VibWire-108

Vibrating Wire Sensor Interface Unit

User Manual Version 1.03 - 2006

Introduction

The following document details the model types, configuration and operational features for the Keynes Controls VibWire-108 range of vibrating wire sensor interface. The instrument is a general purpose interface unit and supports sensors from all of the major manufacturers.

Each of the VibWire-108 units contains 8 x 4 wire sensor inputs The sensor input consists of two inputs for the sensor coil and 2 for the associated thermistor temperature sensors.

This document shows all the different hardware configurations and User options available for the operation of the instrument.

Hardware Options

VibWire-108-RS485	with RS 485 serial comms
VibWire-108-SDI12	with SDI-12 serial comms
VibWire-108-GPRS	with integrated GPRS modem
VibWire-108-TRN24	with 2.4 GHz spread spectrum transceiver.

All systems are supplied with on-board frequency display and a speaker also with or without analogue output ports.

Instrument Scanning Operations

The VibWire-108 is a multiplexed instrument and scans each channel for approximately 2 seconds before working out the sensor frequency and moving on to the next channel. Only after all of the sensor inputs are scanned are the results made available for data transmission across the various communications networks or analogue output interface.

The only time the sensor inputs have any configuration parameters defined is when the analogue output channels are to be used.

Using the instruments to take readings and transmit across a cable free data links such as the GPRS mobile phone network or across the RS-485/SDI-12 serial links then the sensor measurement to data transmission is purely a digital process with no sensor configuration parameters being set or required. Simple install the sensors and read the information.

Power Consumption

All of the VibWire systems use advanced power management operations to minimise the power consumption and so make the instrument ideal for stand-alone remote applications. Power requirements are:

Power Supply	11-18V DC @ 0.25A
Scanning mode:	70mA aprox 30 seconds / scan
Display mode:	90mA continuous
SDI-12/RS485 network::	Waiting for command 20mA continuous
Analog output mode:	25mA continuous
GSM/GPRS	Idle 2mA normal state
GSM/GPRS	Active as above approx 1 minute / reading
GSM /GPRS	Transmitting 100mA typ 300ms / reading
GSM/GPRS	Peek (impulsive) 800mA 2 ms
2.4 GHz Cable Free	Idle 50uA communicating 40mA 2 seconds / reading
Solar Panels	4.8W cell gives 1 Reading /Hr indefinitely for GPRS & 2.4 GHz cable free operation

CE

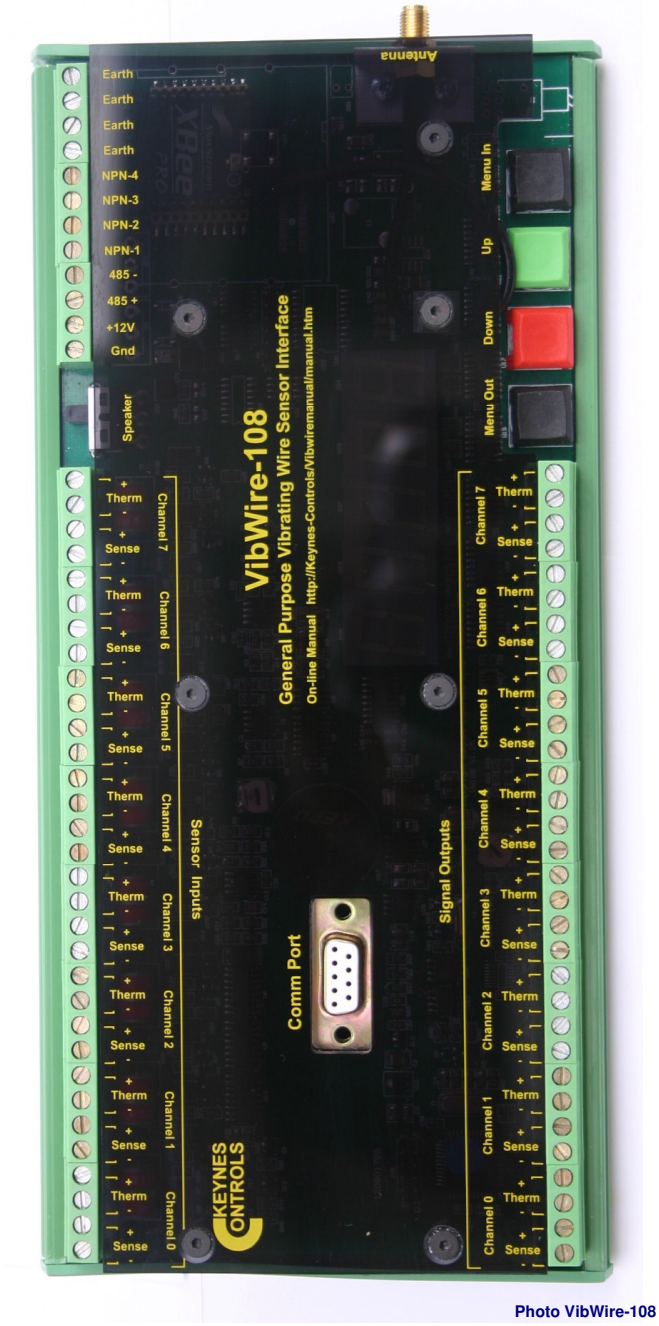

Photo VibWire-108

Field Operations

There are various VW-108 models available offerings cable free, GPRS modem, SDI-12/RS-485 serial port communications and analogue outputs. All instruments no mater the model contain an on board frequency display, ceramic speaker and User keyboard.

In order to ensure that the VibWire-108 systems operate as reliably as possible they all contain lightening protection on sensor inputs and isolated serial ports for digital data transmission.

The VibWire-108 series of instruments support everything needed to make and report accurate vibrating wire sensor readings and also to act as local display and diagnostic tool and report data across all of the most common communication interfaces and data transmission networks.

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Hardware Configuration Options

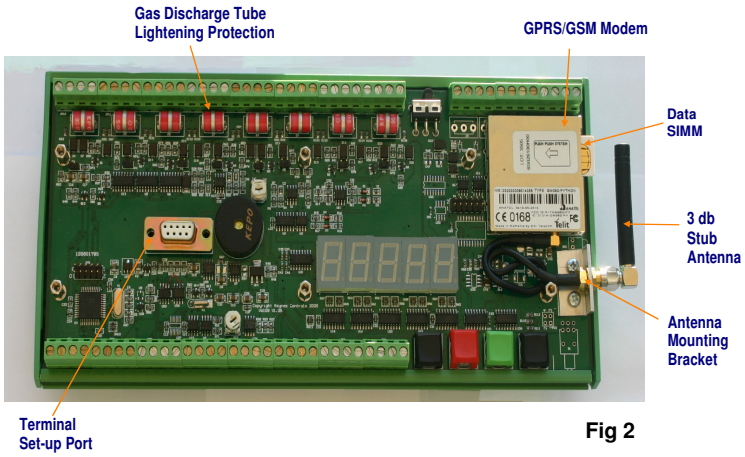


Fig 2

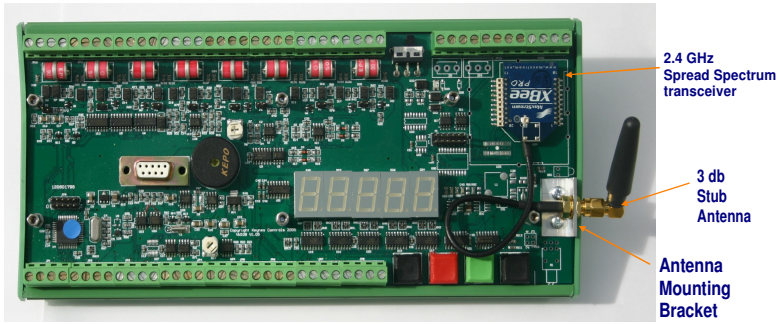


Fig 3

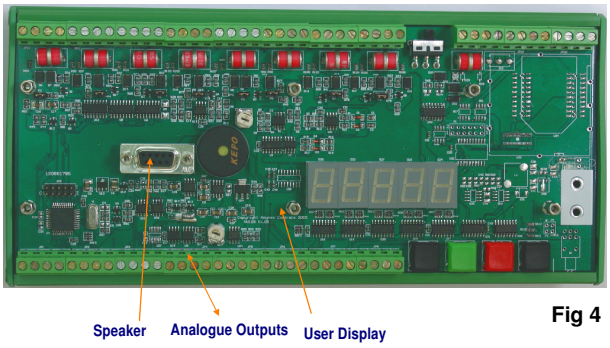


Fig 4

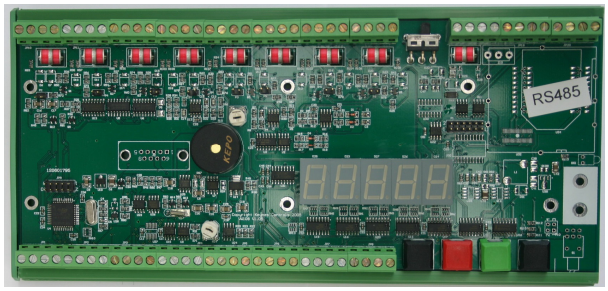


Fig 5

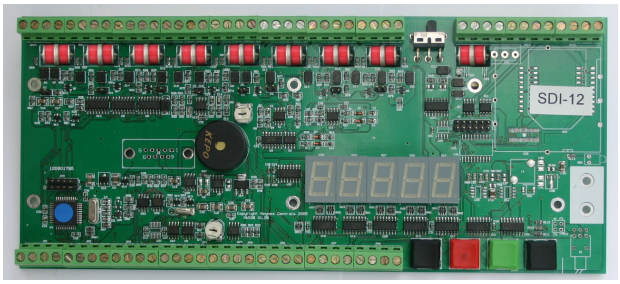


Fig 6

The following page summerises the physical differences between the different VibWire-108 models. Use the photographs below to confirm the instrument part number.

Model VibWire-108-GPRS

Figure 2 shows the VibWire-108-GPRS with integrated GPRS modem.

VibWire-108-GPRS 8 Channel unit GPRS communication only
VibWire-108-GPRS/A 8 channel unit GPRS modem & Analogue output

The analogue output version of this instrument can be connected to any data logger or acquisition system.

The instrument can act as a vibrating wire logger in the periods of inactivity before making a connection to the GPRS network and to maintain information should the GPRS network fail to connect.

Model VibWire-108-TRS24

Figure 3 shows the VibWire-108-TRS24 with integrated 2.4 GHz spread spectrum transceiver

VibWire-108-TRS24 8 Channel unit with embedded 2.4 GHz spread spectrum transceiver communication only
VibWire-108-TRA24/A 8 channel unit with 2.4 GHz transceiver & analogue outputs.

The transceiver can be configured for point-to-point or mesh network data transmission.

Model VibWire-108

The most basic VibWire-108 model that only supports analogue output representation of the sensor signal. This model is the lowest cost vibrating wire interface in the VibWire-108 range.

VibWire-108 8 x Analogue Channel output only.

All units contain the frequency readout display as standard.

Model VibWire-108-RS485

VibWire-108-RS485 with integrated RS-485 serial network port.

VibWire-108-RS485 8 Channel unit with RS485 serial comm. port
VibWire-108-RS485/A 8 channel unit with RS485 port and analogue output.

This version of the instrument supports direct connection to a RS-485 multi-drop serial port network. Data can be read using any standard RS-485 network interface card.

Model VibWire-108-SDI12

VibWire-108-SDI12 with an integrated RS-SDI-12 serial network port. Fully compatible to any logger supporting SDI-12 networks.

VibWire-108-SDI12 8 Channel unit with SDI-12 serial comm. port
VibWire-108-SDI124/A 8 channel unit with SDI-12 port and analogue output.

This version of the instrument supports direct connection to a SDI-12 multi-drop serial port network.

SDI-12 Serial Network Connection

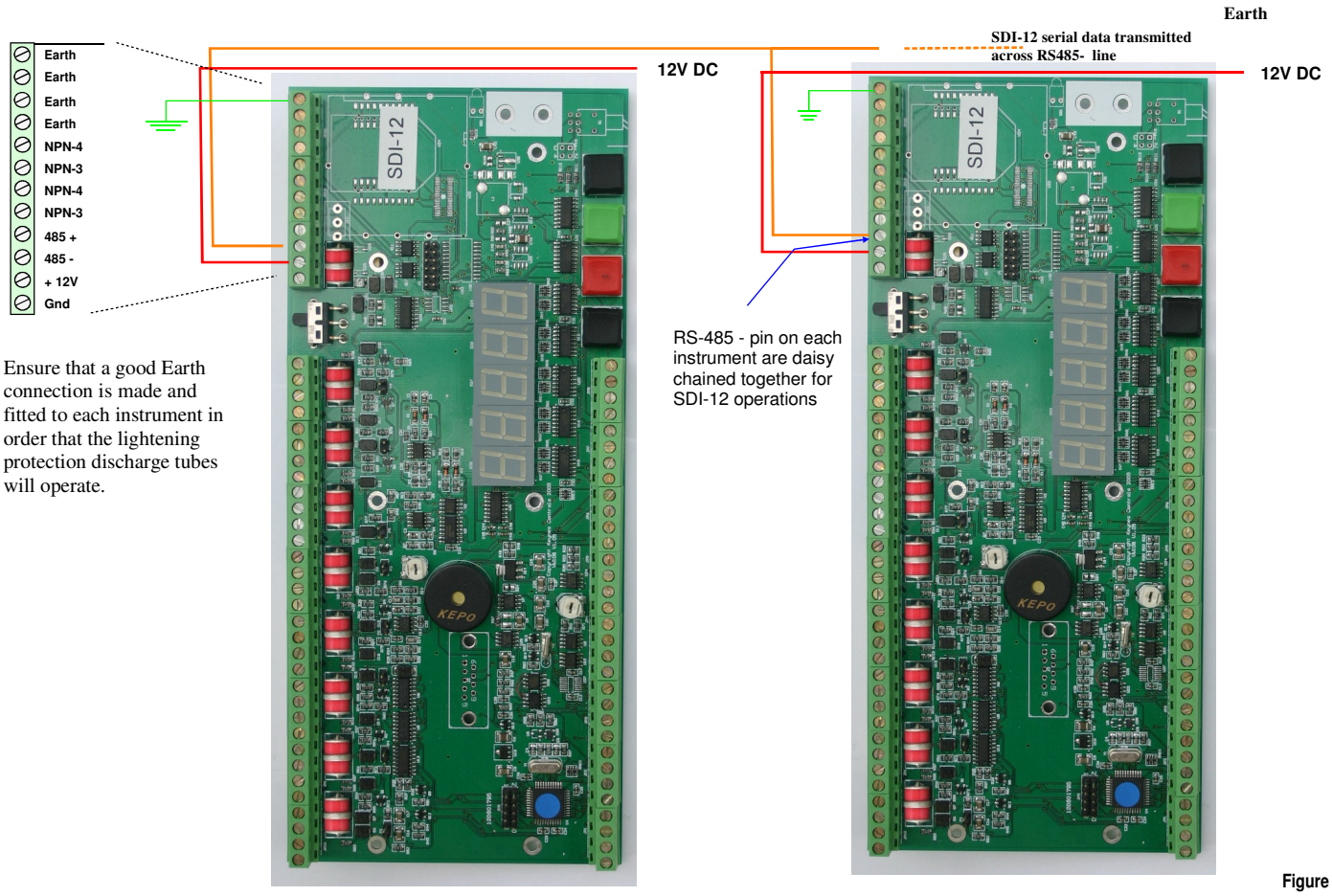


Figure 7

The SDI-12 multi-drop network requires only 1 wire to be connected between instruments for the communication of data. This ensures that the installation and use of the SDI-12 network very simple operation. The SDI-12 network has a limited range but is ideally suited when connecting instruments together within an enclosure or when systems are deployed locally.

Each instrument can have its own independent power supply but must have the two dedicated network wires connected as shown above in Fig 7. A unique instrument identifier has to configured in order to access data from a dedicated instrument. Any data logger supporting the SDI-12 network can obtain information from the VibWire-108-SDI12.

Starting SDI-12 Network Communications

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

1. Starting at

2. Select "**Menu In**" button

3. Use the Up & Down Keys to select the option "**Seral**"

   "**Analg C0d C1d C2d C3d C4d C5d C6d C7d**" are the other options available

   Once the "**Seral**" output is selected the "**Menu Out**" key has to be pressed to confirm this option.

4. The VW-108 will return to the display

   and now the SDI-12/RS-485 port for the instrument is now activated.

Instrument Identifier

Each instrument deployed on the SDI-12 multi-drop network must have a unique instrument identifier set in order to identify specific instrument on the network. For the SDI-12 network this identifier is 0-9.

See Page 8 for details on setting the ID number.

RS-485 Serial Network Connections

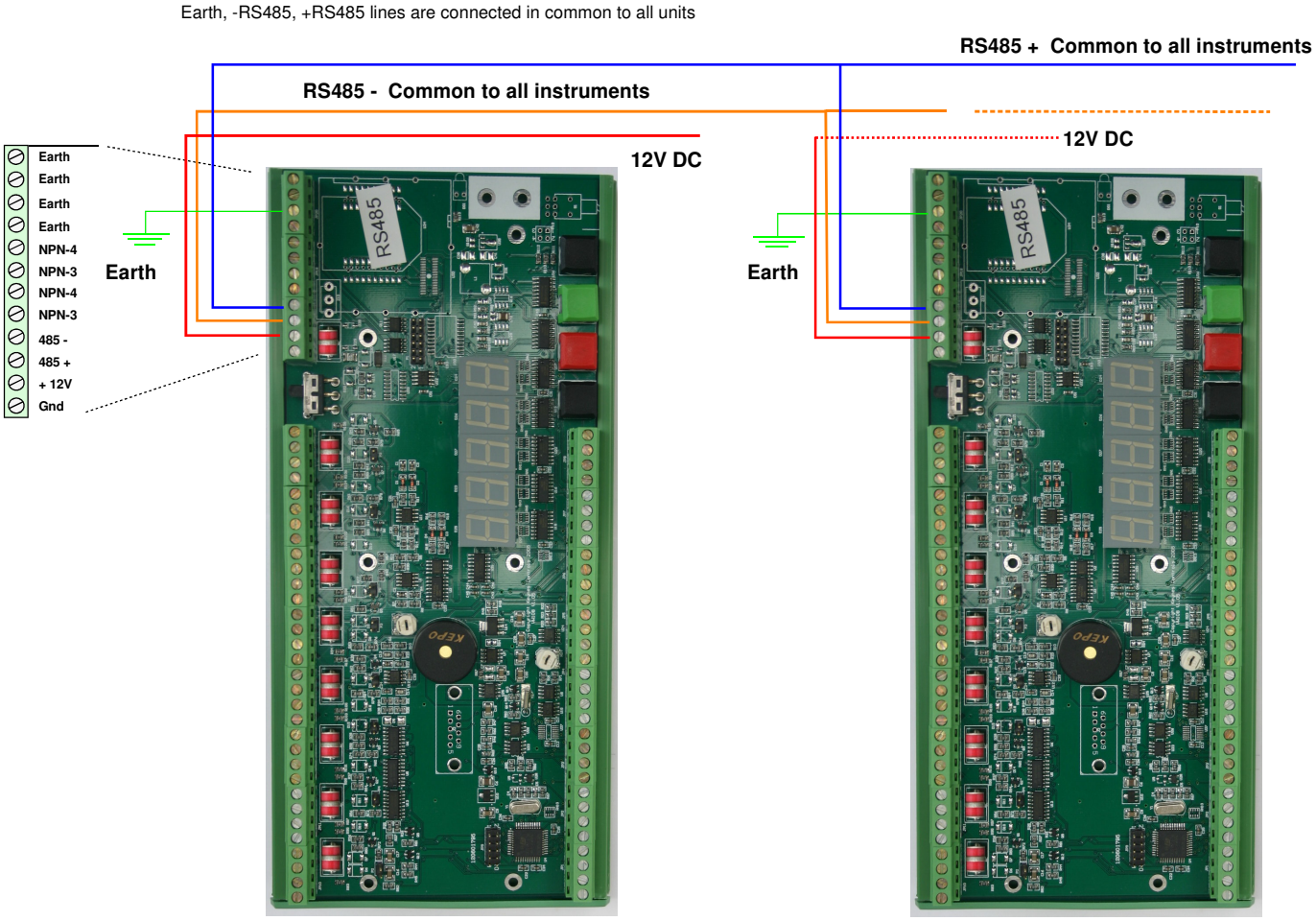


Figure 7

Starting Data Acquisition Operation on a 485 Network

To activate the SDI-12/ 485 output channels on the VibWire-108

1. Starting at

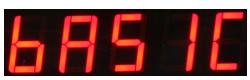
2. Select "**Menu In**" button

3. Use the Up & Down Keys to select the option "**SErAL**"

   "**Analg C0d C1d C2d C3d C4d C5d C6d C7d**" are the other options available

   Once the "**SErAL**" output is selected the "**Menu Out**" key has to be pressed to confirm this option.

4. The VW-108 will return to the display



   and now the SDI-12/RS-485 port of the instrument are now activated.

Instrument Identifier

Each instrument deployed on the RS-485 multi-drop network must have a unique instrument identifier set in order to identify specific instrument on the network. For the RS-485 network this identifier is 0-9 and a-z

See Page 8 for details on setting the ID number.

VibWire-108 Serial Port Communications

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

No sensor configuration details need be applied to the VibWire-108 when operating with the cable free transmitter, RS-485 or SDI-12 network. Simply connect the sensors to the interface as shown in Fig 2 and initiate the commands listed below.

Recommended Test

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

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

The default instrument address for a unit straight out of the box is 0

Issue command **0M!** to start measurement operations. The VibWire-108 will scan all channels
0D0! returns items of data *address ±data 4d1, ±data 4d1, ±data 4d1, ±data 4d1*

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

Command Structure and Operations Across An RS-485 Network

The VibWire-108 uses a command structure across the RS-485 network very similar to that used by the SDI-12 network in order to simplify the overall system operations. Understanding the control of the instrument on one network be that RS-485 or SDI-12 will make using the the unit on the other a very simple operation.

The RS-485 and SDI-12 network both operate at the same speed of 1200 baud.

Even though this is a relatively slow rate, as networks go, it is more than adequate for the small amounts of data transmitted by the instrument.

No break characters are transmitted in an RS-485 command and any sent will be ignored by the instrument.

A short **delay** of approximately **10 ms** is added between a command received by VibWire-108 and its transmission of data since this delay is used to allow time for the host PC to turn off its transmitter when using soft-negotiation for data flow control operations. Under normal RS-485 data transmission operations the RTS line on the serial port is used for flow control operations.

Keynes Controls recommends an RS-485 interface with Hardware negotiation is used to control the VibWire-108 across a network.

Timing Constraints RS-485 / SDI-12 Network

There are no timing constraints for the transmission of instructions and receipt of data across an RS-485 network compared to the operations on and SDI-12 network.

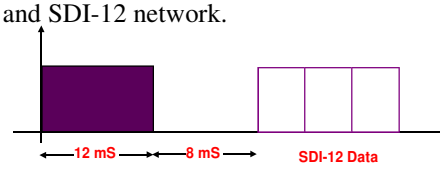


Figure 8 shows timing delay used on SDI-12 serial bus prior to sending data

Data Access Time

Typically the VibWire-108 takes approximately 60 seconds to complete its readings from receiving the command to activate the gauge to making the results available for transmission across the network.

Allow 60 seconds for the unit to respond no matter how many sensors have been fitted.

RS-485/ SDI-12 Commands

The commands used by instruments on the SDI-12 and RS485 network are the same
In the following commands 'a' and 'b' are the address of the instrument and can only be integers 0 to 9 or the characters a - z.

where

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

Start Measurement Commands

There are 2 separate commands supported by the VibWire-108 for initiating measurements across an RS-485 network and are named '**aM!**' and '**aC!**'. Table 1 includes a complete description of the commands used by the VibWire-108

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

The '**aC!**' command starts concurrent operations that are used to initiate measurements upon multiple instruments deployed across the network. The 'aC!' command frees the RS-485 bus so that other devices can operate freely.

Initial Configuration

To setup a multi-instrument RS-485 network the ID number used to select an instrument on the network has to be adjusted from the default factory settings. It is recommended that each instrument is individually configured before being deployed in order that there is no confusion within the configuration settings.

Care is to be taken that each instrument to be deployed has a unique ID number to ensure that data is correctly identified.

The initial factory set ID number for each instrument is 0.

Table Of Commands

The following commands are all those supported by the VibWire-108 for use on the SDI-12 nad 485 multi-drop serial networks.

Description	Master	VibWire-108 Response
Acknowledge active	a!	a\r\n
Send ID:	aI!	a13KEYNESCOVibWire-1080001\r\n
provided to complement SDI-12 protocol		Part Description assigned by Keynes
Address query	?!	a\r\n
identifies instrument address and commonly used on single instrument operations only.	Used to make command set SDI-12 compatible	Where a = number 0 - 9 for SDI-12 0 -9 letters a - z for RS485 A - Z
change Address:	aAb!	b\r\n
used to change instrument address from default to new one for network operations	**a** = initial address **b** = new address	**a : b** = number 0 - 9 or a - z
Start Measurement	aM!	a0608\r\n
instruct an instrument to make measurement	**a** = address of instrument	instrument with address a returns 8 x vibwire & 8 x temp after 60 seconds
Concurrent measurement:	aC!	a06016\r\n
Used for polling multiple instruments on a network to start to make readings. This command frees RS-485 bus for other devices	start measurement instrument address **a**	initial response only after receipt of instruct and no response when data ready to be sent.
Send data	aD0! aD1! aD2! or aD3!	+xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n
data returned aND! = Vib + Vib + Therm + Therm and has same format for each command	aD0! = channel 0 and 3 VibWire Sens aD1! = channel 4 and 7 VibWire Sens aD2! = channel 0 and 3 Therm/analog aD3! = channel 4 and 7 Therm/analog	

Additional Information

1 Strain gauge data is given as frequency in units (Hz)
2 Temperature data is given in millivolts (0000.0 to 2500.0)
3 Communication ports Settings for SDI-12 & RS485 network.

The RS-485 commands are almost identical in their format and use to those used on an SDI-12 network. 1200 baud 8 bit no parity

Examples Of Using RS-485/SDI-12 Instructions

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 SDI-12 networks only supports up to 10 instruments with address range: 0 to 9

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 '**a**A**b**' where a = Start ID b = Final ID

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 Measurements On Distributed Instruments Upon A Network

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

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

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

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

master sends: '2M!'	Instrument responds	'**20608\r\n**'	indicated readings available after 60 secs
	followed by	'**2\r\n**'	when the measurement is completed
7M!		'**70608\r\n**'	
		'**7\r\n**'	
9M!		'**90608\r\n**'	
		'9\r\n'	

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

Start Concurrent Measurements on a Number of Distributed Instruments

The following example shows how to start measurements on multiple instruments deployed on RS-485 and SDI-12 networks. Concurrent measurements '**aC!**' differ from the '**aM!**' command as they free the network after the initial command response to allow other devices to operate. Concurrent measurements enable multiple instruments to respond faster to measurement commands.

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

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

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

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

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

master sends: '**1C!**' Instrument responds '1**0608\r\n**' indicated readings available after 60 secs
RS-485 network is free for other devices as soon as this response is returned.

'**6C!**' '6**0608\r\n**'

'**7C!**' '7**0608\r\n**'

Read Values From The VibWire-108

No matter which instruction 'aM!' or 'aC!' is used to initiate measurement operations for the VibWire-108 has to be instructed to send data when it becomes available. It takes the instrument 60 seconds to make sensor values available after being instructed to make a measurement. The **vibrating wire readings** are in **Units Hz**. The **Temp/Current loop** input are in **Units mV**..

Use the command:
'**aD0!**' -- Vibrating Wire inputs 0 - 3
'**aD1!**' -- Vibrating Wire inputs 4 - 7
'**aD2!**' -- Temp/current loop inputs 0 - 3 (values in mV)
'**aD3!**' -- Temp/current loop inputs 4 - 7 (values in mV

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

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

master sends: **'4D0!'** Instrument responds: '**4+1011.3+1204.4+1101.3+1190.7**' Vibrating wire data
'4D1!' Instrument responds: '**4+1021.5+0000.0+1141.2+0000.0**' 0000.0 is returned when no sensor installed

Temperature/Current loop Data Format

'4D2!' Instrument responds: '**4+0050.6+0056.1+0101.2+0000.0**' shows results with only 3 temp/loop values
'4D3!' Instrument responds: '**4+0051.4+0058.3+0110.2+0015.3**'

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

Note. The temperature values are in mV only. Thermistor linearisation is needed is convert the results into engineering values.

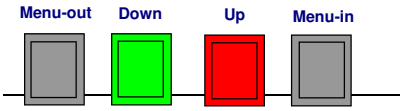
Connection to an analogue data acquisition system

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

Technical Specifications - Analogue Output Ports

8 x 0 - 2.5V DC single analogue output ports - 16 bit DAC
8 x thermistor outputs - 3.3 KOhm completion resistors

User Control Keys



Theory of Operation

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

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

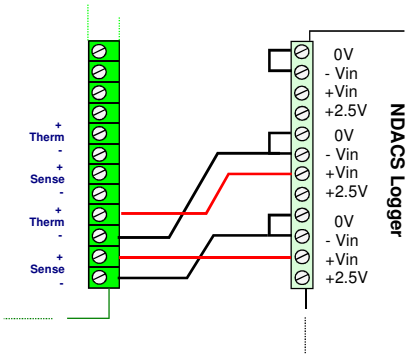


Figure 9

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

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

The example shown in Fig 9 shows the analogue output from the VibWire-108 connected to the NDACS logger unit. The NDACS logger supports a full differential input and so the connection to any other logger or acquisition system will be the same.

Starting Analogue Output Ports

To activate the analogue output channels on the VibWire-108

1. Starting at

2. Select "**Menu In**" button

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

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

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

4. The VW-108 will return to the display

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

Each of the vibrating wire sensor inputs can be individually configured. Setting the analogue output channel is only needed when using the instrument with an external data logger or analogue acquisition system and is not required when measurements are to be made across and SDI-12/RS485/RS232 digital serial network.

Optimising the Analogue Output Settings

Example 1

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

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

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

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

a range of

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

will give the highest resolution for this example

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

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

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

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

Integration to NDACS 6000 Logger

Example 2

A vibrating wire pressure sensor with operating frequency 400 Hz to 1000 Hz connected to channel 5 on the VW-108 and the analogue output is to be connected to an NDACS 6000 logger unit.

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

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

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

The NDACS will use the 'Scaled Current' process option A = 1 B = 0 C = 2.5 D = 400 E = 1000

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

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

Real-time Frequency Display

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

Sensors can be deployed a considerable distance from the sensor interface and may well be have been embedded into a structure. To ensure that the sensors are operating correctly simply observe the sensor operating frequency and then confirm the result is within the operating range as specified by the manufacturer.

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

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

Assigning Real-time Frequency Display

To activate the real-time frequency display

1. Starting at

The "**Basic**" menu item is the first menu item available after the instrument is powered on.

2. Select "**Menu In**" button

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

The Display above shows the option required to place Channel 0 for real-time frequency output

the other options available are:

"**Analg C0d C1d C2d C3d C4d C5d C6d C7d**" C0d = Channel 0 ..... C7d = Channel 7

Once the "**C0d**" option is selected then the "**Menu Out**" key has to be pressed to confirm this option.

4. The VW-108 will now display the real-time sensor frequency for channel 0.

The above example shows a typical real-time frequency result .

Loud Speaker

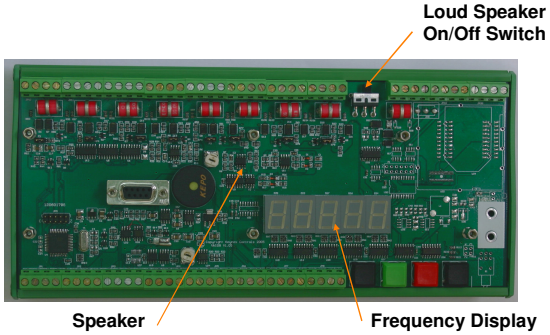


Figure 10

All of the VW-108 range of instruments are supplied with an internal ceramic speaker. The speaker can be activated and the sensor ping and resultant echo can be heard.

The speaker used in collaboration of the frequency display should enable nearly all sensors to be tested no matter their location using only the VW-108 interface unit.

Sensor problems

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

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

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

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

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

Vibrating Wire Sensor Installation

The vibrating wire sensors are connected directly into the Sensor Input channels on the VibWire-108 and supports full 4 wire gauge sensors. The instrument contains a completion resistor for the thermistor sensor enabling the temperature reading to be made along with the vibrating wire sensor readings.

Connection to the instrument is as follows:

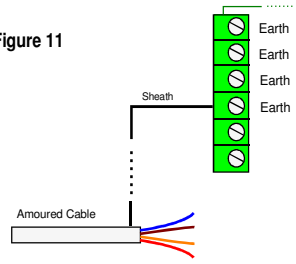


Figure 11

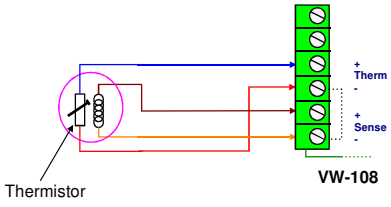


Figure 12

Figure 13

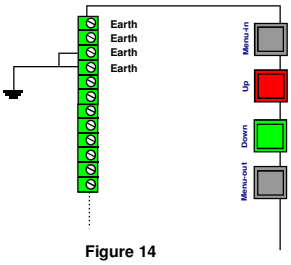


Figure 14

Common Earth/Gnd Points

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

Earth
Earth
Earth
Earth
Gnd

On the power supply connection terminals

Therm -
Sense -

on both the sensor input and analogue output terminals.

Fig 14 shows how the channels are wired together to form common earth connection. Effectively all of the Earth, Gnd, S_{ense} - and T_{herm} - terminals are wired together.

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

Lightening Protection

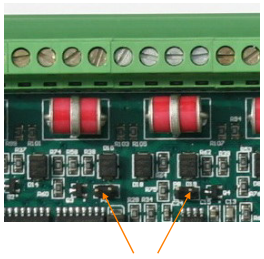
The lightening protection within the VibWire-108 cannot protect the instrument from a direct lightening strike. It is used to protect the instrument from local ground strikes close to the sensors and cabling.

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

The gas discharge tube protection activates at around 92V DC and resets instantaneously after

Fig 14 shows the VibWire-108 connected to a system earth using the Earth terminators mounted adjacent to the power connectors.

PCB Jumper Settings



PCB Jumpers

Figure 15

All of the VibWire-108 models support thermistor, analogue input for the range 0 - 2.5 V DC and current loop inputs.

For current loop operations such as those 0- 20 mA, 4- 20 mA then external excitation is required.

Jumper Open = 0-2.5V DC
4-20 mA loop
Jumper Closed = Thermistor

Multiple Instrument Installation

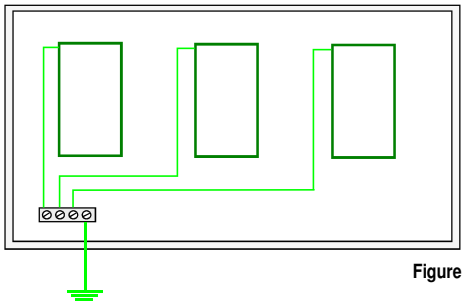


Figure 16

Figure 16 shows how to Earth multiple instruments within a single enclosure. Ensure that good quality cable of around 2.5 mm diameter core is used to connect the instruments earths together and that a good connection to a main system earth is obtained. The Earth connection is essential for the lightening protection to work.

Local Cable Free Data Transmission Configuration

The VibWire-108-TRN24 contains a local 2.4 GHz spread spectrum transceiver capable of providing local cable free operations over a range of 750m - 1 Km using small dipole antennas to several kilometres with a directional antenna. All of the control operations for the transceiver are User Defined and are detailed below.

Local Operation - Under 500 m to Gateway

The VibWire-108 mounted in a plastic or GRPS IP65 enclosure as shown in Figure 17A with the antenna mounted in effective line of site to the data logger or Keynes Gateway systems will operate to a range of approximately 500m. Depending upon conditions at the deployment site it is possible to get greater distances than 500 m so long as there is little interference or no obstructions to the signal path.

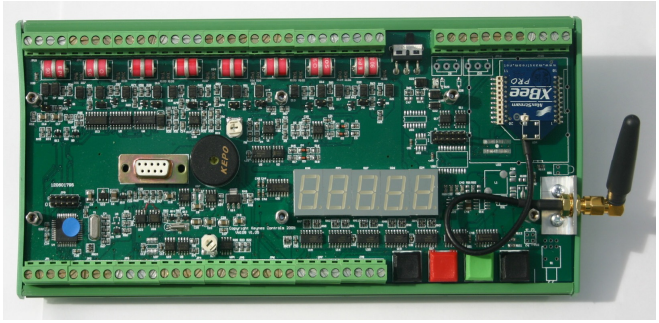


Fig 17 - VibWire-108 with Zigby interface

Figure 17 above shows the VibWire-108-TRN24 with a simple 3 db helical antenna attached that is suitable for local operations only.

Configuring the VibWire-108 for data transmission

The is essentially two separate configuration operations to be undertaken when using the VibWire-108 for local cable free data transmission and they are:

1) Sensor Polling rate.
2) Data Transmission rate.

There is a always a trade off between sensor sampling rate, data transmission rate and power supply requirements. The faster the sensor sample rate and the greater the data transmission then the greater the power that is required to drive the instrument.

At low sample rates such as 1 record from each of the eight channels per day then 12V DC supply made up from AA cells will run the instrument for several years.

For many applications a small 12V rechargeable with a 4.8W solar panel will run the instrument indefinitely.

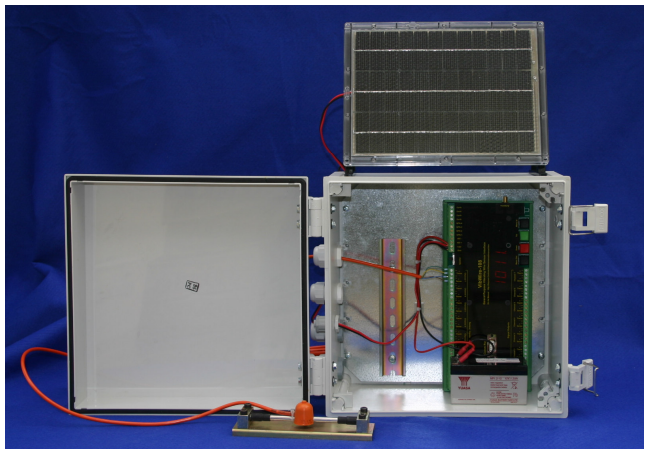


Fig 17A Complete 8 channel vibrating wire sensor system

Setting Data Transmission Rates

To activate the real-time frequency display

1. Starting at

2. Use the ***Up*** & ***Down*** Keys to select the

   "Tra.Int" option

   The other options that will be displayed while the ***Up*** and ***Down*** keys are:

   "**Disp Perod ID Tra Tra.int Ch0.LA Ch0.RA .... **"

   Once the "Tra.int" option is selected press the "**Menu In**" key to access the transmission rate options.

   Options are "**5S 60S 360S 600 1HR 6HR 24HR**"

4. Once the desired transmission rate is set select the "**Menu Out**" key to confirm the option.

   Note the transmission rate can be overwritten during the data logging operation to the SQL database.

Setting Sensor Polling Rate

To activate the real-time frequency display

1. Starting at

2. Use the ***Up*** & ***Down*** Keys to select the

   "**Perod**" option

   The other options that will be displayed while the ***Up*** and ***Down*** keys are pressed are:

   "**Disp Perod ID Tra Tra.int Ch0.LA Ch0.RA .... **"

   Once the "Period" option is selected press the "**Menu In**" key to access the polling rate options.

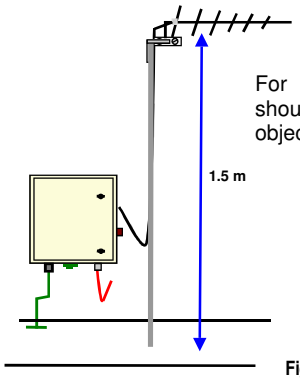
   Options are "**1S 5S 15S 1HR 6HR 24HR**"

4. Once the polling rate is set select the "**Menu Out**" key to confirm the option.

   Press the "Menu Out" key several times to get back to the **BASIC** option.

Antenna Installation

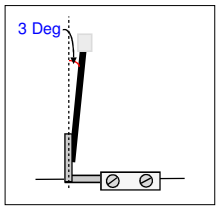
In order to achieve the optimum range or the highest signal strength for the chosen antenna systems then care has to be taken with the choice and deployment



For the best results the directional antenna should be located away from any nearby objects and greater than 1.5 m above the ground

Figure 18

For optimum range tilt the standard omni-directional antenna 3 deg from the vertical in the directional of the receive unit



Keep the antenna 1m above the ground and free from any close objects.

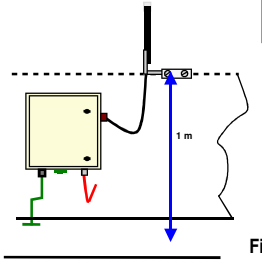


Figure 19

Typical Antenna Solutions for 2.4 GHz Applications

Antenna systems available from

Round Solutions GmbH & Co KG Im Steingrund 3, D-63303 Dreieich, Germany
Tel: +49 (0) 6103 960510 Fax: +49 (0) 6103 960509

www.roundsolutions.com

Antenna type	YAGI
Frequency	2400 - 2500 MHz
Gain	13 dBi
Polarisation	Linear
Beamwidth	
(Azimuth / Elevation)	44° / 48°

Product code	OMNI-A0050
Frequency	2400 - 2500 MHz
Gain	8 dBi
Polarisation	Vertical
Beamwidth	
(Azimuth / Elevation)	360° / 16°

Antenna Type	Dish
Frequency	2400 - 2500 MHz
Gain	9 dBi 20 dBi 25 dBi
Polarisation	Vertical
Beamwidth	
(Azimuth / Elevation)	60° / 60°

Antenna Type	Panel Antenna
Frequency	2400 - 2500 MHz
Gain	14 dBi
Polarisation	Linear (Vertical or Horizontal)
Beam width	
(Azimuth / Elevation)	43° / 43°

Basic System Installation

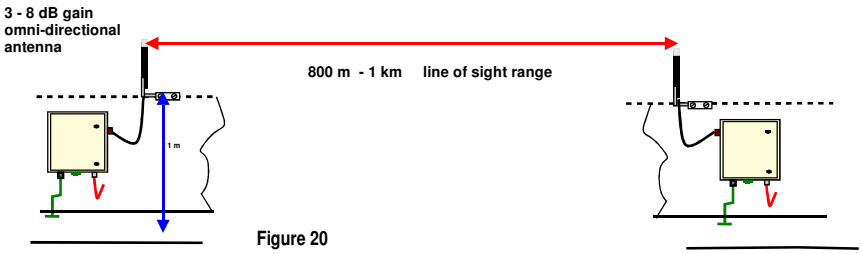


Figure 20

Directional antenna Systems - external mounting

Directional antenna offer increased range for the same transmitted power by restricting the transmitted signal to a specified direction. In order to get the best results it is important to keep the antenna clear of any local metallic objects above the ground. Deploy the antenna about 1.5 m above the ground and make sure any mast system being used is firmly installed.

Ensure that the directional antenna is pointing absolutely at the data logging system antenna and that the polarisation between remote systems is the same ie. Vertical-to-Vertical or Horizontal-to-Horizontal polarisation.

Omni-directional antenna - external mounting

For instruments that are deployed fairly close together and in clear line of sight of each other then omni-directional antenna systems will be ideal for data transmission. Omni-directional antenna systems are the simplest install and maintain.

For optimum range mount the antenna clear of any object and about 1 m above the ground. Any change in this deployment will degrade the range and this degradation will depend upon the environmental conditions prevailing at the site.

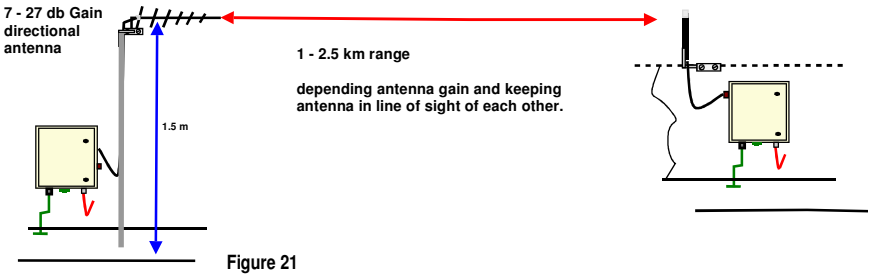


Figure 21

Circular polarised antenna systems are the only type that should be use when systems with mixed polarisation antenna are to be used together.

Internally Mounted antenna within IP65 enclosure

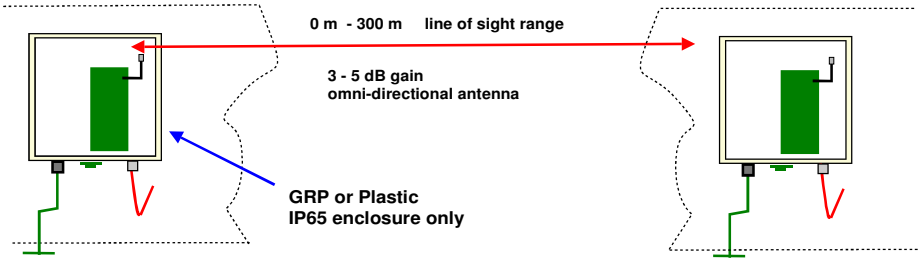


Figure 22

The VibWire-108 supports direct connection of a number of the smaller omni-directional antennas

These antennas can be fitted within the IP65 enclosure but it is essential that this enclosure must be GRP or plastic in order to minimise any signal attenuation.

The range is reduced compared to externally mounted antenna but installation is considerably reduced.

Internal Embedded Chip Antenna

For systems deployed within a 15m line of sight or when local expansion of a instrument box is required then a VibWire-108 system with local cable free interface should be used.

A number of cable free instruments can be mounted within a single enclosure and configured to operate as a mesh network. An additional instrument is easy to add as all that is required is to power the unit and connect in the sensors.

Chip antenna systems only operate over very small distances but have the advantage that the antenna fits on the instrument PCB see Fig 23A.

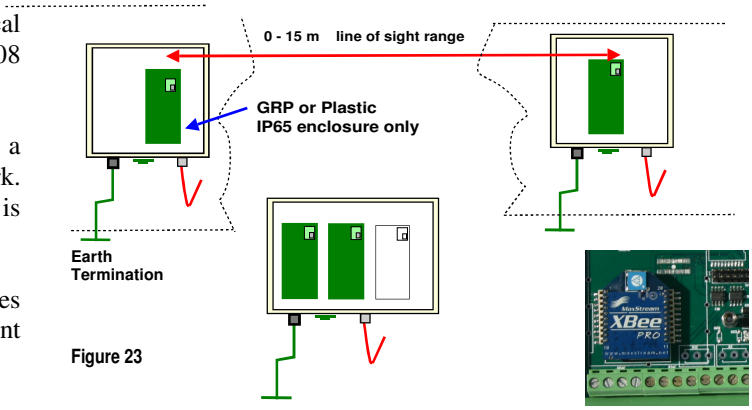


Figure 23

Fig 23A

Mesh Networks (available last quarter 2006)

Networking

Spread Spectrum Type:	DSSS (Direct Sequence Spread Spectrum)
Networking Topology:	Peer-to-peer, point-to-point & point-to-multipoint
Error Handling:	Retries & acknowledgements
Filtration Options:	PAN ID, channel and addresses
Channel Capacity:	XBee: 16 Channels
Addressing:	65,000 network addresses available for each channel
Encryption:	128-bit AES (coming soon)

General

Frequency Band:	2.4000 - 2.4835 GHz
Data	250,000 bps
	Industrial (-40 – 85° C) temperature rating
	U.FL RF Connector, Chip or Integrated Whip antenna options

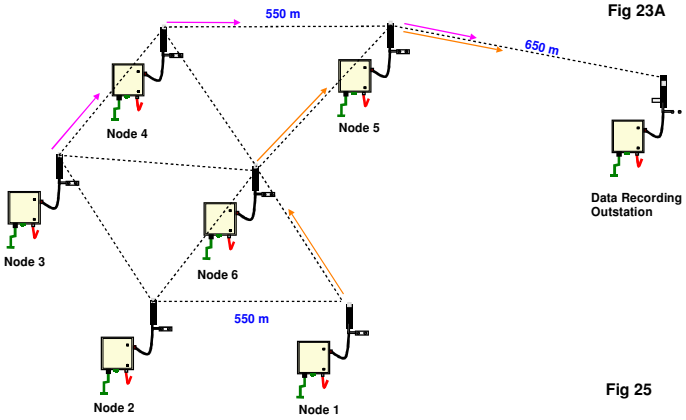


Fig 25

Network Operations

The transceiver unit embedded within the VibWire-108 can used for direct point-to-point communications as well as forming a node within a mesh network.

For Point-to-Point communications each instrument talks directly to the data recording outstation. A mesh network routes the data from one instrument to the next until it reaches the data recorder.

The Keynes Controls Gateway products are fully integrated to the VibWire-108 and can be used as a cable free data recorder, an interface between the mesh network, GPRS mobile phone and local area networks.

The mesh networks operate by routing data between one node and the next until it reaches the desired location. The mesh network can also correct for data path loss so long as another route can be found. Fig 24 shows a simple mesh network with multiple nodes. Upon occasion when the direct link between Node-1, Node-6 and the Data Recording Outstation fail then data can be routed automatically via Node-5. This operation ensures that data communication remains very reliable even different sections of the network are blocked. Fig 25 shows the mesh network operational with new data route.

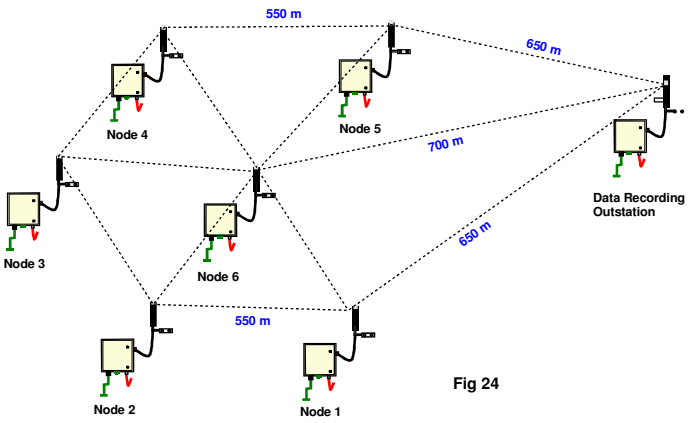
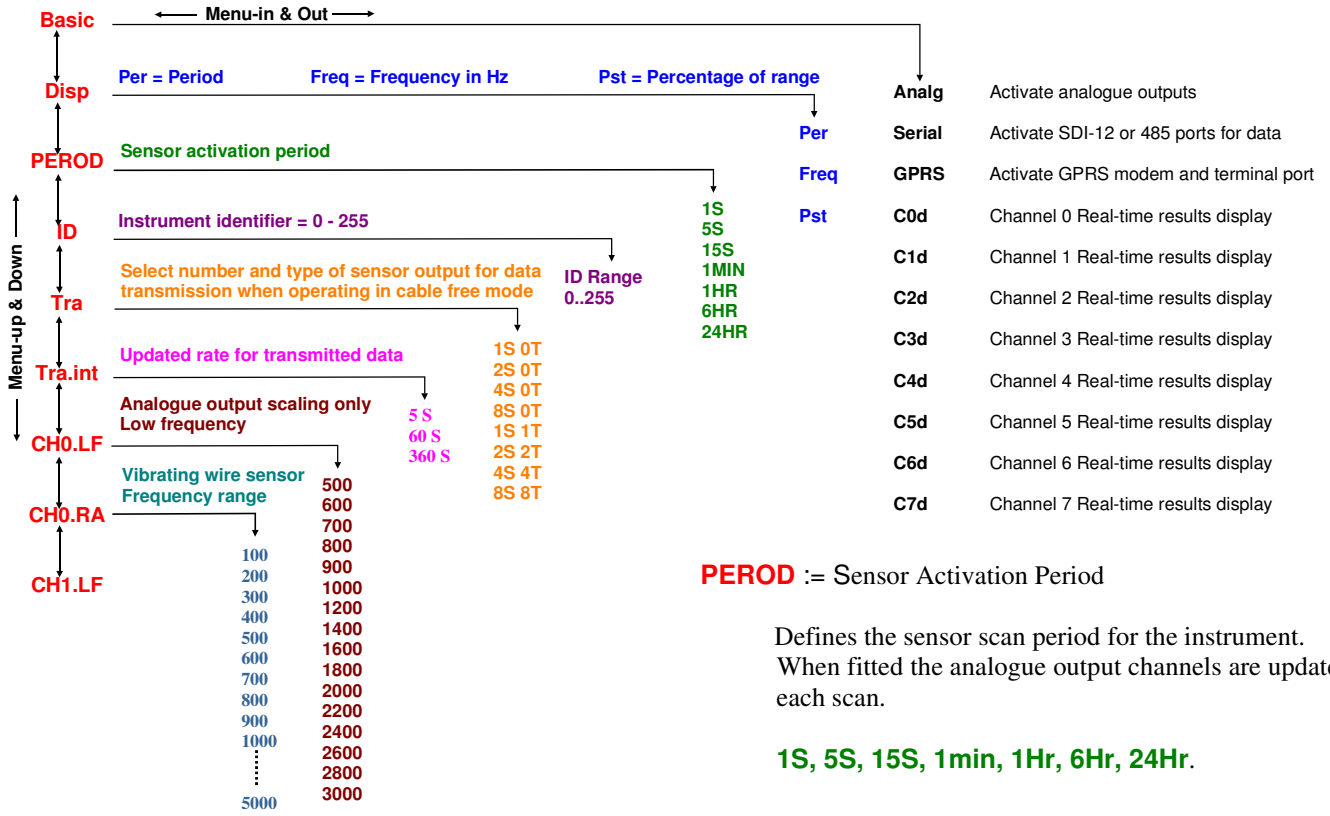


Fig 24

User Command Summary



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

Per = 1/ Freq = period of oscillation in milli Sec
Freq = XXXX.X in Hz
Pst = Percentage of range

the percentage of range is used to optimise the settings for the analogue output port in order to achieve the best result

Example. A vibrating wire sensor showing a PSt = 0.1 on the display and settings of LF (Low frequency) of 500 Hz and range of 2000 Hz. This indicates that the results from the sensor is only operating over the lower 10% of the defined range i.e 500 - 700 Hz

For the assigned range above the analogue output port has a scaling of 0 - 2.5V DC using a 16 bit DAC (65536 levels) and will therefore have 0V = 500 Hz & 2.5V = 2500 Hz, so

resolution = (2500-500)/65536 = 0.03 Hz.

However with the instrument adjusted to operate over the range of 500 to 700 Hz as observed above then

0V = 500 Hz & 2.5V = 700 Hz so resolution = 200/65536
= 0.003 Hz

PEROD := Sensor Excitation Period

This option defines the update period for the sensor excitation and measurement operation. There is always a trade off between the sensor update rate and the power supply requirements of the instruments.

For fast dynamic changes a fast sensor update rate is required but for slow static measurements only a low update rate is required.

PEROD := Sensor Activation Period

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

1S, 5S, 15S, 1min, 1Hr, 6Hr, 24Hr.

ID := System identifier number

Each instrument requires a unique identification number that is required to locate a specific instrument upon a network. Currently the identifier is an integer of range 0 .. 255 offering a maximum

TRa := Transmission Data Options.

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

1S 0T represents 1 vibrating wire sensors - no temperature
2S 0T represents 2 vibrating wire sensors - no temperature

1S 1T represents 1 vibrating wire sensor - 1 temp sensor
2S 2T represents 2 vibrating wire senors - 2 temp sensors

Tra.int := Defines the rate of data transmission across a cable free network. The data is sent and confirmed by the gateway system if installed.

The transceiver fitted inside the VibWire-108 is powered on during the data transmission operation and powered off into a sleep mode between updates.

The faster the data transmission rate the greater the power required to drive the instrument. A compromise is needed to adjust power requirements to the amount of data to be transmitted to guarantee that not readings are lost.

5S, 60S, 360S

VibWire-108-GPRS

With embedded GPRS modem

- **8 x Full 4 Wire Vibrating Wire Sensor Inputs**
- **Unlimited range - GPRS network limitation only**
- **GPRS Network Status messages - Signal strength**
- **Pay-As-You-Go & Contract SIMM Support**
- **SQL Database compatible storage**
- **Data-Upon-Demand**
- **Gas Discharge Lightening Protection all inputs**
- **Local Solid state speaker**
- **Advanced Power Management < 3mA Standby Mode**
- **Full Digital Data Conversion - No sensor setup**
- **Automatic Network Connection**
- **SDI-12/RS485 command set compatible**
- **100 Hz - 10 K Hz sensor range**
- **Automatic Sensor Configuration - Digital Networks**
- **Analogue inputs - Thermistor & 4-20 mA Loops**

The photographs below show the new Keynes Controls GSM/GPRS ready vibrating wire interface. The instrument below shows everything needed to get 8 x 4 wire vibrating wire sensor data onto the Web/Internet.

Using the GPRS/GSM network true cable free distributed solutions across any range can be created. Instruments can be deployed nationally in many different locations and the results stored to a database. The database can be located anywhere that a suitable network connection can be made.

Indefinite distributed operations are possible due to the instruments advanced power management features. A 4W Solar panel should provide enough power to enable the instrument to send a complete scan of reading every 30 mins.

A wide range of third party antenna are available to fit directly onto this instrument such as small 3 db stubs, directional Yagi when signal strength is low or to achieve longer distances between instrument and data recorder.

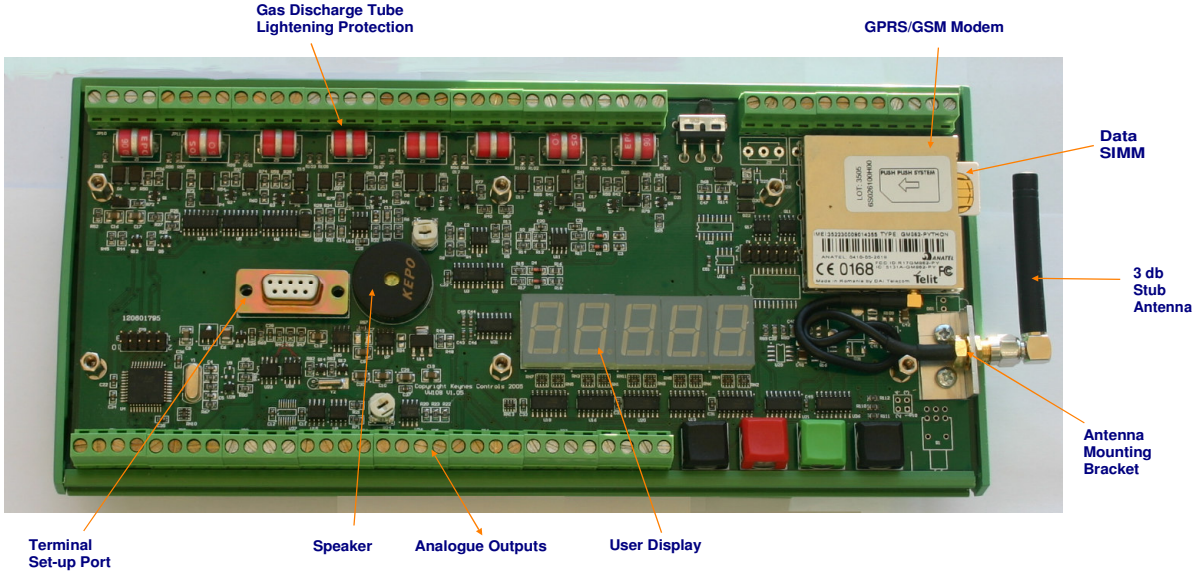


Figure 27

Features

The GPRS/GSM modem fitted to the instrument is a tri-band device and is suitable for operations in most locations in the world. The VibWire-108-GPRS module automatically makes the network connection and alarm/status messages are presented upon the user display to show the status of the connection.

The cable free operational range of this instrument is limited only by the range of the mobile phone network.

Terminal Port

The terminal port is used to configure the instrument and enables the operator to access the GPRS network via control codes sent to the modem. Status messages returned by the modem can be used to show signal strength, test data transmission etc..

Instrument Configuration For GPRS Network

The following parameters are all that need be assigned in order to send data from the VibWire-108-GPRS across the network and all set using the terminal port.

APN (access point number)
Username
Network Password
IP Address (instrument gateway)
Instrument Tag name

Network Transmission Costs

There are no unexpected costs associated with operating the VibWire-108-GPRS/GSM unit across the network since the instrument supports both Pay-As-You-Go and contract SIMMS from most major network suppliers.

Data transmission per scan is as low a 5K so it is easy to obtain the best price plan on Pay-As-You-Go operations and the correct contract SIMM agreement to minimise contract costs. What ever option is taken the User determines how much data is transmitted.

Data Management

Each of the instruments is identified by an assigned name and its information stored into a database. Once the data is being recorded it can accessed and processed to produce reports, plots and trends and even shown on a web page within a 3GL mobile phone.

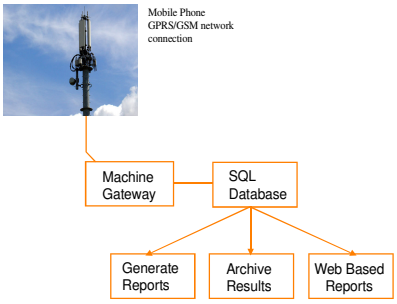
User Display & Speaker Unit

During installation a User can observe the sensor frequency directly within the on-board display. For sensors deployed a long way from the instrument, embedded into a structure or down holes then a useful feature to determine if the vibrating wire sensors are operating correctly is simply to listen to the returned sensor signal. Should the signal be a tone then the sensor is functioning. However should this signal be very distorted then it shows clear signs that the sensor has malfunctioned. Both a frequency display and embedded speaker are standard parts of this instrument.

GPRS Operations

The VibWire-108-GPRS enables true cable free operations to be undertaken any where that a mobile phone network exists and when used in collaboration with the Keynes network database systems.

Information can be gathered and stored into a single database for many instruments deployed upon the GPRS network so long as suitable Internet connection can be made. No longer does a databse have to be located near to or directly connected to the instruments making the measurements.



Flexible Data Scan Operations

The VibWire-108-GPRS unit scans the input channels in a user specified order and transmits the data across the. network. The instrument sends the data out at a specified rate and goes into stand-by mode between scans to save power.

Data-On-Demand

A 2 way network link is established so it is possible to change the scan rate of the instrument when it next makes contact to the database. A User command issued at the console can be used to adjust the scan rate of the remote systems

Database Operations

The Keynes Controls database application utilises the free issue MySQL software and a series of Java applets to gather and format the instrument data into a format suitable for archiving. A wide range of third party add on software is available to support graphical interpretation of data within the database. Keynes Controls can also supply a web server interface enabling data to be displayed across the world wide web.

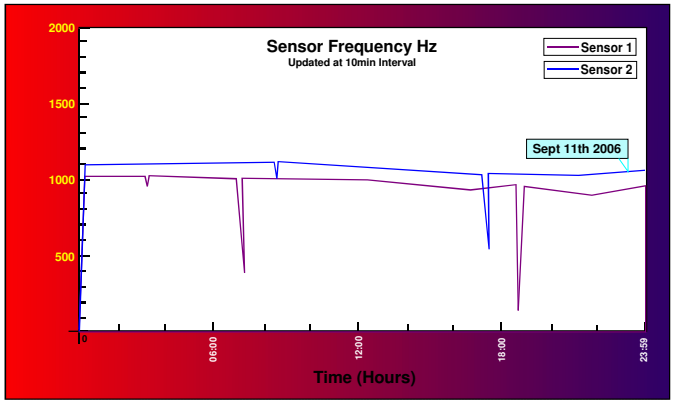


Fig 28 - Daily Data Summary Plot

Data Integrity Operations

When acquiring data across local networks the Keynes Controls software checks and automatically maintains the data integrity of any measurements. Before data is archived it is verified to be correct and any mistake in a value is recovered from the specified instrument before data storage.

Data Summary Plots

Most types of data analysis can be undertaken when the information is archived within the database. This analysis can be as simple as detecting and reporting missed data, statistical analysis upon a range of measurements and all results can be presented upon a range of summary plots both in local Windows and on web pages.

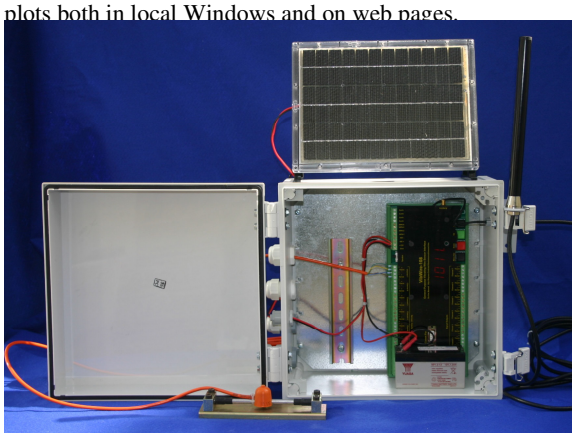


Figure 30

Global Solutions

For widely distributed systems with instruments deployed anywhere within a GPRS network then only a Internet connection will be required to gather information from the instruments no matter where they are located and how they are deployed. Instruments can be deployed globally and all the information easily brought back to a single location for storage and processing.

Local Systems

The database software can be integrated to locally deployed instruments and can be used as the data logger in many applications. It is best deployed when there is a secure fixed site with adequate power is available on a stand-alone dedicated computer system

The most practical method of integrating the database to the locally deployed instrument systems is by reading transmitted data from across the local networks and these can be any combination of SDI-12/RS485 serial port networks, Ethernet and Cable free 2.4 GHz cable free mesh network.

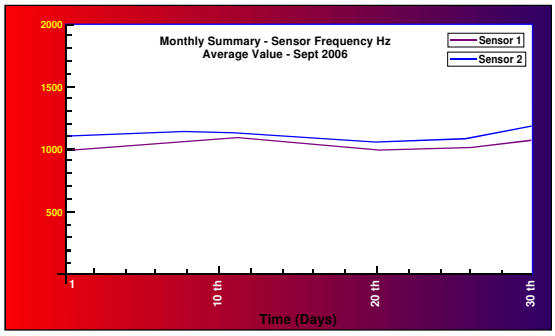


Fig 29 - Monthly Data Summary Plot

GPRS/GSM Modem Specifications

- Dual Band 900/1800 MHz GM862-GPRS
- Quad Band 850/900/1800/1900 MHz on GM862-QUAD
- Output Power: Class 4 (2W) at GSM 900 MHz
- Class 1 (1W) at GSM 1800/1900 MHz
- Integrated SIM card reader
- ROSH compliant
- Operating temperature range -20 to +70 Deg C
- Automatic network identification
- Automatic connection
- Remote network data services
- 50 Ohm antenna termination
- Antenna connector - SMA/M
- Pay-as-you-go SIMM card data services

Figure 30 shows everything needed to get 8 channels of vibrating wire sensors onto a GPRS or 2.4 GHz cable free network. The solar panel shown is a 6W cell and this with the battery backup will give 1 reading per hour indefinitely. For short periods the scan rate can be increased for faster sampling.

Example GPRS Configuration Settings

The following examples show the AT commands needed to connect to the 4 most popular GPRS networks in the UK. Other networks will be configured very similar to the ones below.

Virgin: SMS 800 Texts
PAYG: GPRS CONFIGURATION:

```
at+cgdcont=1,"IP","goto.virginmobile.uk","0.0.0.0",0,0
at#userid="user"
at#passw=""
at#sktset=0,4000,"82.152.20.37"
at#sktop
```

Vodafone: subscription only service

Data10 tarrif: 10MB + £2/MB there after
PAY-as-you-go tarrif

```
at+cgdcont=1,"IP","pp.vodafone.co.uk","0.0.0.0",0,0
at#userid="web"
at#passw="web"
at#sktset=0,4000,"82.152.20.37"
at#sktop
```

T-Mobile: depending on t-zone add-on

Zone dependent service

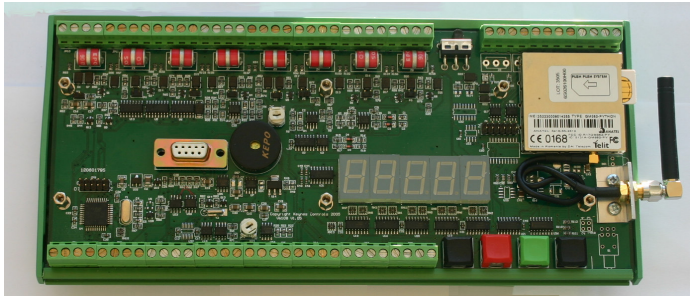
```
at+cgdcont=1,"IP","general.t-mobile.uk","0.0.0.0",0,0
at#userid="user"
at#passw="wap"
at#sktset=0,4000,"82.152.20.37"
at#sktop
```

Orange:

Mobile office Pay-As-You-Go Service

Normal PAYG You may need to add access to data :

```
at+cgdcont=1,"IP","orangeinternet","0.0.0.0",0,0
at#userid=""
at#passw=""
at#sktset=0,4000,"82.152.20.37"
at#sktop
```



Configuring VibWire-108-GPRS for data transmission

The VibWire-108-GPRS requires 2 stages of configuration before information sent across the network and these are:

1) Assign instrument to activate the GPRS modem

2) Assign network details using terminal port

Setting Operation Mode

Before information can be sent across the GPRS network the modem has to be activated and this operation is undertaken from the keyboard.

To activate the real-time frequency display

1. Starting at

   The "**Basic**" menu item is the first menu item available after the instrument is powered on.

2. Select "**Menu In**" button

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

   GPRS

   the other options available are:

   "**Analg SERAL C0d C1d C2d C3d C4d C5d C6d C7d**" C0d = Channel 0 ..... C7d = Channel 7

   Once the "**GPRS**" output is selected the "**Menu Out**" key has to be pressed to confirm this option.

Terminal Port & Hyper-terminal Connection

The GPRS network configuration is to complex to be undertaken using the keyboard by itself and so Keynes Controls use a terminal program to assign the AT commands to the modem.

The RS-232 port on the front of the instrument uses a standard 9 pin D connector modem cable to connect to a PC.

Factory settings are:

Baud rate = 115Kb Parity = Even 8 data bit - no stop bit

Terminal Program

Any terminal program can be used so long as the computer system being used can see the assigned serial port. Common Windows application is "Hyper Terminal" and this works correctly with the VibWire-108.

Serial Port to USB Communication

Using a serial port to USB converter it is possible to communicate to the VibWire-108 using a standard USB port on on laptop or PDA in order to configure the terminal or download information.

Any terminal program can be used but a common application program is the Microsoft Hyper-terminal and this is used in the example below.

Serial Port Interface Cable

A standard 9 pin serial port cable terminated with male and female D-connectors is all that is required to communicate to the instrument.

Port Control Options

Set any serial port configuration to RS232 mode - only Rx / Tx lines are used.

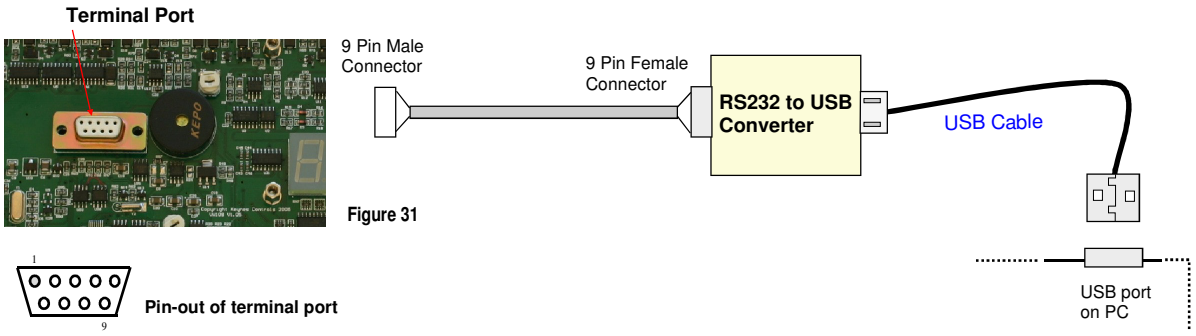


Figure 31

The terminal configuration window below shows Hyper-terminal set to operate under serial port Com-1.

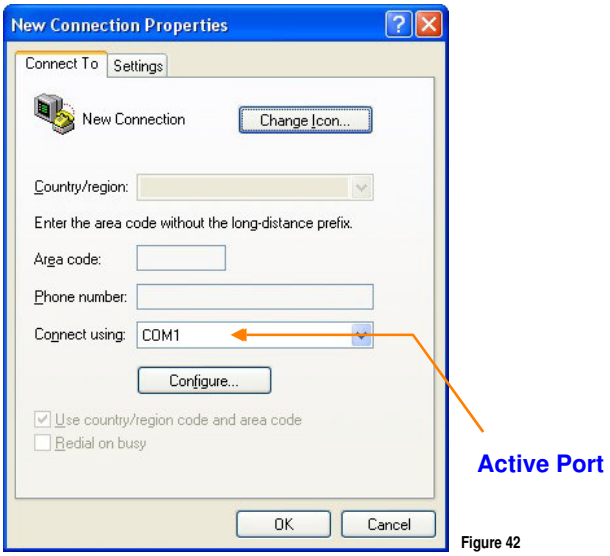


Figure 42

Active Comms Port.

Once the USB interface is installed into the PC the driver software within a Windows based operating system identifies the active port name.

Take care to select the serial port identifier when using the terminal program to talk to the instrument.

Failure to assign the correct serial port within the terminal program will prevent communication to the instrument.

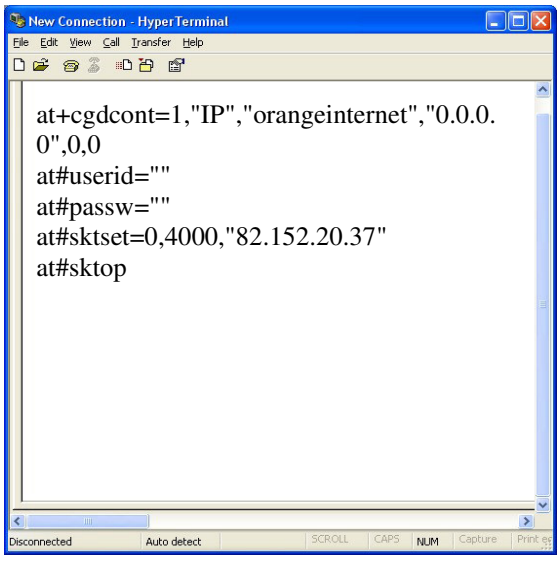


Figure 32

Example above shows instructions required to operate instrument on the Orange GPRS network and has been included to the operation of the terminal program.

Serial Port to Ethernet Communication

Using a serial port to Ethernet converter it is possible to communicate to the VibWire-108 using a standard Ethernet port on a laptop or PDA in order to configure the terminal or download information.

Any terminal program can be used but a common application program is the Microsoft Hyper-terminal and this is used in the example below.

Serial Port Interface Cable

A standard 9 pin serial port cable terminated with male and female D-connectors is all that is required to communicate to the instrument.

There are many different manufactures of Serial port to Ethernet converters that can be used with the VibWire-108. Keynes Controls do not restrict the operations of the instruments to any particular model.

Some interesting sites for converter modules are:

http://www.perle.co.uk/products/Serial-to-Ethernet.shtml
http://www.hw-group.com/products/converter/index_en.html

Port Control Options

Set any serial port configuration to RS232 mode - only Rx / Tx lines are used.

Communications

In order to communicate with a laptop or other computer system take care to ensure the network settings for the converter module are compatible to the host PC or network onto which it will be attached.

Typical Network Layout

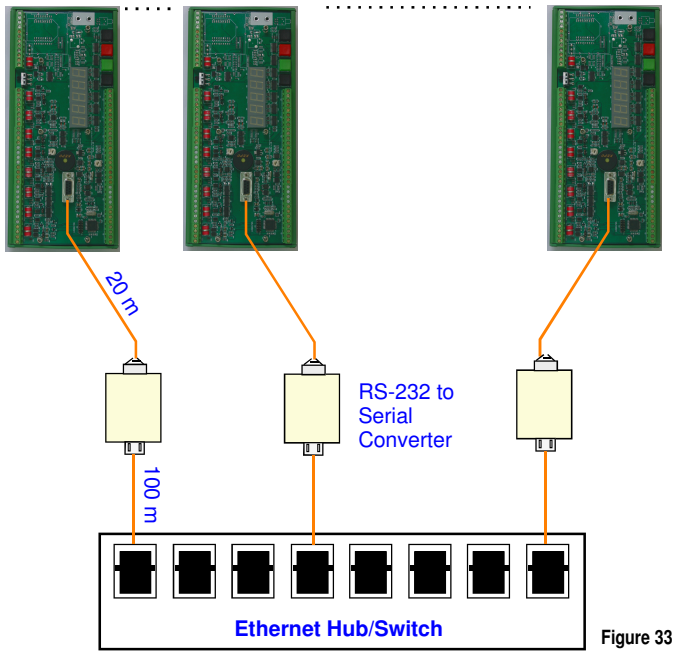


Figure 33

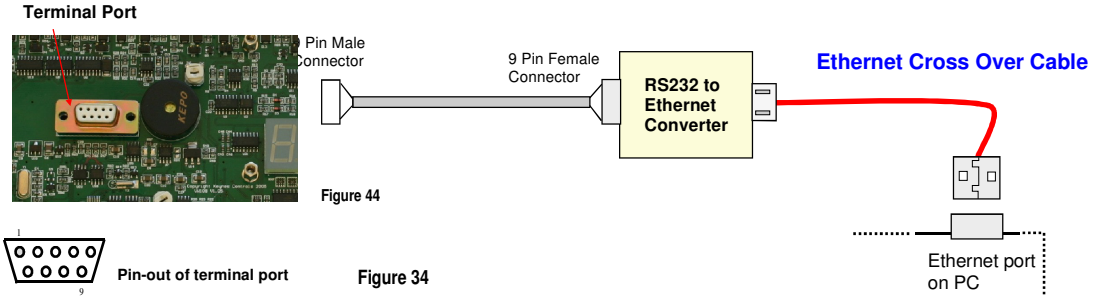


Figure 44

Pin-out of terminal port

Figure 34

Vibrating Wire Sensors

The following sensors are fully compatible to the VibWire-108 instruments an have been included to demonstrate some of the many applications in to which the instruments can be deployed.

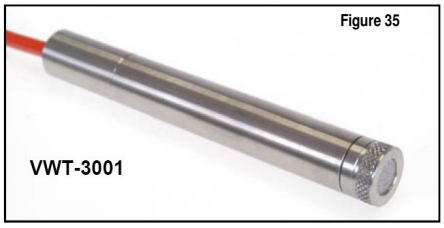


Figure 35

Figure 36

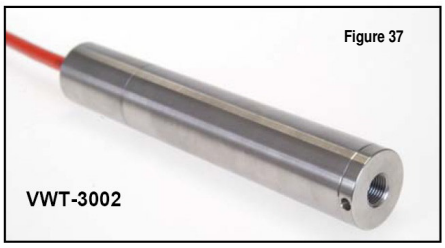


Figure 37

GEOSENSE Vibrating Wire piezometers and transducers use the well-proven method of converting fluid pressures on a sensitive diaphragm into a frequency signal.

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

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

Specifications

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

For additional details contact

Geotechnical Centre . Rougham Industrial Estate . Rougham . Bury St Edmunds . Suffolk . IP30 9ND . England
Tel: +44 (0) 1359 271167 . Fax: +44 (0) 1359 271168 . email: info@mgsgeosense.co.uk. www.mgsgeosense.co.uk

For additional details see

BELL LANE, UCKFIELD, EAST SUSSEX, TN22 1QL, ENGLAND

Website www.soil.co.uk Tel: 01825 761740


Crack meter

Crack meters are available with ranges up to 100 mm

Resolution	0.025% of range
Accuracy	± 0.2% of range
Temperature effect	–0.02mm/℃ (typical)
Operating temperature	–30 to +70℃
Cable: 2 and 4 Core screened	

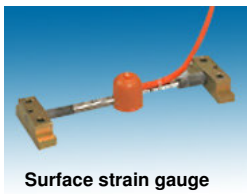

Joint meters

Joint meters are available with ranges up to 100 mm

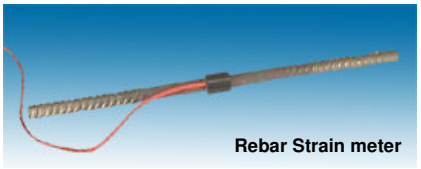
Resolution:	0.025% of range
Accuracy:	± 0.2% of range
Temperature effect:	–0.02mm/℃ (typical)
Operating temperature:	–30 to +70℃
Cable:	2 Core screened

Gage Technique International
PO Box 30
Trowbridge, Wiltshire
BA14 8YD, England

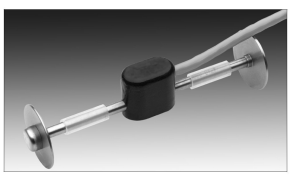
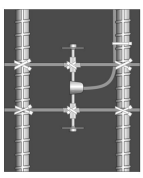
Tel: +44(0)1761 431777
Fax: +44(0)1761 431888
enquiries@gage-technique.com
www.gage-technique.com


Surface strain gauge

Gauge Type:	TSR/5.5/T surface mounting strain gauge.
Gauge factor:	3.025 x 10-3 micro-strain per Hz squared.
Measurement range:	> 3000 micro-strain.
Resolution:	Generally better than 1 micro-strain.
Coil Resistance:	Approximately 100 ohms.
Operating temp range:	-200C to 800C.
Thermal coefficient:	11 ppm per 0C.


Rebar Strain meter

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



Embedment Strain Gauge

Range:	3,000 micro-strain, set mid-range.
Resolution:	1 micro-strain
Accuracy:	± 0.1% FS.
Thermal Coefficient:	11 ppm / ℃.
Operating Temp:	-20 ℃ to 80 ℃.

The details on this page have been obtained from the sensor manufacturers web sites and are liable for change at any time.

Vibrating Wire Sensor Applications

The details below show just a few of the applications for which vibrating wire sensors are used. The best results from the instrumentation are only achieved when a good understanding for the overall structural behaviour is available. The examples demonstrate the common uses of structural monitoring within civil engineering applications.

A lot of vibrating wire sensor applications are undertaken with the sensors buried into the structure such as within concrete or within a bore hole. The vibrating wire sensors maintain very accurate results without need for re-calibration over many years and generally more reliable than other forms of sensor, less prone to failure in damp conditions and relatively easy to install.

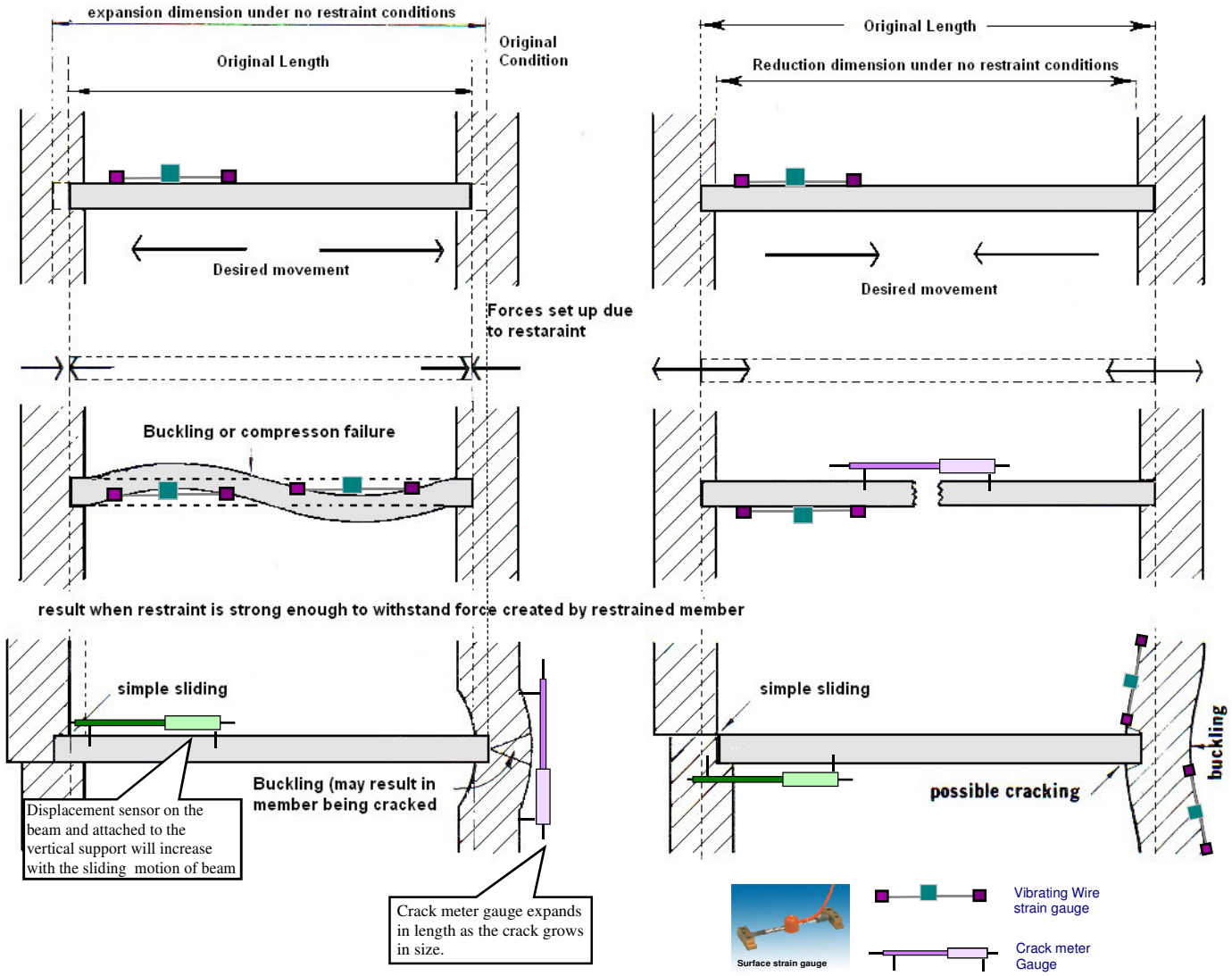


Fig 38

Figures 38 and 39 show sister bar gauges and examples of their installation and use. The sister bar strain gauge comprises of two lengths of ribbed rebar welded to a central gauge section. The central gauge section has a miniature stainless steel, vibrating wire strain gauge element, fitted along the longitudinal axis of the gauge. Incorporated within the gauge section are two coils for excitation and output of the vibrating wire strain gauge element. This type of gauge is particularly rugged and reliable. They are particularly applicable for strain measurements in mass concrete pours where placing of concrete is remote and uncontrolled such as typically occurs in diaphragm walls or deep piles.

The sister bars can be connected to a single VibWire-108 instrument and data

Fig 39

The embedment or dumbbell gauge (See Fig 40) is designed to measure strain in concrete. This vibrating wire strain gauge is typically tied to a reinforcing cage. It is usual to install them in arrays of three or four gauges at several depths horizons within the structure.

Fig 40

Case Study - Bore Hole Pump Control

The following examples detail the use the VibWire-108 range of instruments within water flow and control systems. Two examples are shown. The first example demonstrates the VibWire-108 as a stand-alone control system used to monitor bore hole water and the second example, shows how the VibWire-108 is used with a data logger to report on and control the water flow in a v-notch weir.

Bore Hole Water Level Control

The VibWire-108 can be configured to operate as a stand-alone control system when used with Vibrating wire peizometers and the transistor output ports.

Fig 43 shows a sealed bore hole with 2 peizometers deployed. The lower level sensor reports the water level height. The top sensor acts as a reference and reports the internal bore hole pressure only. The water level height measurement can be in error if there is a build up of gas pressure in the hole and it is to correct for gas pressure changes that the reference is fitted.

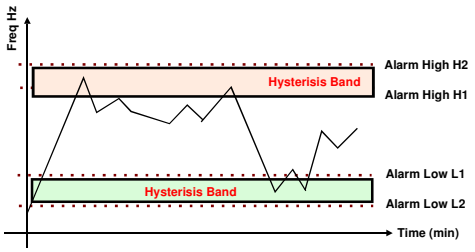


Figure 41

The VibWire-108 is configured to activate the digital output when the water height exceeds the higher alarm levels. Upon detection of a water level exceeding the pre-determined upper alarm level then the transistor output is activated to switch a relay.

The relay switching can be used to activate the ignition circuit on the pump if it is powered by a petrol engine or switch the power supply if an electric pump is being used.

Summary

As long as the Peizometer frequency settings are defined correctly and a suitable hysteresis level is set, then the VibWire-108 can run indefinitely to control a pump to maintain the water level within a bore hole below a pre-set level.

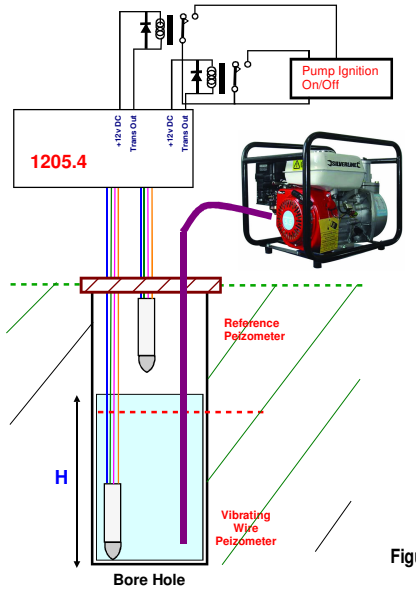


Figure 43

Stand-alone Weir Control System with Data Logger

For applications where a control system is required to let a set amount of water to flow and to maintain a record of events then a control system similar to that shown below will be required. Apart from maintaining details of flow the control unit can also act as an alarm system and shut of water flow should the defined limited be exceeded.

Consider the example of the V-notch weir below. A dedicated complex formula is required to calculate the discharge over the bottom of the notch. There are a number of different formula available for this calculation but they depend upon the water height at different positions within the weir.

A series of vibrating wire peizometers are used to monitor the water height and are connected to the VibWire-108. The VibWire-108 communicates the water height details to a programmable logger, such as the Keynes Controls gateway systems. The logger is used to calculate the discharge and to record the results.

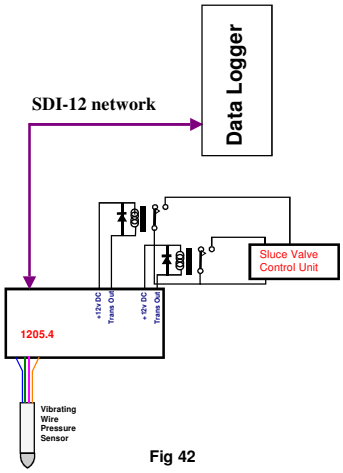


Fig 42

Fig 42 shows the basic control system showing the VW-108 connected to a logger across a digital network.

The instantaneous pressure levels are monitored by the logger and used within the V-notch discharge formula.

The logger can be used to produce a permanent result record that can be downloaded by an operator and also to trigger the transistor outputs within the VibWire-108 when used for alarm level control.

Fig 45 shows the v-notch weir profile. The water height is measured accurately using a precision vibrating wire sensor and these types of sensors are very accurate and stable over long periods of time.

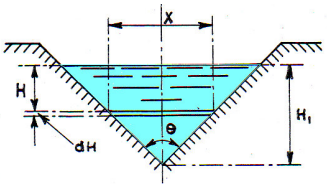


Fig 45

V-Notch Weirs

Referring to Fig. 44 in this instance the discharge $dQ = X\sqrt{2gH}dH$, where X is the width of the element at depth H below the surface. Denoting the angle of the V-notch by θ, $X = 2(H_1 - H)\tan\frac{\theta}{2}$, so that,

$$dQ = 2\tan\frac{\theta}{2}\sqrt{2g}\,(H_1 - H)\sqrt{H}dH$$

and the total discharge,

$$Q = 2\tan\frac{\theta}{2}\sqrt{2g}\int_0^{H_1}(H_1 - H)\,H^{\frac{1}{2}}dH$$

$$= \frac{8}{15}\tan\frac{\theta}{2}\sqrt{2g}H_1^{5/2}$$

Fig 42 shows the basic instrument system used to monitor and control a V-notch weir.

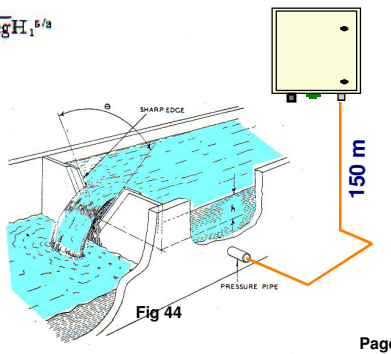


Fig 44