

VibWire-108 Operations

Connecting the VibWire-108 to the Datalogger DT80

Download the VibWire-108 User manual at <http://keynes-controls.com/vibwire/usermanualv103.pdf>

The following pages details how to connect the Datalogger DT80 logger to the VibWire-108 family of vibrating wire sensor interfaces using SDI-12 serial network and analogue input ports available within the logger. This information sheet is based upon the User having prior knowledge of the configuration of the DT80 and for programming data acquisition operations using the SDI-12 command set.



Operations

The VibWire-108 can be supplied with SDI-12 and an analogue output port making it ideally suited for integration to the DT80 logger.

The complete process of reading a signal from a Vibrating wire sensor to storage within the DT80 is a purely a digital operation when using the SDI-12 network. Up to 40 instruments making 320 vibrating wire sensors and analogue inputs can be can be connected to the DT80 across this interface.

The standard SDI-12 commands shown within DT80 manual are compatible to reading data and configuring the VibWire-108 across the network. Refere to the DT80 manual for programming examples.

The VibWire-108 family of products support models having analogue output representation of the sensor input signals and these can be connected to any analogue data acquisition system including the DT80.

The User keys on the instrument enable the operator to locally configure the instrument and make any in the field changes to operations including the assigning the real-time display and changing the ID number.

Datalogger DT80 Logger



Connects to 5D - 8D Digital Port

The DT80 operates as the SDI-12 Master and issues commands to the units across SDI-12 network. Care must also be taken to ensure a good system earth in order to ensure that the lightning protection will operate.

SDI-12 Serial Network Operation

Each VibWire-108 must have a unique identifier set in order that the logger unit can correctly identify the information from a specific interface.

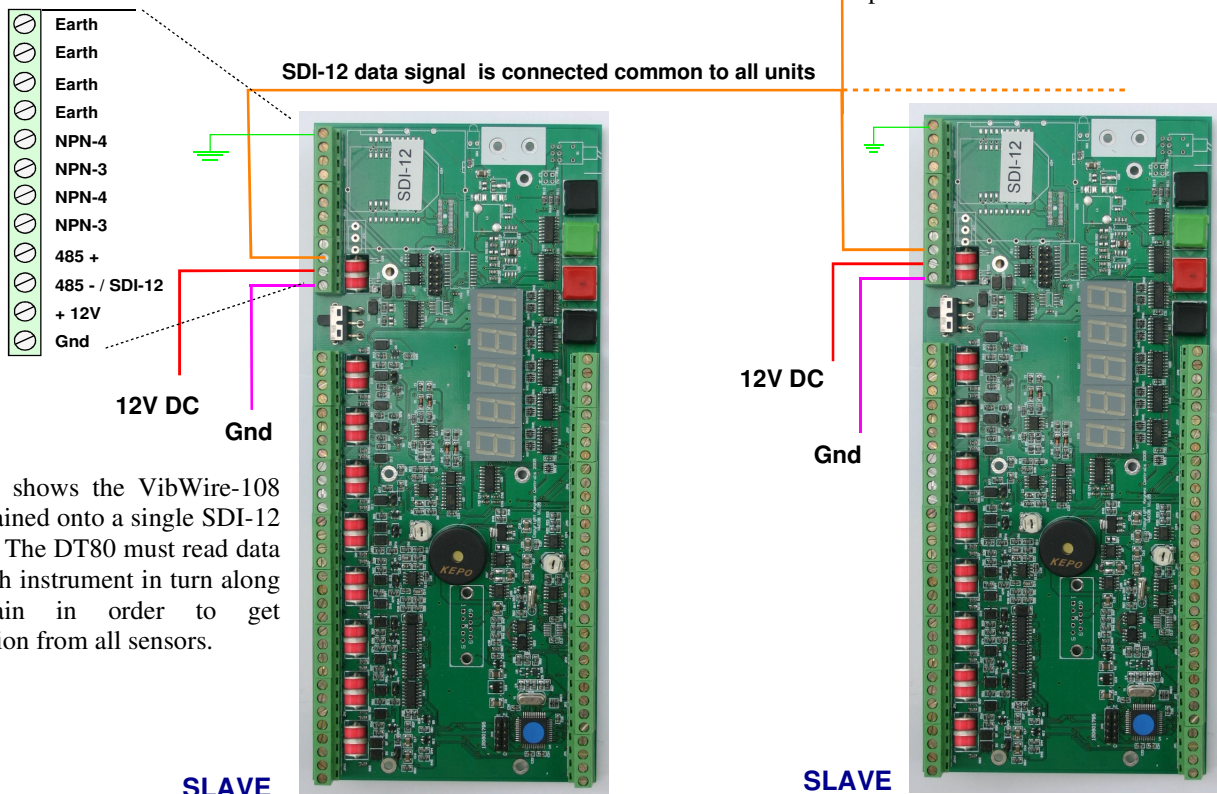


Figure 1 shows the VibWire-108 daisy chained onto a single SDI-12 network. The DT80 must read data from each instrument in turn along the chain in order to get information from all sensors.

Fig 1

Further Information

The DT80 logger and VibWire-108 can be seamlessly integrated to form a flexible stand-alone Geotechnical logger unit with USB data storage capability and all the facilities available from the DT80. The VibWire-108 contains all necessary protection circuitry to enable the system to be directly deployed for remote field applications. Low power operations can be optimised under program control within the DT80 software operations.

Fig 2 - Direct Connection to DT80



PCB Jumper Settings



PCB Jumpers

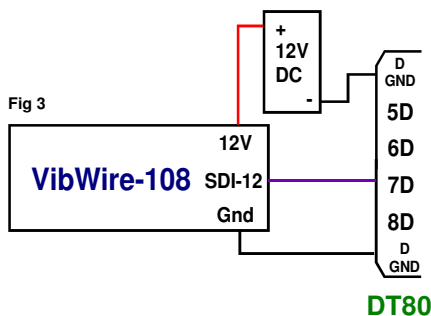
All of the VibWire-108 models support thermistor, analogue input for the range 0 - 2.5 V DC and current loop inputs.

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

Fig 3 shows how the VibWire-108 connected to the SDI-12 ports on the DT80. Any SDI-12 port on the DT80 can be used so long as defined within software.



Direct Connection to DT80 Logger

The simplest way to use the VibWire-108 and DT80 together is connect the two instruments together using the SDI-12 port for communications and to power the VibWire-108 from the same source as the DT80.

The VibWire-108 only requires approximately 70 mA at 12V DC at its peak level when operating in SDI-12 mode. A small solar panel with battery backup is all needed to deploy the VibWire-108 for unlimited stand-alone operations in most applications.

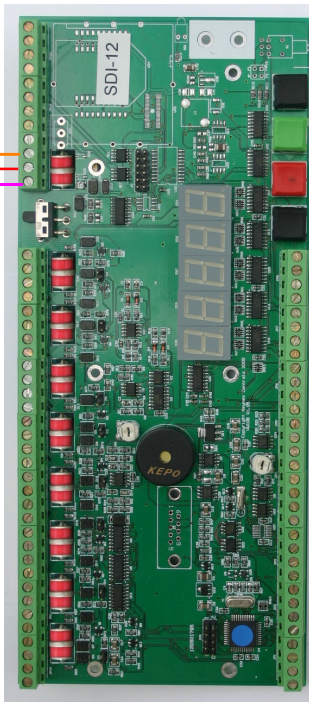
Operations

The VibWire-108 will operate within its factory default settings with ID = 0, and the output set to SDI-12 mode.

VibWire-108 remembers its configuration and so can be left in its preset state ready to operate immediately upon power on.

The relay within the DT80 is ideally suited to control power to the VibWire-108 and can be used to switch the instrument off between readings.

After applying power the DT80 can then instruct the VibWire-108 to make a measurement and read then sensor values. Once the new sensor information is read the VibWire-108 can be powered off.



Scan Time

The VibWire-108-SDI12 takes approximately 30 seconds to complete the scan for 8 channels and this reduces to 8 seconds for 2 vibrating wire sensor inputs. However this delay is dependent upon the operating frequency of the sensors being used. The lower the vibrating wire sensor frequency then the longer it takes to determine the result. Analogue input signals are measured instantaneously and as such are not considered to cause a delay within the measurement cycle.

Lightening Protection

The VibWire can be fitted with both gas discharge tube and transorb lightning protection so ensuring that the instrument will operate as safely as possible under the effects of local ground strikes.

Power Consumption

Scanning mode	70 mA	Duration 30 secs --- typical response time
Display mode	90 mA	Continuous
SDI-12 mode	20 mA	Continuous while waiting for commands
RS4-85 mode	20 mA	Continuous while waiting for commands
Analogue output mode	25 mA	Continuous

The advanced power management built into the VibWire-108 range enables the instruments to be deployed using Solar cells for many applications.

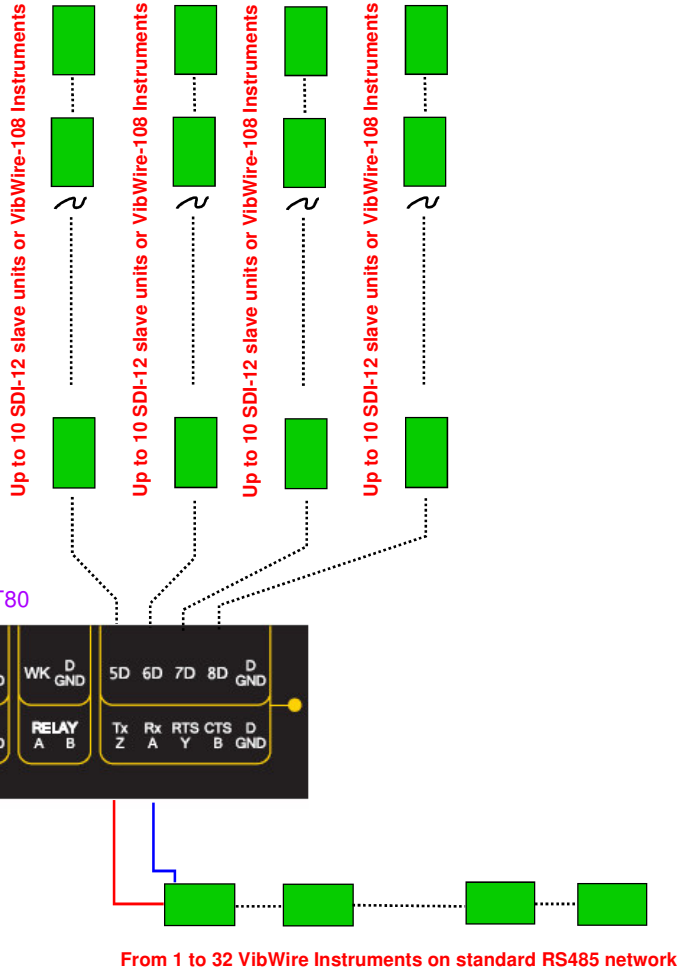
DT80 and SDI-12 Bus Operations

The DT80 logger supports SDI-12 applications and this means that information from any VibWire-108 instrument can be accessed and processed. The diagram below shows how many VibWire instruments can be connected together and on to which port they can communicate to the DT80. The VibWire-108 has 16 configurable inputs and all can be accessed by the logger unit.

The number of sensors shown deployed is based upon the basic specification for each network. Keynes Controls can expand the SDI-12 network identifier to 36 nodes instead of the standard 10 and 255 nodes for the 485 network upon request.

Fig 4 - Network Connection diagram for the VibWire-108 to the DT80 Logger

Each SDI-12 network supports to
 80 Vibrating wire sensor inputs
 80 Analogue inputs.



The RS-485 network within the DT80 supports 32 individual VibWire-108 instruments

256 Vibrating wire sensor inputs
 256 Analogue inputs

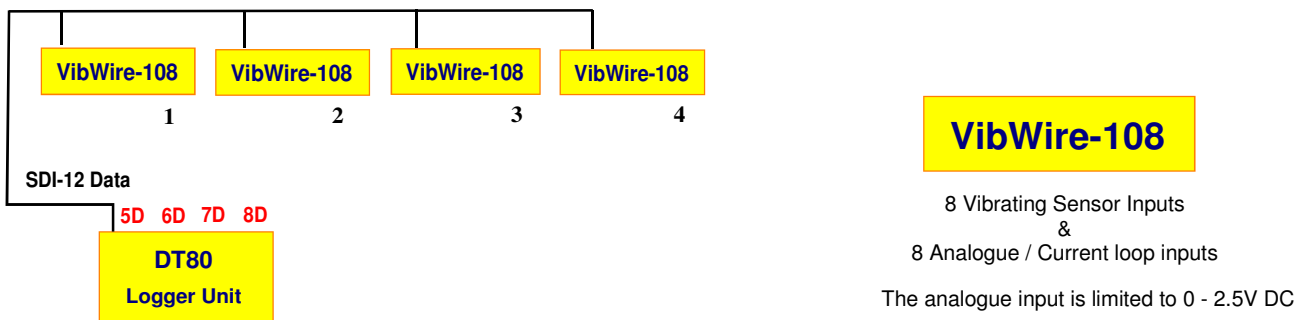
From 1 to 32 VibWire Instruments on standard RS485 network

Stand-alone DT80 Deployment - Up to 32 Sensor Inputs

For small stand-alone applications the recommended method of deployment is shown below. A single SDI-12 network connection wired to a daisy chained group of VibWire-108 units offers the simplest and most convenient way of forming multi-channel geotechnical applications.

To speed up scan times the VibWire-108 can be configured to operate with 2 to 8 sensors however the lower the sensor count the faster the instrument will respond. The sample time per VibWire-108 instrument is dependent on the number of vibrating wire sensors being used and the operating frequency of the sensors. The lower the operating frequency of the sensors the longer it will take to determine the measured frequency.

For fixed applications where no prior knowledge for the response of the sensors is known then a delay of 60 seconds after making the request to measurement until reading the sensor values back from the VibWire-108 is recommended. After this time all sensors will have responded and new data values will be available.



Connecting the DT80 to SDI-12 Devices

The DT80's tri-stateable digital I/O channels (**5D-8D** on DT80, **4D** on DT81) can be used to control up to four SDI-12 buses. Up to ten VibWire-108-SDI-12 interface units can be connected to each bus.

As shown in *Figure 3*, an SDI-12 bus is connected to the DT80 as follows:

The SDI-12 **DATA** line connects to one of the digital I/O terminals **5D – 8D** (**4D** for DT81)

The SDI-12 **GROUND** line connects to the **D GND** terminal

The SDI-12 **POWER** line is typically connected to the DT80's external power input terminal (+), or alternatively a separate 12V DC supply can be used.

When connecting a VibWire-108 to the DT80 for the first time, it's best to connect only to a single interface, ie. you should temporarily disconnect any other sensors on the same SDI-12 bus. This ensures there will be no address conflicts.

Testing and Configuring a VibWire-108-SDI-12 Device

By default the ID number of a factory ready VibWire-108 and unless otherwise stated with the documentation is ID = 0.

All the VibWire-108-SDI-12 interfaces act as full SDI-12 slave units and so support at least ten different addresses. The interface ID number can be changed manually using the User Keys mounted on the instrument or remotely using SDI-12 commands issued from the logger unit.

If only a single VibWire-108-SDI12 is to be connected to any of the SDI-12 ports on the DT80 at any one time then the factory set ID number need not be changed.

Setting the ID number using the User Keys

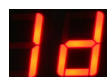
To activate the real-time frequency display

1. Starting at



The **Basic** menu item is the first menu item available after the instrument is powered on and can also be accessed by pressing the "Menu In" key at any time in the instrument operations.

2. Select "Up" and "Down" button until the



Other Menu options that appear as the "Up" and "Down" keys are pressed are **DISP PEROD TRa** etc.. menu item is displayed.

3. Select the "Menu In" key and the instrument ID number will be displayed. 0 being the default ID



Use the "Up" and "Down" keys to alter the Id number from 0 to 9.

Once the new ID number is set press the **"Menu Out"** key to confirm the option

The new ID number can now be used to access information from the VibWire-108 interface.

Measurement Modes

Due to the nature of Geotechnical measurements the acquisition of sensor data is relatively slow compared to other aspects of data acquisition operations. The VibWire-108 does support only Measurement-upon-demand mode of operation for SDI-12 / 485 networks and a continuous mode only when the analogue output port is being used.

Measurement on demand

The VibWire-108 is idle (held in a low power mode) until it is woken by the data logger sending it a measurement request. The interface then takes the measurement returns the data. The time taken to return data to the DT80 logger is proportional to the operating frequency of the vibrating wire sensors. The lower the operating frequency then the longer the delay before a new value is available for reading. The maximum delay is 60 seconds from issuing the measurement request to reading new values.

Measurement on demand minimises the overall system power usage and also reduces wear on the coil used with the vibrating wire sensor. In order to operate in Measure on demand mode the DT80 must first send a measurement request instruction and wait VibWire-108 to complete the measurement operation before moving on to the next instrument. It is not currently possible for other SDI-12 tasks to be carried out while the DT80 is waiting for the data to be returned from the VibWire-108.

Either of the **aM!** or **aC!** commands will start the VibWire to make a scan of the input channels.

Continuous Measurement - Analogue Output Only

The analogue output port is used only when the VibWire-108 is connected to an analogue data acquisition system. The vibrating wire sensor inputs have to be manually defined and the results scaled to engineering units within the logger unit. The results can be observed faster than those reported over an SDI-12/485 network but there are errors inherent in the digital-analogue and analogue-digital conversion processes involved.

The output ports within VibWire-108 can be connected to the DT80 analogue data acquisition system when relatively fast results are required.

Firmware Identification

SDI-12 applications running within the DT80 can take advantage of the features available for intelligent sensors just like the VibWire-108 and can interrogate the instruments for their identifier details. In the case of the VibWire-108 the ID is by default

KEYNESCOVibWire-1080001 -- represents instrument with firmware release 1
where the last three digits represent the firmware version number.

Registers

The VibWire-108 supports 8 vibrating wire sensors and 8 analogue input channels and all these values can be accessed by the DT80. The VibWire-108 divided it's set of registers in to a number of register sets and each set holds 4 values. The data format is:

aD0! = channel 0 and 3	'aD0!'	--	Vibrating Wire inputs 0 - 3
aD1! = channel 4 and 7	'aD1!'	--	Vibrating Wire inputs 4 - 7
aD2! = channel 0 and 3 Therm/analog	'aD2!'	--	Temp/current loop inputs 0 - 3 (values in mV)
aD3! = channel 4 and 7 Therm/analog	'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

VibWire-108 Sensor Scanning & Start-up Operations

The VibWire-108 is a stand-alone interface using embedded software as such boots up as soon as power is applied. In practice the instrument starts to operate as soon as the initial "BASIC" menu can be observed on the seven segment display. The "BASIC" menu is displayed prior to the instrument starting any operations.

The VibWire-108 remembers any preset configuration and will restart in that condition upon being powered on. This enables groups of units to have their ID numbers and network ports preset so that under control from the logger units they can be powered on in turn, used to acquire data and switched off with out need to reset any comms etc..

The start up time from powering on the unit to being able to send instructions in approximately **1 sec**.

The time taken from issuing an instruction to the VibWire-108 to the unit sending a reply from power on is approximately **2 secs**.

The VibWire-108 uses a phase locked loop and resonant frequency tracking system to operate the ping for vibrating wire sensors. This circuit settles almost immediately after the first ping to a sensor. The ability to use a phase locked ping ensures the minimum amount of energy is used to drive the sensors as they are always being driven very close to resonance.

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, SDI-12 and RS-485 network. Simply connect the sensors to the interface and start the SDI-12 applications. Ref DT80 manual for full details.

Recommended Test

Use a single instrument only when undertaking initial measurements with a VibWire-108 on the SDI-12 or RS-485 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 networks with the ones shown on-board frequency display of the unit. The on-board display is accurate to 1 Hz compared to 0.1 Hz for a measured sensor value.

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 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.

Real-time Frequency Display

The VibWire-108-SDI12 contains a 5 digit 7 segment display and this can be used to display the instantaneous frequency from any one of the vibrating wire sensor inputs.

The Vibrating wire sensors can be deployed a considerable distance from the interface and may well 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

A 7-segment display showing the word "bASIC" in red. The 'b' is lowercase, 'A' is uppercase, 'S' is uppercase, 'I' is uppercase, and 'C' is uppercase.

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

A 7-segment display showing "C0d" in red. 'C' is uppercase, '0' is a digit, and 'd' is lowercase.

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

the other options available are:

"**Analog 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.

A 7-segment display showing the number "546.7" in red. '5', '4', and '6' are digits, and '.7' is a decimal point followed by a digit.

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

Starting SDI-12 Network Communications

To activate the SDI-12 output port on the VibWire-108-SDI12.

1. Starting at



2. Select “Menu In” button

3. Use the Up & Down Keys to select the option “Seral”

“Analog 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 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 below for details on setting the ID number.

Using SDI-12 Commands with the DT80

The DT80's use the **SDI12SEND** command allows to manually send SDI-12 commands to the VibWire-108 for testing and configuration purposes.

The format of this command is as follows: **SDI12SEND channel "string"** where:

channel is the digital I/O channel (5 – 8) (4 for DT81)

string is a valid SDI-12 command string to send to the device. All commands start with the sensor address (0 – 9) and end with a ! character.

If there is a reply from the device then it will be displayed, assuming the /M (enable messages) and /h (free format) switches are set. For example, the *aI!* command (*a* = address) should result in the sensor returning an identification string, eg.

SDI12SEND 5 "0I!" -- send out ID request for instrument attached port 5D.

5SDI12: 0I !a13KEYNESCOVibWire-1080001\r\n

Part Description assigned by Keynes

Example - Measure on Demand Application

In this example the documentation for a hypothetical stand-alone geotechnical instrument system states “send the *aC1!* (or *aM1!*) command to measure (1) strain - Frequency Hz (2) displacement - Frequency Hz (3) Pressure - Frequency Hz (4) temperature - Frequency Hz (5) sensor temperature - mV (6) sensor temperature - mV (7) Current loop - Volts (8) Current loop - volts for an instrument with ID number of 6 and connected to the DT80 using digital I/O 7D.

In this application we are looking at a VibWire-108 configured to use 4 vibrating wire sensors with two of these sensors having the temperature compensation sensor being monitored and 2 current loop input signals being recorded from the analogue input channels.

In order to make the VibWire-108 report values it first must complete a scan of all channels. To force the VibWire-108 to scan the input sensors issue the command

BEGIN “Getdata”

-- this program runs repeatedly for 2 min samples

RA2M 7SDI12(AD6, R101, “Displacement Hz”)

7SDI12 (AD6,R202, “Temp mV”)

7SDI12 (AD6,R204, “Loop value - mV”)

LOGON

END

Note The VibWire-108 supports both the *aMn!* and the newer *aCn!* SDI-12 commands then be sure to refer to the section on the *aCn!* DT80 manual command in the logger documentation when determining which register numbers to use. These two SDI-12 commands do the same thing but the timing constraints for the operation of the command may be different. The DT80 always uses the *aCn!* command in preference to *aMn!*.

Table Of Commands

The following commands are all those supported by the VibWire-108-SDI12 for use on the SDI-12 and 485 multi-drop serial networks.

See <http://www.keynes-controls.com/vibwire/usermanualv103.pdf>

for additional information on how to program and use the VibWire-108 range of interfaces

Comm Port Settings - SDI-12 & RS485 Network

Communication ports Settings for SDI-12 & RS485 network. *1200 baud 8 bit no parity*

Changing the ID Number (address) under SDI-12 Commands

The following example demonstrates how to change the instrument ID number from the default factory setting 0 to 5.

Use the command 'aAb' where a = Start ID b = Final ID
 master sends: '0A5' Instrument responds 5\r\n Return New Line (5 representing new ID number)

Factory Settings

Unless otherwise specified the VibWire-108 is default factory set to ID = 0 with comm port settings 1200 baud 8 Bit no parity
 8 vibrating wire sensors and 8 analogue inputs.

SDI-12 Command Summary

The following SDI-12 commands are supported by the VibWire-108-SDI12.

Description	Master SDI-12 Commands	VibWire-108 Response
Acknowledge active	a!	a\r\n
Send ID: provided to complement SDI-12 protocol	aI! SDI12SEND 5 "0I!"	a13KEYNESCOVibWire-1080001\r\n Part Description assigned by Keynes
Address query identifies instrument address and commonly used on single instrument operations only.	?! Used to make command set SDI-12 compatible	a\r\n Where a = number 0 - 9 for SDI-12 0 - 9 letters a - z for RS485 A - Z
change Address: used to change instrument address from default to new one for network operations	aAb! a = initial address b = new address	b\r\n a : b = number 0 - 9 or a - z
Start Measurement - Not Supported DT80 instruct an instrument to make measurement	aM! a = address of instrument	a0608\r\n instrument with address a returns 8 x vibwire & 8 x temp after 60 seconds
Concurrent measurement: Used for polling multiple instruments on a network to start to make readings. This command frees RS-485 bus for other de- vices	aC! start measurement instrument address a	a06016\r\n initial response only after receipt of in- struct and no response when data ready to be sent.
Send data data returned aND! = Vib + Vib + Therm + Therm and has same format for each command	aD0! aD1! aD2! or aD3! 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	+xxxx.x+xxxx.x+xxxx.x+xxxx.x\r\n