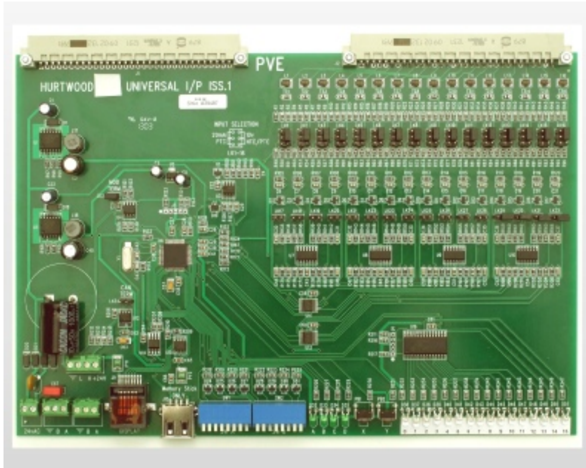
Universal Input Card User Guide



PRODUCT OVERVIEW

The 16 channel input card is designed to fit directly into existing Satchwell BAS 2000, 2800 and Sigma rack type control enclosures (known as UNC 696 and UNC 796 controllers) and hence allow the existing analogue and digital inputs to be read by a modern, web based master controller over a Modbus two wire RS485 network.

PRODUCT SPECIFICATION

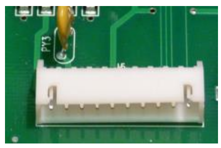
The card provides 16 inputs, which can be configured by jumpers to measure voltage (0 - 10V), current (0 - 20mA) or resistance (PTC and NTC thermistors) in 2 ranges so as to give maximum accuracy. For reading digital signals, thresholds are set and can be adjusted over the Modbus network. Inputs can provide accurate pulse-counting and frequency calculation of a varying signal. Each input has an LED that can be set over the Modbus network to display the status of the digital and analogue inputs.

The card is communicated with by Modbus over a two-wire RS-485 network. The data format is 8bit RTU, with a choice of address, baud-rates and message formats configured by dip switches (see Section 1.3). A software set-up tool is also available for commissioning the cards via a supervisor port in the absence of the master controller and Modbus network.

The input values can be read directly out of the card by selecting one of 34 pre-installed profiles via the Modbus register. These profiles cover all the common current, voltage and thermistor types (see Section 2.3 and Appendices A & C).

The card must be powered off a 24VDC power supply. The inputs are protected against static discharge, but normal static precautions should be taken when handling the cards.

1. Hardware Configuration



1.1. Connections

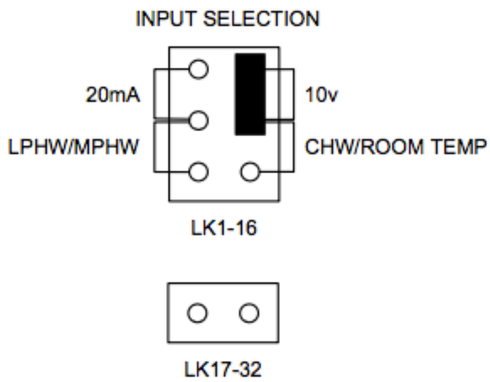
The power and communications connections are made through connector J4, which in turn connects to the ConBus board. The ConBus board can then link up to six Satrofit cards with 24VDC, 0V, A = Data + and B = Data –. **NOTE:** Some Modbus devices, e.g. Vacon variable speed drives, employ the convention of A = Data –. Connecting the data connections round the wrong way won't damage the card, it just won't work.

1.2. Input Type Selection

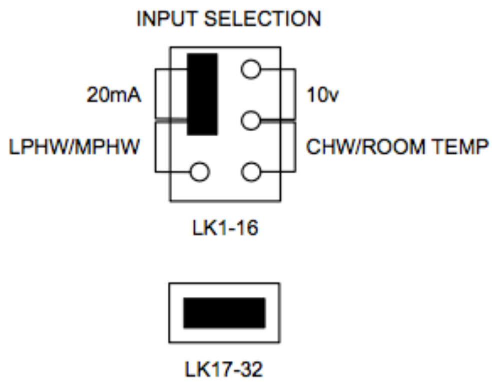
The choice of voltage, current or thermistor is made via the two banks of jumpers on the board.

Two thermistor ranges exist, a high resistance range for measuring space temperatures and chilled water and a low resistance range for Positive Temperature Co-efficient (PTC) thermistors and for measuring Low Pressure Hot Water (LPHW) temperatures up to the 150C limit for thermistors, ranges where the resistance of the thermistor bead is low.

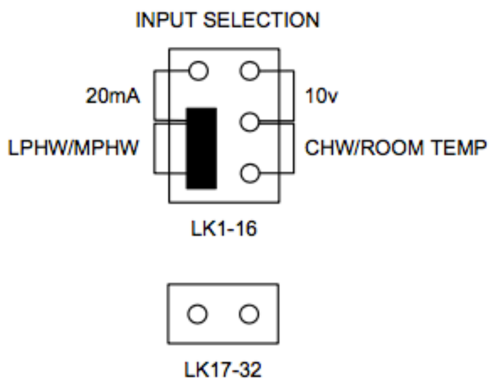
The actual range to be used depends on the thermistor to be used and the application. See Appendix D for guidance on this. The setting of the bank of six-pin jumpers, together with the two-pin link is shown below:



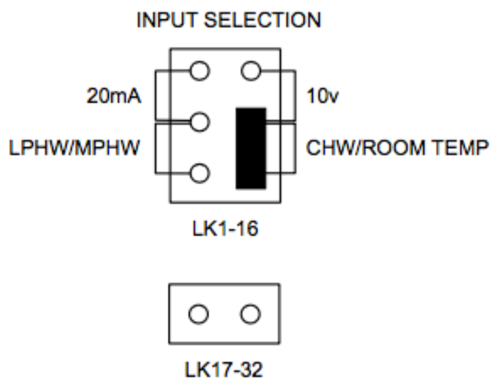
Link setup for 0 - 10V inputs



Links setup for 0 - 20mA inputs



Link setup Low and Medium Pressure Hot Water sensor inputs



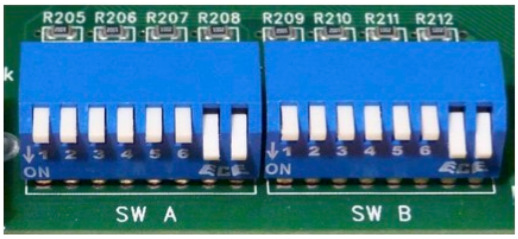
Links setup for Chilled Water and Room Temperature sensor inputs

For digital inputs, either use the thermistor ranges for volt free contacts (the most common occurrence) or the 0-10V range where the pulse generator (e.g. meter) generates a voltage.

1.3. Modbus Address and Communication Set-Up

NOTE: POWER CYCLE THE CARD TO USE THE NEW SETTINGS

Switch bank A, labelled “SW A” sets the Modbus address / ID of the card on the Modbus network. This can be set to any number between 0 – 255 (although zero should not be used as that is the Modbus broadcast address). The switches specify the number in binary. For example with all switches “up” (away from the board) except for the right-most two, the address will be 3.



Switch bank B, labelled “SW B” specifies the communications parameters for data transmission on the bus. The right-most three switches (labelled 6, 7, 8) specify the baud-rate, the next two switches (labelled 5, 4) specify the parity setting and the next single switch (labelled 3) sets the number of stop bits, as follows:

Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8	Baud Rate
			OFF	OFF	OFF	1,200
			OFF	OFF	ON	2,400
			OFF	ON	OFF	4,800
			OFF	ON	ON	9,600
			ON	OFF	OFF	19,200
			ON	OFF	ON	38,400
			ON	ON	OFF	57,600
			ON	ON	ON	115,200

The Modbus message is 8 bits. The Parity configuration is set below:

Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8	Parity Bit
	OFF	OFF				None
	OFF	ON				Odd
	ON	OFF				Even
	ON	ON				None

Stop bits:

Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8	Num Stop
OFF						1
ON						2

The MOD TERM jumper, when fitted, puts a 440 Ohm resistance across the Modbus A and B wires. This may be required if the board is an end-node on a long bus and is recommended to be fitted for all end of the line boards.

1.4. LEDs

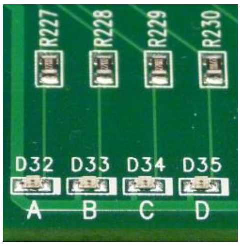
There are four indicator LEDs labelled A, B, C and D. They are used as follows:

A - flashes during the main loop showing everything is running as normal.

B - is on while a Modbus “frame” is being received.

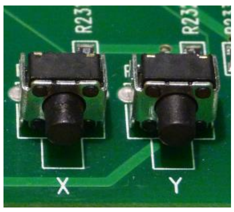
C - is on while a Modbus “frame” is being transmitted.

D - flashes while the recording feature is active (see below).



1.5. Push Buttons

Pressing button Y for two seconds will reset the processor on the card. After this the processor will enter the boot-loader. When button Y is released the boot-loader will launch the main firmware. If the firmware needs to be upgraded this can be achieved by inserting a USB memory stick containing it, while still holding the Y button. This process is described in a separate document.



Pressing button X on its own will do nothing. Pressing button X and then pressing button Y while still holding button X, for four seconds, will reset the stored configuration to factory default settings. This configuration consists of all Modbus registers that are used to setup the behaviour of the card. These are described later in Appendix A.

1.6. USB port

The USB port is primarily for upgrading the firmware. However, inserting a memory stick while the card is powered will cause a text file to be written to the memory stick, describing the configuration and current-state of the software. In particular it will contain the software version and the Modbus parameters, so can be useful for setting-up a system and fault-finding.

2. Functionality and Control

Note that the configuration of all features of the card is stored in non-volatile memory, so is maintained across power outages, etc.

2.1. Reading Data from the cards Using Modbus

Linear Data: Linear readings such as pressure or humidity can be read in one of two ways:

1) WRITE a top of range value to the card and read the actual pressure or humidity direct from the card.

2) Read the 0-100% value for voltage or current (depending on the sensor) from the card using the scaling profiles described later and conversion in the master controller to pressure or humidity. This can be achieved by a rescale or a multiplication factor.

Method 2 is the recommended way as this involves setting up a simple rescale module in the master controller software and not having to write values to the card. If Method 1 is used, continuously write the top of range to the card so that in the event of a card being replaced, it is configured with the correct settings on being connected to the Modbus comms.

Resistance Data: By its nature, thermistor data is non-linear, hence you can either:

1) Read the voltage input from the card using the scaling profiles described later and characterise the data in the master controller.

2) If your thermistor sensor is one of the comprehensive list of sensors set-up in the cards, you can read the resultant temperature value directly out of the cards.

2.2. Analogue Level Reading

The 16 inputs are sampled by the 10-bit ADC approximately 8 times a millisecond (actually once every 121 microseconds). This value is averaged over 8 samples, so a new analogue reading is available every millisecond. The value is then scaled to be in the range from 0, to the “top of range” value which is configurable via Modbus. By default it is 4095 so 10V at an input pin will give a reading of 4095 when read over Modbus. These 16 values are available as the first 16 Modbus Input Registers.

2.3. Scaling Profiles

The card provides a set of scaling profiles, through which inputs can be read, to give "real world" values across Modbus. This is the real power behind Satrofit and saves having to carry out complex characterisations of an A-D value in the master controller. The scaling-profiles are accessed through different ranges of Modbus addresses. There is a specific range for each scaling-profile. These ranges start at address 10000, and are detailed in the Register Listing later on in Appendix A.

When using the scaling profiles it is important to interpret the Modbus values correctly. This means that with the master controller, it is important to use the correct scaling and data type. See Appendix A for a full description.

2.4. Digital Level Reading

The card provides a simple filtering system for calculating a digital state for each input. The system has three parameters: a low threshold, a high threshold and a "filter count". For the signal to be considered "low" it must be below the low threshold for the filter-count number of readings. Similarly for the signal to be considered "high" it must be above the high threshold for filter-count readings. If the signal stays between the two thresholds then the digital state does not change value.

A reading occurs once every 121 microseconds. By default the filter-count is 2. So an input has to be within a threshold for 2 consecutive readings, for that input to change state. The default thresholds are 1/3 and 2/3 of full-scale. So for voltage readings this corresponds to 3.33V and 6.67V.

The thresholds are also set using the "top of range" scaling. See the Modbus table in Appendix A later for address details.

The defaults will enable the card to correctly register digital statuses and will only need adjusting if very fast pulse counting is required.

2.5. Pulse counting and frequency calculation

For each input four statistics are continually gathered, based on the digital value of the signal. The statistics can be reset at any time, to suit the application and expected nature of the signal. The four calculated values are:

- Pulse count – actually the number of low-to-high transitions.
- Low time – the number of milliseconds the signal has been considered low.
- High time – the number of milliseconds the signal has been considered high.
- Frequency – the average frequency of pulses, calculated from the three values above.

These values can be read in two ways across Modbus, as Input Registers or as Holding Registers. Input Registers are read-only and as such reading the value will not change the value. Whereas reading the corresponding Holding Register will immediately reset the value to zero. In this way data can be gathered by the Master without any loss of information. Ideally all three or four registers should be read at once, so they are all reset at the same time (but often the application may only require the information from one of the registers).
The values can also be reset without reading them, by writing a zero to the Holding Register. No other value will be accepted by these Holding Registers. See the Modbus table in Appendix A for details of the register addresses that control this feature.

Using the filter count of 2, a signal of around 1,000Hz can be read accurately. Note that it is important to consider the expected pulse frequency, high-time and low-time when choosing values for the digitisation of the input (See Section 2.4). For example, in selecting the filter count, a 1,000Hz signal will change state twice every millisecond, that is once every 500 microseconds. Given that the input is sampled once every 121 microseconds, the highest value for the filter-count would be 4 (4 times 121 equals 484). But this does not leave much time for the change of state of the signal, and occasions where the signal is slightly above 1,000Hz. Therefore the default value for the filter-count of 2 is probably the most robust, giving some noise-immunity and allowing for up to 2,000Hz at the limit.

Similarly, slower pulse count systems, particularly electro mechanical ones, may suffer from “bounce” in which case, a high filter count can be used to eliminate any spurious readings.

2.6. Input LED control

The 16 LEDs on the front of the board can operate in one of two modes. By default, the LEDs reflect the calculated digital state of the corresponding input. When in this mode state-change requests from Modbus are not accepted. They can be changed to an alternative mode such that they are entirely controlled externally, and their state is set over Modbus. See the Modbus table in Appendix A for address specifics.

2.7. Recording

The card has a simple "recording" feature, which allows the value of one input to be recorded to a CSV file. The inputs are sampled at over 8000 readings a second, so this generates a lot of data in a short amount of time. Continual recording of data to a memory stick, at this rate, while still performing all other activity, is not possible by this hardware. Instead the last four seconds of data can, at any time, be dumped to a CSV file. This allows running the system and then, when something "interesting" happens, dumping the previous 4 seconds of activity, to analyse later (in Excel, etc.).

Alternatively, the "averaged" analogue value can be recorded. This value is updated every 8 samples, so allows the input history to be remembered for 8 times as long (32 seconds). If the high resolution of 8 readings a millisecond is not needed then this option may be more useful.

The feature is controlled as follows:

1. Create a text file in the root directory of a USB memory stick, with the name "Hurtwood- Command.txt".

2. Write one line in this file "record n", replacing n with the input number to record. For example "record 15".

3. Insert the stick into the card's USB slot.

4. The card will read the file and start "remembering" the values of the desired input, in a circular buffer of about 33000 entries (4 seconds @ ~8000 entries / second). This is indicated by flashing LED D.

5. When some external event of interest has occurred press either of the X Y buttons briefly. This will stop the recording and create the CSV file. LED D stays on solidly while the file is being written. When LED D turns off the USB stick can be removed.

To record the averaged value instead of the instantaneous value, change the line in the file to "record-average n".

Note that Excel has a limit of 32,000 entries for creation of some types of graph. The CSV file generated will slightly exceed this limit, but Excel will warn you that some data is being ignored.

When the hurtwood-command.txt file is present on a memory stick the card does not create the "Hurtwood-Board-Info.txt" file. It only processes the command file.

This feature is completely independent of Modbus (although while writing to the USB stick, Modbus requests will not be actioned).

2.8. Satrofit Tool Port

The RJ45 connector block allows all the data including profiles described above that can be accessed over Modbus to be viewed using the Satrofit tool. (See the Satrofit tool data sheet) The Satrofit tool allows the card and all its connected field devices to be commissioned without the presence of the Modbus comms. The tool is a free software program that can run on any PC with a USB port. In addition, for commissioning and service, the tool also provides for each sensor:

1) A text field for entering the sensor name (max 40 char) and the units.
2) A text field for entering the date of the last calibration in dd/mm/yy format.
3) A text field for entering the sensor type (max 16 char) so the installer can put in the part No. of the sensor, useful for difficult to get to sensors.
4) For digital inputs, the high and low time hours and the number of pulses.
5) A sensor offset can be applied in DegC and % to allow the servicing and recalibration of the connected field devices without access to the master controller or the Modbus comms.

Appendix A: Using Modbus Registers

Modbus registers are the method by which data is read from, and written to the Satrofit card. Each manufacturer of master controllers will have variations on how this data is read and written, however, some basics rules will apply.

Register Format:

Registers can be either Hex, Decimal or Modbus.

Satrofit has both 1 based and zero based registers within it. Zero based registers are called Decimal registers and 1 based registers are called Modbus registers. Decimal registers are in the 0-15 data format so to read from input 7, you need to use 6 in the register. Modbus registers start at 1 so to read, say input 7, you would use 7.

For example, North BT and OSS use zero based registers or offsets. Register type: There are four data register types:

Input Status or Contact (02) – Literally a relay contact - a digital input. These can be read from the set of Modbus addresses beginning at 10001

Coil (05) – Literally a relay coil – a digital output. These can be set by the Modbus addresses beginning at 20001

Input Register (04) – An analogue input. These can be read from the set of Modbus addresses beginning at 30001

Output or Holding register (06) – An analogue output or a parameter in the cards, for example, the top of range for the inputs or the digital input thresholds. These can be read from or written to the set of Modbus addresses beginning at 40001

The numeral next to each in brackets is the Modbus function code as defined in the Modbus protocol.

Manufacturers will either use a code to define what type of register it is or will have a strategy block that can communicate with each type. Holding registers and coils can also indicate status's.

Scaling

The scaling (divide or multiply) is needed since the basic Modbus spec requires all values to be transmitted as 16 bit integers.

The cards, because of their 12 bit A-D conversion can work to 3 significant figures, hence a temperature or percentage can have 1 decimal point and a voltage or current can have 2 decimal points, e.g. 1.23V or 15.56mA

So for example a temperature of 20.1C has to be transmitted as the integer 201. This number then needs to be interpreted as "degrees C times 10", so needs to be scaled by 10 to get actual temperature.

So all temperatures require scaling by 10, and readings of Volts or milli-Amps require scaling by 100, e.g. a voltage of 1.23V is transmitted as the integer 123.

Each manufacturer will provide codes or formulae numbers (as in North BT) or ask for a scaling factor in modules to achieve the scaling required above.

Data Type

All the registers except the Ohms ones are treated as signed binary integers because they may be negative, e.g. temperatures or voltages. However, signed binary integers cannot have values above 32767, which of course isn't an issue with temperature and voltages. However, when reading raw ohms you might need to measure a resistance of more than 32K so this is best read as an unsigned value. If it is read as a signed value, and the resistance is more than 32,767 Ohms, you will get a nonsensical negative number.

Hence, unless reading resistances, you will use signed binary values for analogue values (Inputs and outputs) and lowest bits of registers for digital inputs and outputs.

Again, some manufacturers will provide codes such as A, B and C in the North BT strings or the strategy modules will have a drop down list of permitted data types.

Inputs

Below are the registers for reading analogue and digital inputs, setting up linear scaled readings and setting up digital inputs. At the end are the registers for reading basic card information. For these registers, the user has a choice of decimal, i.e. zero based and Modbus, i.e. 1 based registers.

DECIMAL ADDRESS	MODBUS ADDRESS	TYPE	VALUE DESCRIPTION	ADDRESS BLOCK EXPLANATION
0	30001/10001	Input Registers or Discrete Inputs	input 1 value	Can be read as an analogue (3000x) or digital input (1000x) type. Digital type intended for a switch type input with jumpers set for resistance.
1	30002/10002		input 2 value	
⋮	⋮		⋮	
15	30016/10016		input 16 value	
50	10051	Discrete Inputs	input 1 value inverted	Digital inputs, but inverted. Intended for active inputs, where pin is driven by a voltage, and jumpers are set for voltage reading.
51	10052		input 2 value inverted	
⋮	⋮		⋮	
65	10066		input 16 value inverted	

DECIMAL ADDRESS	MODBUS ADDRESS	TYPE	VALUE DESCRIPTION	ADDRESS BLOCK EXPLANATION
100	40101	Holding Registers	input 1 scaling upper	The value here is the "top of range" value. Default: 4095
101	40102		input 2 scaling upper	
⋮	⋮		⋮	
115	40116		input 16 scaling upper	
200	40201	Holding Registers	input 1 lower-threshold	If the (scaled) analogue value is below this number then it is considered digitally to be a zero. Default: 1/3rd top-of-range
201	40202		input 2 lower-threshold	
⋮	⋮		⋮	
215	40216		input 16 lower-threshold	
300	40301	Holding Registers	input 1 upper-threshold	If the (scaled) analogue value is above this number then it is considered digitally to be a one. Default: 2/3rd top-of-range
301	40302		input 2 upper-threshold	
⋮	⋮		⋮	
315	40316		input 16 upper-threshold	
400	40401	Holding Registers	input 1 filter-count	An analogue value must be inside one of the above thresholds for this many consecutive acquisitions for the digital output value to change state. There are 8 acquisitions per millisecond. Default: 2 (allowing for min pulse width of 1/4 milli-second)
401	40402		input 2 filter-count	
⋮	⋮		⋮	
415	40416		input 16 filter-count	
600	40601	Holding Registers	input 1 scaling lower	The value here is the "bottom of range" value. Default: 0
601	40602		input 2 scaling lower	
⋮	⋮		⋮	
615	40616		input 16 scaling lower	
1000	31001	Input Registers or Holding Registers	input 1 pulse-count	The three "pulse-train" statistics gathered for each input. The first register is the pulse-count (actually number of low-to-high transitions). The two time registers contain the total number of milliseconds the input was considered low/high. Reading these values as Holding-Registers
1001	31002		input 1 low time (msecs)	
1002	31003		input 1 high time (msecs)	
1003	31004		input 1 frequency	
1010	31011		input 2 pulse-count	
1011	31012		input 2 low time (msecs)	
1012	31013		input 2 high time	

DECIMAL ADDRESS	MODBUS ADDRESS	TYPE	VALUE DESCRIPTION	ADDRESS BLOCK EXPLANATION
			(msecs)	resets them to zero, allowing for lossless counting. Read three or four in one go for the values to be related. Reading the values as Input-Registers does not reset them.
1013	31014		input 2 frequency	
⋮	⋮		⋮	
1150	31151		input 16 pulse-count	
1151	31152		input 16 low time (msecs)	
1152	31153		input 16 high time (msecs)	
1153	31154		input 16 frequency	
2000	22001	Coils (discrete outputs)	LED 1 state	On / Off control of the 16 LEDs on the board
2001	22002		LED 2 state	
⋮	⋮		⋮	
2015	22016		LED 16 state	
2090	42091	Holding Register	LED mode	0 = LEDs controlled by Master 1 = LEDs show digital state of the inputs
900	30901	Input Registers	Serial Number	Basic information about the board
901	30902		Software Major Version	
902	30903		Software Minor Version	
903	30904		Hardware Revision	
904	30905		supply voltage (mV)	
905	30906		15V level (mV)	
906	30907		10V level (mV)	
907	30908		-5V level (mV)	
908	30909	Discrete Input	Healthy Bit	1 if card is healthy, 0 or no reply otherwise

Scaling Profiles: Below are the scaling profiles for reading “human” values, such as volts, Ohms, milliamps and temperature for the thermistor sensors directly from the card without having to set- up scaling profiles. These are all decimal i.e. zero based input registers (Type 04).

The lower to upper is the top of range and bottom of range described above and set using 40101- 16 and 40601-16 holding registers.

Profile name	Decimal address range	Scale By	Thermistor Ohms Range (High or Low)
Voltage 0 - 10V <-> 0 - 100%	10000 to 10015	10	-
Voltage 0 - 10V <-> lower - upper	10100 to 10115	1	-
Voltage 2 - 10V <-> 0 - 100%	10200 to 10215	10	-
Voltage 2 - 10V <-> lower - upper	10300 to 10315	1	-
Voltage 0 - 5V <-> 0 - 100%	10400 to 10415	10	-
Voltage 0 - 5V <-> lower - upper	10500 to 10515	1	-
Current 0 - 20mA <-> 0 - 100%	10600 to 10615	10	-
Current 0 - 20mA <-> lower - upper	10700 to 10715	1	-
Current 4 - 20mA <-> 0 - 100%	10800 to 10815	10	-
Current 4 - 20mA <-> lower - upper	10900 to 10915	1	-
Voltage in Volts	11000 to 11015	100	-
Current in milli-Amps	11100 to 11115	100	-
Resistance in Ohms - High Range	11200 to 11215	0.1	-
Resistance in Ohms - High Range	11300 to 11315	0.1	-
10K Potentiometer - High Range	11400 to 11415	10	-
100K Potentiometer - High Range	11500 to 11515	100	-
Thermistor 1.8KA1-(TE-DTAC)	11700 to 11715	10	LOW
	11750 to 11765	10	HIGH
Thermistor 2.2K3A1	11800 to 11815	10	LOW
	11850 to 11865	10	HIGH
Thermistor 3K3A1-(TED3K)	11900 to 11915	10	LOW
	11950 to 11965	10	HIGH
Thermistor 5K3A1-(TED5K)	12000 to 12015	10	LOW
	12050 to 12065	10	HIGH
Thermistor 10K4A1-(TEDA)	12100 to 12115	10	LOW
	12150 to 12165	10	HIGH
Thermistor 10K3A1-(TEDT)	12200 to 12215	10	LOW
	12250 to 12265	10	HIGH
Thermistor 20K6A1-(TEDH)	12300 to 12315	10	LOW
	12350 to 12365	10	HIGH
Thermistor 30K6A1-(TEDD)	12400 to 12415	10	LOW
	12450 to 12465	10	HIGH
Thermistor 50K6A1-(TEDP)	12500 to 12515	10	LOW
	12550 to 12565	10	HIGH
Thermistor 100K6A1	12600 to 12615	10	LOW
	12650 to 12665	10	HIGH
Thermistor - Landis & Gyr	12700 to 12715	10	LOW
Thermistor Ni1000/TK5000	12800 to 12815	10	LOW
Thermistor – 500 Ohm Balco	12900 to 12915	10	LOW
Thermistor PT1000A	13000 to 13015	10	LOW
Thermistor T Range-(TE-DSAT)	13100 to 13115	10	LOW

	13150	to	13165	10	HIGH
Thermistor - Satchwell DW	13200	to	13215	10	LOW
Thermistor - Satchwell DD/DR	13300	to	13315	10	LOW
Thermistor - Satchwell DO	13400	to	13415	10	LOW

When replacing Satchwell BAS input cards, to obtain readings from the original Satchwell T-range sensors, for low temperatures such as room temperature and chilled water, use the scaling profiles in BLUE above and set the jumper on the High resistance range.

For high temperatures such as LPHW and MPHW, use the scaling profile in RED above and set the jumper on the Low resistance range.

When measuring Voltage, use the scaling profile highlighted in light grey and fit the jumper to the voltage connection. This will give a 0-100% value.

NOTE: When measuring resistance or voltage, ensure that the appropriate jumper on the second bank ISN'T fitted.

When measuring current, use the scaling profile highlighted in dark grey and fit the jumper to the current pins. Ensure the appropriate jumper is fitted on the second bank. This will give a 0-100% value.

Appendix B – Specific Instructions for the North BT Commander

The instructions below are for the North Commander whereby the Modbus register is read and written to via a text string.

Interface Number: S (S & Number) The interface number in the controller. Modbus needs to be selected as an interface and the details of the serial port number, baud rate and data format set-up in the Modbus module.

Card Number: A (A & Number) The card address

Object Reference: f (Letter & Number) This sets the type of command, whether it is a read or write command and whether it is analogue (a register) or a digital input (a status) or a digital output (a coil). Letters A-D from the table below are the only formats that we need to use. The number is the register listing that tells the Modbus device what input or output or internal register it wants to read/write. The internal registers are principally used for the scaling profiles which are the real power behind Satrofit. These are "real world" values that have been calculated from the raw inputs.

Type	*Meaning*	*Modbus Read Code*	*Modbus Write Code*	*Type*	*Meaning*	*Modbus Read Code*	*Modbus Write Code*
A	Input Status	02	n/a	K	Output Multi-Registers - 12	03	16
B	Input Register	04	n/a	L	Output Multi-Registers - 16	03	16
C	Output (Coil) Status	01	05	M	Input Multi-Registers - 1	04	n/a
D	Output Register	03	06	N	Input Multi-Registers - 2	04	n/a
E	Output Multi-Registers - 1	03	16	O	Input Multi-Registers - 3	04	n/a
F	Output Multi-Registers - 2	03	16	P	Input Multi-Registers - 4	04	n/a
G	Output Multi-Registers - 3	03	16	Q	Input Multi-Registers - 6	04	n/a
H	Output Multi-Registers - 4	03	16	R	Input Multi-Registers - 8	04	n/a
I	Output Multi-Registers - 6	03	16	S	Input Multi-Registers - 12	04	n/a
J	Output Multi-Registers - 8	03	16	T	Input Multi-Registers - 16	04	n/a

Reading Type e: (letter): The data type of the value we are passing. The most common one we use is C, the signed binary value.

Type	Meaning
A	Value of lowest bit of register
B	Unsigned binary value in register
C	Signed binary value in register
D	BCD value in lower nibble of register bytes
E	BCD value in both nibbles of register bytes
F	ASCII value in lower byte of register
G	ASCII value in both bytes of register
H	Unsigned binary value in lower byte of register
I	Unsigned binary value in upper byte of register
J	IEEE float stored in 2 registers

Maths z: (Number): This allows a multiplication to be made to the value read or written. The table of the available mathematical functions is below:

Formula	Multiply	Add	Formula	Multiply	Add
21	10	0	31	2	0
22	100	0	32	5	0
23	1000	0	33	0.2	0
24	10000	0	34	0.5	0
25	100000	0	35	0.05	0
26	0.1	0	36	0.005	0
27	0.01	0	37	1	0
28	0.001	0	38	1	0
29	0.0001	0	39	1	0
30	0.00001	0	40	1	0

The object refs are interpreted as follows:

C26 – C = A signed Binary integer. Use of 26 scales the reading by 0.1, i.e. divides the reading in the card by 10 to get the 0-100% figure

C = A signed Binary integer. Values scaled between the upper and lower limits come out as raw values hence no scaling is used.

B21 – B an unsigned binary Integer.

Example 1: A message in the format: S2.A2.B13150.C26

S2 = interface number 2 on the master controller

A2 = Satrofit card address 2

B13150 = an input register and register number 13150 is the reading in degrees C from a Satchwell SAT thermistor sensor connected to input 1 on the card and with the jumpers set on the high resistance range to read a room temperature sensor.

C = the reading is a signed binary value (It could of course be negative!)

26 = divide the value read by 10.

Example 2: A message in the format: S2.A2.B13101.C26

S2 = interface number 2 on the master controller

A2 = Satrofit card address 2

B13101 = an input register and register number 13101 is the reading in degrees C from a Satchwell SAT thermistor sensor connected to input 2 on the card and with the jumpers set on the low resistance range to read an LPHW boiler flow temperature sensor.

C = the reading is a signed binary value.

26 = divide the value read by 10.

Example 3: A message in the format: S2.A2.B12265.C26

S2 = interface number 2 on the master controller

A2 = Satrofit card address 2

B12265 = an input register and register number 12265 is the reading in C from a 10K3A1 thermistor sensor connected to input 16 on the card and with the jumpers set on the high resistance range to read a room temperature sensor.

C = the reading is a signed binary value (It could of course be negative!)

26 = divide the value read by 10.

Appendix C - Profiles Available within the cards Firmware

The following profiles are available within the current firmware of the cards. The appropriate jumper connections are also indicated.

1) Voltage 0 - 10V 0 – 100%
2) Voltage 0 - 10V 0 – 4095 (default but with selectable Upper (U) and Lower (L) limits)
3) Voltage 2 - 10V 0 – 100%
4) Voltage 2 - 10V 0 – 4095 (default but with selectable U and L limits)
5) Voltage 0 - 5V 0 – 100%
6) Voltage 0 - 5V 0 – 4095 (default but with selectable U and L limits)
7) Current 0 - 20mA 0 – 100%
8) Current 0 - 20mA 0 – 4095 (default but with selectable U and L limits)
9) Current 4 - 20mA 0 – 100%
10) Current 4 - 20mA 0 – 4095 (default but with selectable U and L limits)
11) The Voltage in Volts
12) The Current in mA
13) Resistance Linear 10K – For potentiometers 0-100%
14) Resistance Linear 100K – For potentiometers 0-100%
15) The Raw Resistance value in Ohms with Low Resistance jumper fitted
16) The Raw Resistance value in Ohms with High Resistance jumper fitted

NTC Thermistors – Select jumpers depending on application

17) Resistance 1.8KA1
18) Resistance 2.2K3A1 – Ambiflex 2040
19) Resistance 3.3KA1 – Allerton
20) Resistance 5K3A1 – Schlumberger (air)
21) Resistance 10K4A1 – Andover, A/Automatrix, York Sibe
22) Resistance 10K3A1 – Ambiflex 2012, Honeywell Aquatrol, JEL, Thorn, Trend, York
23) Resistance 20K6A1 – Honeywell Excel
24) Resistance 30K6A1 – Drayton DC 1000
25) Resistance 50K6A1 – Ambiflex 5015
26) Resistance 100K6A1 – Schlumberger (immersion)

PTC Thermistors – Low Resistance Range Only

27) Resistance Landis & Gyr
28) Resistance Ni1000 TK5000 PTC
29) Resistance 500 Ohm Balco PTC
30) Resistance PT1000 RTD PTC

Satchwell Equivalent Thermistors

31) Resistance SAT1 - (Satchwell T range)
32) Resistance Satchwell DW
33) Resistance Satchwell DD/DR
34) Resistance Satchwell DO

Appendix D: Jumper Settings for Maximum Accuracy

Jumper Settings for maximum accuracy					
Sensor Type		Chilled Water	Room Temperature	Low Pressure Hot Water	Medium & High Pressure Hot Water
Resistance	1.8KA1	HIGH	HIGH	LOW	LOW
Resistance	2.2K3A1	HIGH	HIGH	LOW	LOW
Resistance	3K3A1	HIGH	HIGH	LOW	LOW
Resistance	5K3A1	HIGH	HIGH	LOW	LOW
Resistance	10K4A1	HIGH	HIGH	LOW	LOW
Resistance	10K3A1	HIGH	HIGH	LOW	LOW
Resistance	20K6A1	HIGH	HIGH	LOW	LOW
Resistance	30K6A1	HIGH	HIGH	HIGH	LOW
Resistance	50K6A1	HIGH	HIGH	HIGH	LOW
Resistance	100K6A1	HIGH	HIGH	HIGH	LOW
Resistance	Landis & Gyr Compatible	LOW	LOW	LOW	LOW
Resistance	Ni1000 TK5000 NTC	LOW	LOW	LOW	LOW
Resistance	500 Ohm Balco NTC	LOW	LOW	LOW	LOW
Resistance	PT1000 RTD NTC	LOW	LOW	LOW	LOW
Resistance	SAT1 (Satchwell T range)	HIGH	HIGH	LOW	LOW
Resistance	Satchwell DW	LOW	LOW	LOW	LOW
Resistance	Satchwell DD/DR	LOW	LOW	LOW	LOW
Resistance	Satchwell DO	LOW	LOW	N/A	N/A

Appendix E: Revision History

Revision	Applicable Firmware Version	Date	Description
0.1		18th Mar 2013	Document created.
0.2		18th Jul 2013	Scaling profiles, bottom-of-range, healthy-bit added. For firmware version 1.1.
0.3		1st Nov 2013	Scaling profiles and description of jumpers amended.
0.4		22nd Nov 2013	Inverted digital input info added to register listing.
0.5		8th May 2014	Added text regarding LED control.
0.6		13th Jun 2014	Additional examples of registers added.
0.7		7th Oct 2014	Added drawings of link settings.
0.8		10th Oct 2014	Updated input card image.
0.9	2.07	15th Oct 2014	The table now reflects that the Modbus range 10001-16 reads Volt-free contacts and that the default mode of operation of the LEDs is from the card and not the master controller.
1.0	2.08	02nd Dec 2014	New firmware to provide additional fields of data for servicing.