# VibWire-301

Single Channel Vibrating Wire Sensor Interface

Last Updated October 8th 2023

## Introduction

The VibWire-301 is a general purpose, DIN rail mounted single channel vibrating wire sensor interface that can be used in a wide range of applications. The VW-301 can be directly connected to any third party data logger or acquisition system supporting SDI-12, RS-485 and Modbus digital communications, as well as analogue measurement capabilities. The device also supports 4-20 mA current loop operations.

The VibWire-301 uses the Keynes Controls auto-resonance Sensor Excitation technique, therefore no prior knowledge of the sensor operating characteristics is required. The device can be directly connected into many third party SCADA systems using the 4-20 mA current loop and Modbus operations..

## Easy Use

The VibWire-301 is the latest in a range of Keynes Control vibrating wire sensor interfaces. The device has been designed from the outset for accuracy of measurement, ease of use, flexible use of communication systems.

The Auto-resonance sensor excitation ensures that no prior vibrating wire sensor operating characteristics need be known in advance, and the minimum wear for sensors.

## Network Interfaces

The VibWire-301 supports SDI-12, RS-485, Analogue output (0-2 V DC), and 4-20 mA current loop operations in the same unit. The 4-20mA current loop output is supplied for both the frequency and temperature sensor signals

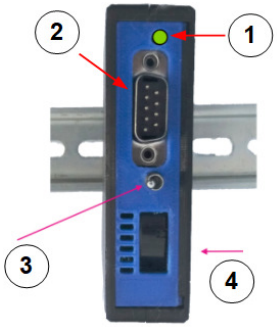
## DIN Rail Installation

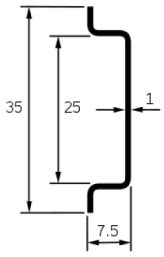
The VibWire-301 is installed into enclosures using industry standard DIN rail. A clip on the bottom of the unit secures the device to the rail. A DIN rail mounted device enables fast installation, and replacement as necessary.

## PC Based Data Acquisition

The VibWire-301 is fully integrated into the free Keynes Controls Q-LOG Data Acquisition and Display Software enabling the device to be used as a component part within a PC based Vibrating Wire sensor data acquisition system. The software can be used to configure, display and record measurements across a network.

**VibWire-301 in a PC Data Acquisition System**




Top Hat rail IEC/EN 60715

1. LED Status Indicator
2. RS232 Terminal Port
3. Speaker Switch
4. Speaker

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

The Status LED shows the User at a glance how the device has been configured.

## Features

1 x 4 Wire Sensor Port
Isolated Sensor Input Ports - 1000V DC
Communications: SDI12 / RS485 / 4-20 mA / 0-2V DC / Modbus
Auto-resonance Sensor Excitation
400Hz to 15 KHz Range
Full User Configured Outputs - Hz , Digits, SI Units
Fully Integrated into the Q-LOG Data Acquisition Software
Supports 2 and 4 Wire Sensors
Analogue Output 0 to 2 V DC Frequency and Temperature
Current Loop 4 to 20 mA Outputs
DIN Rail Mounted Device
MODBUS over RS485

## High Speed Measurements

The VibWire-301 is capable of high speed sensor measurements. The basic model supports as standard 10 readings a second with the measurements stored directly into CSV file format.

## Concurrent Measurements

The VibWire-301 is capable of simultaneous sampling operations for units on a network. The device supports the 'Concurrent' C! Command.

## Q-LOG Windows PC Data Acquisition & Display Software

A complete version of Q-LOG without any restrictions can be download from
http://keynes-controls.com/Download/QLogSetup50_21may2020.zip

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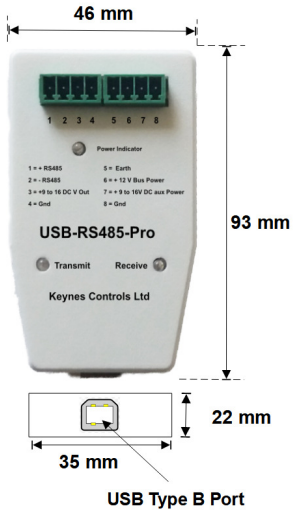
## Technical Specification

| | |
|---|---|
| **Physical Size** | Height 120 mm - Width 100 mm - Depth 22 mm |
| **Weight** | 125 g |
| **Power Supply** | 8-15 V DC |
| **Communication Ports** | 1 x RS-485 Slave - 9600 Baud, 8 data, 1 stop, no parity<br>1200 Baud, 7 data, 1 stop, even parity<br>1 x SDI-12 - - 1200 Baud, 7 data, 1 stop, even parity |
| **External Power Supply** | 8 - 15V DC @ 22 mA |
| **Vibrating Wire Measurements** | |
| **Analogue Input** | 24 Bit Sigma Delta |
| **Sensor Excitation** | Auto-resonance - Fully automatic frequency selection |
| **Operating Frequency** | 400 - 15 KHz |
| **Measurement Resolution** | 0.01 Hz RMS - 20 to 70 Deg C |
| **Measurement Accuracy** | ± 0.014% of reading - 20 to 70 Deg C |
| **SI Units** | Hz, Digits ($Hz^2$/1000), Eng Units (Quadratic Cal Factors) |
| **Temperature Measurements** | Thermistor Temperature Sensor |
| **Analogue Input** | 24 Bit Sigma Delta |
| **Analogue Output** | 0 - 2 V DC / 4-20 mA Temperature and Frequency |
| **Current Loop Isolation** | 500V DC |
| **Temperature Range** | - 50 to 100 Deg C |
| **Measurement Accuracy** | ± 0.25 % of reading - 20 to 70 Deg C |
| **Output** | Temperature - Deg C<br>Frequency (Hz), Digits, SI Units |
| **Temperature Sensor** | Steinhart-Hart factors: A B C & D<br>Beta Value - lower performance using Beta |
| **Expansion Options**<br>**1 x MUX-16/32 expansion unit** | 1..32 - 2 X Wire Frequency or Temperature,<br>1..16 - 4 Wire vibrating wire sensor inputs |
| **Scan Rate: Dynamic** | 10 - 20 Samples/ Sec (9600 B RS-485) - 10 Hz Analog Out<br>2 Sec/Chan - using expansion module<br>250 ms update |
| **16 x 4 Wire / 32 x 2 Wire** | 30 Sec, 1 minute. |

## Optional USB Media Converters

An optional media converter can be used to connect the VibWire-301 to a Windows PC using either the SDI-12 or 485 digital networks.




**Part No: USB-485-Pro Isolated RS-485 Media Converter**
**USB-SDI12-Pro Isolated SDI12 Media Converter**

The vibrating wire sensor calibration factors can be assigned using the Q-LOG software in a Windows Environment

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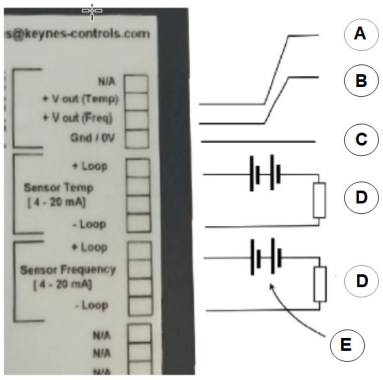
## Analogue Output Ports / 0-2 V DC / 4-20 mA Loop




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

### Connection to a Data Logger

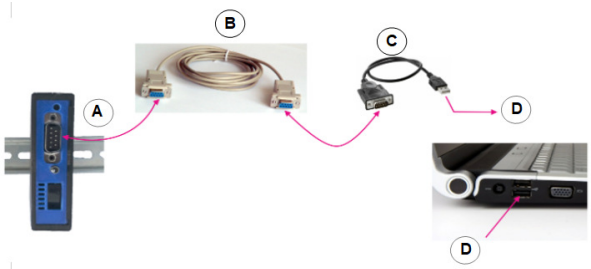
The VibWire-301 connects to any third party data logger supporting SDI-12, 485 Communications or directly onto an analogue data acquisition.

### Analogue Output Ports -- 0..2 V DC / 4..20 mA Loop

The analogue output ports, regardless of type, can be scaled to represent any measurement value in Hz, Digits and SI units for the frequency components, and Deg C for the temperature signal.

The device has isolated loops for both the frequency and temperature signals..The current loop opto-isolation prevents signal corruption due to ground loops.

### Terminal Port Communications Setup




The VibWire-301 can be fully configured using the Terminal Port Menu system built into the device and accessed using the RS-232 Port mounted on the front of the device.

No device drivers are required when configuring the device using the RS232 port

**A** = RS232 Terminal Port Connection **B** = Null Modem cable
**C** = RS232 to USB Converter **D** = PCB USB Port

**SDI-12 1200 = 1200 Baud, 7 , E, 1 Stop**
**RS485 1200 = 1200 Baud, 7 , E, 1 Stop**

**RS232 Terminal Port** - 9600, 8, N,1,STOP

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## Q-LOG Data Acquisition, Configuration and Display Software

Q-Log is the Keynes Controls Data Recording and Display software and has been designed solely for use with intelligent sensors and interfaces. The software operates as a stand-alone package and requires the use of an SDI-12, or RS-485 media converter. Q-LOG enables PC based systems to be created and tested. The software is free issued with the Keynes Controls instrumentation.

Common Keynes Controls device identifier strings.

| Product | ID string |
|---|---|
| VibWire-201-Pro | 13KEYNESVWRDOA001 |
| VibWire-101 VW sensor interface | 13KEYNESCOVW101A011 |
| VibWire-108 VW sensor interface | 13KEYNESCOVW108A016 |
| PIEZO-RM water level sensor | 13KEYNESCOPRESR001 |
| Barom-SDI-12 barometer | 13KEYNESCOBAROMR003 |
| I-P-I | 13KEYNESCOIPINCL005 |
| AquaDAT sensor interface | 13KEYNESCOAQUDAT008 |
| Single channel strain gage | 13KEYNESCOSTRAIN027 |

**Q-LOG Devices List Window.**

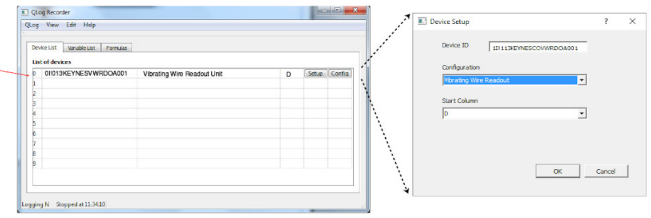
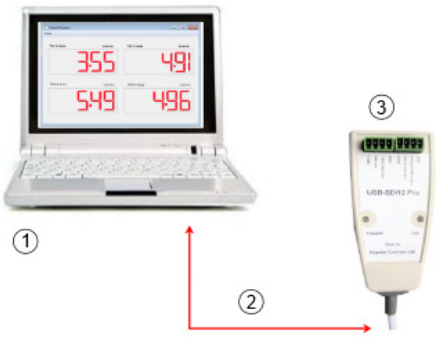


Fig-16

Image opposite demonstrates how the VibWire-301 is identified in Q-LOG. All the devices that are detected on a network are shown here.

## Windows PC based Data Acquisition Systems

The simplest Windows PC based vibrating wire sensor solution is shown below. A Windows PC running Q-LOG and an isolated USB media converter..



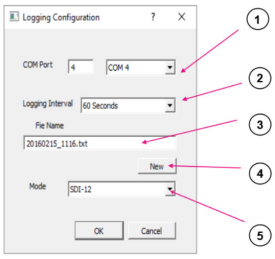

1. **Windows PC running Q-LOG**
2. **USB Data Link**
3. **Optional Media Converter**

Part Number: USB-SDI12-Pro ( SDI12 Network)
USB-485-Pro ( RS485 Network)

The Keynes Controls media converters can power the VibWire-301 directly from a laptop / Desktop USB Port without the use of an external power supply.

## Configuration

The measurements are recorded into unique time stamped text files that can be read by a spreadsheet. Information is easy to understand and process.




**Q-LOG Network Configuration Window**

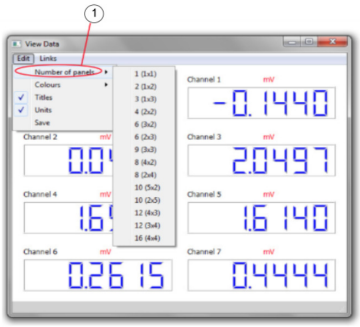
**YOUTUBE**

Youtube: https://youtu.be/pxOO7UZbX5g

## Q-LOG Data Display

The Q-LOG software can be used to:

1. Display Results in - Hz / Digits / Engineering Units
2. Real-time Charts.
3. User Defined Panel meters




**Q-LOG Panel Meter Selection Window**

No programming experience is required. The sensor calibration factors can be written directly into the device. Their panel meters can be used to display sensor results.

**Youtube Video Title: VW-301 Qlog Basic Operations**

See: https://youtu.be/gWV1D8KPPfc

## Data Acquisition and Testing

The Q-LOG software is an ideal tool for testing measurement systems in the workshop before installation on site, Sensors can be configured, test measurements made, results displayed for easy analysis.

Confidence can be made in the measurements before any installation onto data recorders or site wide monitoring systems.

### Configuration Settings

1. Enter Comm Port identified for USB media converter
2. Data Recording Sample Rates
   - **(1, 5, 10 Secs, 1 to 10 minutes, 1 and 6 Hours )**
3. Time stamp Log FIlename
4. New Button
   - Automatically create a new time stamped log file.
5. Network Type Selection - SDI-12 / RS-485.

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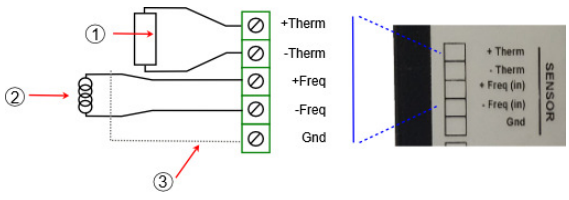
## SDI-12 / RS-485 Supported Commands

The following commands are supported by the VibWire-301 and are used by data loggers and data acquisition systems. The commands have been included to allow the VibWire-301 to operate easily with third party data loggers that support industry standard SDI-12 command set.

**Start Measurement:** M0! D0! – is the main command required to start a measurement and return the data to a logger unit or PC data acquisition system.

| Description | Master | VibWire-301 Response |
|---|---|---|
| Acknowledge active | a! | a\r\n |
| **Send ID:**<br>provided to complement SDI-12 protocol | aI! | a13KEYNESVWRDOA001\r\n<br>Part Description assigned by Keynes |
| **Address Query**<br>identifies instrument address and commonly used on single instrument operations only. | ?!<br><br>Used to make command set SDI-12 compatible | a\r\n<br><br>Where a = ID number<br>0 - 9 (standard) / (a..z) Enhanced SDI-12<br>0 - 9 / a - z for RS485 |
| **Change Address:**<br>used to change instrument address from a (initial) to b new ID for network operations | aAb!<br><br>a = initial address b = new address | b\r\n<br><br>**a** : **b** = number 0 - 9 or a - z |
| **Start Measurement**<br><br>instruct an instrument to make measurement | aM!<br><br>**a** = address of instrument<br>example 0M! starts scan for ID 0 | a0261\r\n ****<br><br>instrument with address a returns 1 x 4 wire reading in 1 second. |
| **Concurrent measurement:**<br>Used for starting a measurement for all instruments on a network at the same time.<br><br>This command frees RS-485 bus for other devices | aC!<br>start measurement instrument address 'a' | a0268\r\n<br><br>initial response only after receipt of instruction and no response when data ready to be sent. |
| **MUX-16/342 Expansion Unit** | 32 x 2 Wire Measurements<br>**aM2!** aD0! aD1! aD2! aD3! - 16 x Freq<br>**aM3!** aD0! aD1! aD2! aD3! - 16 x Freq<br><br>16 x 4 Wire Measurements<br>**aM2!** aD0! aD1! aD2! aD3! aD4! aD5! aD6! aD7!<br>D0-D4 = Frequency D4-D7 = Temperature | +xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n |
| **Thermistor 1 & 2** | VibWire-301 supports 2 thermistor types | |
| **Thermistor Type 1**<br>Temperature sensor settings<br><br>Parameters from the sensor calibration sheet<br>Steinhart-Hart Parameters<br>Thermistor resistance/temp calculation | aXT1RE!<br>aXT1T0! = 25<br>aXT1BET!<br><br>aXT1ST0!<br>aXT1ST1!<br>aXT1ST2!<br>aXT1ST3! | Resistance at 25 Deg C<br>T0 - generally 25 Deg C<br>Beta Value<br><br>A in Steinhart-Hart<br>B in Steinhart-Hart<br>C in Steinhart-Hart<br>D in Steinhart-Hart |
| **Thermistor Type 2**<br>Temperature sensor settings<br><br>Parameters from the sensor calibration sheet<br>Steinhart-Hart Parameters<br>Thermistor resistance/temp calculation | aXT2RE!<br>aXT2T0! = 25<br>aXT2BET!<br><br>aXT2ST0!<br>aXT2ST1!<br>aXT2ST2!<br>aXT2ST3! | Resistance at 25 Deg C<br>T0 - generally 25 Deg C<br>Beta Value<br><br>A in Steinhart-Hart<br>B in Steinhart-Hart<br>C in Steinhart-Hart<br>D in Steinhart-Hart |
| **VW Sensor Input Channel Settings**<br><br>Sets the process option for frequency calculations | aXCH0FN!<br><br>F = Frequency type<br>N = VW Channel 0 .. 7 | 0 = output in Hz<br>1 = output in digits = $F^2/1000$<br>2 = use formula<br>A + B*digits + C*digits$^2$ + D*temperature<br>digits = Frequency$^2$ in units of Hz$^2$ |
| **Thermistor Temperature Calculation** | aXT1TYn!<br>a = ID n = integer 0 .. 2 | 0 = resistance ratio - thermistor data sheet ($R_t/R_{25}$)<br>1 = Beta value calculation<br>$1/T = 1/T_0 + \log(r)/Beta$ where $r = R_t/R_{25}$<br>2 = Steinhart-Hart equation<br>$1/T = A + B(\text{Ln } R_t/R_{25}) + C(\text{Ln } R_t/R_{25})^2 + D(\text{Ln } R_t/R_{25})^3$ |

### Sensor Connection




1. Thermistor Temperature Sensor.
2. Vibrating Wire Sensor.- 2 or 4 Wire.
3. Earth / Shield.

### Calculations

The VibWire-301 can be configured to convert frequency into engineering units. The common calculation for vibrating wire sensors uses Digits. Keynes Controls defines the Digits calculation as:

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

**SI Units Calculation** $X = A + Bd + Cd^2 - D(T - T0)$

where **d** = measured frequency in Digits.
and **D** = Temperature Correction Coefficient
**T** = Temperature in Deg C
**T0** = Calibration Temperature of sensor typically 25 Degree Celsius

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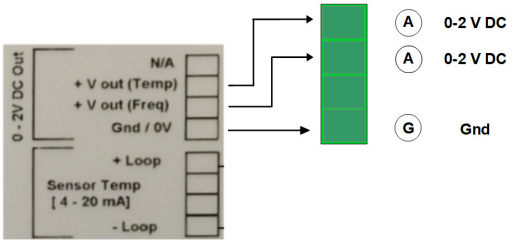
## High Speed Measurements - 4-20 mA / 0 - 2 V DC

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

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

### Analogue Output Port Connection




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

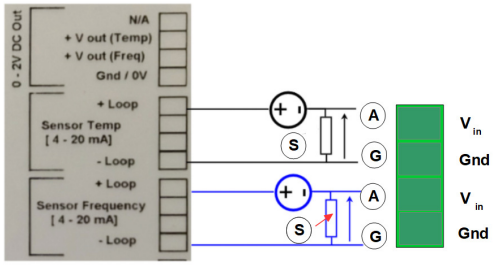
The menu system below are the default settings for a vibrating wire sensor operating over the range 500 - 1300 Hz as used by the Geokon 4200 sensor.

**Sensor Setup**

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

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

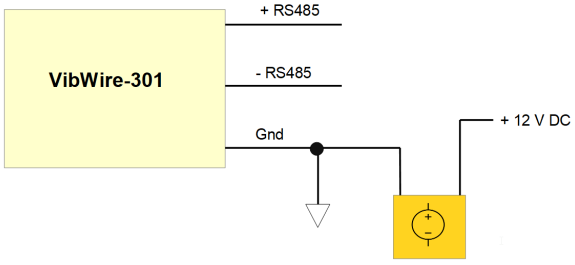
### Current Loop Port 4-20 mA




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

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

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




Power Supply

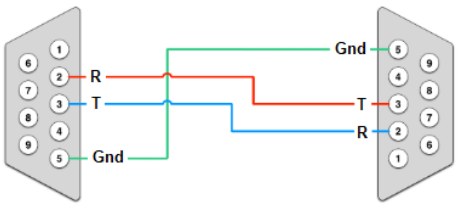
### Power Supply / Earth Connection

Connect the VibWire-301 to a power supply as shown in the figure opposite.

The 0V / Gnd connection of the DC power supply connects to the Gnd connection on the VibWire-301

Incorrect power supply connection can stop the VibWire-301 from operating correctly.

### NULL Modem Cable - Pin-outs




A 9-Pin Null-Modem cable connects the 9-PiN D connector port on a USB to RS232 converter to the terminal port on the instrument.

where R = Receive
T = Transmit
Gnd = Ground.

## MODBUS Registers

### 16 / 32 Bit - MODBUS Data Format

The MODBUS version of the instrument stores data into a series of 4 byte registers as shown below. Measurements are processed as a floating point 4 byte number. The data is in HEX format with the high word being the first 2 bytes and the last being in the next 2 bytes as shown.

The VibWire-301 supports both 16 and 32 bit format MODBUS registers.

### System Information

The last 2 registers in the VibWire-103 are used to check the data integrity. Register with address 32 increments upon the completion of an instrument scan and is used to show that the instrument is still operating.

Register with address 34 increments when the VibWire-301 receives a new MODBUS 'Read Input Registers' FC=04 command. .

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

| | 2 Bytes | 2 Bytes |
|---|---|---|
| **Floating Point Data Value** | High Word | Low Word |

#### 32 Bit Floating Point Registers

The table below shows how the registers holding the VibWire-301 32 bit (floating point) data is stored.

| Address Offset | Parameter | Description |
|---|---|---|
| 0<br>1 | Frequency Signal | High Order Word<br>Low Order Word |
| 16 | Temperature | High Order Word<br>Low Order Word |
| 32 | Number MODBUS read operations | High Order Word<br>Low Order Word |
| 34 | Number of Scans | High Order Word<br>Low Order Word |

#### 16 Bit Integer Registers

The table below shows how the registers holding the VibWire-301 16 bit - Integer data is stored.

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

| Address Offset | Parameter | Description |
|---|---|---|
| 128 | Frequency Signal | Integer Word |
| 136 | Temperature | Integer Word |
| 144 | Number MODBUS read operations | Integer Word |
| 145 | Number of Scans | Integer Word |

The MODBUS registers follow the same format as used by the model VibWire-108-MODBUS instrument.