0.0089750451
5 Cal C	28.976750
6 Cal D	-2.3069E-3
U Up. T Top.	

Displacement calculations within Q-Log

Q-Log is the free data display and recording software from Keynes Controls Ltd.
++

Linear

$E = G(R_0 - R_1)$
$E = G.R_0 - G.R_1$

where $G.R_0$ is a constant term.

Enter this formula into Q-log and the results will be in mm.

SAMPLE Calibration Data Sheet

CALIBRATION DATA VIBRATING WIRE PIEZOMETER

Serial No   0 9 - 1 3 4 8 9

MAXIMUM PRESSURE	10 MPa
MAXIMUM OVERLOAD PRESSURE	20 MPa
BAROMETRIC PRESSURE AT CALIBRATION	1012 mBar
FACTORY ZERO READING	9061.304 Hz^2/1000
CABLE RESISTANCE (TWO WAY)	51.25 Ohms
PRESSURE CHANNEL COEFFICIENTS	

P4= $-1.08331E-15$

P3=   0.00000E+00

P2= $-2.21240E-05$

P1=   0.00000E+00

P0=   FROM TEMP CH

TEMPERATURE CHANNEL COEFFICIENTS

C4=	8.50983E-14
C3=	-2.05402E-09
C2=	1.84317E-05
C1=	-8.09166E-02
C0=	2.10758E+04

SWEEP FREQUENCY MIN	1978 Hz SWEEP
FREQUENCY MAX	3311

Sigra - Piezometer Set-up

Frequency Input Configuration

Vibrating Wire		
	DIGITS	
1 Frequency proc		
2 Thermistor type	1	
3 Cal A	0.0	
4 Cal B	-2.21240E-05	
5 Cal C	0.0	
6 Cal D	-1.08331E-15	
U Up. T Top.		

Common VW Sensor Thermistor Part Numbers

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

The part numbers are for a 3 K Ohm thermistor commonly used by most different manufacturers.

The sensors give 3 K Ohm resistance at 25 Deg C.

Thermistor Configuration

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)	2.0 6E-4
7 Steinhart-Hart 2nd order (C)	2.08E-6
8 Steinhart-Hart 3rd order (D)	7.30E-8

U Up. T Top.

Appendix- A - Displacement Sensor

Principle of Operation

The change in displacement is sensed by the vibrating wire sensor and is converted to an electrical signal which is transmitted as a frequency to the readout unit. The frequency, which is proportional to the displacement and in turn, to the tension 's' in the sensor coil wire, and is determined as follows:

Vibrating Wire Standard Equation

$f = [\sigma\gamma/\rho]1/2/ 2l$ Hz

where:

σ = tension of wire in kg/cm^2

g = acceleration due to gravity in cm/sec^2

ρ = density of wire in kg/cm^3 l = length of wire in cm

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

$$\textbf{Digits} = \frac{\textbf{Frequency}^2}{\textbf{1000}} \quad \frac{(Hz^2)}{1000}$$

Displacement Sensor Calibration Sheet - Example

SAMPLE

Unit B1, Lambs Farm Business Estate 3276067
Basingstoke Road, Swallowfield, Berks, RG7 1PQ

t: +44(0)118

e: sales@keynes-controls.com

Keynes Controls Ltd, Registered in England, Number 3199347

VIBRATING WIRE INSTRUMENT CALIBRATION CERTIFICATE

Sensor Type	KDE-V150	**Serial Number**	100002

Instrument Range	0.00 to 150.00 mm	Calibration Date	1/6/2017
Linear Gauge Factor	0.0652	Calibration Temperature	21 Deg C
Polynomial Gauge Factor A	-1.26E+02	Barometric Pressure	1011 mb
Polynomial Gauge Factor B	6.52E-02 [Gauge Factor]	Calibration Eng:	Dr Paul Bayton
Polynomial Gauge Factor C	3.42E-07	Calibration Equipment	VW201-Pro Digital micrometer
Temperature Correction Coeff:	-1.40E-02 [Temperature Correction Coefficient]	S/N	1141

Measurement Points

x (mm)	F (Hz)	d (Hz²)
0	1385.1	1918.5
75	1743.4	3039.4
150	2036.6	4147.7

Calibration Factors

All of the KDE-VXX range of displacement sensors use the following calibration equations to convert frequency into SI units:

$$X = A + Bd + Cd^2 - Dt \quad \text{where } d = F^2 / 1000 \text{ (Digits) in m Hz}^2$$
$$\text{and } D = \text{Temperature Correction Coefficient}$$
$$t = \text{temperature in Deg C}$$

The instrument detailed above has, as acceptable, been tested and calibrated in accordance with procedures, which are part of our ISO 9001:2015 Quality Management System, and unless otherwise indicated, performs within +/- 0.20 % Full Scale (Polynomial) as specified. The sensor conforms in all respects to the relevant specifications and drawings.

Certified: …………………….. Engineer

Sample VW Crack Meter

Using equation $X = A + Bd + Cd^2 + Dt$

FORM No G/QF/125	
ISS.	10
DATE :	Jun-18
SIG.	GC

VIBRATING WIRE CRACK METER CALIBRATION

Model	VWCM 4000
Serial	510120
Works ID	898
Cable m	20
Readout No.	VR0814
R/O Cal.Date	15/08/2018

Cal date	17-Oct-18
Master	011
Temp °C	20
Batch	75
Range mm	12.5
Shipment Reading (Digit)	
2915.6	

Applied Displacement	Output (Hz^2 *10-3)			Indicated Displacement (mm)		Linear Error	Polynomial Error
mm	1 up	1 down	Avg. Rdg	Linear	Poly.	% FSO	% FSO
0.00	3063.4	3068.3	3065.9	-0.02	0.00	-0.15%	-0.03%
2.50	3943.3	3954.9	3949.1	2.51	2.51	0.08%	0.05%
5.00	4817.9	4830.2	4824.1	5.01	5.00	0.11%	0.01%
7.50	5688.7	5697.9	5693.3	7.50	7.49	0.01%	-0.09%
10.00	6565.0	6574.9	6570.0	10.01	10.01	0.08%	0.06%
12.50	7433.8	7434.7	7434.3	12.48	12.50	-0.13%	-0.01%

CALIBRATION FACTORS

Linear factor k (mm)

mm/Digit
0.002861902

Polynomial factors (mm)

	mm/Digit
A	5.88882E-09
B	0.002800057
C	

Calibration of Displacement Rig S/N: P49 valid from 07 December 2016, Calibrated using equipment which provides traceability to UKAS standards (UKAS Laboratory No 0157)

Sensor Configuration

Sensor Setup : Output in mm

```
1 Frequency proc          DIGITS
2 Temperature output      1
3 Centre Frequency (Hz)   2000
4 First Ping (us)         5000
5 Cal A          0.                  constant
6 Cal B          0.002861902         linear
7 Cal C          0.                  Quadratic
8 Cal D          0.                  Temperature
U Up.  T Top.
```

Thermistor YSI 44005 - (Temperature Sensor)

Shown below are the calibration factors from a temperature sensor built into many third party Vibrating Wire sensors. This is a popular temperature sensor, and has been added as an example of how the calibration factors from a data sheet are identified and used. The calibration factors can be written directly into the instrument using the terminal port menu system, or Q-LOG Data Display & Storage Software.

The Steinhart-Hart temperature - resistance conversion equation gives superior results than using the simplified Beta temperature coefficient conversion.

A = 1.4051 x 10^{-3} B = 2.369 x 10^{-4} & C = 1.019 x 10^{-7} .

The calibration factors are written into the device using standard scientific number format:

If no calibration factors are defined for a sensor then use the factors shown below.
The VibWire-301 has the industry standard thermistor sensor calibration factors built in.

A = 1.4051E-3   B = 2.369E-4   & C = 1.019E-7,

See Terminal Port Menu System on page 31 for the Terminal Port Menu options where the calibration factors are stored.

Thermistor Configuration

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)	1.4051E-3
6 Steinhart-Hart 1st order (B)	2.369E-4
7 Steinhart-Hart 2nd order (C)	1.019E-7
8 Steinhart-Hart 3rd order (D)	7.30E-8

U Up. T Top.

Appendix B- Vibrating Wire Total Pressure Cell - Calibration Sheet

VW TOTAL PRESSURE CELL

SAMPLE

Model	VWTPC-4000	Cal date	04/07/2017	SN.	8233
Serial		Baro	1008.8	Readout No.	14002
Works ID	G3 11 92	Temp $^\circ$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$_2$O per digit
-0.051254234	-0.007434	-0.005226

Polynomial factors

	kPa	psi	mH$_2$O
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$_2$O per °C
0.344313957	0.04993676	0.035110

Thermal Factor

Note: Digits are Hz^2 x 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 Q-LOG setup Window below is only valid for VibWire-301 operating in SDI12 and RS485 modes of operation.

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-301 unit is set to convert frequency measurement to SI unit of KPa. Polynomial Linearisation is used.
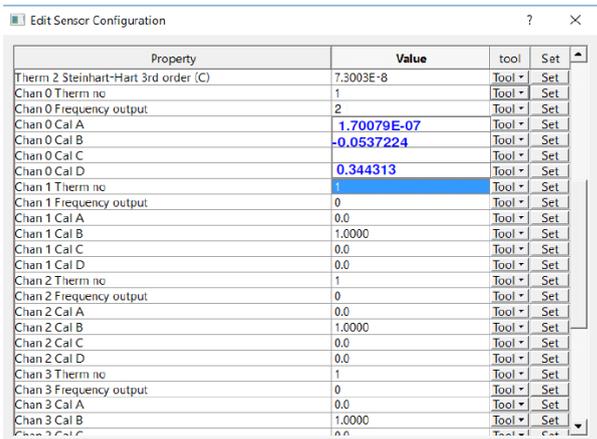
Terminal Port Configuration

The measurement returned for Chan-0 is in SI Units of KPa. The linearisation is undertaken using the Polynomial calculation. Note the 'Frequency proc' is 2.

Temperature compensation is assigned as Cal factor D.

The VibWire-301 uses the Digits calculation to convert the measured frequency value into SI units. Note the 'Frequency proc' is 1.

Temperature compensation is assigned as Cal factor D.

Channel 0   **(Units kPa)**

1 Frequency proc	SENSOR
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.	

VW Sensor   **(Units psi)**

1 Frequency proc	SENSOR
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.	

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
Chan 3 Cal C	0.0	Tool ▾	Set

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Appendix

High Speed VW Measurements using the Analogue Output Ports

For instruments shipped after June 1st 2021 have the facility to undertake high speed vibrating wire measurements using the analogue and current loop output ports to represent the signals.

High Speed Measurements - 4-20 mA / 0 - 2 V DC

The VibWire-301 can operate in high speed mode. The simplest way to use the device in high speed mode is to connect it to an analogue data acquisition system via the 0-2 V DC or 4-20 mA loop output ports. The analogue output ports can also be used to drive process display units.

The device has two analogue output signals that can be individually configured to represent the sensor frequency in Hz, Digits or SI Units. The temperature sensor output can be scaled to represent Degree Celsius or mV. High speed vibrating wire measurements

Analogue Output Port Connection
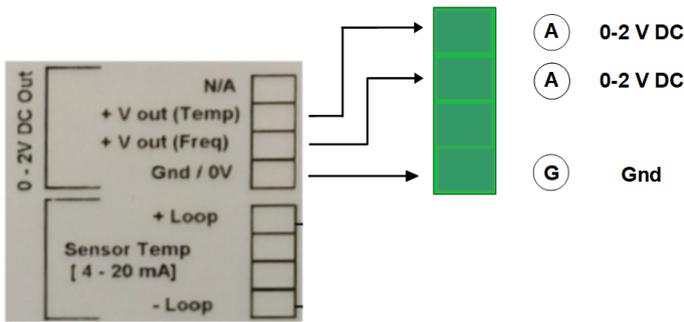
A = Analogue Input 0-2 V DC (Frequency and Temperature signals)
G = Gnd/ 0V

The menu system below are the default settings for a vibrating wire sensor operating over the range 500 - 1300 Hz as used by the Geokon 4200 sensor.

Sensor Setup

1 Frequency proc	Hz
2 Centre Frequency (Hz)	900
3 First Ping (us)	5000
4 Cal A	0.
5 Cal B	1.0000
6 Cal C	0.
7 Cal D	0.
8 Stabalization after pluck (us)	5000
9 Sample number of pulses	20

The configuration settings show the output signal from the device will represent a Vibrating Wire signal in Hz.

Current Loop Port 4-20 mA
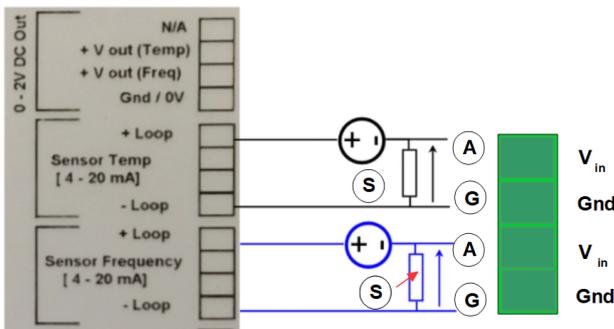
A = Analogue Input 0-2 V DC (Frequency and Temperature signals)
G = Gnd/ 0V

The VibWire-301 supports two individually isolated 4-20 mA loop outputs that can be configured to represent the Frequency and temperature signal components of the sensor. The current loop not only represents the sensor signal but is also powered from it.

A precision 100 Ohm sense resistor is used to convert the loop signal to a voltage that can be measured by an analogue data acquisition system.

The sensor output signal can be configured to represent Hz, Digits or SI units.