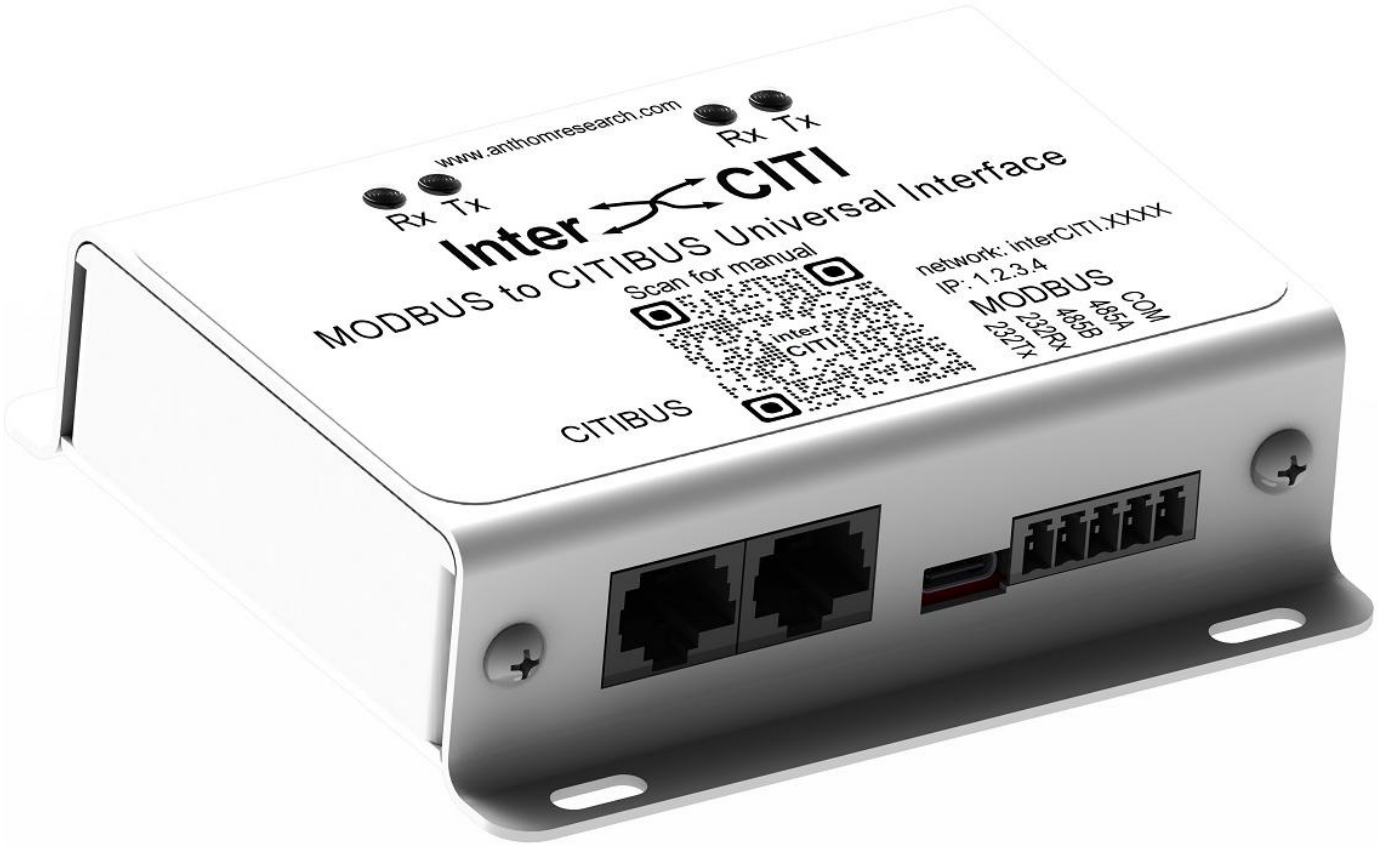
InterCITI
Modbus to CITIBUS
Universal Interface

Installation and Operation Manual



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Introduction

The InterCITI universal Modbus to CITIbus interface allows direct connection between any Modbus capable device and the Baker Hughes GCS and Advantage variable speed drives (VSD's).

The Baker Hughes (BH) VSD's do not have a Modbus interface as standard, and to connect a Modbus capable device typically the user would be required to purchase a Remote Data Communication Module (RDCM) from BH, an expensive and often hard to find device. The InterCITI module duplicates the function of the RDCM but is a fraction of the price, is readily available, much faster to install, more capable, supports additional features and is much easier to configure, even from your truck!.

InterCITI Competative Comparison Chart.

	Anthom Research InterCITI	**ACE Downhole ADCM**	**Baker Hughes Remote Data Commication Module**
Configure with VSD safely closed.	✓	✗	✓
Configure over WiFi using phone.	✓	✗	✗
Configure while sitting in the truck out of the weather.	✓	✗	✗
PC not required for configuration.	✓	✗	✓
PC can be used for configuration.	✓	✓	✗
Universal mount included - both DIN rail or panel.	✓	✗	✗
Supports master and slave Modbus.	✓	✓	✗
Display live polled Modbus status and results on phone.	✓	✗	✗
Device 1, 2 & 3 may all be RS-232	✓	✓	✗
Optically isolated RS-232, RS-485 & USB ports	✓	✓	✗
Sensor presets.	**8**	**5**	**3**
Warranty.	**3 years**	**2 years**	**90 days**
Technology generation.	**2025**	**2018**	**Sometime in the 80's**
Cost.	**$**	**$$$ or $$$$$**	**$$$$**
Availability.	**Now**	**10 to 30 days**	**Sporadic**
Order placement to shipment time.	**Less than 24 Hours**	**3 to 6 weeks**	**If available 1 to 3 months**

Dimensions and Specifications:

Input Power	24 Volts DC (supplied by the VSD CITIbus)
Modbus RS-485 (Isolated)	3 wire standard
Modbus RS-232 (Isolated)	3 wire standard
USB Modbus (Isolated)	Standard USB-C
CITIbus VSD Interface (Isolated)	Transparent pass through, emulates RDCM CITIbus
Power Consumption	0.1 Amp
CITIbus CIM Compatible	Yes- Recycle Centinel Interface
CITIbus RDCM Compatible	Yes - Recycle or scrap RDCM
CITIbus Modes Supported	Advantage CITIbus & GCS Legacy CITIbus
Operating Temperature	0°F to 158°F,-18°C to 50°C
Dimensions (unit):	4”x4”x1.5”
Dimensions (shipping):	6”x6”x4”
Weight:	1lb

GENERAL SAFETY INSTRUCTIONS

Warnings in this manual appear in either of two ways:

1. *Danger warnings* – The danger warning symbol is an exclamation mark enclosed in a triangle which precedes letters spelling the word “DANGER”. The Danger warning symbol is used to indicate situations, locations and conditions that can cause serious injury or death:

 **DANGER**

2. *Caution Warnings* - The caution warning symbol is an exclamation mark enclosed in a triangle which precedes letters spelling the word “CAUTION”. The Caution warning symbol is used to indicate situations and conditions that can cause operator injury and/or equipment damage:

Other warning symbols may appear along with the Danger and Caution symbol and are used to specify special hazards. These warnings describe particular areas where special care and/or procedures are required in order to prevent serious injury and possible death.

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For the purposes of this manual and product labels, a **Qualified Person** is one who is familiar with the installation, construction, operation and maintenance of the equipment and the hazards involved. This person must:

1. Carefully read and understand the entire manual.

2. Be trained and authorized to safely energize, de-energize, clear faults, ground, lockout and tag circuits and equipment in accordance with established safety practices.

3. Be trained in the proper care and use of protective equipment such as safety shoes, rubber gloves, hard hats, safety glasses, face shields etc. in accordance with established safety practices.

4. Be trained in rendering first aid.

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The Original Language for this document is English. Translations to other languages may not be accurate.

NOTICE

As Anthom Research LLC Inc. strives to promote safety in the maintenance and operation of Anthom Research LLC Inc. equipment, we request that the following safety features be followed, along with any additional safety procedures set by the customer's safety officers, or local codes.

1. **Read manual completely before attempting installation or operation of this unit.**
2. **Incoming electrical power must be properly shielded, routed, and grounded. All safety codes should be followed. Study wiring diagrams before attempting installation.**
3. **Disconnect power to equipment before removing any guards or covers. Replace guards or covers before resuming operation of unit.**
4. **Do not bypass safety switches.**
5. **Do not attempt repairs while equipment is running.**
6. **Use only original equipment parts designed to safely operate in the equipment.**
7. **Only authorized personnel should be allowed to operate or perform maintenance on the unit.**
8. **The equipment should only be used for the purpose for which it was sold, and should not be modified in any way, without notifying the General Manager of Anthom Research LLC Inc. in writing, of the modification.**

System Overview

The BH VSD's use a proprietary internal high speed data bus, called CITIbus, to communicate between various internal circuit boards in the VSD and optional interfaces, for example to support additional inputs and outputs from the VSD. The optional modules typically mount inside the VSD and all connect to the VSD via an 8 conductor CAT 5 cable daisy chained from one PCB or module to another. Note that although CITIbus uses a CAT 5 cable, this is not an Ethernet connection, but rather a custom proprietary BH interface.

The InterCITI universal Modbus to CITIbus interface also plugs into this daisy chain. Since it requires minimal power the InterCITI interface is powered from the VSD via the interface cable and does not require other power sources or connections. The InterCITI interface accepts polling requests from the VSD and replies with results that it has in turn accumulated from devices it polls via its electrically isolated Modbus port. Since the the InterCITI interface emulates a BH RDCM the VSD will accept the the InterCITI interface replies and use them exactly as if they had come from an RDCM, so all BH VSD screen settings, formatting, adjustments, set points etc. will be exactly the same as if an RDCM was installed.

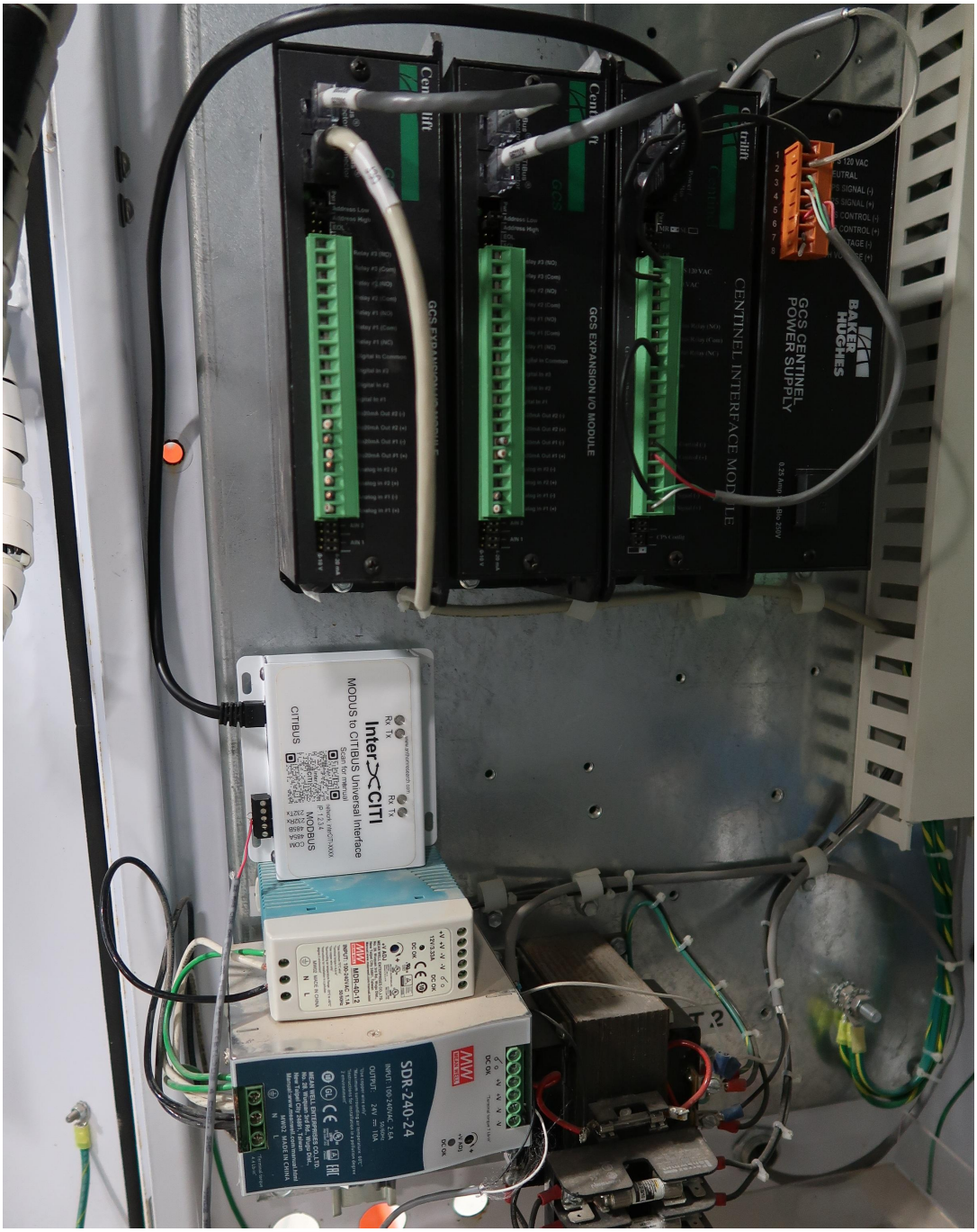
However the InterCITI interface is much more intelligent than the RDCM. To specify which registers the RDCM may want to poll from an external device a convoluted, complex set of menus on the VSD has to be used which can be very time consuming to set up, especially outdoors in the field. The InterCITI interface bypasses this setup completely, and does not require this complex VSD procedure. The InterCITI interface stores the complete setup internally, it does not need to use the VSD menus for configuration and the setup may be viewed or modified, either via Modbus or via the operators phone using local WiFi, provided by the InterCITI interface, even while the VSD is running. There is no need to even open the VSD cabinet to view or change settings, the operator may be sitting in the truck nearby.

To speed and ease installation even more, the InterCITI interface has built in presets for all of the most popular third party downhole sensors, so configuration can be as simple as powering down the VSD, snapping the InterCITI interface on to the DIN rail, plugging it in to the CITIbus network, closing the VSD door, powering up the VSD, climbing back in the truck, connecting via WiFi then clicking the selected sensor. Hours of service time may be saved during the installation compared to using an RDCM.

System Installation / Configuration

First power off and lockout / tag out the VSD per safe operating procedures. Open the VSD and look for existing CITIbus compatible modules usually mounted on the left inside of the VSD. The InterCITI module typically mounts on a DIN rail that is installed just below these modules. If an RDCM is installed disconnect and recycle it. If a Centinel power supply and Centinel Interface are installed they may also be disconnected and recycled. If there is not a DIN rail already installed one can be added by the installer and the module clipped on to it, or the three screws holding the DIN rail clip on to the back of the module may be unscrewed, the DIN rail clip removed, then the module may be attached to the panel with self tapping screws through the module flanges.

Typical InterCITI Module Installation

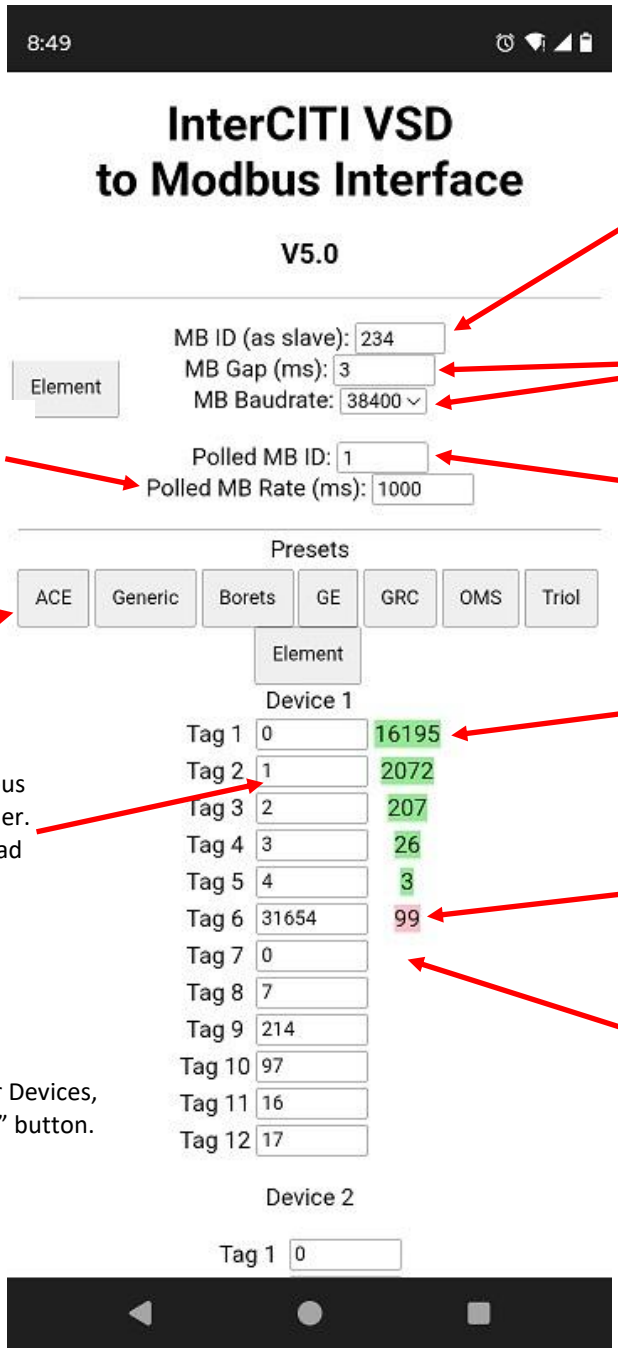


Using the CAT 5 8 pin cable supplied with the module connect the module to the existing CITIbus modules. Either of the 8 pin sockets may be used, and the module may also be used as a pass through unit if needed due to cable routing. Connect the RS-232 or RS-485 connector pins to the device that needs to be supplying data to the drive, typically a readout for a downhole sensor. For both RS-232 and RS-485 three wires should be connected, signals and common. Although RS-485 typically will work if the common is not connected it is highly recommended to use all three wires since the electrical interference inside the VSD can be severe and the common shield will reduce the chance of any serial communication errors. The USB-C connector also connects to the same comm port of the interface, but it is typically only used if direct PC access is required to configure the interface. See USB-C notes at the end of this chapter concerning USB-C connectivity and direct PC access. Once these connections have been made and the cables secured the VSD may be closed and powered up.

At this point the InterCITI interface should be ready for configuration. By far the quickest and easiest way to do this is via the built in WiFi configuration utility. No cell phone service, mobile data or internet access is required to use this feature, it just requires a cell phone, tablet or laptop that supports WiFi. To connect proceed as follows, using a phone as an example but other devices will be similar. Open the WiFi settings on the phone and look for a network called interCITI-XXXX where XXXX will be the last four characters of the module MAC address (so multiple units in close proximity may be uniquely identified). Connect to this network, ignore any security messages that may appear, then depending on the device a message may appear saying the internet cannot be reached. This is fine as the internet is not required, select “connect anyway” or accept a similar message. Now open a browser and in the address bar type 1.2.3.4 for the address. In a second or two a screen similar to below should be displayed.

This will display the selection of 36 modbus register addresses the module will scan and accumulate ready to pass on to the VSD via CITIbus. The Baker VSD terminology lists these registers on the drive as 12 ‘tags’ for 3 ‘devices’, in reality they are just 36 modbus registers that are defined here. The VSD has a complex method for the operator if using an RDCM, via the HMI keypad to set the modbus address's, baud rate, comm port parameters etc. inside the VSD. However the InterCITI module does not require that, it ignores all of HMI serial settings and the operator may set all the required parameters here, on this screen, directly from their phone. All settings are stored inside the InterCITI module, not in the VSD.

Typical Live Phone Screen Display



From 1 to 36 registers may be scanned to bring into the VSD, in any order. These settings will be stored inside the module, not in the VSD. Even better, the InterCITI module already has preset groups of settings for the most popular devices, so for example if an Oxford Monitoring System sensor is connected simply click the OMS button to preload all the correct registers, default baud rate etc., then click save at the bottom of the page to store the settings in the module.

At this point the device registers should start to be scanned, and if everything is configured and wired correctly live readings should start be appear, colored green, next to the register list on the phone. If the readings are red then an error occurred for that particular scan, and would

typically be caused by incorrect baud rate setting, RS-485 A & B wires reversed, an unsupported register being requested, wiring error, etc.

Although the module can scan up to 36 registers this is rarely required, typically sensors have 8 or less registers of interest that the VSD may use. The module will start polling for Device 1 Tag 1 register, and will continue in sequence until the last register (Device 3 register 12, the 36th), or until it sees a register to poll that has the same address as the first (Device 1 Tag 1) register, then it will restart at the first. This way if only a few registers are required it will just keep repeating those polls and not waste time polling unwanted registers. If the register is not polled the result will be blank next to the register target.

So, with the VSD cabinet closed and the powered up (running or not) it is possible to modify, confirm correct operation for the module to scan and accumulate plus display the confirmed live readings from the connected modbus device. This capability is impossible with the RDCM.

Some customers may require no WiFi access to the InterCITI module, and the device may be ordered without WiFi access. In this case it is possible to configure the module via the RS-232, RS-485 or USB-C port using a PC with a suitable cable. The device may be programmed using Modbus commands since the module is able to accept Modbus master commands and respond to them as a Modbus slave. If it does not receive a Modbus command for approximately 10 seconds it will automatically switch back to Modbus polling mode. This allows the settings to be modified then switch back to normal operation. A general purpose Modbus program could be used to do this, or the ACE SRU2/3/ADCM configuration program will also work with the InterCITI module. Connect to the InterCITI using 38400, 8-N-1 using Modbus address 234. Note the InterCITI module may already be transmitting Modbus polls, but will switch to slave mode automatically when it receives an incoming Master poll. It is not possible to display live polled readings via the serial port / PC since the module will be in slave mode when accessed by a PC.

The InterCITI module would typically poll a device of interest with the module acting as a Modbus master, however the module will work just as well as a Modbus slave, so registers from any Modbus device acting as a Modbus master may effectively be pushed into the module which will switch to Modbus slave mode. The module does this automatically, there is not even a configuration setting required to do this.

The registers acquired by the InterCITI module that are to be written to the VSD via CITIbus are in locations 219 - 254 in the module. If a device is set up as a Modbus master connected to the module the master may write to these locations pushing registers into the module and the register contents will then be passed on and appear on the VSD as Device 1 Tag 1 (from module register 219) up to Device 3 Tag 12 (module register 254).

To display the correct scaling and units on the BH VSD proceed as follows. Depending on existing VSD security settings some of the changes may be locked out by the VSD . To unlock and allow changes proceed as follows. On the main VSD screen select Scada / Security. Then change the User, Level 1 and Level 2 passwords to 0. Next scroll to the right to find “User Menu Level” and set it to Advanced. On the main screen select select GCS Modules->GCS Module Status. Ensure that the “Remote Data Com” is enabled so the VSD will communicate with the InterCITI module. Press the Menu key to return to the previous menu, then select ‘Remote Data Com Module’. This will take you to the ‘Device 1 Tags’, which shows all live readings being polled, its the first of 4 screens relating to the module. There are 3 “Device” screens and one RDCM setup screen. To set the scale and units use the left or right keys to get to the ‘RDCM Setup Screen’. Then select

‘Device 1 Setup’ which will show a screen full of parameters related to RDCM setup. The InterCITI module will automatically configure itself to communicate and none of these items have any effect or meaning except ‘Tag Cfg’. and ‘Device Type’. To allow setting correct units and scaling enter ‘cstm’ for ‘Device Type’.

Once this has been done select ‘Tag Cfg’ to bring up a screen that allows the user to change the display to match the ‘Dec’, ‘Unit’ and ‘Data’ columns. Note the Data field determines if the VSD handles the register as a 15 bit signed register (if set to 1) or a 16 bit unsigned register (if set to 2), these should typically all to be set to 2. Select what needs to change, press the enter key then use up/down to change. Press enter again to stop editing that parameter. The registers may be scaled, displayed, have units assigned and used just like standard registers from an RDCM. Refer to the Baker Hughes documentation for further details.

NOTE:

Many versions of the BH Advantage drive have the following software error. If the drive RDCM setting is set to ‘Custom’ it will collect and display correct readings from the interCITI, however this also results in false ‘Setpoint Change” events being logged every time a parameter value (not a set point) changes, and these false events will quickly fill the event log. It will not cause alarms or shutdowns but overwrite the event log.

Note that this is a VSD software issue, and exactly the same error occurs with a BH RDCM, it is not an interCITI issue. There are two work arounds, either ignore the event log or set the RDCM setting in the drive to any preset sensor and the event log will no longer be overwritten.

To correct the problem call BH and request corrected software be installed in the VSD. This problem does not occur in the earlier BH GCS VSD which operates correctly.

Notes on USB-C connection. The InterCITI module supports the modern USB-C interface so it may directly connect to a PC etc. without requiring a special RS-232 or RS-485 interface cable. USB-C differs somewhat from the earlier standard, USB-A which always treated the USB-A port on a PC as a ‘master’ typically intended for printers and other devices that were essentially slaves. If the PC also has a USB-C connection it results in the same physical connection at both ends, so there can be some confusion as to the master/slave operation for communications. The result is that sometimes there is confusion or interface problems depending on the order of cable insertion and power up of devices. If the PC does not connect correctly try powering down/up the InterCITI after the USB-C cable is inserted. This problem is not seen when using a USB-A to USB-C cable, which the majority of users will have.

Modbus Map

Address	
20	Software version of InterCITI Module. (10 = Ver. 1.0)
146	Total number of CITIbus packets processed since power up (lower 16 bits, wraps at 9999 to prevent overflow if shown on VSD display).
147	Total number of CITIbus packets processed since power up (upper 16 bits).
148	Total number of CITIbus errors / timeouts since power up.
219	Result of polling Device 1, Register 1
220	Result of polling Device 1, Register 2
221	Result of polling Device 1, Register 3
“ “ “	….etc.
230	Result of polling Device 1, Register 11
231	Result of polling Device 1, Register 12
232	Result of polling Device 2, Register 1
233	Result of polling Device 2, Register 2
“ “ “	….etc.
242	Result of polling Device 2, Register 12
243	Result of polling Device 3, Register 1
244	Result of polling Device 3, Register 1
“ “ “	….etc.
254	Result of polling Device 3, Register 12
1015	Modbus ID of InterCITI when a slave (additional user address is default 234).
1016	Modbus silent time when a slave in mS.
1017	Modbus baud rate.
1070	This contains the Modbus register to poll by the module for Device 1 Tag 1
1071	This contains the Modbus register to poll by the module for Device 1 Tag 2
“ “ “	….etc.
1081	This contains the Modbus register to poll by the module for Device 1 Tag 12
1082	This contains the Modbus register to poll by the module for Device 2 Tag 1
“ “ “	….etc.
1093	This contains the Modbus register to poll by the module for Device 2 Tag 12
1094	This contains the Modbus register to poll by the module for Device 3 Tag 1
“ “ “	….etc.
	This contains the Modbus register to poll by the module for Device 3 Tag 11
1105	This contains the Modbus register to poll by the module for Device 3 Tag 12
1106	Modbus address of the device the module will poll, 1-255. Address 234 is reserved.
1108	Poll time in mS between polling Modbus slave devices.

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14. APPLICATION LIABILITY. AR assumes the buyer to be an expert in his intended application of AR products. AR claims no special expertise in the application of its products into the buyer’s equipment. AR accepts no responsibility for the buyer’s selection and use of AR products. Buyer’s interpretation and implementation of application suggestions and recommendations by AR, general or specific, transmitted verbally, electronically or in writing, published or unpublished, is strictly at the buyers own risk.