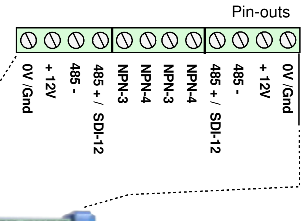
KEYNES CONTROLS

VibWire-108-Modbus

8 Channel Vibrating Wire Sensor Interface -Using Modbus over 485

Model No. VibWire-108-modbus



Terminal Port Cover

Model VibWire-108-Modbus

Overview

The VibWire-108-Modbus is a rugged, versatile, general purpose vibrating wire sensor interface for connection directly to SCADA applications and data recorders across a RS-485 network using the industry standard Modbus protocol. The VibWire-108 range of devices gives third party systems the ability to use vibrating wire sensors even if the original hardware is not designed to do so.

Sensor Excitation - Auto Resonance

All of the VibWire-108 range of interfaces utilises an auto-resonance sensor excitation and measurement technique for activating the vibrating wire sensors and taking a reading. This technique has the advantage over pluck systems in that no prior User knowledge of the vibrating wire sensor is required. Auto-resonance sensor excitation minimises the strain on the sensor coil as it always acts to maximise the output signal from the sensor, and does this without wasting energy on out of band excitation frequencies.

Terminal Port - Configuration

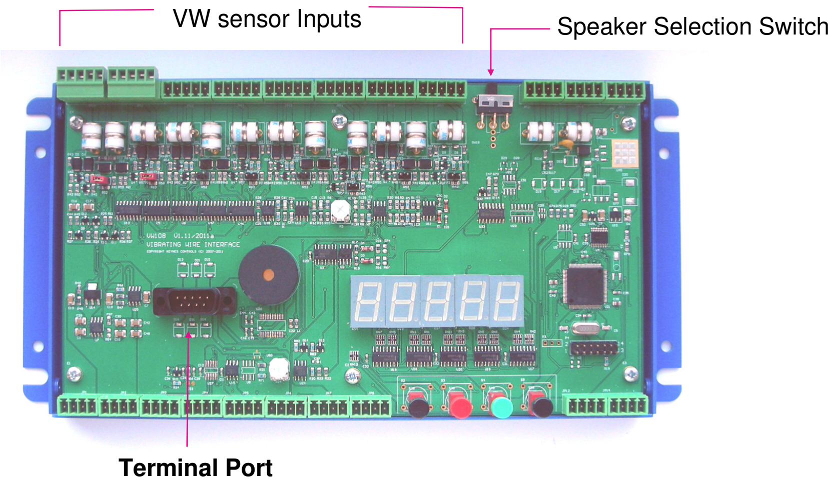
A terminal port menu system is be used to configure this device. The User can configure the instrument to send measurement values in Hz, Digits or SI units. No programming is required to configure this instrument.

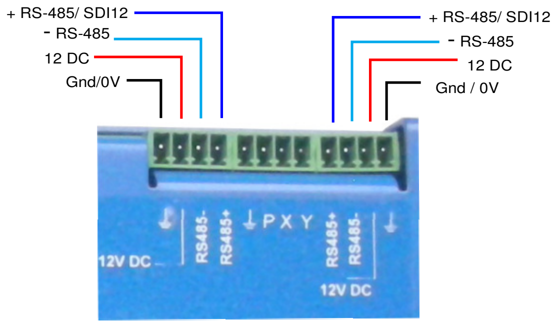
Features

- 8 x 4 Vibrating wire sensor inputs
- Resolves the VW signal to less than 0.01 Hz (industry standard 0.1 Hz)
- Gas discharge tube sensor protection
- Real-time frequency display - 5 digit
- Audible output
- Auto-resonance VW excitation
- Modbus RS-485 network support
- Automatic VW sensor configuration
- Digital communications to remove noise sources and errors.
- Simplified configuration and data logger support.
- Industry standard protocol - supported by SCADA systems
- Output - Frequency, Digits, SI Units, Temp Deg C
- Steinhart-Hart thermistor linearisation support
- Options 2 Independent thermistor configuration
- Integrated polynomial linearisation - quadratic Support direct from VW sensor calibration data sheet.

Specifications

Description		
Frequency display	5-segment display	Resolution 0.1 Hz
Vibrating wire inputs	8 x 4 wire inputs	
Scan time	2 - 24 Secs	1 to 8 channels depending on sensor operation.
Line resistance	up to 2K ohms	
8 Analogue Inputs	0 - 2.5V DC 3.3K / 10 K Ω	0- 2.5V DC thermistor
Lightning protection	Gas discharge tube	
VW excitation range	400 - 6 K Hz	
VW excitation mode	auto-resonance	
Operating voltage	9 - 18V DC	
Ceramic loudspeaker	VW sensor	selector switch
Power Consumption		
Scanning mode	20 mA Typical	Duration 24 Seconds - 3 Sec /chan
Display mode	60 mA	continuous
Modbus RS-485	2.2 mA	Continuous while waiting for commands
Slave ID	1	Max nodes on a 485 network
Software		
VW sensor linearisation	Quadratic	$Y = A + BF + DF^2$
Temperature sensor linearisation	Steinhart-Hart	User-selectable via terminal port





RS-485 Network Connection

The VibWire-108 interfaces supports the full 4 wire gauge input and can use any in-built thermistor temperature sensor.

All of the vibrating wire sensor interfaces and digital network port are protected by gas discharge tube in order to prevent damage by local lightning strikes.

Part Numbers:

VW-108-Modbus	VibWire-108 with RS485 Digital Port
USB-485	USB to RS-485 media converter

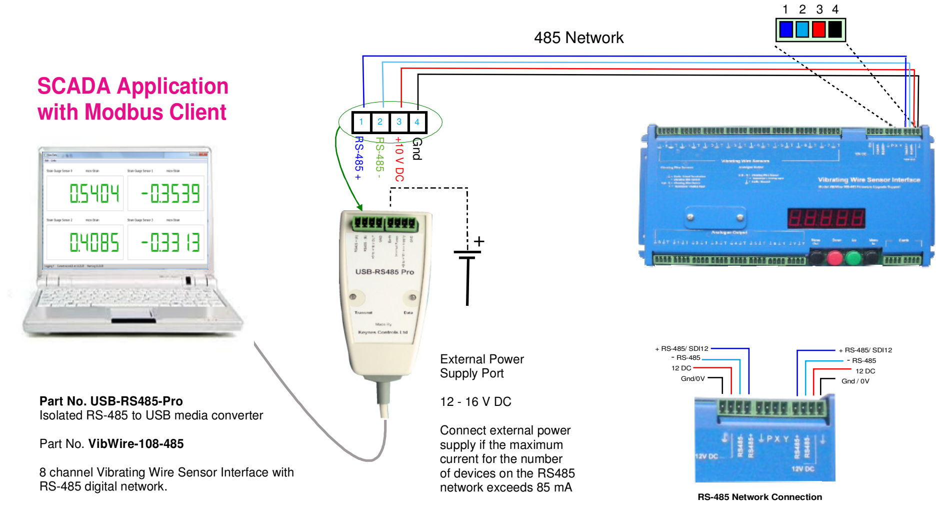
Measurement Data:	
Number of channels	8 x 4-wire VW inputs - user-selectable
VW sensor coil resistance	to 2K Ohm (standard) - other ranges on request
Distance of VW sensor to interface	0 .. 10 Km depending on cabling.
Frequency range	400 - 6 KHz (standard) - other ranges on request
Frequency resolution accuracy	32-bit resolution 0.001 Hz
Long-term stability	± 0.05 % FS max. (Per year)
Temperature range	- 50 to 70 degC
Temperature resolution	0.1 °C +/- 0.2 deg thermistor 10 K Ohm standard 3.3 K Ohm on request
Temperature accuracy	± 0.2 °C / 0.2 °F RS-485 version only
Thermistor measurement	A half-bridge ratio-metric measurement . Value returned in mV. Is used for temperature compensation on VW measurements.
Thermistor excitation	2.5V DC 50 ppm /degC
Input resistance	10K Ohm 0.1 % completion resistor (Standard) 3.3K Ohm on request
Units	Freq (Hz) temperature (mV)
Display only - resolution	5 digit - 0.1 Hz
Electrical Data:	
Voltage supply	**RS-485** 10.5 to 16V DC
Current compensation RS-485 option only:	Typical values are @ 12V DC excitation
idle mode active / measurement	2.2 mA 10 mA data transmission 60 mA including frequency display
	These values may change slightly between sensors. Use figures as a guide only.
Measuring time: warm up response	 500 ms 3 seconds per channel depending on the VW sensor being used (Typical)
Length of data lines RS-485	0 .. 1000 m
RS-485 address mode	Supports enhanced addressing 0 .. 9 A .. Z
General Data:	
Dimensions (mm)	L =260 W = 127 D = 38
Material	Powder - coated aluminium
Operating Temperature	-20 to + 65 Deg C
Data Types	
Digital port	RS-485, 9600 Baud, 8-bit, 1 stop bit, even parity - other speeds on request
CE conformity	CE conformity according to EN 61000-6
Weight	500 g
Digital communications	
Terminal port	9-way male - 9600 Baud 8 data, no parity, N stop
RS485 port - Modbus	9600 baud, 1 start bit, 8 data, even parity bit, 1 stop

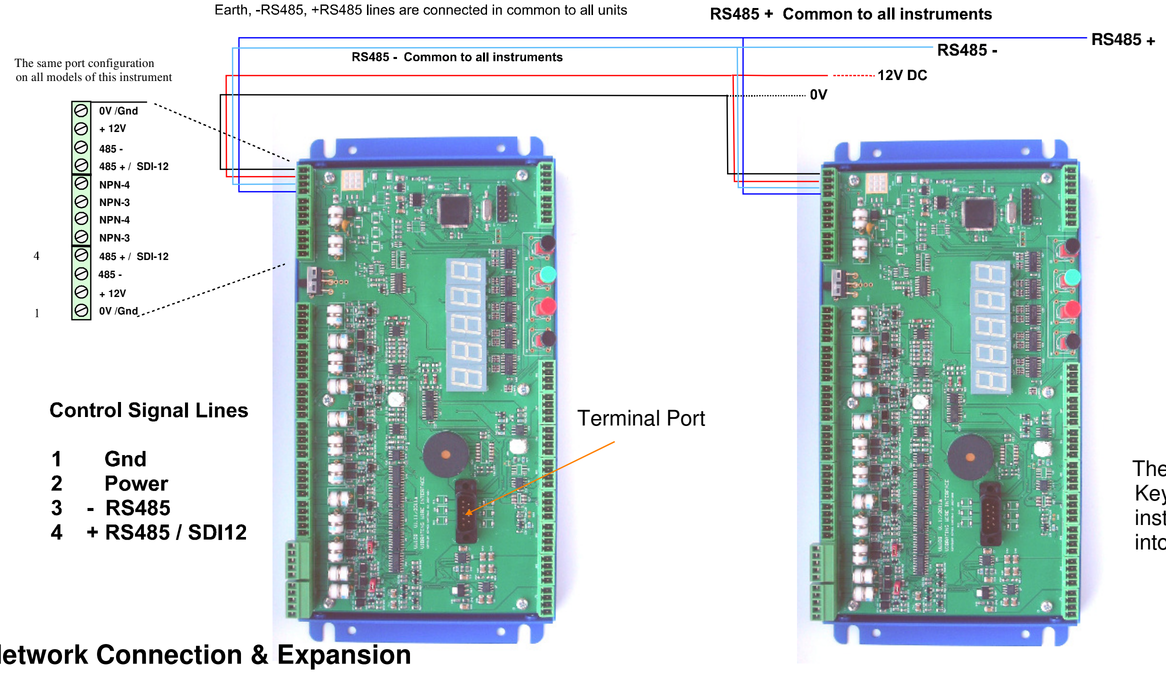
Network Connection & Expansion

The image opposite shows how the VibWire-108-Modbus interface is connected to the USB-485-Pro isolated media converter.

The USB-485-Pro is the simplest device to be can be used with this product as it not only converts the 485 network to USB for reading on a PC/Laptop, but also can power up-to 2 devices directly from the USB port.

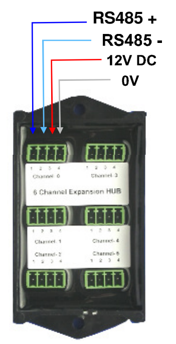
Any SCADA system running a Modbus Client can talk to the devices are





Control Signal Lines

1 Gnd
2 Power
3 - RS485
4 + RS485 / SDI12



Part No. Hub-6-Port

The expansion hubs are supplied by Keynes Controls to simplify installation of multiple the instruments into enclosures and panels.

Network Connection & Expansion

The Modbus operations are transparent over the 485 network.

Floating Point Data Value

2 Bytes	2 Bytes
High Word	Low Word

The USB-485-Pro media converter is shown in the diagram above, however any other similar device can be used.

The VibWire-108-Modbus instrument operates as a master /slave system where the SCADA system or data recorder is the master and the instrument acts as the slave. The device scans the input channels once powered and updates the data registers after completing any new measurements.

The number of channels scanned, and so the time taken to make a complete scan is set directly into the instrument via the push buttons or using the terminal port.

Like all other Modbus products use a series of registers to hold measurement data. These registers are updated are after each scan and data is sent to the Master on receipt of the

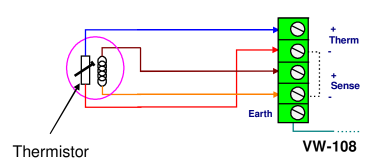
The registers are updated are after each scan and data is sent to the Master on receipt of the FC=04 command.

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

Address Offset	Parameter	Description
16	Chan-0 Temp	High Order word
17		Low order word
18	Chan-1 Temp	High Order word
19		Low order word
20	Chan-2 Temp	High Order word
21		Low order word
22	Chan-3 Temp	High Order word
23		Low order word
24	Chan-4 Temp	High Order word
25		Low order word
26	Chan-5 Temp	High Order word
27		Low order word
28	Chan-6 Temp	High Order word
29		Low order word
30	Chan-7 Temp	High Order word
31		Low order word

Sensor Connection Circuit

Figure 14A



The diagram above shows how the VW sensor is connected to a VibWire-108 input channel in 4 x Wire mode.

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

Response:

03 04 04 000A F8F4

03: The slave address (03 = 03 hex)
04: The function code (read analogue input registers)
02: The number of data bytes to follow (2 registers, 32-bit floating-point)
0000: The contents of register 30001, first frequency output
F8F4: The CRC (cyclic redundancy check - this will vary)

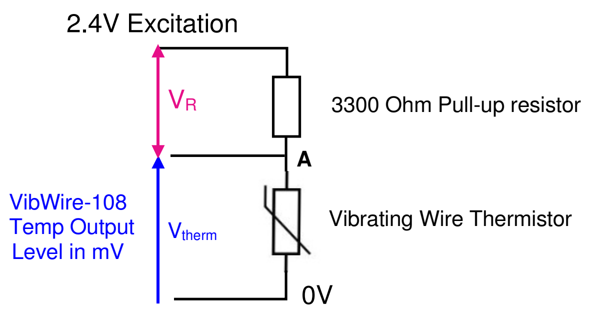
Temperature Value Conversion to Engineering Units

The following section details how the instrument determines thermistor resistance values for a vibrating wire thermistor connected to the temperature input of the device.

The current version of the instrument firmware only stores 2 different temperature sensor configuration options.

Refer to the ‘**User Manual**’ for setting up the thermistor inputs,

The circuit below shows the VibWire-108 temperature input with pull-up resistor completion



The VibWire-108-mobus uses 2.4 V excitation for the sensor thermistor.

V_{therm} = Voltage across thermistor

V_R = Voltage across pull up resistor

Example. A VibWire-108 provides an output temperature value of 1086 mV then

$I_{therm} = (2.4 - V_{therm}) / 3300$ where 3300 = pull-up resistor value

therefore

$I_{therm} = (\text{Excitation volt} - V_{therm}) / 3300_{(\text{Pull-up Resistor})} = (2.4 - 1.086) / 3300 = 1.414 / 3300 = 0.398$ mA

using Ohms Law

Note 1086 mV = 1.086 Volts

The Resistance of the Thermistor is calculated

$R_{therm} = V_{therm} / I_{therm} = 1.086 / 0.000398 =$ 2727.4 Ohm

Now 2727.4 ohms is the resistance of the thermistor at the at temp (T)

Temperature Conversion

The thermistor resistance value is converted to temperature using the Steinhart-Hart Equation.

$$T = \frac{1}{C_1 + C_2 . \text{In}\backslash R_{therm} + C_3(\text{In}R_{therm})^3}$$

where T = absolute temperature in Kelvin R_{therm} in Ohms.

Conversion to Deg C is

$$T(C) = \frac{1}{C_1 + C_2 . \text{In } R_{therm} + C_3(\text{In}R_{therm})^3} - 273.15$$

The sensor data sheet will show for the thermistor a calibration equation similar to that below. The values for the parameter C_1, C_2, & C_3 will be listed.

$$(1/T) = C_1 + C_{2.} \text{Ln}(R_{therm}) + C_{3\,.} \text{Ln}(R_{therm})^3 - 273.15$$

Example

In Vibrating Wire sensors is the 44005RC Precision Epoxy NTC Thermistor is commonly used for temperature monitoring applications.

The data sheet for this product can be downloaded at

http://www.aquabat.net/downloads/1350009-2.pdf – The thermistor data sheet is valid to 11/12/2013 refer to the manufactures data sheet for the latest information.

An example Excel spreadsheet that demonstrates the temperature calculations can be downloaded at

http://www.aquabat.net/downloads/ThermistorWorksheet.xls

Example

The VibWire-108 is can be set to give ratiometric or mV temperature values from the built in thermistor of a vibrating wire sensor. depending upon the sensor configuration. Ratiometric values are calculated between the 3300 Ohm pull up resistor and thermistor resistance and is value between 0 – 1. The Vibwire-101 has returned a value of 0.663 from the thermistor.

In the spreadsheet below the VW-108 gives a temperature value (Ratiometric) of 0.663. The constants A, B and C are from the calibration data sheet. The spreadsheet below shows the temperature to be 7 Deg C,

ThermistorWorksheet.xls Screen image

Calculation of temperature based on voltage ratio

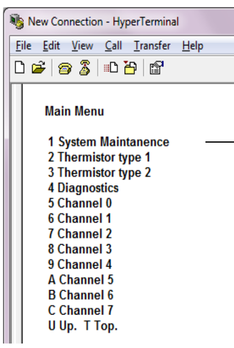
Voltage ratio	0.663	Input
Excitation (Ohm)	3300	Fixed
Thermistor resistance	6905	Calculated
Thermistor R0	3000	Thermistor property
A	1.41E-03	Thermistor property
B	2.37E-04	Thermistor property
C	1.02E-07	Thermistor property
Inv Temperature	3.57E-03	
Temperature (Celsius)	7.0	Calculated value

Steinhart-Hart Calibration Parameters obtained from calibration data sheet.

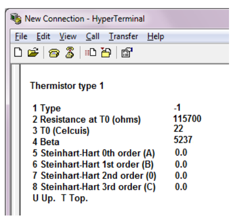
Temperature value

Terminal Port Menu System

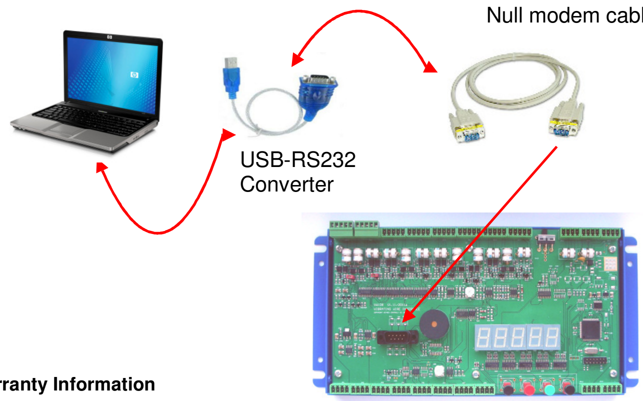
The terminal port menu system enables the the VibWire-108 to be fully configured using a simple pull down menu system. All the inputs can be individually setup and the results supplied in Engineering SI units. No programming is required to configure this device.



Thermistor Type-1 Option



Terminal Port Connection



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Dimensions of the VibWire-108 Back Mounting Panel

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