

# KEYNES CONTROLS Ltd

Model VibWire-101-Pro

## Vibrating Wire Sensor Analyser & Data Recording Unit



Part No: VibWire-201-Pro

**ADVANCED FFT SENSOR ANALYSER**  
**PRECISION TEMPERATURE READINGS**  
**USER PRE-SET VW SENSOR CONFIGURATIONS**  
**SDI-12 & RS-485 COMMUNICATION PORTS**  
**DAYLIGHT READABLE LCD DISPLAY**

**DATA LOGGING TO MICRO SD MEMORY CARD**  
**UP TO 32 GB STORAGE**  
**SPREADSHEET FORMAT DATA FILES**  
**REAL-TIME CLOCK**  
**EXPANSION OPTIONS**  
**- 16 x 4 WIRE INPUTS**  
**- 32 x 2 WIRE INPUTS**

Features

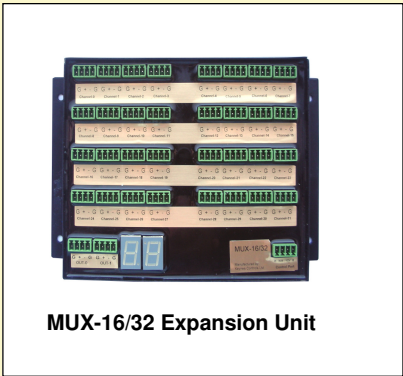
- Lightweight, Portable & Rugged
- Compatible with most manufactures vibrating wire sensors
- Real-time displays Freq (Hz), Digits (Hz<sup>2</sup>/1000), SI-Units, Spectra
- FFT Spectral based algorithms for interference free measurements
- Auto-resonance excitation 400 - 15 K Hz range - minimises sensor stress
- Fully configured sensor operations
- Large data storage - 100 million readings - SD Flash Cards to 32 Gb
- Fast data recording - 1 sec to 1 hour logging intervals
- No Vibrating Wire Sensor Prior operating conditions required
- Expandable to 32 channels
- SDI-12 and RS-485 ports for remote network connection
- Optional radio interfaces for cable free operations
- Firmware up gradable device - load software revisions with factory return



Benefits

- Out the box solution for vibrating wire sensor measurements
- Daylight readable LCD Display
- Provides superior measurements by automatically reducing incorrect readings caused by noise sources
- Customised FFT-based algorithm ensures readings are accurate and free from interferences
- Real-time Sensor Spectra Display
- No special cables or connectors required
- No programming experience required to interface to 3rd party loggers and data acquisition systems..
- Interfaces up to 32 channels using the MUX-16/32 Expansion unit.
- High resolution—less than 0.001 Hz (industry standard is 0.1 Hz)
- Low power consumption - Uses readily available AA battery life - 24 Hours continuous use
- Suitable for laboratory testing and field measurement applications
- Precision temperature and frequency measurements from vibrating wire sensors
- Works with all RTD-temperature sensors regardless T0 resistance - 3 K, 10K etc
- Free Data Storage and Display Applications Software -

Additional items commonly used with the VibWire-201-Pro Unit



MUX-16/32 Expansion Unit



USB-SDI12-Pro Media Converter



USB-485-Pro Media Converter

This device is used to expand the number of sensor inputs that can be used by the VibWire-201-Pro from a single channel to 32 inputs.

This device can be powered directly from the VibWire-201-Pro for stand-alone measurements.

This device is used to connect the VibWire-201-Pro to a Windows PC remotely across the SDI-12 digital network. The USB-SDI12-Pro can be used to power the VibWire-201-Pro for fixed monitoring applications

The device supports all of the Keynes Controls SDI-12 sensor and interfaces, including many 3rd party devices.

The USB-SDI12-Pro isolates the network devices from the Windows PC USB port and protects it against possible damage caused by sensor failures.

This device is used to connect RS-485 based intelligent devices including the VibWire-201-Pro a Windows PC.

The device not only can power sensors on the network, but also isolates the PC USB port from any possible device failure in order to prevent damage to the host PC.

The device supports all of the Keynes Controls RS-485 sensor and interfaces, including many 3rd party devices.

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VibWire-201-Pro demonstrating the ability to calculate and display a real-time vibrating wire sensor spectra.



### Product Changes

Keynes Controls Ltd has an on-going policy of design review and reserves the right to amend the design of their product and this instruction manual without notice

HAND HELD VW LOGGER UNIT WITH FFT ANALYSER

Hardware Features

Fig-1

Carbon fibre reinforced ABS plastic enclosure

**Power On**

To power on the VibWire-201-Pro unit, hold and press the On/Off button for 2 seconds. The device will initiate and start a measurement operation.

The device will initialise using the last defined sensor.

**Power Off**

Hold and press the On/Off button and the device will power off.

**Menu-In & Power On/Off Button**

**MUX-16/32 Control Port**

**Sensor Port**

Compatible with the VW101 & VW108 units

Rubber protective boot cover

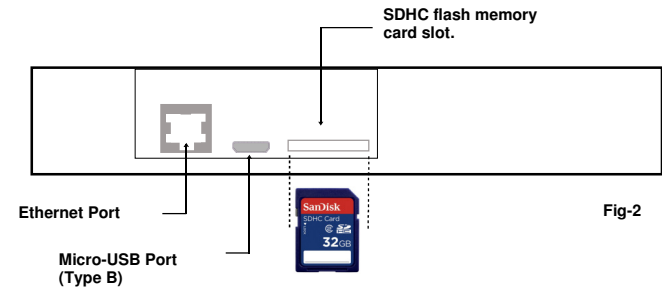
Powering on the Unit

Press and hold for 2 seconds the 'Menu Out' button. The device will power on and the 'Start-up Screen' will be displayed. Repeat the operation to power off the device.

Menu-Out On/Off Button

Automatic Time-out

The VibWire-201-Pro will power down automatically after 30 minutes of un-attended operation, unless configured to make measurements.



Ethernet Port

The Ethernet port is currently not used in the VibWire-201-Pro and has been added for future expansion.

Micro-USB Port (Type B)

The micro-USB port is used to configure the VibWire-201-Pro and to download data. Use the VW201pro configuration software tool assign sensor configuration information into the instrument.

SDHC Flash Memory

The VibWire-201-Pro supports a single SDHC memory card slot. The memory card has to be pre-formatted before use.

The maximum size memory card currently supported is 32 Gb.

Calculations

Keynes Controls use the following calculation

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

Day Light Readable LCD Display

The LCD display is clear to read in most lighting conditions. A back light is available for low level light environments. Three levels of display brightness can be 'User' assigned.

**Back light - LCD Screen**

Options for High , Low, Off.

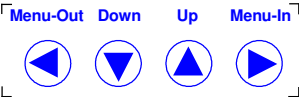
**User Defined Sensors - 20 options**

Use the Windows Configuration software to assign sensor details.

Menu Control Buttons

Use the Menu-In and Menu-Out buttons to select the different menu systems.

Use the 'Up' and 'Down' menu keys to select the menu items.



**RS-485 network port**

**SDI-12 network port**

The 4 wire sensor port mounted at the bottom of the instrument is used a general sensor test port. Bare sensor wires can be simply connected directly into the spring terminal posts.

4 Wire Sensor Inputs + Earth

Spring Terminal Post Connectors

Real-time Clock

Temperature compensated real-time clock accurate to 50 ppm / Deg C.

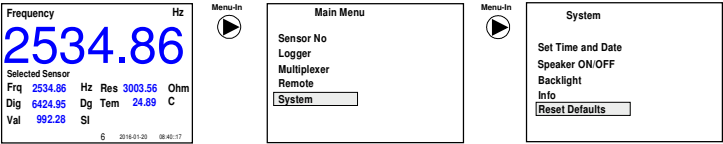
Protective Case

The case for the VibWire-201-Pro is manufactured from carbon fibre reinforced ABS plastic. This makes the case highly safe from accidental damage.

The rubber boot prevents provides additional protection from the wear and tare of site work. A rear stand enables the device to free stand while in operation.

Factory Default Setting Reset

Select the 'Reset Defaults' option shown below to reset the device to its factory settings. The image below shows the menu operations required to undertake this task.





Quick User Guide

The instructions shown in the Quick User Guide presumes that the batteries have already been installed into the device and a vibrating wire sensor is ready for testing.

The VibWire-201-Pro will operate with any sensor manufactures device.

The VibWire-201 comes pre-configured with default temperature sensor calibration factors defined. The pre-set temperature sensor calibration factors are based on a 3 K Ohm @ 25 Deg C device. The following sensor part numbers all use the same calibration settings.

Default Thermistor Part Numbers

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

- 1. Power On The VibWire-201-Pro.

Press and hold the 'Power On' for 2 seconds. and with no sensor connected the default Frequency display is shown opposite.

Default screen with no sensor attached.

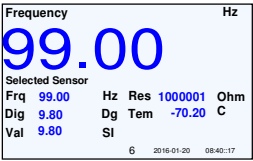


Fig-3 Initial Start-up Screen

- 2. Connect a vibrating wire sensor to the device

Connect a single sensor to either the 5 pin terminal block input port or directly onto the sensor port mounted at the bottom of device using the spring loaded terminal posts..

Connect the frequency output signal from the sensor to the red and black terminal posts.

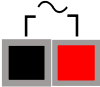


Fig-4

Connect the vibrating wire sensor thermistor (temperature sensor) to the green and yellow terminal posts.



Fig-5

- 3. Real-time Results

As soon as the vibrating wire sensor is connected to the VibWire-201-Pro then the measurements will be displayed on the display.

A typical display screen is shown opposite.

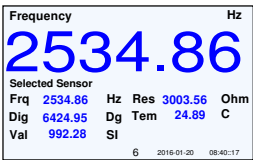
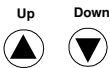


Fig-6

- 3. Use the 'Up' and 'Down' keys to switch between Hz, Digits and Spectra.



The SI unit display remains blank until configured.

Adjusting the display

Use the keyboard 'Up' and 'Down' arrow keys to adjust the results display screens.

The display screen will be change as the Up and Down keys are pressed.

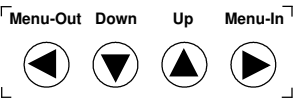
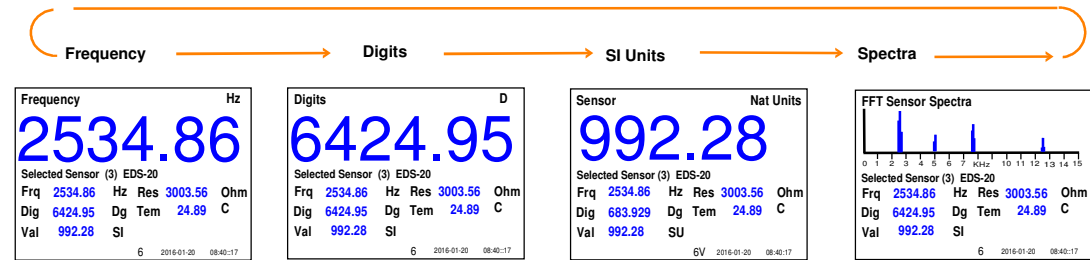


Fig-9



The results shown above are obtained using an Encardio-rite EDS-20 vibrating wire pressure sensors.

VW Sensor Installation

The VibWire-201-Pro supports full 4 wire sensor operations. The device measures frequency and temperature from any suitable vibrating wire sensor.

Connect a Vibrating Wire sensor to the 5 pin 'Sensor Input' port or directly to the spring return termination posts mounted at the bottom of the unit.

- 1. Connect the sensor coil to the 'Frequency Input' port.
- 2. Connect the sensor thermistor (temperature) sensor to the 'Temperature Input' port.
- 3. Use the **VW201cal.exe** software to define thermistor calibration factors.

Figures 7 and 8 show how to connect a vibrating wire sensor to the device.

Sensors connected to the spring loaded terminal posts

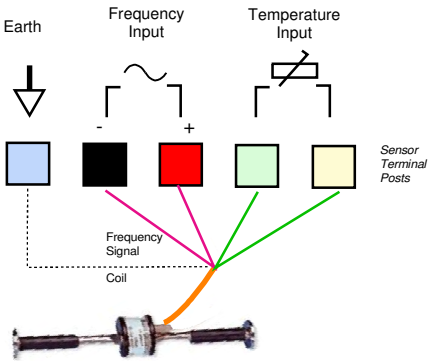


Fig-7

Sensors connected to the Sensor Port

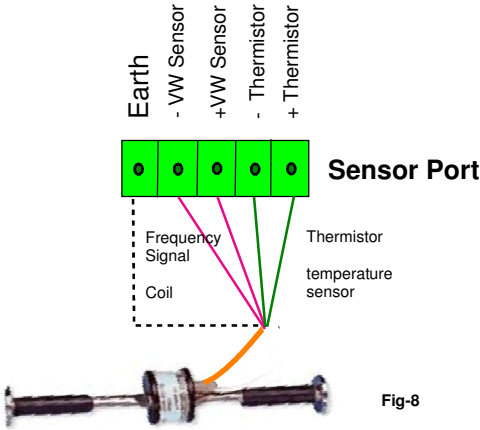
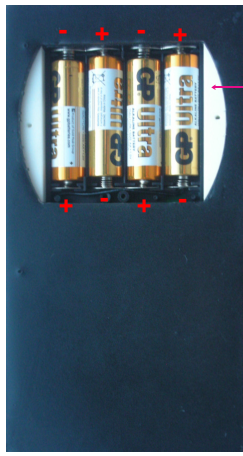


Fig-8



AA 1.5 V Cells

Fig-10

## Fitting Batteries

Only fit standard AA batteries in the VibWire-201-Pro.

1. Remove the battery cover from the rear of the device by simply unscrewing the securing bolts.
2. Replace the battery set in the layout shown in the image opposite.
3. Replace the battery cover and power on the unit.

The battery level indicator will show **6V** when a new set of batteries has been installed See Fig 11.

## Battery Life

When operating as a single channel device using a new set of batteries the VibWire-201-Pro will operate for approximately 40 Hours continuous use.

## MUX-16/32 Expansion Operations

The VibWire-201-Pro powers the MUX-16/32 expansion unit directly across the SDI-12 BUS and will reduce the battery life of the device if used without an external power supply.

## IMPORTANT NOTE

Remove the batteries from the VibWire-201-Pro should the device not be used for a long period of time.

## Low Battery Level Effects

Once the battery levels falls before 4.5 V then

1. Display may not update at the correct rate and appears to flicker.
2. Measurement values can be erratic.

Once the display falls below 4.5V then the '**Low Battery**' indicator flashes, see Figure 13 below. Should the unit continue to operate then the display may flicker. Fit a new set of batteries.

## Initial Start-up Screen

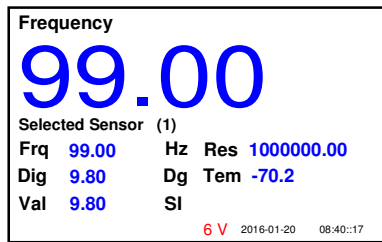


Fig-11

Battery level when a new set of batteries are installed into the unit.

## Setting the Real-time Clock

The real time clock in the VibWire-201-Pro is configured using the '**Set Time and Date**' menu. See Page FF section G.

The VibWire-201-Pro can be used as a stand-alone VW sensor data logger recording measurements automatically, and also to take single shot readings under '**User**' control.

Measurements are stored to the flash memory card.

See Page MM for details on selecting the 'Time and Date' menu.

### Real-Time Clock Menu System

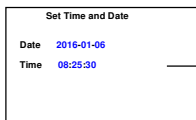


Fig-12

Example  
6<sup>th</sup> January 2016  
08:25 AM 30 Seconds

(Time/Date Format)

Date Year-Month-Day  
Time Hours:Minutes:Seconds

⚡ (Selected Item Indicator)

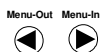
Use the Up and Down keys between '**Date**' and '**Time**' options.



Select Date or Time to be configured

Use the '**Menu-Out**' and '**Menu-In**' keys to move along the Date or Time fields.

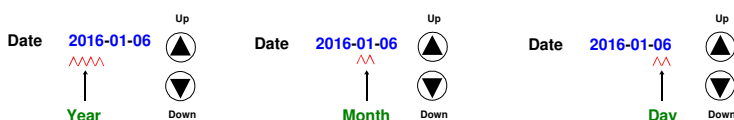
As the keys are pressed the ⚡ item indicator symbol will be displayed under chosen item.



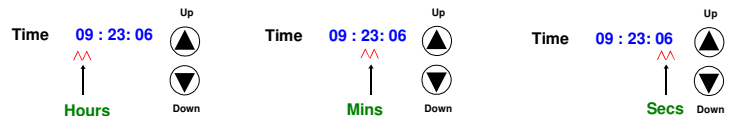
Once the parameter to adjust has been chosen then use the '**Up**' and '**Down**' buttons to make changes.

The '**Up**' and '**Down**' buttons will increment, or decrement a parameter by 1 unit after each action.

## Adjusting the Date



## Adjusting the Time



Move through each date and time parameter in turn making adjustments as necessary.

## Saving New Parameters

Once all parameters have been set, press the **Menu-Out** button until the default '**Frequency**' menu is displayed.

The new date and time values will be stored and the real-time clock settings updated to the different menus.

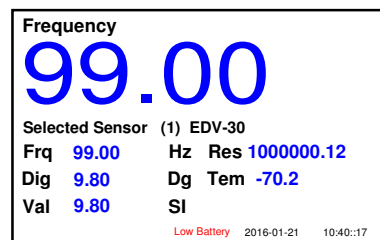


Fig-13

Low Battery Indicator

Date and time string will update with the new settings.

## Note

The **VW201cal.exe** Windows configuration software automatically sets the time and date used by the VibWire-201-Pro to the PC clock.

Real-time Results

Figures 14 below shows the default display that appears as soon as the device is powered on and with no sensor connected to an input port.

Upon connection of a sensor to the input port then the device automatically displays the frequency and temperature values.

With no sensor coil connected to the frequency input then the device defaults to 99.00 Hz.

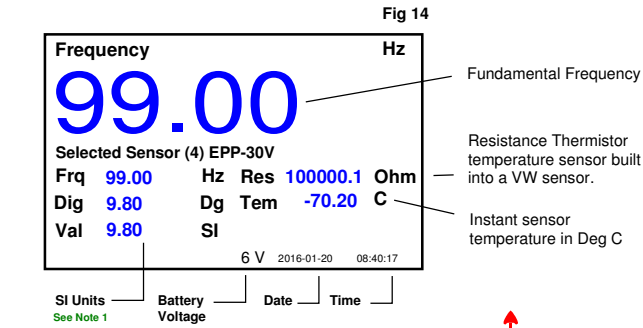
Important Note

Use the 'Up' and 'Down' arrow keys to switch between the different results screens.

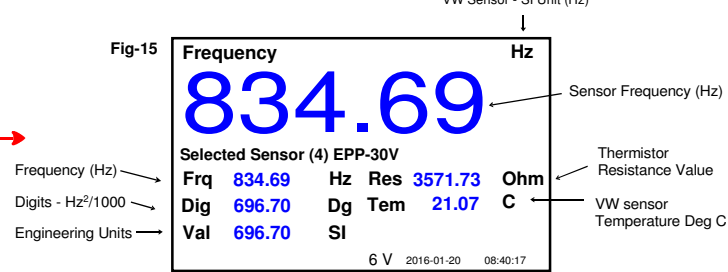
Up

Down

Initial Start-up Screen

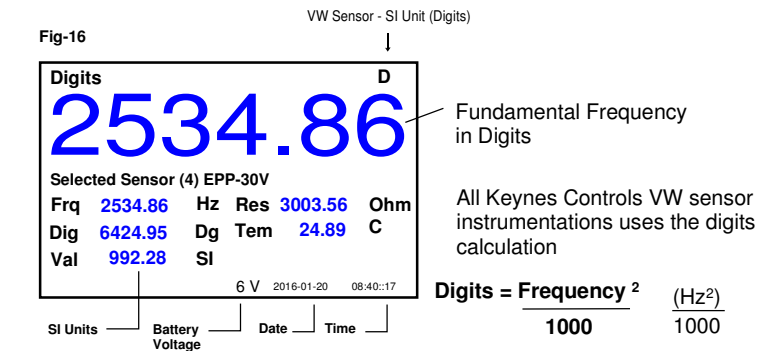


Frequency Results - Hz

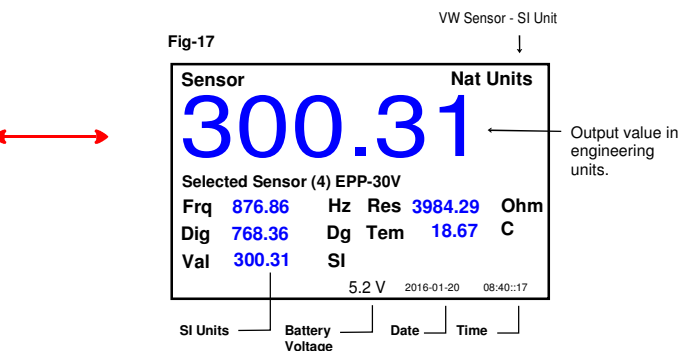


Once a vibrating sensor is connected to an input port the display will change similar to that shown above.

Frequency Results - Hz<sup>2</sup> (Digits)



Natural Units (SI)



The VibWire-201-Pro undertakes the spectral calculations on the incoming vibrating sensor signal and gives the results immediately.

Once the calibration factors have been set, and the process option set to '2' see Fig 24 on page 11.

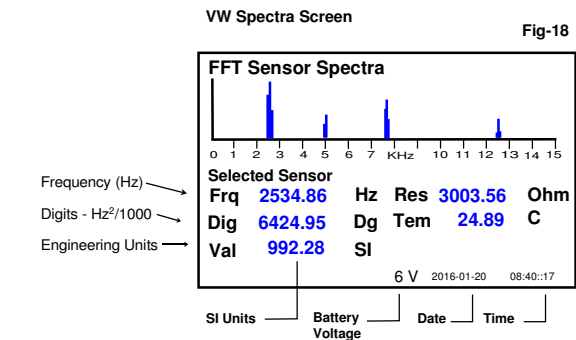
There are no 'User' configuration settings required to be assigned in order to undertake a spectral calculation.

The largest peak is taken as the fundamental operating frequency of the sensor. See Fig 19 opposite.

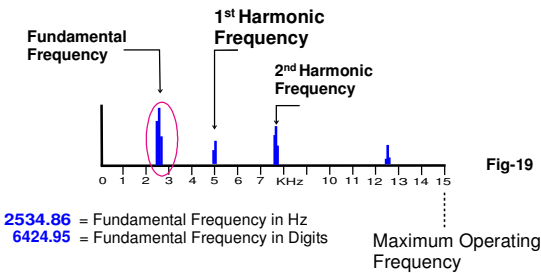
All Keynes Controls VW sensor instrumentations uses the digits calculation

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

Spectra (Hz)



FFT Sensor Spectra



Note. The example screens have been determined using a free standing Encardo-Rite EPP-30V pressure sensor



Selecting Remote Network Connections

The VibWire-201-Pro unit can connect to the SDI-12 and RS-485 networks for use in remote vibrating wire sensor measurements.

The SDI-12 and RS-485 ports enable the VibWire-201-Pro to transmit sensor data into third party data logger and acquisition systems.

Device Port Selection

To select the network port type for remote data acquisition operations on the VibWire-201-Pro, use the menu system to select either of the menu items shown below.

The device will then make measurements, and transmit data over the specified network port.

Page 30 shows the menu system built into the VibWire-201-Pro.

SDI-12 Port Operation



Fig-20

RS485 Port Operation

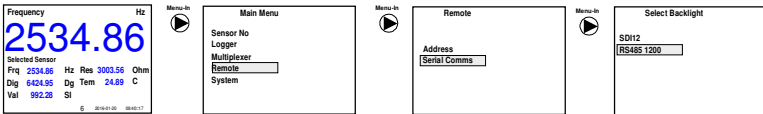
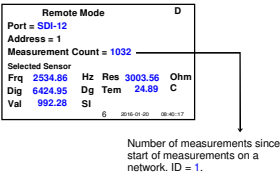


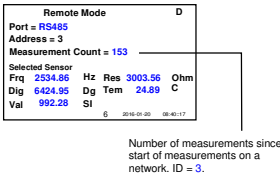
Fig-21

For single channel operation, once the output port is specified the sample data can be shown on the display.


SDI12 Remote Port



RS485 Remote Port



Storing the menu option

Once the selected menu option is highlighted simple press the  button to store the new option.

Repeat the operation until the '**Frequency**' display appears. See Figure 15 on page 8.

SDI-12 Network Connection

Figure 22 below shows how to connect the VibWire-201-Pro SDI-12 port to a USB-SDI12-Pro media converter. The USB-SDI12-Pro media converter connects to a Windows PC and allows measurements from VibWire-201-Pro to displayed directly into

RS-485 Network Connection

Figure 23 below shows how to connect the VibWire-201-Pro RS-485 port to a USB-485-Pro media converter. The USB-485-Pro media converter connects to a Windows PC and allows measurements from VibWire-201-Pro to displayed directly into the Q-LOG data display and recording software.

The VibWire-201-Pro acts like any other intelligent 485 device, and will operate with any other suitable device 3rd party device on the network.



Technical Specification

The current technical specification for the VibWire-201-Pro is:

Description	
Physical Size (Excluding boot cover)	Height 184 mm - Width 74 mm - Depth 32 mm
Weight	125 g
Battery	4 x AA - 2000 mA/Hr
Auto-logging no back light	6 mA - standby - 340 Hours continuous use
	20 mA/Hr with display - Low
	50 mA/Hr with display mode - Full brightness
	150 mA/Hr with MUX-16/32 - Peak (Note-1)
Communication Ports	1 x RS-485 Slave - 1200 Baud, 8 data, 1 stop, no parity
	1 x SDI-12 - - 1200 Baud, 8 data, 1 stop, no parity
	1 x micro USB configuration port
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
Operating Frequency	400 - 15 KHz
Measurement Resolution	0.001 Hz RMS - 20 to 70 Deg C
Measurement Accuracy	± 0.014% of reading - 20 to 70 Deg C
Spectral Analysis	1024 line Zoom FFT - with data weighting
Resolution	0.001 Hz
Window Function	Hamming
Update Rate	0.25 Sec typical
SI Units	Hz, Digits (Hz2/1000), Eng Units (Quadratic Cal Factors)
Temperature Measurements	
	Used for temperature compensated vibrating wire measurements, and stand-alone temperature sensors for Geotechnical applications. Ratio-metric measurement.
Analogue Input	24 Bit Sigma Delta
Measurement Range	- 50 to 100 Deg C
Measurement Accuracy	± 0.25 % of reading - 20 to 70 Deg C
SI Units	Deg C
Cal Factors	Steinhart-Hart
	Beta Value - lower performance using Beta
Bridge Type	Half Bridge
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	2 Sec/Chan - using expansion module
	250 ms update to screen
Memory Expansion	1 x SD Card = 1 .. 32 GB
Storage file format	CSV - Comma Separated Variables
Logging Rates	Internal to flash card
	1s, 10s, 1 Min, 10 Min, 1 Hour, 6 Hours
	MUX-16/32 Expansion
	30 Sec/Chan
	1 minutes
16 x 4 Wire Mode	10 user defined sensors options
32 x 2 Wire	DOS
No. Pre-set Sensor Configurations	
File Type Format	
Operating Temp Range	-20 to 75 Deg C
Storage temperature	>5 Deg C with batteries installed.

Note-1 - Use external supply for long term monitoring with MUX-16/32 unit 150 mA peak .

Table 1

Temperature Measurements

The VibWire-201-Pro is factory set to use the most common thermistor calibration factors that is fitted into most manufactures vibrating wire sensors. The thermistor is used to measure temperature.

The thermistor calibration factors are taken from the sensor material manufactures data sheet and are as accurate as possible.

The voltage input measurements are factory calibrated to traceable national standards, and can be externally calibrated upon request. There is an extra charge for operation.

Common VW Sensor Thermistor Part Numbers

YSI 44005	The part numbers are for 3 K Ohm thermistor commonly used by most different VW sensor manufacturers to measure temperature
Vishay 1C 3001 B3	
RS Part no: 151-215	The sensors give 3 K Ohm resistance at 25 Deg C
	The most common material used in these sensors uses material type F from GE sensing.

Under most practical applications, the in-built thermistor calibration factors will give accurate results without the User having to be concerned with understanding of process involved.

Simply connect the thermistor output from the sensor to the VibWire-201-Pro and the device will instantly display the temperature.

Sources of Error

The principle source of error in field measurements will be the added resistance due to long sensor wires. The resistance added to the thermistor measurement will give a fixed offset error. Make temperature measurements as close to the temperature sensor as is practically possible.

Calibration Factor Error

Take care when using the calibration factors supplied on a vibrating wire sensor manufactures data sheet. The factors are often given from sample sensors taken from a batch and not necessarily from the individual sensor being used. Where possible ensure that the sensor manufacturer calibrates the sensor and supplies all test data so that the calibration factors can be verified.

User Defined Stein-hart-Hart Calibration Factors

The VibWire-201-Pro has the facility to enter User defined Steinhart-Hart calibration factors.

The calibration factors are entered into the device using the VW201cal software package. See figure 57 on Page 20.

Sensor Information

A calibration report should be provided with each vibrating wire sensor and it will contain all the information required to convert Hertz, the frequency value output by the sensor into appropriate SI units (e.g., displacement, pressure etc..)

1. If the values in the Calibration Report are in digits, use the following equation to convert the VibWire-201-Pro frequency values from Hertz to digits.

Digits = Frequency <sup>2</sup> / 1000 (Hz<sup>2</sup>) / 1000

2. Use the gauge factors and polynomial provided in the Calibration Report to calculate SI units.

The VibWire-201-Pro uses:

Natural Units = A(R1)2 + B(R1) + C + K(T1-T0) - (S1-S0) (Equ 1)

Calibration equation.

and this is expanded to:

= C(R1-R0)2 + B(R1-R0) + A + K(T1-T0) - (S1-S0) (Equ 2)

when initial conditions in the measurements are involved.

The additional terms used in equation 2 only change the constant parameter ( A ) when used.

Associated Part Numbers

Part No:

- VibWire-201-Pro - FFT VW Sensor Interface
- USB-485-Pro - Isolated USB to 485 media converter
- USB-SDI12-Pro - Isolated USB to SDI12 media converter
- MUX-16/32 16 x 4 Wire/ 32 x 2 Wire Expansion unit

Device Configuration Software

The VibWire-101-Pro configuration software runs with on most modern Windows platforms such as XP, 8.1 and 10 operating systems.

The software automatically identifies the USB port in use and allows for a true plug and play operation. Simply enter the sensor calibration factors and select the 'Connect' button to store parameters into the device.

Download the software at:

Pre-set Sensor Configurations

The VibWire-201-Pro cab be configured using the **VW201cal.exe** software which is available as a free download at:  
<http://www.aquabat.net/downloads/VW201cal.zip>

Features

The VW201cal software gives the User the ability to configure the VibWire-201-Pro in an easy to use Windows environment.

- Automatically sets time and date to host PC.
- Set the User defined frequency and temperature calibration factors.
- Select preset thermistor calibration factors.
- 20 Pre-set sensor configuration options.

The sensor names entered into the VW201cal software appear on the VibWire-201-Pro sensor list.

The VibWire-101-Pro supports up to 20 built-in User defined vibrating wire sensor configuration options.

Sensor Configuration

$$SI\ Unit = A + B(R1) + C(R1)^2 + D(T)$$
  
where R1 = Current Reading  
T = Temp Deg C  
D = Thermal Factor

Process Option  
0 = Frequency, 1 = Digits, 2 = SI Units

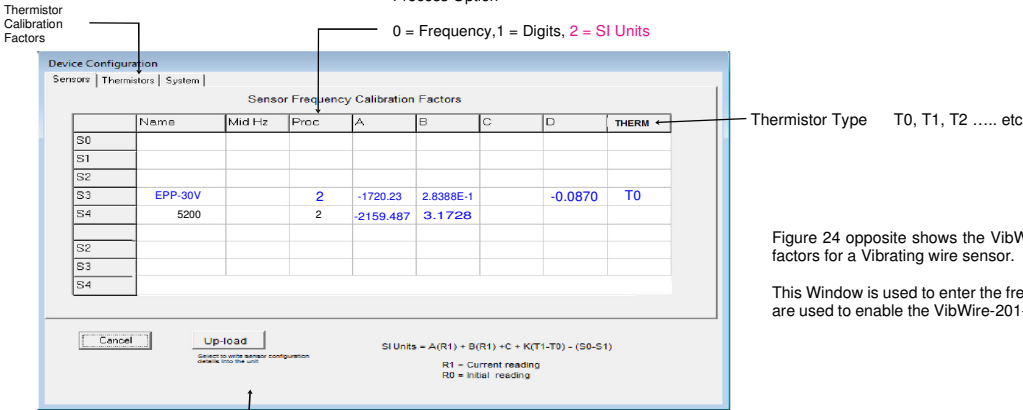


Figure 24 opposite shows the VibWire-201-pro Setup software used for entering the calibration factors for a Vibrating wire sensor.

This Window is used to enter the frequency component calibration factors. The calibration factors are used to enable the VibWire-201-Pro to display measurements directly in engineering SI units.

Write configuration details into the device.

Fig 24

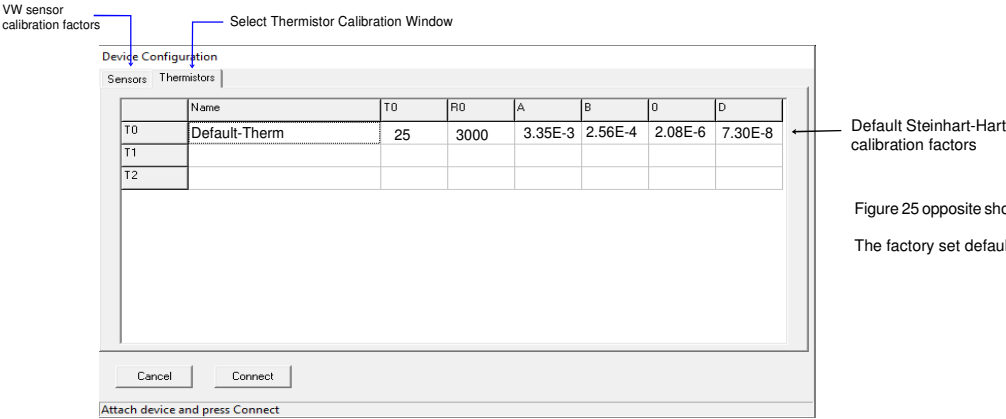


Figure 25 opposite shows the thermistor calibration settings window for the **VW201cal** software.

The factory set default thermistor parameters for T0 are displayed.

Fig 25 Default Thermistor Calibration Factors

Downloading and Installing device setup software

1. Download the VW201cal software from:  
<http://www.aquabat.net/downloads/VW201cal.zip>

Run the install software script.

Follow the on-line instructions to install and activate the software.

Once activated the main Window shown in Fig 24 above will be displayed.

Automatically setting the Real-time Clock

The VibWire-201-Pro can be used as a stand-alone VW sensor data logger recording measurements automatically, and also to take single shot readings under 'User' control. In order to act as a logger the internal real-time clock has to be set.

The real-time clock is used to keep track of the time and date of a measurement. The clock is set automatically the VibWire-201-Pro is connected to the PC via the USB cable and the 'Upload' button is activated. Once the sensor data is written into the device then the clock is automatically synced to the host PC.

SI Units

In order for the SI unit formulae be applied the process option has to be set to '2'. Fig 24 above shows how this is done.

Setting the process option to 0 or 1 shows results in Hz or Digits.

Common VW Sensor Thermistor Part Numbers

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

The sensors give 3 K Ohm resistance at 25 Deg C

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

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

Pre-defined Thermistor Calibration Parameters

The VibWire-201-Pro uses the following predefined calibration parameters to defining the operation of the 3 K Ohm thermistor temperature sensors built into most Vibrating Wire sensors.

(Steinhart-Hart Factors)

$$A = 3.35E-3, B = 2.56E-4, C = 2.08E-6, D = 7.30E-8$$

Channel Expansion Options

The VibWire-201-Pro is expanded using a single MUX-16/32 expansion unit.

The expansion unit offers 16 x 4 wire or 32 x 2 wire sensor operations.

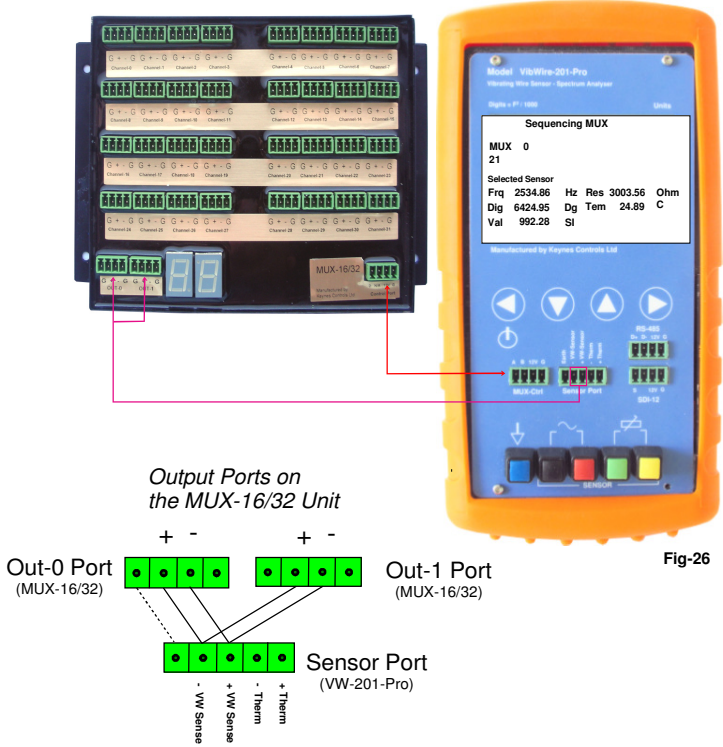
16 x 4 wire mode offers 16 x Frequency and 16 x Temperature inputs.

The 32 x 2 Wire sensor mode offers 32 x Frequency inputs or 32 x temperature measurements.

The VibWire-201-Pro can record data internally onto a SD memory card, or remotely across a digital network to a stand-alone PC running the Keynes Controls Q-LOG applications software.

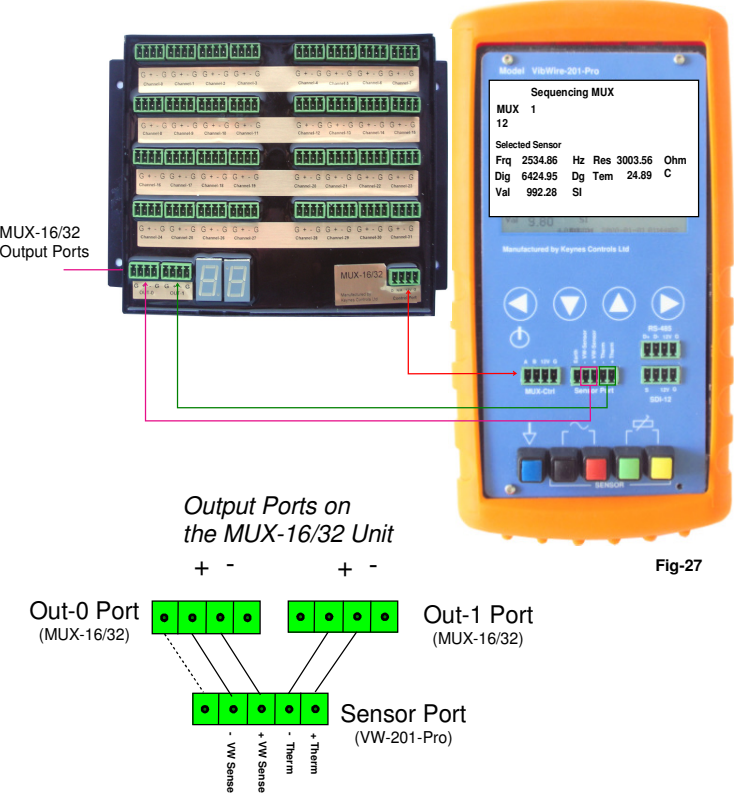
32 x 2 Wire Expansion

Unit shown below is configured for 32 x 2 wire frequency measurements.

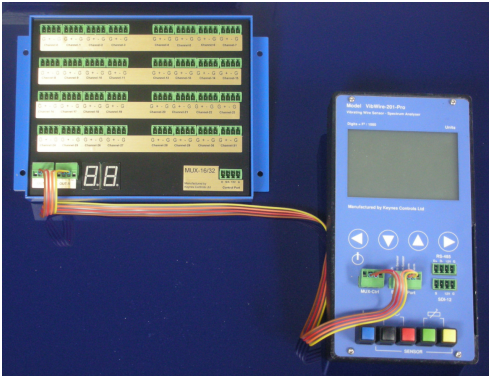


16 x 4 Wire Expansion

4 Wire operations records frequency and temperature simultaneously.



2 Wire operations records frequency or temperature but not both at the same time.



MUX-16/32 Expansion Unit - User manual

For 32 x 2 wire operations the output ports on the MUX-16/32 expansion unit are connected together.

Full details for configuring and the MUX-16/32 unit can be seen in the User manual.

Download the User manual at

<http://www.aquabat.net/downloads/mux32manualv1.pdf>

Number of Channels

The VibWire-201-Pro data supports 4 data recording modes:

**Single Channel** - Records measurements from the sensor attached directly to the instrument.

The following modes require the MUX-1632 expansion unit to be fitted:

MUX-16/32 Expansion Unit

- 16 x 4 Wire (VW and Temp) - 16 x Freq + 16 x Temp
- 32 x 2 (VW only) - 32 x Freq
- 32 x 2 (Freq) - 32 x Temp

when using the MUX-16/32 expansion unit 32 measurement values are stored into each record.

To select the data recording mode

1. Make sure a flash memory card is installed into the VibWire-201-Pro, See Page 5 Figure 2.
  2. Starting at the default 'Frequency' display, use the 'Menu In' key to select 'System Setup' followed by 'Mux Mode' menu options.
- The **Mux Mode** menu system will appear.
3. Use the 'Up' and 'Down' keys to select the mode of operation of the instrument.

Setting Scan Mode

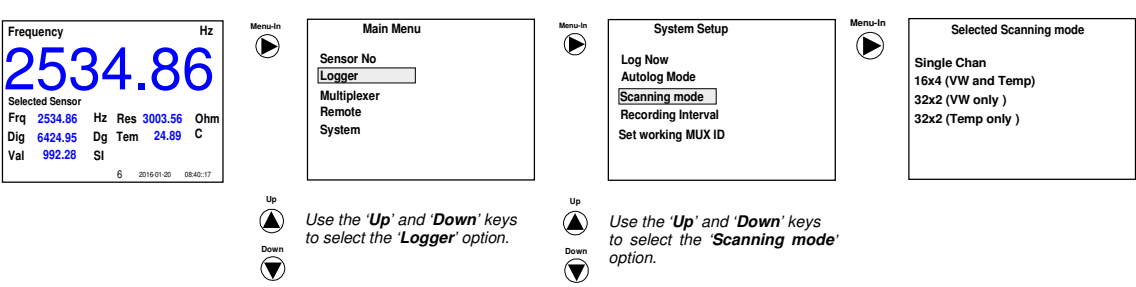


Fig-28

Menu system defines the number of measurements made after each scan. The MUX-1632 expansion unit must fitted for 16x 4 wire or 32 x 2 wire operations.

Data Recording

The VibWire-201-Pro can store measurements directly on to a SD flash memory card.

Max SD Card = 32 Gb (160 million records)

DOS format file system.

The data table stores results in C.S.V. (Comma separated variable), for direct importing into spreadsheet such as Microsoft Excel.

Data Recording Options

The VibWire-201-Pro supports 3 x logging modes. Single Channel, 16 x 4 Wire and 32 x 2 Wire.

**Single Channel** - Continually records a single measurement from a sensor connected to the sensor port on the device.

1 x single measurement on demand.  
Single Channel on MUX-16/32 Unit.

Both the 16 x 4 Wire and 32 x 2 wire recording modes require the use of the MUX-16/32 expansion unit.

- 16 x 4 Wire - 32 measurement values made up of 16 x Frequency + 16 x temperature.
- 32 x 2 Wire - 32 x Frequency measurements.

Important Note

The VibWire-2-1-Pro will adjust automatically to the fastest sample rate allowed for the number of channels to be scanned.

The fastest sample rate that is allowed for a 32 channel operation operation is 60 seconds (1 min).

Set Logging Interval

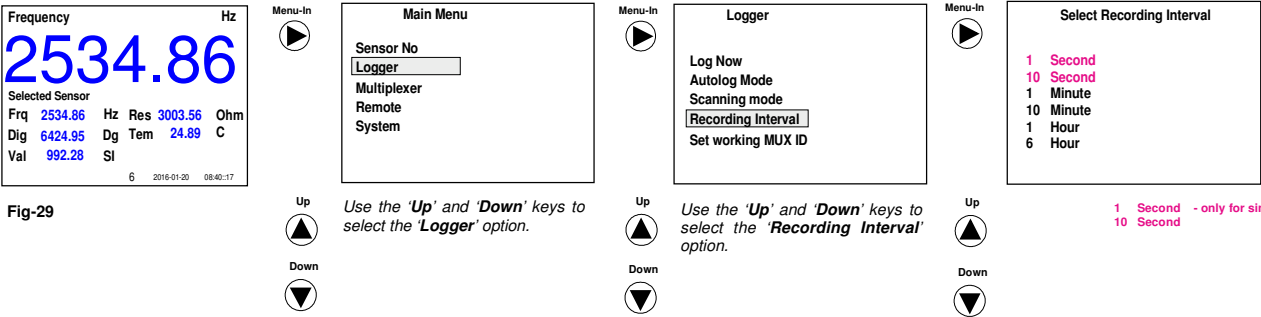


Fig-29



## 17 Commands for scanning MUX-16/32 in 32 x 2 wire mode

Table 2 below shows the commands used to scan the MUX-16/32 unit in 32 x 2 wire mode.

The MUX-16/32 unit has to be set to operate in 32 x 2 Wire mode. This is done via the VibWire-101 setup menu. See page 17, section 25.2 for instruction in setting the 'Scan Mode'.

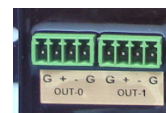
In 32 x 2 wire mode the channel counter displays the range 0 .. 31.



Start Measurement Command	Description	Channel Number	No. Data Values	SDI-12 Get Data Command
<b>aM2!</b>	MUX ID=0 Chan 0..15	Chan 0 .. 15	Returns 16 values x Freq	aD0! aD1! aD2! aD3!
<b>aM3!</b>	MUX ID=0 Chan 16..31	Chan 16 .. 31	Returns 16 values x Freq	aD0! aD1! aD2! aD3!

Each get data command returns 4 values.

Table 2



Chan 0..15 Freq

Chan 16..31 Freq

Fig 31 - Output Ports used in 2 Wire mode.

When operating in 2 wire mode, the VibWire-101 scans the MUX-16/32 in blocks of 16 channels.

Under normal operating conditions Channels 0-15 are scanned first and the results stored into a data table. This is followed by the scanning the final block of 16 channels and storing the measurements. Table 1 shows the sequence of the 2 blocks of commands needed to scan the MUX-16/32 unit in 2 wire mode.

## 16 Switching between 2 & 4 Wire Mode Operation under SDI-12 Command

The MUX-16/32 expansion unit supports 2 and 4 wire VW sensor operations. The selection between 2 and 4 wire sensors is undertaken using software commands only and these are issued across the MUX-16/32 using the SDI-12 control port. The same procedure for issuing instructions for changing the ID number is followed as is used for selection the mode of operation.

The following SDI-12 command selects 2 or 4 wire sensor operation:



aXDn! (n=0 or 1) Sets 2 or 4 wire operations on the MUX-16/32.

Example SDI-12 command **'0XD1!'** sets MUX-342 with ID=0 to 4 Wire mode.

## 18 Commands for scanning MUX-16/32 in 16 x 4 wire mode

Table 2 below shows the commands used to scan the MUX-16/32 unit in 16 x 4 wire mode.

The MUX-16/32 unit has to be set to operate in 16 x 4 Wire mode. This is done via the VibWire-101 setup menu. See page 17, section 25.2 of the User Manual for instructions in setting the 'Scan Mode'.

In 16 x 4 wire mode the channel counter displays the range 0 .. 15.

Start Measurement Command	MUX Identification	Channel Number	No. Data Values	SDI-12 Get Data Command
<b>aM2!</b>	MUX-0 Chan 0..15	Chan 0 ..15	returns 32 values 16 x Freq + 16 x Temp	aD0! aD1! aD2! aD3! aD4! aD5! aD6! aD7!

Table 3



To VW frequency port on the VW101

To temperature port on the VW101

After each MUX has been scanned, and all 32 sensor readings have been taken, then the following command is required to download the data from the VibWire-101 to a data table in the AquaLOG data logger. The same command should work on any suitable SDI-12 data logger.

Get data:     aD0! aD1! aD2! aD3!     aD4! aD5! aD6! aD7!

                 16 x Freq Readings                      16 x Temperature Readings

where each command aD0! returns 4 values

## IMPORTANT NOTE

The MUX-16/32 expansion unit is used to expand the VibWire-201-Pro for additional channel.

Full details for sensor connection and operation can be found in the User manual at:

<http://www.aquabat.net/downloads/mux32manualv1.pdf>

The MUX-16/32 unit operating mode, 16x4 wire or 32x2 wire is assigned using the Q-LOG software via the in-built SDI-12 Control Port.

## Frequently Asked Questions

### 1. What cable is used to connect the VibWire-201-Pro to a data logger.

A single 4 core ribbon cable is all that is required for the most common SDI-12 and RS-485. No special cabling is required for this instrument.

Figure 61 on page 21 shows the connections to a logger

Farnell Web Site: <http://www.farnell.co.uk>

Farnell Part No. **150427**  
Manufactures Part No. **05091504-01-50M.**

The maximum cable core diameter is 2 mm for the sensor terminated with a plug for connection to standard sensor input.

The sensor terminal posts can take larger diameter cables.

### 2. What might cause an VibWire-201-Pro to not communicate with a data logger?

There is no programming required for setting up and using the VibWire-201-Pro.

The most common cause for lack of communication is faulty wiring. Check that the cable cores are correctly terminated by into the plugs. Use a DVM to test each core and pin on the plugs for continuity.

Make sure the correct network port is selected.

For SDI-12 communications see menu system in Figure 21 on Page 9,.

For RS-485 option - see menu system on Figure 22 on page 9.

### Network ID number

Make sure the ID number used to identify the VibWire-201-Pro on a network is set correctly. See menu system on page 29 section 'Setting network address', or by the standard SDI-12 commands on page 20. A full list of User commands is shown on page 19.

The ID number for the measurement command used to acquire data from the VibWire-201-Pro must match the ID number set in the device.

Logger using command: **3M!** **3D0!** - then the ID number should be set to '3'.

Remote Mode		D	
Port =	SDI12		
Address =	3		
Measurement count = 4312			
Selected Sensor			
Frq	2534.86	Hz	Res 3003.56 Ohm
Dig	6424.95	Dg	Tem 24.89 C
Val	992.28	SI	
6		2016-01-20	08:40:17

Page 30 shows the menu options to set the ID number.

## IMPORTANT NOTE

When multiple devices are being used on the same network, each device must have a unique ID number assigned. Failure to do so will prevent the VibWire-201-Pro from communicating to a logger unit.

### How fast can the VibWire-201-Pro make a measurement?

Currently the fastest data recording rate is 1 measurement / Second for a single channel.

The fastest sample rate is supported on the SDI-12 and 485 network measurements using the Q-LOG free data acquisition and display software, and to the in-built data recording to the flash memory card.

### Where Can I download a copy of Q-LOG software ?.

Download a copy of the Q-LOG software at:  
<http://www.aquabat.net/QLOGFree/qlogv2.html>

### Erratic Measurements - most common cause.

When the battery level goes below 3.9 Volts the measurements can be come noisy and erratic. Replace the batteries in the unit for a new set, or connect an external power supply. Faulty sensor coil seating which can be seen in the sensor results spectra.

### How do make measurements on my PC without any programming experience.

Use the free Keynes Controls Q-LOG software which can downloaded without restriction from the companies web site, and one of the USB-SDI12-Pro or USB-485-Pro media converters. The Q-LOG Windows software can be configured

The Q-LOG software gives complete control of the data acquisition operations for the VibWire-201-Pro in a simple to use Windows environment. See page 18 for additional information.

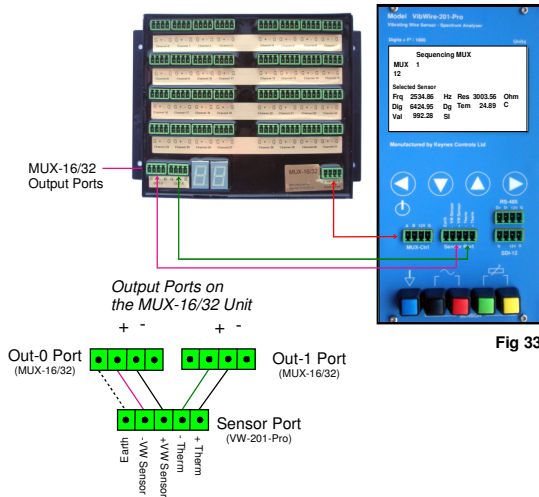
The USB-SDI12-Pro and USB-485-Pro media converters can both be power the VibWire-201-Pro direct from a PC USB port. No additional power supply is required.

Install the software - Assign USB COM Port details - Scan Network ( Identify Instruments ) - Start Data Acquisition.

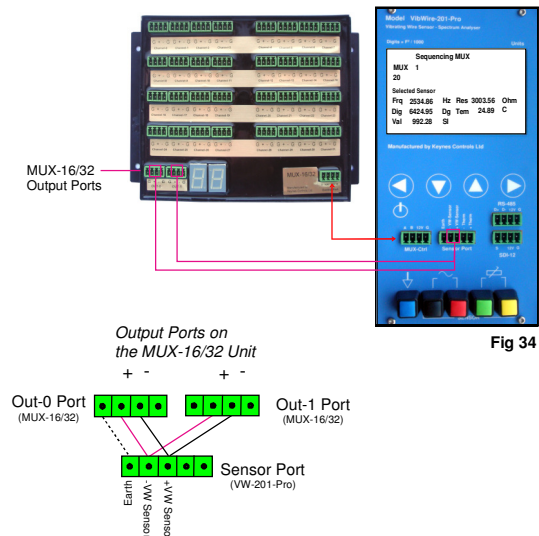
The Log files are stored to C:\Q-LOG\Logfiles\'Timestamp-file'.TXT in a format suitable for reading by a spread sheet package,

'Timestamp-file.TXT' is a unique log file in CSV ( Comma Separated variable).

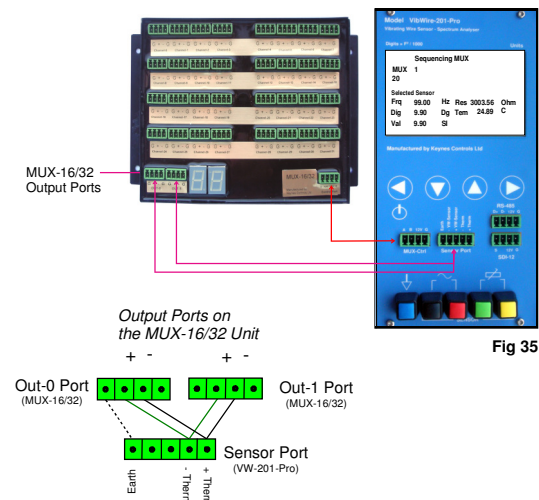
### 16 x 4 Wire Expansion



### 32 x 2 Wire Expansion - Frequency Measurements



### 32 x 2 Wire Expansion - Temperature Measurements



Selecting a MUX-16/32 Channel

The VibWire-201-Pro can be used to manually select a channel on the MUX-16/32 expansion unit and take readings.

The feature enables the user to test sensors during an installation, or to use the MUX-16/32 expansion unit as a switch box. The channel selection works in 16 x 4 wire and 32 x 2 wire modes.

MUX-16/32 Settings for operation with VibWire-201-Pro

The MUX-16/32 must be set to ID = 0

The setting of the MUX-16/32 ID number is easiest set using a USB-SDI12-Pro media converter and Q-LOG software. See Page H Appendix A for details.

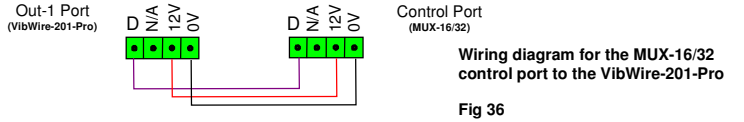


Fig 36

- 1. Connect the MUX-Ctrl port on the VibWire-201-Pro to the Control port on the MUX-16/32 expansion unit.

Figures 33 to 35, page 15 above show the wiring diagram for the MUX control ports.

MUX-16/32 User Manual

Full details for the operation and configuration of the expansion unit can be found at:

<http://www.aquabat.net/downloads/mux32manualv1.pdf>

Signal and Control Ports

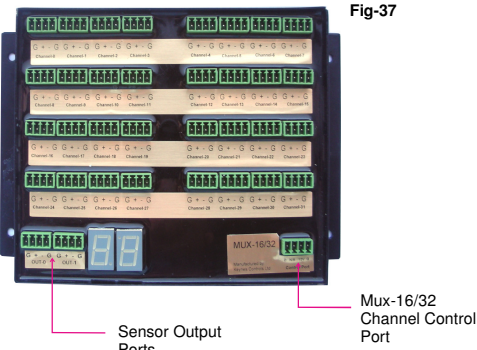


Fig-37

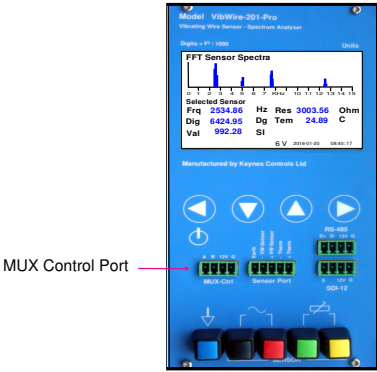
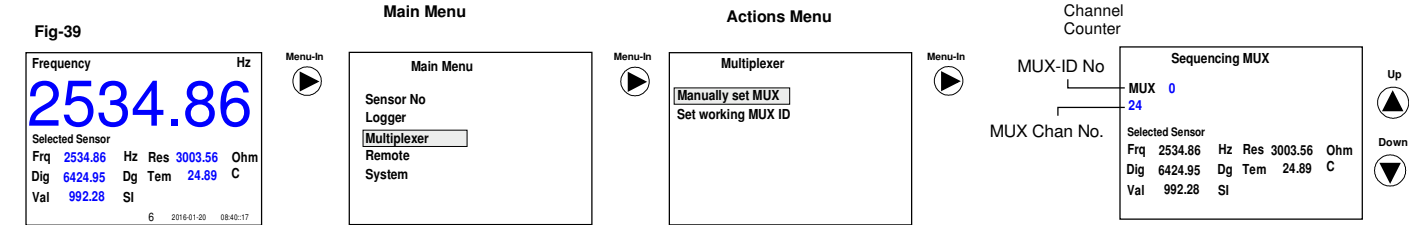


Fig-38

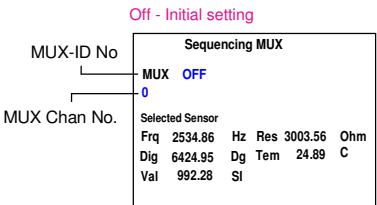
Manually setting the MUX-16/32 Channel

Manually set the MUX-16/32 channel number. The channel range will depend on the scan mode assigned. The MUX Chan number indicator will change as the 'Up' and 'Down' keys are pressed.



- MUX 0 .. 15 4 Wire Mode - MUX-16/32 Channel counter changes between 0 ..15
- 0 .. 31 2 Wire Mode - MUX-16/32 Channel counter changes between 0 ..31

Use the 'Up' and 'Down' buttons to change the MUX channel. The channel counter on the MUX-16/32 will update automatically.



The image above shows the Initial Startup display should the MUX channel selection be activated without a MUX-16/32 expansion unit connected.

Off - Initial Position 0 - 15 (4 Wire) and 0 - 31 (2 Wire)

Channel Select Display

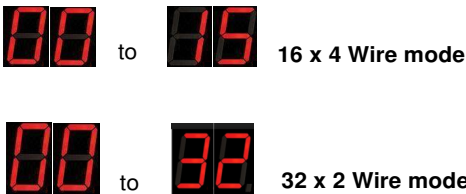


Fig-40

The menu system above shows the commands to follow to manually adjust the active MUX channel.

Changing the MUX Channel Number

Use the 'Up' and 'Down' keys to manually select the MUX-16/32 channel. As the keys are pressed the MUX-16/32 channel will increment.

The Channel counter on the menu system will increment/decrement at the same time as the MUX-16/32 unit.

Sensor Configuration Example - Piezometer

The following example shows how to configure the VibWire-201-Pro to use an Encardio-rite vibrating wire piezometer water level sensor. The piezometer is configured in a similar way as to a strain gauge but has the added complication for requiring barometric correction for true water level measurements.

The example will use the linear formula to convert frequency to pressure into SI units of k Pa. (Kilo Pascal )

A copy of a sample calibration data sheet used in this example is shown in **Appendix-A**.

The example demonstrates how to allow for initial conditions to improve the accuracy of the measurements.

Temperature Compensated Calibration Factors - Results in Natural (SI) Units

The example below demonstrates how to use the calibration factors on a sensor data sheet, and local initial conditions to determine the factors to be used by the VibWire-201-Pro to give results in SI Units. The example sensor data sheet, see Appendix-B page 32 gives results in kPa. Use suitable scaling factors to convert the output into other SI Units. The formula section of Q-LOG can be used to convert pressure into other SI Units.

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

where G = Linear gauge factor from the calibration data sheet.

$$= C(R1-R0)^2 + B(R1-R0) + A + K(T1-T0) - (S1-S0)$$

where A B and C are the calibration factors used in the VW201pro software.

— Sensor formula for conversion frequency (in Digits) to kPa

— Formula used by VW201pro software for configuration

For this example there is no C(R1-R0)<sup>2</sup> and there is no barometer to correct for local barometric conditions.  
Therefore the absolute water level measurements in kPa formula is now:

P(kPa) = B(R1-R0) + K(T1-T0) - temperature corrected absolute level readings

The initial condition measurements from the sensor are: **6064.0 Digits at 14 Deg C**.  
Different initial conditions will change final offset value only.

G = 2.8388E-1 - See Cal Data sheet

$$P(kPa) = G(R1-6064) + K(T1-14)$$
$$= 2.8388E-1*(R1-6064) - 0.087*(T1-14)$$
$$= (2.8388E-1*R1)-1721.448 - (0.087*T1)-1.218$$
$$= (2.8388E-1.R1) - (0.087.T1) -1720.23$$

This formula gives the output from the sensor in k Pa and allows for local temperature correction.

Examining the formula now gives the parameters required for the VW201Cal software

A = -1720.23      B = 2.8388E-1      D = -0.0870

**Important Information**

Use the Barom-SDI12 or Barom-485 digital barometer modules to give local barometric levels in kPa for local atmospheric effects.

- where R0 = Initial reading in Digits  
T0 = Initial sensor temperature Deg C
- R1 = Current Frequency reading in Digits  
T1 = Current temperature reading in Deg C
- S1 = Current barometer value - SI Unit KPa  
S0 = Initial Barometer reading - SI Unit KPa

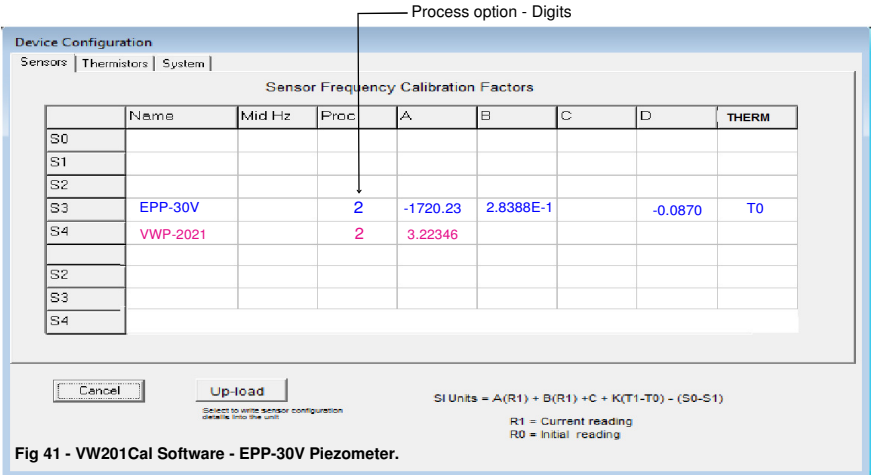


Figure 41 shows how the VW201cal software is configured for a Encardio-rite EPP-30V piezometer as sensor 3.

The output SI unit value will be in units kPa.  
The output will be temperature compensated.

**Process Option setting**  
In order for the VW201-Pro to use the calibration factors in the software then the process option has to be set to **2**.

**Thermistor Type**  
Enter thermistor type into cell labelled **'THERM'**.  
Results in Deg C.

**Pre-set Sensor Configuration Settings**  
Once the calibration factors have been determined and set into the **VW201cal** software, then they will be automatically loaded into the VibWire-201-Pro. This is done by simply connecting the device to the host PC and pressing the **'Connect'** Button.

All defines sensor types will be loaded into the device and can be selected using the menu system. See Figure 44 opposite.

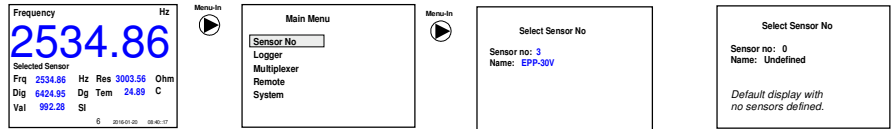


Fig 43

Use the 'Up' and 'Down' keys to select the sensor type.  
The assigned sensor calibration factors will then be used by the VibWire-201-Pro to determine the SI units for any sensor that is attached.

Simplified Calibration Factors

As shown above the temperature effects on the sensor are not significant and for most applications can be ignored.

If the initial conditions are: **6064.0 Digits**

then the simplified formula becomes much easier to use

kPa = G (R1-6064) gain from the calibration data sheet G = 2.8388E-1 therefore kPa = 2.8388E-1(R1 - 6064) where R1=current reading  
= 2.8388E-1 - 1721.44

The output on the VibWire-201-Pro will now be the height of the water above the initial condition starting point in SI units kPa.

This gives the calibration factors for the VW201cal software as A = -1721.44 and B = 2.8388E-1.



Q-Log - Quick User Guide

The VibWire-201-Pro is integrated into the Q-LOG data acquisition software.

The VibWire-201-Pro can be used with both the SDI-12 and RS-485 ports in the Q-LOG software.

A copy of the Q-LOG software can be downloaded at:

<http://www.aquabat.net/QLOGFree/qlogv2.html>

A copy of the User manual can be downloaded at:

<http://www.aquabat.net/downloads/Q-log-guidev2.pdf>

Factory Default Settings

The VibWire-201-Pro has the following default settings

ID = 0      Single Channel Operation for both SDI-12 and RS-485 networks

Sample Rate Options

The sample rate options for single channel operation is:

1s , 10s, 30s,1 min, 10 min, 1 hour, 6 Hours.

Maximum sample rate = 1 Hz.

Example

The example below assumes that the Q-LOG software has been installed and that a USB-12-Pro media converter is in use. 3rd party SDI-12 media converters will work with the Q-Log software but Keynes Controls do not support them.

USB-SDI12-Pro media converter using COMM Port 1 on the operating system.

The Q-LOG software can be used by third party media converters but they are not supported by Keynes Controls Ltd.

Logging Configuration Window

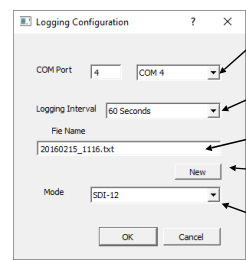


Fig-46

Enter Comm Port identified for USB media converter  
Example shows **COMM Port-1**. Use device manager to locate port no.

Data Recording Sample Rate - **60 Secs**

Log Filename - **20160215\_1116.txt** (time stamped file)

Automatically create a new time stamped log file.  
- Unique file each time selected.

Network Type Selection - **SDI-12**  
Options for **SDI-12** and **RS485** networks

Before data can be obtained from a device on the SDI-2 network it first has to be identified.

The procedure for identifying sensors and interfaces on a network is called 'Scanning for Devices'. Figure 48 below shows how to Scan for devices.

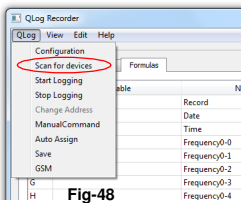


Fig-48

Scanning for Devices

Select the 'Scan for devices'.

The Status LED indicators on the USB-SDI12-Pro media converter illuminate during the scanning operations.

For a single device connected to a SDI-12 network then the device list will appear as shown below.

Any addition sensors on the SDI-12 network require a separate and unique ID number, and will appear in the list below.

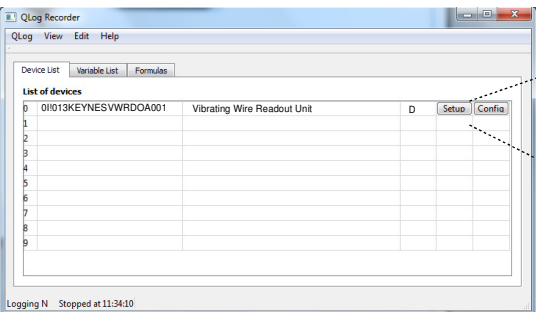


Fig-49

Figure 44 opposite shows how to connect a VibWire-201-Pro to the SDI-12 network using the USB-SDI12-Pro media converter.

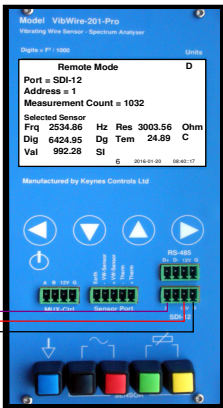
Important Note

Ensure that the COMM port number for the USB media converter and network type have been set in the 'Configuration' Window of Q-LOG.

Failure to do so will prevent the software from identifying the VibWire-201 device.



Fig-44



VibWire-201-Pro

Image below shows how the VibWire-201-pro is connected to the USB-SDI12-Pro media converter.

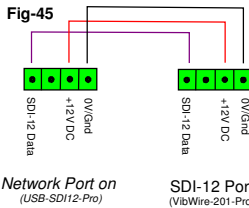


Fig-45

External Power Supply

For stand-alone operations, or when multiple VibWire-201-Pro are connected onto the network, then an external power supply should be connected to external power supply port on the USB-SDI12-Pro.

The USB-SDI12-Pro can power 2 units directly from the USB port of a PC,

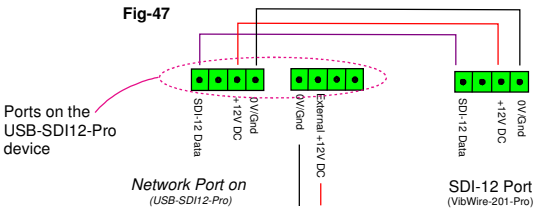


Fig-47

Common Keynes Controls device identifier strings.

Product:	ID string:
VibWire-101 VW sensor interface	13KEYNESCOVW101A011
VibWire-108 VW sensor interface	13KEYNESCOVW108A016
PIEZO-RM water level sensor	13KEYNESCOPIESR001
Barom-SDI-12 barometer	13KEYNESCOBAROMR003
I-P-I	13KEYNESCOIPINCL005
AquaDAT sensor interface	13KEYNESCOAQUADAT008
Single channel strain gage	13KEYNESCOSTRAIN027
VibWire-201-Pro	13KEYNESVWRDOA001

PC Data Acquisition - Start data recording

Select the 'Start Logging' menu option and measurements will be made and data stored to the results file. See Fig QQ below.

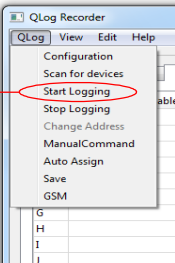
If a USB-SDI12-Pro or USB-485-Pro media converter is being used then the device status LED indicators will flash after each measurement.

Q-LOG will run with 3rd party media converters but Keynes Controls do not support devices we don't manufacture.

Note.

When multiple devices and interfaces are on the same network then select 'Auto Assign' to set cell locations into the data table. The Auto assign option will make sure the results from different devices wont overlap.

Fig-50



Start Data Logging menu option

Start Data Acquisition

High speed single channel data acquisition readings for a single channel vibrating wire sensor can be made.



SDI-12 / RS-485 Supported Commands

The following commands are supported by the VibWire-201-Pro and are used by data loggers and data acquisition systems. The commands have been included to allow the VibWire-201-Pro to operate easily with third party data loggers that support industry standard SDI-12 command set.

Prefix the commands in Table 3 below with the ‘%’ for use in RS-485 data logger and acquisition systems.

Example, the command ‘a!’ becomes ‘%a!’. – access the device identifier string.

Description	Master	VibWire-201 Response
Acknowledge active	a!	a\r\n
Send ID:  provided to complement SDI-12 protocol	a!!	a13KEYNESVWRDOA001\r\n
Address Query  identifies instrument address and commonly used on single instrument operations only.	?!	a\r\n
Change Address:  used to change instrument address from a (inital) to b new ID for network operations	Used to make command set SDI-12 compatible  aAb!  a = initial address b = new address	Where a = ID number 0 - 9 (standard) / (a..z) Enhanced SDI-12 0 - 9 / a - z for RS485  b\r\n
Start Measurement  instruct an instrument to make measurement	aM!  a = address of instrument example 0M! starts scan for ID 0	a0261\r\n ****
Concurrent measurement:  Used for starting a measurement for all instruments on a network at the same time.  This command frees RS-485 bus for other devices	aC!  start measurement instrument address ‘a’	a0268\r\n
MUX-16/342 Expansion Unit	32 x 2 Wire Measurements aM2! aD0! aD1! aD2! aD3! - 16 x Freq aM3! aD0! aD1! aD2! aD3! - 16 x Freq  16 x 4 Wire Measurements  aM2! aD0! aD1! aD2! aD3! aD4! aD5! aD6! aD7! D0-D4 = Frequency D4-D7 = Temperature  VibWire-201 supports 3 thermistor types	+xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n
Thermistor 1 & 2		
Thermistor Type 1 Temperature sensor settings  Parameters from the sensor calibration sheet  Steinhart-Hart Parameters Thermistor resistance/temp calculation	aXT1RE! aXT1T0! = 25 aXT1BET!  aXT1ST0! aXT1ST1! aXT1ST2! aXT1ST3!	Resistance at 25 Deg C T0 - generally 25 Deg C Beta Value  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  Steinhart-Hart Parameters Thermistor resistance/temp calculation  Page 36 shows sample calibration data sheet	aXT2RE! aXT2T0! = 25 aXT2BET!  aXT2ST0! aXT2ST1! aXT2ST2! aXT2ST3!	Resistance at 25 Deg C T0 - generally 25 Deg C Beta Value  A in Steinhart-Hart B in Steinhart-Hart C in Steinhart-Hart D in Steinhart-Hart
VW Sensor Input Channel Settings  Sets the process option for frequency calculations	aXCH0FN!  F = Frequency type N = VW Channel 0 .. 7	0 = output in Hz 1 = output in digits = F^2/1000 2 = use formula A + B*digits + C*digits^2 + D*temperature  digits = Frequency^2 in units of Hz^2
Thermistor Temperature Calculation	aXT1TYn!  a = ID n = integer 0 .. 2	0 = resistance ratio - thermistor data sheet (R <sub>r</sub> /R <sub>25</sub> )  1 = Beta value calculation 1/T = 1/T <sub>0</sub> + log(r)/Beta where r = R <sub>r</sub> /R <sub>25</sub>  2 = Steinhart-Hart equation  1/T = A + B(Ln R <sub>r</sub> /R <sub>25</sub> ) + C(Ln R <sub>r</sub> /R <sub>25</sub> ) <sup>2</sup> + D(Ln R <sub>r</sub> /R <sub>25</sub> ) <sup>3</sup>

Table 3

Examples Of Using RS-485/SDI-12 Commands

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

The SDI-12 networks 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 used with 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 ‘?!’ .

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

Start a measurement for Instrument on a network

The following example shows how to start measurements on instruments with ID numbers 2

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

Problems with measurement systems - Spikes in measurements

A common source of noise for vibrating wire measurement systems is earth - current loops.

Earth loop effects cause spikes in measurement values and can be intermittent. Earth loops are often caused by power supplies and multiple earth connections between different sections of a measurement system. Earth loop noise can cause random spikes

Figure 51 shows how some distributed applications are wired together and this is how different earth potentials can form current loops between the subsystems.

Isolated Power Source

The VibWire-201-Pro operates using its internal AA batteries and as such is totally isolated from the power sources used in permanently installed data acquisition and recording systems.

The VibWire-201-Pro when running on batteries operates in full isolation to any other device.

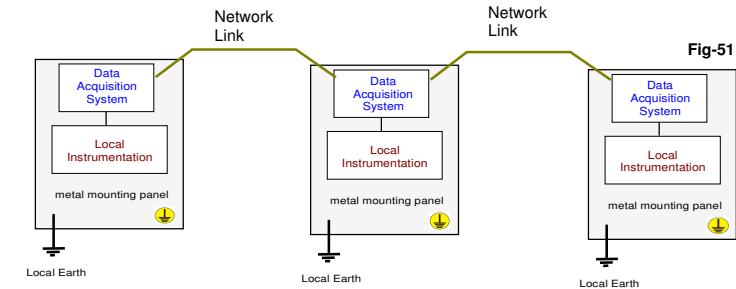


Fig-51

Diagnostics

The VibWire-201-Pro is a perfect tool to assist engineers in the setup and diagnostics of Geotechnical systems.

A common problem is that a geo-technical monitoring system seems to be running correctly and then spikes appearing at random in a sensor trace keep appearing.

Spikes can be caused by interference on a sensor cable or loop noise.

Fit the problematic sensor signal directly into the VibWire-201-Pro and set it up for stand-alone logging to the flash memory card. The logging operation can be set fast for short periods of time, or to save battery life to slow sampling.

The device runs completely isolated from any other device. The recording will be purely the sensor signal and will not be effected by any other local device. If the sensor trace shows no sign of irregularities then the problem is on the fixed installation.

It is highly unlikely that cable pickup noise, including any environmental noise such as mains 240V 50 Hz can effect any measurements on the VibWire-201.

A sensor can be isolated from a main system and run independently.

MUX-16/32 Expansion Unit

A MUX-16/32 expansion unit can be run directly from the batteries in the VibWore-201-Pro so blocks of sensors can be tested directly and the results recorded by the device to the flash memory card.

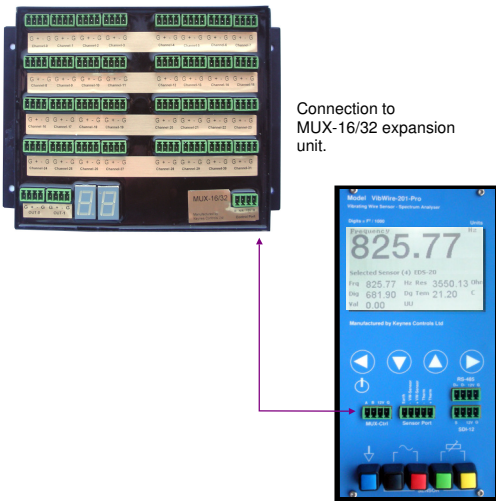
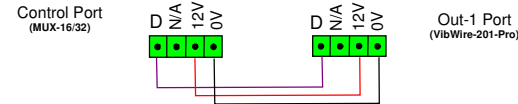


Fig-52 MUX Control Signal Connection to VibWire-201



Data Record to Flash Memory Card

The VibWire-201-Pro can store reading directly onto a flash memory card that can be installed into the unit.

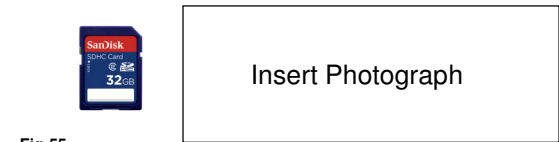


Fig-55

- 1. Insert a flash memory card into the VibWire-201-Pro.

Make sure the device is DOS formatted before use.

This operation can be carried out on any PC or laptop.

High Speed - Single Channel Data Recording

Single channel data recording and signals analysis is the most common operation undertaken with the VibWire-201-Pro. High speed data capture can be undertaken by setting the sample rate to 1 Hz.

- 1 Sec, 1 Minute, 10 Minutes, 1 Hour, 6 Hours

Use the 'Recording Interval' menu to set the desired sample rate.

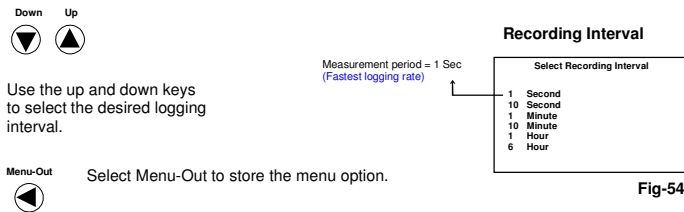


Fig-54

Memory Card Type

The VibWire-201-Pro requires SD type flash memory cards.

SD cards are usually 4 GB storage size or above.

Error Message

Do not use MMC type flash cards, even though same physical size as SD type memory cards since they will not work in this unit.

NO SD – this can appear on the display to indicate that the wrong card type has been installed into the unit.

MMC type cards typically have storage capacity of 256 Mb to 4 Gb

Once the recording interval is set the VibWire-201-Pro will commence recording measurements to the flash memory card.

Removing The Memory Card

Using a small amount of applied pressure to the flash memory card. Push the card into the device to release it from the holder.

The card will now be ejected from the VibWire-201-Pro and can be read using a PC or another reading device supporting DOS file system.

The data stored on the card is in CSV (Comma separated format) and can be read by spread sheet and similar software.

As soon as the card is remove the data logging operations will stop.

Storing the menu option

Once the selected menu option is highlighted simple press the button to store the new option.

Repeat the operation until the 'Frequency' display appears. See Fig 15 page 8.

Default Sample Rates

The default sample rate for any VibWire-201-Pro in 32 x 2 wire is 1 minute

The default sample rate for 16 x 4 wire mode operation is 30 seconds.

External Power Supply

For long term monitoring applications an external power supply can be fitted onto the VibWire-201-Pro.

The external power supply is applied to the +12 V and Gnd (G) pins on the SDI-12 and RS-485 ports.

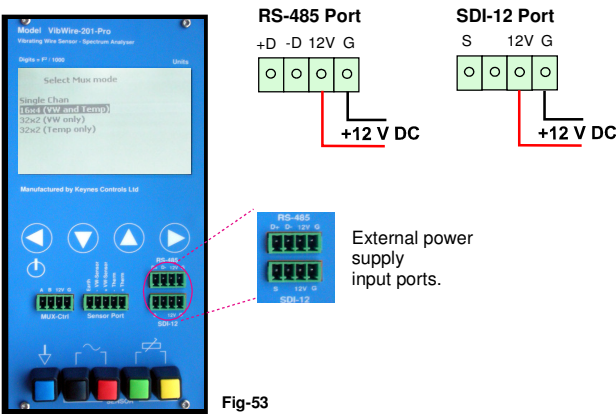


Fig-53

The VibWire-201-Pro only acts as a slave device when connected onto a digital network. As such the external power supply only powers the device and no other device upon the network.

Isolated USB Media Converters

The VibWire-201-Pro can be powered directly from the a PC USB port using either of the USB-SDI-12 or USB-485-Pro media converters.

The USB-SDI12-Pro and USB-485-Pro media converters offer the simplest way for externally powering the VibWire-201-Pro and interfacing to a PC for data recording operations.

The Keynes Controls media converters are supplied with the Q-LOG data acquisition and logging software and so make a very cost effective

Figures 56 and 57 below shows the pin-outs for the media converters.

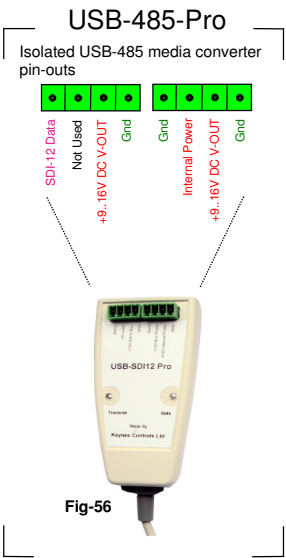


Fig-56

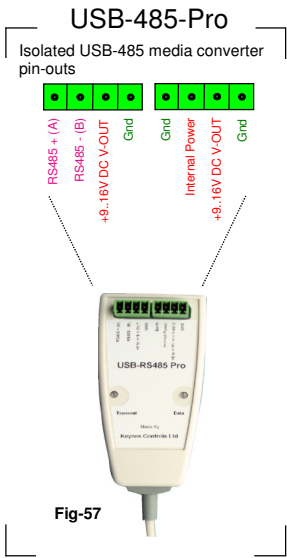


Fig-57

Full installation instructions can be found at

<http://www.aquabat.net/user-manuals/UserManuals.html>

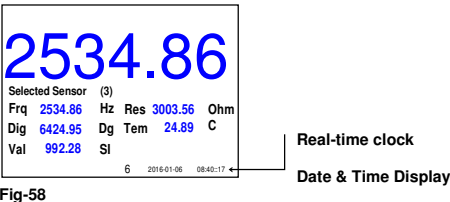


Fig-58

Real-time clock  
Date & Time Display

Worked Example - Spot Welded VW Strain gauge

The following pages demonstrate how to use the VibWire-201-Pro to display values in engineering units. The examples below show the use of a strain gauge and piezometer and give engineering values in micro-strain.

Vibrating Wire Strain Gauge Calibration Factors

Model	5200	5202	5204	5210	5214
Gage Factor	3.305	0.392	1.421	0.3569	0.3664
Start Frequency	450 Hz	1400 Hz	800 Hz	1400 Hz	1400 Hz
End Frequency	1200 Hz	3500 Hz	1600 Hz	3500 Hz	3400 Hz

Table 4

Strain Gauge Type	Nominal Batch Factor (B)
5200	0.96
5202/5204/5210	0.92
5214	0.97

Table 5

Please Note.

The calculation allows for initial measurement conditions an gives the results in SI units - micro-Strain

A common procedure for calculating strain from a vibrating wire strain gauge uses the formulae:

$$\Delta\mu = (R1 - R0)G \times B$$
$$= R1.G.B - R0.G.B$$

where R0 = Initial condition reading (Digits)  
R1 = Current reading (Digits)  
G = Gauge Factor  
B = Batch factor

The equation can be re-written as:

$$\Delta\mu = R1.A - D$$
 where D = R0.G.B and A = G.B

Now R0.G.B = Constant Value = A in the Windows calibration factors

Example. A model 5200 strain gauge is to be used with the VibWire-201-Pro to monitor strain on a bridge member. The gauge has been preset to operate at its mid-point and all subsequent measurements are to be taken from this initial condition.

Model 5200: Start Freq = 450, End Frequency = 1200 Hz (Range = 1200 - 450) - Initial setting of the gauge = 450 + (Range / 2) = 825 Hz.

Using Table 4, Gauge factor = 3.305 and Batch factor = 0.96 Note. When the batch factor is missing from the calibration sheet use B = 1.

VibWire-201 Results Display

The VibWire-201-Pro has to be set to show results in Digits, see Page 8 Figure 16.

$$\Delta\mu = R1.A - D$$
 - Units micro-Strain

R1.A - D where A = 3.305 x 0.96 and D =  $\frac{(825 * 825) * 3.305 * 0.96}{1000}$

= 3.1728

Therefore

$$\Delta\mu = R1 * 3.1728 - 2159.487$$

If the strain gauge under load alters its operating frequency to 827.00 Hz then the display

The Figure below shows how to set the calibration factors for the Model 5200 strain gauge into the VW201cal setup software.

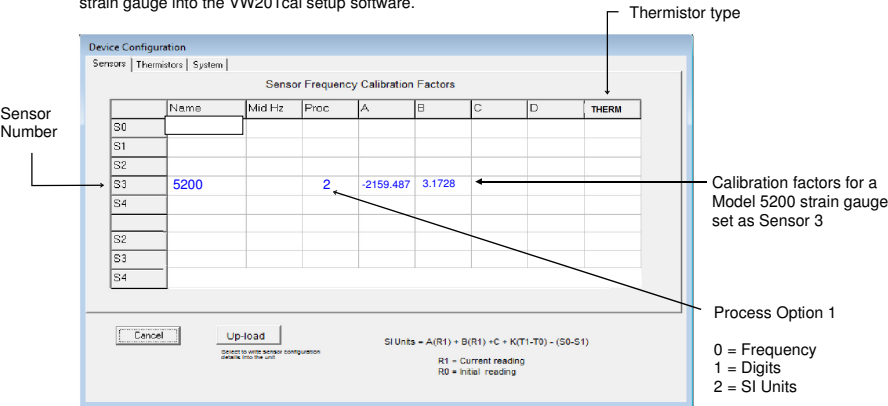
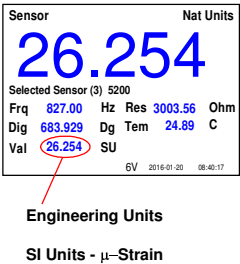


Fig-59 - Inserting Calibration Factor into VW201cal software

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

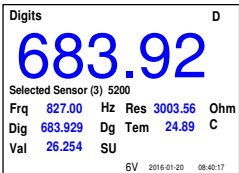
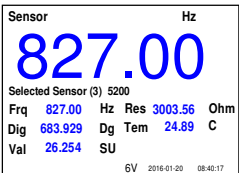
In order to use vibrating wire gauges and to display the results on engineering units, the calibration factors are based on using Digits (Hz<sup>2</sup>) as the measurement value.



Example display for a model 5200 vibrating wire strain gauge showing in output in micro-Strain.

The output allows for initial measurement conditions.

Note 5200 - is just a sensor manufacturer part number.



Temperature Calibration Factors

Figure 60 below shows the thermistor setup Window of the VW201cal software.

The software currently supports 3 different thermistor configuration options. Most sensor manufactures use the same thermistor type for their temperature monitoring and so 3 defined thermistor type configuration options is sufficient for most applications. It is unlikely that any setting other than the default thermistor parameters are required for most sensor temperature readings regardless to the sensor manufacturer.

The VW201cal software has option **T0** pre-defined to the most common thermistor Stein-hart-Hart calibration factors used for the thermistor's built into vibrating wire sensors. These factors will work satisfactorily with most manufactures devices.

Keynes Controls recommends that option **T0** be selected when setting up and new sensor, and only changed if proved inaccurate for a defined sensor.

To write new calibration factors into a VibWire-201-Pro unit make sure that the device is connected to a USB port on the host PC running the VW201cal software. See Figure 64 on page 23.

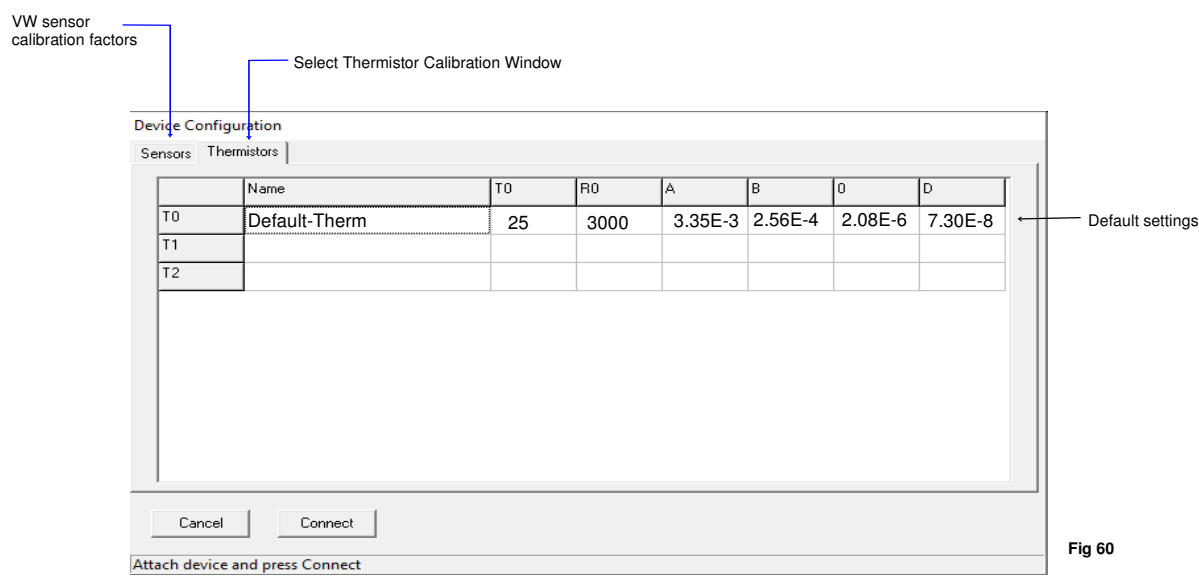


Fig 60

Adding a new thermistor type

This is a simple operation using the VW201Cal Windows software package.

Calibration parameters and what they mean

Each thermistor obtained from a reputable supplier will have the following calibration factors defined on it's calibration data sheet. R0 = Resistance at temperature T0. For vibrating wire sensors these are most commonly set at R0 = 3 K Ohm, and T0 = 25 Deg C. The resistance of the thermistor is 3 K ohm at a temperature of 25 Deg C.

Each sensor has 4 calibration factors labelled A,B,C and D on calibration sheet. These factors are used by a polynomial equation to convert resistance to temperature.

Sample Calibration Factors

The following factors have been created for example purposes only.

A thermistor with T0 = 25 Deg C and R0 = 3300 Ohms. Stein-hart Hart calibration factors are:  
A = 4.6541E-3, B = 2.675E-4, 3.05E-6, 5.07E-8.

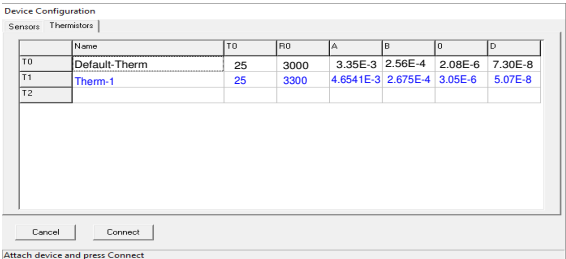


Fig-61 VW201cal - Thermistor Calibration factors

1. Select the 'Thermistor' Tab.
2. Assign name - Good idea to use a unique name for each new sensor type.
3. Fill in the calibration constants into the table.  
  
Cell 'A' = 4.6541E-3 Cell 'B' = 2.675E-4  
  
repeat until all the cells are filled.

Once the cells are filled simply press the '**Connect**' button to write the parameters to the VibWire-201-Pro.





Fig-62

Configuration Setup



Fig-64



Micro-USB

Data Logger Operations

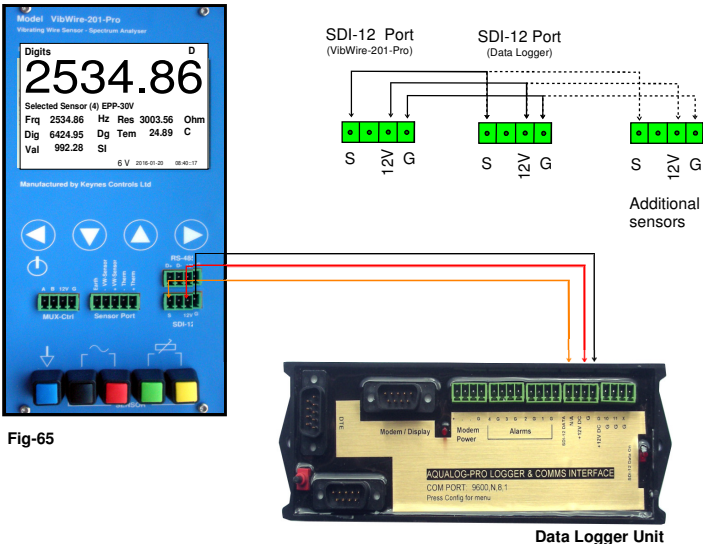


Fig-65

Data Logger Unit

Figure 58 opposite demonstrates the minimum system parts required to undertake barometrically corrected water level recording using the VibWire-201-Pro and a barometer module direct to a PC.

MUX-16.32 Expansion unit

SDI-12 Network Operations

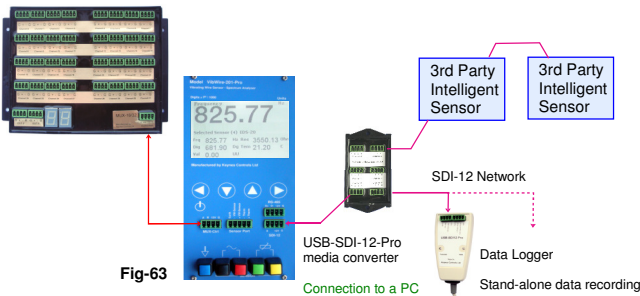


Fig-63

Digital Network Port Options

The VibWire-201-Pro operates in the same fashion as to the standard VibWire-101 but the advantage that a single device can be used on both SDI-12 and RS485 digital networks.

Device USB Configuration Port

The simplest way to configure the VibWire-201-Pro is to use the free Windows VW201cal software which operates under the Microsoft Windows operating system.

Use the USB cable provide with the instrument to connect the device to a port on a laptop.

Setup the configuration parameters using the VW201cal software.

Press the 'Upload' button and the assigned configuration parameters will be written into the unit.

The in-built sensor configuration parameters will be updated. The 'Date' and 'Time' real-time clock parameters of the device automatically set to the host PC clock settings.

Note

It is possible to configure the device using SDI-12 commands, however this much more difficult task than just using the VW201cal software.

Connection to a Data Logger

Figure 61 opposite demonstrates how the VibWire-201-Pro is connected to a Keynes Controls AquaLOG data logger unit.

The VibWire-201-Pro will operate with any third party data logger supporting SDI-12 or RS-485 communications and capable of issuing the measurement commands.

Measurement Command:

aM! aD0! - Start measurement - Get data where a=ID number

When operating on a digital network the VibWire-201-Pro acts as a slave device only. The logger issues the measurement commands and the VibWire-201 responds like any other intelligent sensor.

Temperature Measurements

The VibWire-1201-Pro is capable of accurate temperature measurements suitable for many geotechnical and laboratory measurements. The thermistor temperature sensor built into most vibrating wire sensors connects directly into the device.

The VibWire-201-Pro can make temperature measurements simultaneously to the frequency measurements when in 16 x 4 Wire mode.

The VibWire-201-Pro can also act as a stand-alone temperature recorder in 32 x 2 Wire mode using the MUX-16/32 expansion unit.

Factory Set Steinhart Hart Calibration Factors

The VibWire-201-Pro is supplied pre-set to use

Steinhart-Hart 0th order (A)	3.35E-3
Steinhart-Hart 1st order (B)	2.56E-4
Steinhart-Hart 2nd order (C)	2.08E-6
Steinhart-Hart 3rd order (D)	7.30E-8
Beta	5234

The VibWire-201-Pro default thermistor settings will give accurate results for most of the different manufactures vibrating wire sensors.

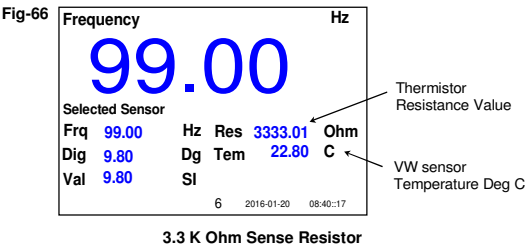
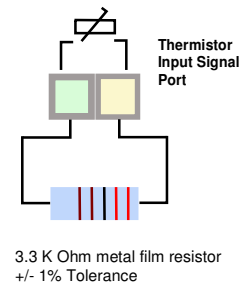
Full adjustment to the calibration factors can be carried out using the VW201cal.exe Windows software.

Testing the temperature measurements

Fit a 3.3 K Ohm to the thermistor input port.

Set the thermistor input uses the default calibration parameters as shown above.

22 Deg C fixed point - 3.3 K Ohm temperature test resistor



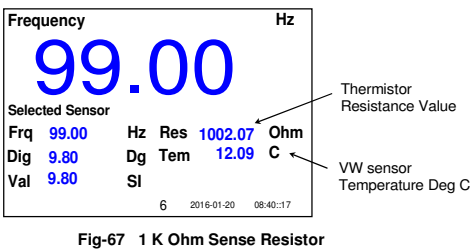
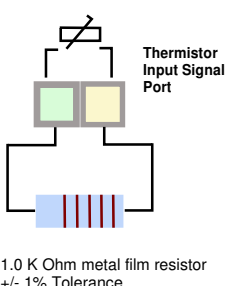
With no frequency input to the VibWire-201-Pro the screen will default to 99.00

The device measures and displays the sense resistor in Ohms, see Fig 66 opposite. Even though the sense resistor is marked at 3.3 K Ohm, due to the tolerance of the device it is unlikely that exactly 3.3 K Ohms will be supplied.

There is a small variation on the value sensor resistor. The example shows 3.3K + 1.0% = 3333 Ohms.

The higher value sense resistor, then the lower the temperature that is being simulated.

52 Deg C fixed point - 1 K Ohm temperature test resistor



Metal film resistors have excellent stability under load and severe environmental conditions, and can be sourced from many different suppliers.

Sensor Problems and Diagnostics

The spectral display feature of the VibWire-201-Pro offers the user excellent tool for testing and diagnosing sensor problems. The ability to observe a sensor signal in the frequency domain enables the User to observe that a sensor installed and operating correctly. Should a sensor installation be badly installed then the spectra will show unusual spectral components.

Due to how the vibrating wire sensors operate, each sensor in a system can be examined from a central point, such as where the sensor cabling goes into a logger system, since the cable length from the sensor to the device has little to no effect on the measurements to be made. All sensors can be examined before installation into a permanent logging system.

Spectra (Hz)

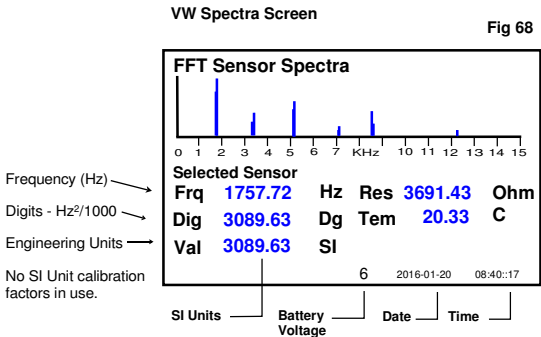


Figure 68 opposite shows the spectral display screen used to display the frequency components of a vibrating wire sensor signal on the VibWire-201-Pro. See page 30 for the menu selection operations required to access this display.

The images below demonstrate the use of the Spectral FFT display to show the operating features for a arc welded vibrating wire strain gauge.

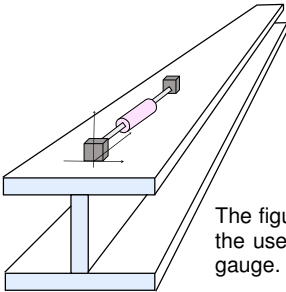
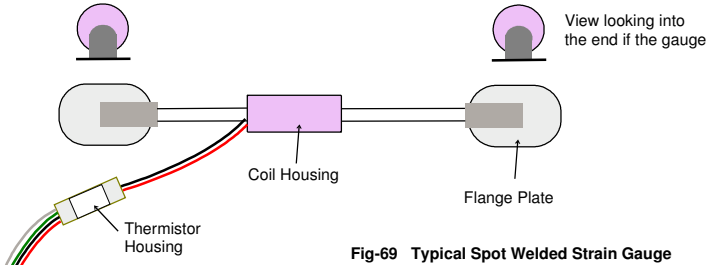
The figures below demonstrate what the User should observe when using a strain gauge and some of the operating characteristics

Sensor Operating Characteristics

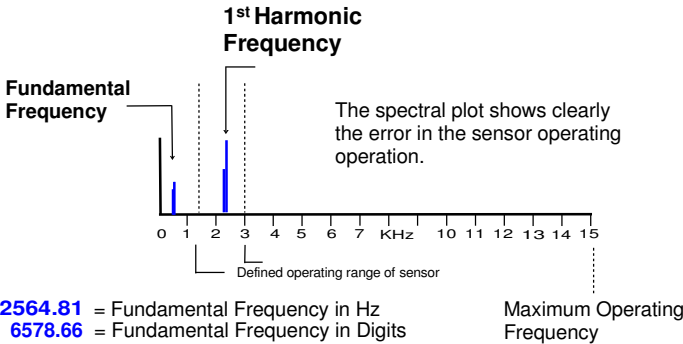
The examples below are taken from a UK manufactured spot welded vibrating wire strain gauge.

Due to the physical size of the strain gauges and regardless to the manufacture, nearly all of the spot welded vibrating wire strain gauges have similar operating characteristics. The strain gauges typically have high operating frequencies when deployed correctly.

The Operating frequency of the sample gauge is between 1500 to 3 K Hz. The sensors give out their optimum signal strength only when operating within there defined range, and installed correctly onto a suitable structure. A arc welded strain gauge has to be pre-tensioned before use.



The figure above shows a typical application for the use of the spot welded vibrating wire strain gauge.



Free Standing Strain Gauge

Fig 70 opposite shows a typical spectra for a free standing gauge.

The fundamental frequency as calculated by the VibWire-201-Pro is outside the defined operating range for this type of sensor.

The spectral display clear shows that a fault condition has occurred.

Figure 71 shows additional details that can be seen on a sensor spectra. The additional harmonics can be caused with flaws in the sensor installation.

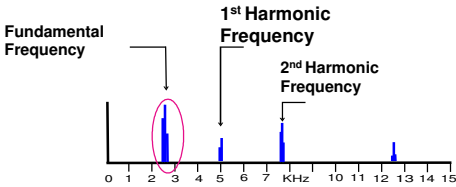
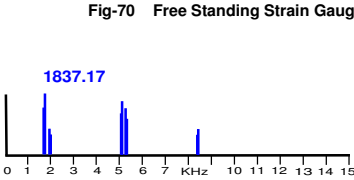


Fig-71

The harmonic component levels can vary in amplitude depending on how well the sensor has been seated to the structure. Any out of axis stresses on the sensor will cause harmonic levels to change.

VW strain gauge - Pre-tension gauge mounted onto a structure.

Once the strain gauge is mounted onto the structure it should be pre-tensioned using the mount to operate inside the defined operating range as specified by the manufactures data sheet.

The example below shows a typical spectra with a sensor pre-tensioned to operate at 1700 Hz. The sensor is correctly attached to a structure.

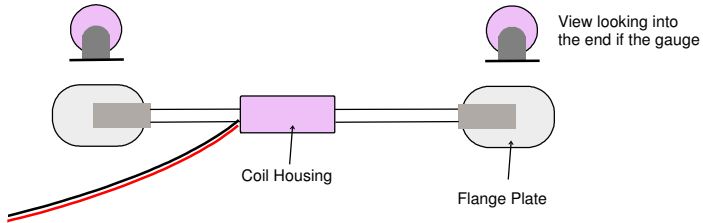
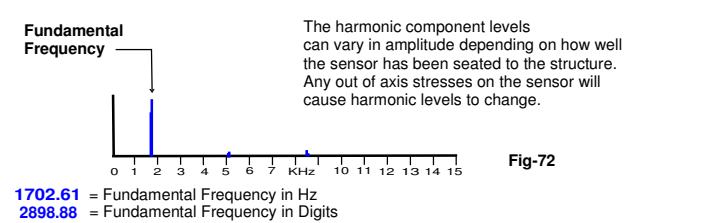
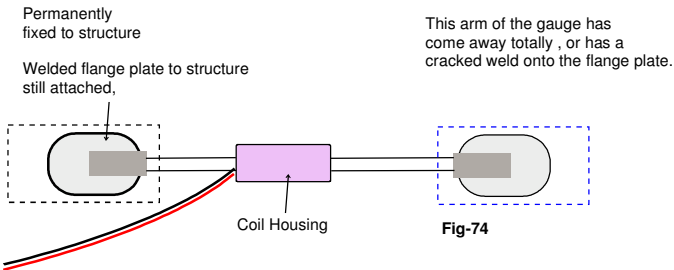
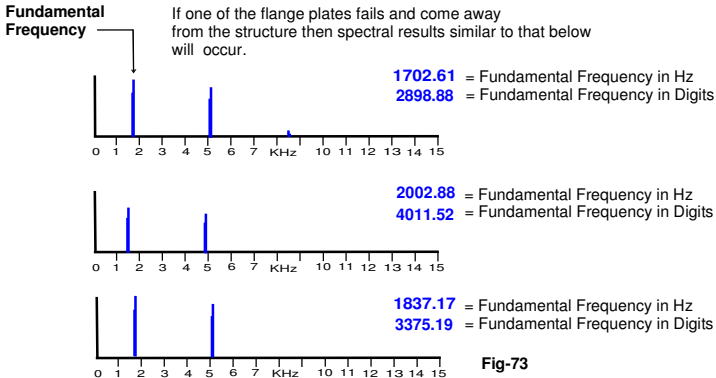


Fig 72 above shows what a spectra should be like for a perfectly fitted vibrating wire strain gauge sensor. The fundamental frequency will vary for depending on the application.

In this example it is just possible to see that harmonics in the resultant spectra. The harmonics can disappear altogether as the operating frequency increases. The spectra makes is very easy for the operator to see that the sensor.

VW strain gauge - Failed or loose weld



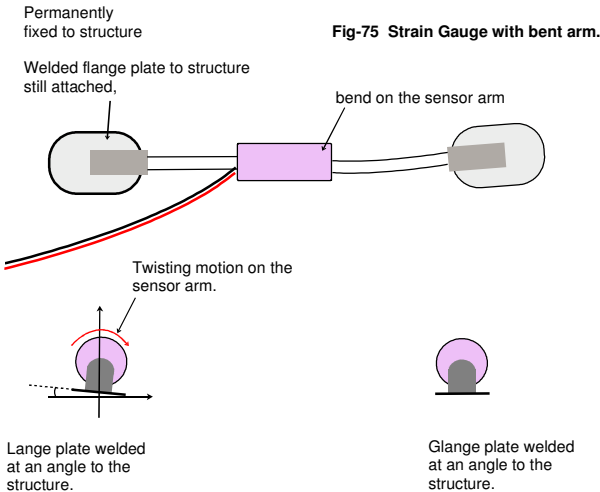
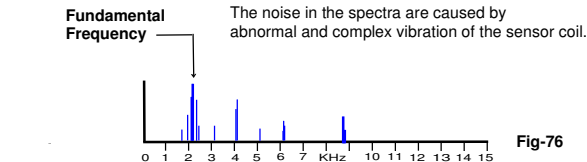
The fundamental frequency can vary considerably. The 3rd harmonic levels can become higher magnitude than fundamental and so the recorded results will be erratic. The VibWire-201-Pro results will oscillate to values between the fundamental and harmonic signal component.

VW strain gauge - Badly seated flange plate

If the sensor flange plates are not seated correctly, or if a sensor arm is stressed away from its normal direction of operation, then the sensor frequency response can be contaminated by unwanted harmonics, see Fig 76 below.

Figures 74 and 75 opposite show badly fitted sensors.

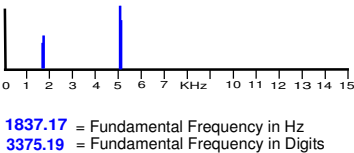
Depending on the amount of miss-alignment or stress put onto the sensor coil then the fundamental frequency will move from the true frequency. The amplitude of the harmonic components can exceed the level of the fundamental and cause erratic results.



Vibrating Wire Sensors - Badly seated coil assembly

The unseating of the coil alters the mode of vibration of the sensor. If the sensor is permanently broken then the operating frequency will most likely be out of specification.

Third harmonic levels can appears to be higher magnitude than the fundamental. The effect is that the sensor is operating outside of its design specification. The results can will be erratic



One of the most common sources of sensor failure is that the coil assembly has become unseated. This can occur at any the time, however the most common causes are, damaged during transit, impact damage once deployed and simply poor manufacture.





# APPENDIX-A

## Menu System Summary

Menu Options

The following page shows a summary of the menu options used by the VibWire-201-Pro.

Spectra

Results Menu Selection Options

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Digits  
6424.95  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Sensor  
992.28  
Selected Sensor (I) 5200  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

FFT Sensor Spectra  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Storing the menu option

Once the selected menu option is highlighted simple press the button to store the new option.

Repeat the operation until the 'Frequency' display appears. See Fig M page N..

Remote Readout

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Remote  
Address  
Serial Comms

Select Backlight  
SD12  
RS485 1200

Select SDI-12 or RS-485 ports for remote data access across the network.

Back light

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

System  
Set Time and Date  
Speaker ON/OFF  
Backlight  
Info  
Reset Defaults

Select Backlight  
Off  
Low  
High

To optimise the battery life set the back light intensity to make the results clearly visible under the conditions of operation. The battery life will be optimised with the back light switched off.

Setting Network Address

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Remote  
Address  
Serial Comms

Selected Serial Comms  
0  
1  
2  
3  
4  
5  
6  
7

Sets the ID for the RS-485 and SDI-12 ports.

SDI-12 Port Operation

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Remote  
Address  
Serial Comms

Select Backlight  
SD12  
RS485 1200

Sets the VibWire-201-Pro to transmit data through the SDI-12 Port

RS485 Port Operation

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Remote  
Address  
Serial Comms

Select Backlight  
SD12  
RS485 1200

Sets the VibWire-201-Pro to transmit data through the RS-485 Port

Scanning Modes

16 x 4 or 32 x 2 scanning modes require the MUX-16/32 unit to be attached. Remember to set MUX-16/32 scan mode for the expansion unit selecting expanded data recording modes.

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

System Setup  
Log Now  
Autolog Mode  
Scanning mode  
Recording Interval  
Set working MUX ID

Selected Scanning mode  
Single Chan  
16x4 (VW and Temp)  
32x2 (VW only )  
32x2 (Temp. only )

The MUX-1632 expansion units fitted for 16 x 4 wire or 32 x 2 wire operations.

Recording Interval

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Logger  
Log Now  
Autolog Mode  
Scanning mode  
Recording Interval  
Set working MUX ID

Select Recording Interval  
1 Second  
10 Second  
1 Minute  
10 Minute  
1 Hour  
6 Hour

1 and 10 second logging is only available on single channel measurements.

1 min, 10 min, 1 Hour, 6 Hour logging MUX-16/32 expansion unit.

Time & Date Settings

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

System  
Set Time and Date  
Speaker ON/OFF  
Backlight  
Info  
Reset Defaults

Set Time and Date  
Date 2016-01-06  
Time 08:25:30

Auto-Logging

Start the data recording operations to the SD Flash memory card. Single channel mode - is only for the sensor attached directly to the device. 16 x 4 or 32 x 2 scanning modes require the MUX-16/32 unit to be attached. Remember to set MUX-16/32 scan mode for the expansion unit before

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Logger  
Log Now  
Autolog Mode  
Scanning mode  
Recording Interval  
Set working MUX ID

Scan Type  
See Note 1  
Auto-logging  
Time 2016-01-06  
Rec No 123  
ID=0  
CH=0  
MUX Channel  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI

Note 1  
VibWire-201-Pro Scan Modes  
Single  
16 x 4 Wire  
32 x 2 Frequency  
32 x 2 Temperature

Manually Set MUX-16/32 Channel

Manually set the MUX-16/32 channel number. The channel range will depend on the scan mode assigned. The MUX Chan number indicator will change as the 'Up' and 'Down' keys are pressed.

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Manually set MUX ID  
Set working MUX ID

MUX-ID No  
MUX 0  
MUX Chan No.

Sequencing MUX  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI

Use the 'Up' and 'Down' buttons to change the MUX channel. The channel counter on the MUX-16/32 will update automatically.

MUX 0..15 4 Wire Mode - MUX-16/32 Channel counter changes between 0..15  
0..31 2 Wire Mode - MUX-16/32 Channel counter changes between 0..31

System Information Mode

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

System  
Set Time and Date  
Speaker ON/OFF  
Backlight  
Info  
Reset Defaults

Device info  
Firmware version 1.1.003  
Firmware Date 23 Feb 2016

A firmware upgrade facility is available for this product.

Keynes Controls release upgrades and new features software from time to time. The device does not have returned for a factory upgrade and can be carried out.

Sensor Setup

Select a sensor type for measurement operations

Frequency  
2534.86  
Selected Sensor  
Frq 2534.86 Hz Res 3003.56 Ohm  
Dig 6424.95 Dg Tem 24.89 C  
Val 992.28 SI  
E 2016-01-06 08:40:17

Main Menu  
Sensor No  
Logger  
Multiplexer  
Remote  
System

Select Sensor No  
Sensor no: 0  
Name: Undefined

Select Sensor No  
Sensor no: 3  
Name: EDV-305

Use the 'Up' and 'Down' keys to select the sensor type.

The assigned sensor calibration factors will then be used by the VibWire-201-Pro to determine the SI units for any sensor that is attached.

## **Inspection**

It is vital to check all the equipment in the shipment as soon as possible after taking delivery and well before any field use is to be carried out.

Check that the case has not been physically damaged in shipment.

Install a new set of batteries.

In the case of units shipped with the protective environmental cases then new battery sets should be included with the instrument.

## **Power on the instrument**

**With no sensor connected the instrument will default to the screen shown in Figure 11 on page 7**

# APPENDIX-B

## Sample Calibration Data Sheets

Sensors

Piezometer  
Spot Welded Strain Gauge



# 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	:		Date	: 02.02.2012
P.O. No.	:		Temperature	: 19°C
Instrument	:	V W Piezometer	Atm. Pressure	: 100 kPa
Serial number	:	xxxxx		
Capacity	:	350 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 :  $P(\text{kPa}) = G(R0 - R1) + K(T1 - T0) - (S1 - S0)$ Polynomial :  $P(\text{kPa}) = A(R1)^2 + B(R1) + C + K(T1 - T0) - (S1 - S0)$ 

R1 = current reading &amp; R0 is initial reading in digit.

S1 and T1 = current atmospheric pressure(kPa) and temperature (°C)

Readings at the time of shipment

f	:	Hz
f <sup>2</sup>	:	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 thermistor 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.)

The example above is for a VW Piezometer and so the engineering units calculations vary between the different sensor types.

For a Piezometer the local barometric levels are taken into consideration.

The engineering units for this example is K Pa

The term (S1-S0) is a constant offset that allows for local atmospheric conditions and be taken from a barometer module such as models **Barom-SDI12** or **Barom-485**.

The VW sensor units have to be set to 'Digits' that is Hz<sup>2</sup>/1000.



Sample Calibration Data Sheet

**Vibrating Wire Displacement Sensor**

Company QUALITY FORM

Form No: PQF178

Date: 16th Jan 2016

Sig: IT

**VWP-2021**

Calibration Date	12th Nov 2015
VW Readout Unit	AVW200
Calibration Jig S/N	463253

Batch No	Serial Number Range
11	800000-800016

<b>Batch Factor</b>
<b>1.041</b>

<b>Gauge Factor</b>
<b>3.09651</b>

+ Gauge factor calculated using theoretical values

Calibration of AVW200 S/N 7162 valid from 21st December 2015, Calibrated using equipment which provides traceability to UKAS standards (UKAS Laboratory No 2510)

Calibrated in house using slip gauges Cert No GC9033 valid from 17 Nov 2015. Calibrated using equipment which provides trace ability to UKAS standards (UKAS Laboratory No 9146)

**Users must establish site zero base reading for Linear calculation purposes**

**Linear calculation [mm] = GF x BF x (Current Reading - Site Zero Reading)**

Details in this example are for demonstration purposes only.

No temperature calibration factors are included. The default factors specified by Keynes Controls are to be used.

**= 3.2234 x (Current Reading - Site Zero Reading)**

## Limited Warranty

The manufacturer, Keynes Controls Limited, warrants the VibWire-201-Pro manufactured by it, under normal use and service, to be free from defects in material and workmanship under the following terms and conditions:-

Sufficient information has been provided to Keynes Controls by the purchaser as regards the operating environment to allow Keynes Controls to check compatibility of the VibWire-201-Pro and other component parts.

In the absence of any site data being provided by the purchaser standard construction materials will be supplied. All costs for subsequent modifications will be borne by the purchaser.

The VibWire-201-Pro instrumentation shall be installed or used in accordance with the manufacturer's recommendations.

The equipment is warranted for 1 year from the date of shipment from the manufacturer to the purchaser.

The warranty is limited to replacement of part or parts which, are determined to be defective upon inspection at the factory. Shipment of defective part or parts to the factory shall be at the expense of the Purchaser. Return shipment of repaired/replaced part or parts covered by this warranty shall be at the expense of the Manufacturer.

Unauthorised alteration and/or repair by anyone which, causes failure of the unit or associated components will void this LIMITED WARRANTY in its entirety.

The Purchaser warrants through the purchase of the VibWire-201-Pro equipment that he is familiar with the equipment and its proper use. In no event shall the manufacturer be liable for any injury, loss or damage, direct or consequential, special, incidental, indirect or punitive, arising out of the use of or inability to use the equipment sold to the Purchaser by the Manufacturer. The Purchaser assumes all risks and liability whatsoever in connection with the VibWire-201-Pro instrumentation from the time of delivery to Purchaser.

## RETURN OF GOODS

### 1 Returns procedure

If goods are to be returned for either service/repair or warranty, the customer should contact Keynes Controls Ltd for a Returns Authorisation Number, request a Returned Equipment Report Form and, where applicable

The Goods Returns Numbers must be clearly marked on the outside of the shipment.

Obtain from Keynes Controls and Complete the Returned Equipment Report Form, including as much detail as possible, and enclose it with the returned goods.

A copy of Good Returns Form should be faxed / e-mailed to the Keynes Controls Ltd offices, in advance of shipping the goods.

### Chargeable Service or Repairs

#### Inspection & Estimate

It is the policy of Keynes Controls Ltd that an estimate is provided to the customer prior to any repair being carried out. A set charge for inspecting the equipment and providing an estimate is sometimes chargeable.

#### Packaging and Carriage

All used goods shipped to the factory must be sealed inside a clean plastic bag and packed in a suitable carton. If the original packaging is not available, Keynes Controls Ltd should be contacted for advice. Keynes Controls Ltd will not be responsible for damage resulting from inadequate returns packaging under any circumstances.

#### Transport & Storage

All goods should be adequately packaged to prevent damage in transit or intermediate storage.

#### Warranty Claim

(See Limited Warranty Conditions - Page 36)

This covers defects which arise as a result of a failure in design or manufacturing. It is a condition of the warranty that the VibWire-201-Pro must be operated only in accordance with the manufacturer's instructions and has not been subject to misuse.



## CONFORMITY

Keynes Controls Ltd  
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Tel: +44 (0)118 327 6067

E-mail: [sales@keynes-controls.com](mailto:sales@keynes-controls.com) , Web: [www.aquabat.net](http://www.aquabat.net)

### Declaration of Conformity

We Keynes Controls Ltd at above address declare under our sole responsibility that the product detailed below to which this declaration relates complies with protection requirements of the following harmonized EU Directives,

Low Voltage Directive 73/23/EEC (as amended by 93/68/EEC)  
The Electromagnetic Compatibility Directive 2004/108/EC  
The Construction Products Directive 89/106/EEC

Equipment description Vibrating Wire Sensor Interface  
Make/Brand: VibWire



**Model Number:** VibWire-201-Pro

This equipment has been designed and manufactured with reference to EN 61326-1 and EN 61010.  
All mechanical drawings used in the production of this equipment are based upon BS 8888 and all electrical/electronic drawings are based upon BS 3939.

A technical file for this equipment is retained at the above address.

Ian Thomas

Director

Remote Communication Options.

The VibWire-201-Pro can be used with a range of communication devices to enable the device to transmit data across wireless networks for cable free operations. The devices include WiFi modem for connection onto popular industry standard WiFi networks, and wireless network modems data recording applications where cabling solutions cannot be practically installed.

WiFi Modem

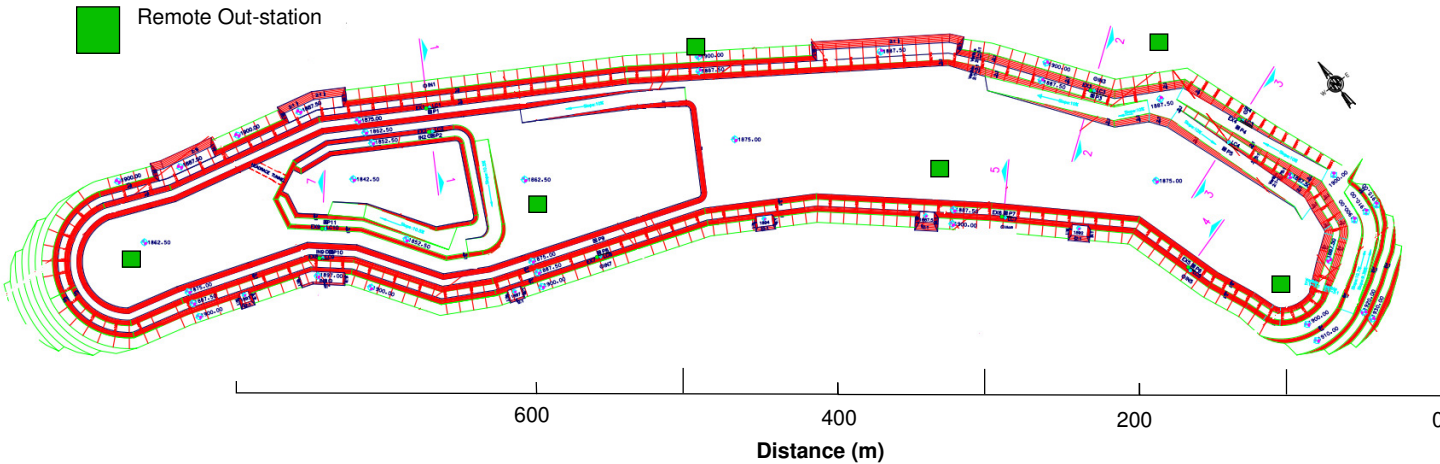


With this WiFi serial adapter you can connect the VibWire-201-Pro to your computer over a standard WiFi network.

Data can be transferred over TCP/IP, UDP or HTTP with the advantage of using 802.11 b/g/n infrastructure or Adhoc mode (Simple AP / Station Mode) networking which allows you to use existing wireless WiFi network connectivity, and it allow you to connect a standard RS485 to any secure or open wireless network or access point.

The WiFi modem enables data from remote instruments to be recorded automatically into the Keynes Controls Ezi-LOG Web Interface.

Distributed WiFi Data Acquisition System



Cable Free RS-485 Network



Part No: SST-2450

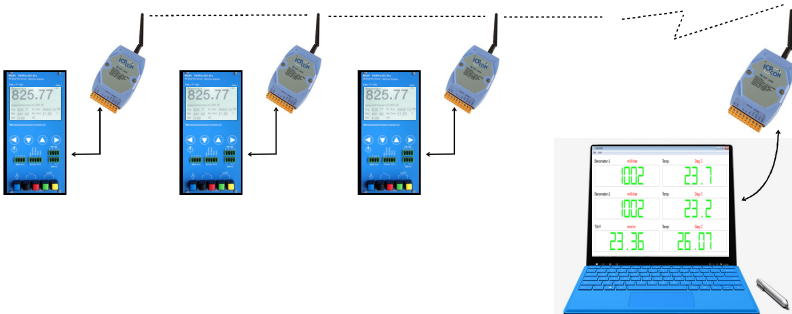
The SST-2450 is a spread spectrum radio modem with RS-485 interface port that can be used with the VibWire-201-Pro. It is designed for applications between host data logging computer and remote devices. It is also useful for those applications where cable installation is difficult or impractical.

The SST-2450 can be used in not only peer to peer mode but also multi-point structure.

Based on direct sequence spread spectrum and RF technology operating in ISM bands. The Frequency Range is 2410.496MHz~2471.936MHz. The Channel Spacing is 4.096MHz.

Different antenna options enabling long and short range operations.

Wireless RS-485 Network



Q-LOG Application