Point Colour

Remote Telemetry Unit

User Guide

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Contents

About this manual

This manual describes the functionality of the Point Orange and Point Blue Remote Telemetry Units (RTU) from the Point Colour range. It explains how to configure, program and install these RTU's.

It is assumed that the reader has a basic understanding of telemetry, RTU's and configuration of central telemetry systems.

Text conventions

This user guide uses different text types.

- *Note: Notes provide extra information to help improve understanding of the text, or to introduce other related topics.*

WARNING

Warnings are deliberately conspicuous as they only convey critical information. They should never be ignored.

The remaining text types are shown below:

This	Represents
bold	Words that require extra emphasis
italics	Referenced chapter or section headings

Numerical conventions

This user guide refers to decimal values unless otherwise stated. In some cases, binary and hexadecimal notation may be used, as indicated below:

This	Represents
2#00010	Binary
0x24 or 16#24	Hexadecimal

Terms and Abbreviations

Abbreviation	Description
APN	Access Point Name
BCF	Bulk Configuration File (WITS)
CA	Configuration Application (WITS)
CCITT	Comité Consultatif International Téléphonique et Télégraphique (International Telegraph and Telephone Consultative Committee)
CSQ	Carrier Signal Quality
CSV	Comma Separated Value
DBE	Database Editor
DC	Direct Current
DG	Data Gatherer
DNP3	Distributed Network Protocol
EMC	Electromagnetic Compatibility
FMEA	Failure Mode and Effects Analysis
FTP	File Transfer Protocol
FTPS	File Transfer Protocol Secure
GPRS	General Packet Radio Service
GSM	Global System for Mobiles
HCDS	Health Check Data Set
IC	Incremental Configuration (WITS)
IET	The Institute of Engineering and Technology
IIN	Internal Indication (DNP3)
IO	Input / Output
IP68	Ingression Protection 68 – according to IEC60529
LTC	Lithium Thionyl Chloride
M2M	Machine To Machine
MC	Master Control
PC	Personal Computer
PDP	Packet Data Protocol
PEM	Privacy Enhanced Mail
PSU	Power Supply Unit
RTU	Remote Terminal Unit
SD	Secure Digital
SIM	Subscriber Identity Module
USB	Universal Serial Bus

Abbreviation	Description
UTC	Coordinated Universal Time
WITS	Water Industry Telemetry Standard
WITS-DNP3	Water Industry Telemetry Standard extending the DNP3 protocol

Storage and Handling

The Point Colour RTU's have internal lithium thionyl chloride (LTC) battery packs. This is a mature proven primary lithium battery technology that has been deployed globally to power millions of devices. The manufacturer of the cells used in Point Colour has an exemplary track record and excellent design and quality assurance. These cells are used in many industries and have been certified to all relevant standards.

However, as with all lithium batteries, it is important to follow the manufacturers recommended guidelines for handling and storage. These guidelines are repeated below for convenience and are subject to update by the cell manufacturer. Please contact Metasphere if you require any further information about the lithium battery pack used on Point Colour.

WARNING

This equipment contains lithium thionyl chloride batteries which must not be short circuited, punctured, crushed, deformed, recharged or exposed to water, moisture or high temperatures. Batteries should not be removed from this housing.
Replacement packs are available from Metasphere Ltd.

Storage

Store in a cool, regulated (preferably below 21°C and in any case below 30°C), dry and ventilated area, away from possible sources of heat, open flames, food and drink. Avoid exposure to direct sunlight for prolonged periods.

Temperatures above 100°C may cause leakage and rupture, resulting in shortened battery service life. Keep proper clearance space between batteries and walls. Since short circuit can cause burn hazard, leakage or explosion hazard, keep batteries in original packaging until use and do not mix them.

Handling

- Do not open the battery system.
- Do not crush or pierce the cells.
- Do not short (+) or (-) terminal with conductors.
- Do not reverse the polarity.
- Do not submit to excessive mechanical stress.
- Do not remove the Printed Circuit Boards from the unit housing.
- Do not mix batteries of different types or mix new and old ones together.
- Do not expose the unsealed unit to water or condensation.
- Do not directly heat, solder or throw into fire. Such unsuitable use can cause leakage or spout vaporized electrolyte fumes and may cause fire or explosion.

Point Colour Overview

Point Orange is a compact Logger/RTU device with integrated battery, a combined tri-band 3G modem with quad band GPRS/GSM fallback, internal and external antenna options, flexible IO, and an integrated submersion sensor. The Point Blue is an intrinsically safe version of the Point Orange. It provides all the features of the Point Orange but in addition it can be installed and operated in hazardous areas (in particular, areas where there is a risk from the ignition of potentially explosive gases).

The unit is designed to be intrinsically safe in accordance with EN60079-0:2012 and EN60079-11:2012, the device is certified as Ex II 1G Ex ia IIB T4 Ga (-20°C ≤ Ta ≤ +50°C). It can operate in areas classified as Zone 0, gas group IIB and temperature class T4 between a minimum of -20°C and a maximum ambient temperature of +50°C.

The key functions of Point Orange and Point Blue are:

- IP68 enclosure, suitable for submersion to 4m for 4 days
- Integrated installation bracket offering a range of mounting options
- Up to five programmable external IO channels, allowing over 100 possible combinations of serial, analogue, counter and digital inputs
- Internal submersion sensor – to detect when the unit is submerged under water
- Communicates with Medina Data Gatherers, DNP3, WITS-DNP3 masters, or an FTP/S server via a combined Tri-band 3G and quad band GSM/GPRS modem
- Internal and external antenna with automatic antenna selection
- Internal lithium battery pack for long life
- Provision for connecting an external DC supply or battery pack
- Local diagnostic points such as GSM signal strength, temperature and battery voltage

Available models

Point Orange

The Point Orange is available with a 3G modem that provides GPRS fall-back in the event that no 3G network is available. The model can be identified by reading the serial number label or the product identification label. Both will include the full product name. For reference a serial number label is shown below;

Point Blue

Like the Point Orange the Point Blue is available with a 3G modem that provides GPRS fall-back. Further, the RTU can be powered by either an internal battery, or by a higher capacity external battery. With these options there are 2 variants of the Point Blue RTU;

- Point Blue 3Gi (3G modem, internal battery)
- Point Blue 3Ge (3G modem, external battery)

The 3rd part of the product name specifies these options using “i” for an internal battery and “e” for an external battery.

The different versions can be identified by reading either the serial number label, or the product identification label. Both will include the full product name. For reference the serial number labels are shown below;

Basic functionality

The Point Colour is an intelligent Remote Telemetry Unit (RTU) that allows the user to monitor signals from a wide variety of sensors. The data read, can be logged at regular intervals (Trending), log when a particular event has occurred (Events) or report by exception if an urgent message needs to be reported (Alarms).

Data is stored using the onboard memory, and reported using either Medina, DNP3, WITS-DNP3 or FTP/S protocols to a server using the internal modem. The Standalone mode allows the Point Colour to behave as a logger, with data that can be retrieved using Poco+.

External connections

The Point Colour has two external connectors; the first is the main connector at the front, which is used for connecting external sensors and/or the USB cable for configuring or

monitoring the RTU. The second connector is the external antenna connector that allows for a second antenna for use in areas of poor GSM network coverage.

Configuration

Before using Point Colour, it needs to be configured using the Poco+ configuration tool available from Metasphere. Poco+ is a Windows based application that allows the user to specify how the Point Colour should operate. For more information on Poco+ please contact Metasphere.

The Point Colour should be connected to the PC running Poco+ using the Point Colour Service Cable which connects to the main connector on the Point Colour and a spare USB port on the PC.

External IO

The Point Colour has up to five IO channels; these are provided through the single main connector on the front of the unit. The function for each of these channels is controlled by software and is configured using Poco+.

The options for each channel include Analogue Inputs (AI), Counters (CI), Digital Inputs (DI) or Serial. The exact options will vary depending on the configuration selected, for example, the unit is limited to supporting two active loop analogue inputs. However, given the flexibility of the various channels, over 100 IO combinations are possible.

Internal Points

In addition to external sensors the Point Colour has a wide range of internal points that can be read by a master station such as battery voltage, ambient temperature, or whether the unit is submerged or not. These points are always available and can be logged by the RTU as configured. Details can be found in the Points List section of this User Guide.

Points

The Point Colour has a fixed list of points built into the firmware. These points are available to be measured by the selected telemetry protocol or can be monitored using Poco+. A complete list of all available points is provided in the Points List section of this User Guide.

This section provides a high-level overview of the points available. This is followed by further sections with more details, including what they are and how they are configured and updated. To ease navigation, the external points are described first with a section for each point type, followed by a section about the internal points. In general, all points are advertised as analogue inputs, counters, digital inputs or string points.

The first five points for AI, CI and DI are reserved for external IO. These points are always in existence; however, they will only register values if configured in the Poco+ IO tab. If the IO points are not configured, and the points are measured, the values will be fixed at zero.

Internal points are always present in the configuration of the Point Colour and can be measured as required.

Analogue points are measured using raw values. The measurement can be scaled by providing the raw values and the engineering units they map to at each end of the measurement range. This indicates the possible raw values of the point, and the suggested values for configuring the master station's engineering scaling conversion factors.

Updating point values

The Point Colour has been designed with the principle of conserving power. As a result, the point values are only updated when the RTU is awake. For example, if the highest frequency trend configured on the RTU is 15 mins, then the point values will only be updated at this frequency, as the RTU is asleep in between these samples. There are three exceptions to this rule;

- When the USB is connected
- If an alarm is configured on a passive analogue input
- Digital inputs

USB Connected

The first exception is for when the USB is connected to the Point Colour, the RTU will not go to sleep, as it is assumed that the user is configuring the RTU or wishes to monitor the point values as they are updated. In this instance, all passive points are updated continuously on a 2 second cycle.

In addition to this it is possible for the Point Colour to be configured to keep the loop supply switched on if the USB is connected at boot up. After the configured sensor settle time, the sensor will be continuously sampled until the USB is disconnected. After which the loop supply is turned off and will revert to any configured trend period frequency. This feature is useful when installing the Point Colour in the field to verify that the sensor readings are accurate. This feature is called 'Sensor Validation' and can be activated by selecting the check-box in Poco+.

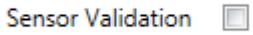


Figure 1: Sensor Validation setting

WARNING

Connecting the Point Colour to the PC using the USB cable will leave the Point Colour on for the duration of the connection. This will drain the battery and prolonged periods of connection should be avoided.

WARNING

The Point Blue ATEX/IECEx certificate specifies that the USB connection should NOT be used in the hazardous area. All users should adhere to these instructions along with the other guidelines in the Point Blue Safety Guide provided with every Point Blue.

Analogue Alarms

The second exception is for passive analogue points that are configured with an alarm. In this instance, the Point Colour will wake up at the frequency specified by the 'Alarm Check' setting in Poco+. This setting is NOT used for any active sensors or serial points which are checked according to the trend period.

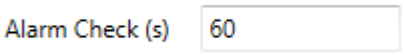


Figure 2: Alarm check setting

Active sensors, i.e. those that are powered by the RTU are only sampled on the specified trend frequency, or at power up when the USB is connected. Therefore, the value displayed in Poco+ when monitoring is the reading from the last trend period unless Sensor Validation is active.

If no trends have been configured for external active sensors then the RTU will only take one reading, at power up. The point value will not be updated until a trend has been configured on the RTU. All serial points are treated as active points and are therefore only updated when a trend is configured on any serial point.

Digital Inputs

The third exception is digital inputs. The DI channels are interrupt driven, so if an external DI channel is configured in Poco+ then the RTU will wake up when a state change is detected. The action taken upon detection of the state change will depend on the configuration. i.e. if an alarm or event is configured.

External IO

The Point Colour has 5x software configurable IO channels; these are provided through the single main connector on the front of the unit. They can be configured to perform distinct functions – for example, channel 1 can be configured to be a digital input, an analogue input, or a counter input. Note that not all channels can support all options – for example, the unit

is limited to supporting two active loop analogue inputs. However, given the flexibility of the various channels, over 100 IO combinations are possible. The external IO options available include:

- Digital input
- Counter input
- Active loop analogue input
- Passive loop analogue input
- Active voltage analogue input
- Passive voltage analogue input
- Serial connection (e.g. RS485, RS232, SDI-12)

For each of these options, the range of signal they can read and how they should be connected to the Point Colour is summarised below and described in more detail in following sections.

Type	Max No.	Range	Notes
Digital input	5	0-1	Volt-free
Counter input	4	32-bit	Volt-free, up to 100 Hz
Active loop	2	4-22mA	Independent settle time, 12V supply
Passive loop	2	4-22mA	
Active voltage	2	0-2V	Independent settle time, 12V supply
Passive voltage	5	0-2V	
Serial	1	N/A	Supports connection to various serial slave devices via interfaces such as RS232, RS485 full and half duplex

External IO Configuration

The Point Colour has software configurable IO – no hardware settings or switches are used. This allows the RTU to be easily configured for a wide range of applications. The Poco+ tab to configure the IO is made up of three sections (Available IO, Configured IO Channels, and Pin table) and is shown below.

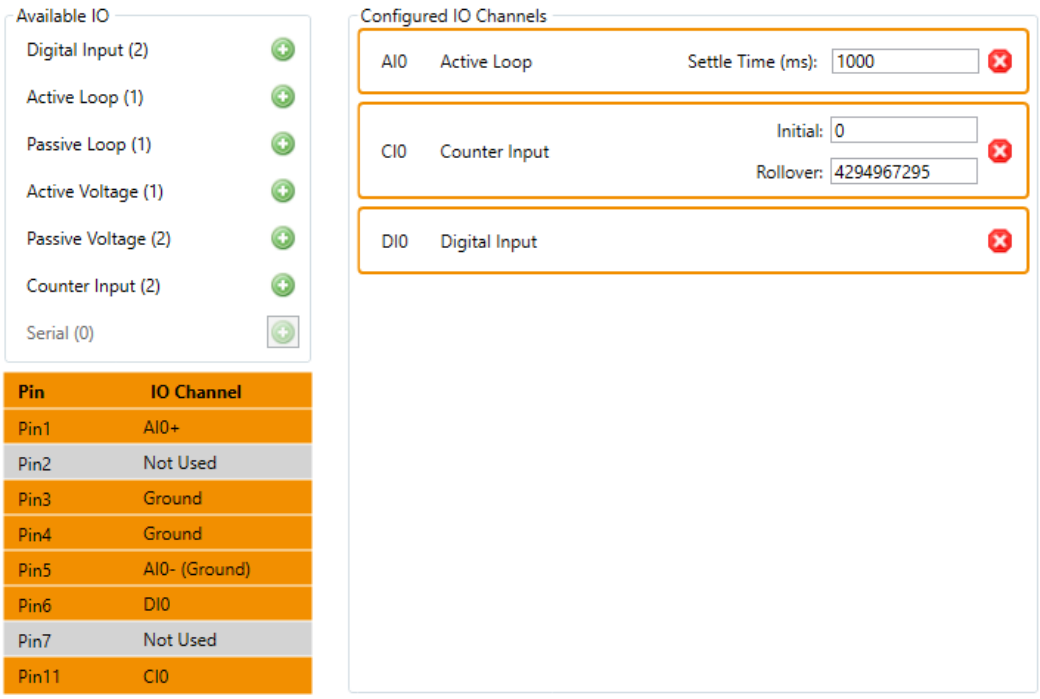


Figure 3: IO Configuration tab

Available IO

The IO options available are listed in the upper left-hand box, with a green '+' button next to each option.

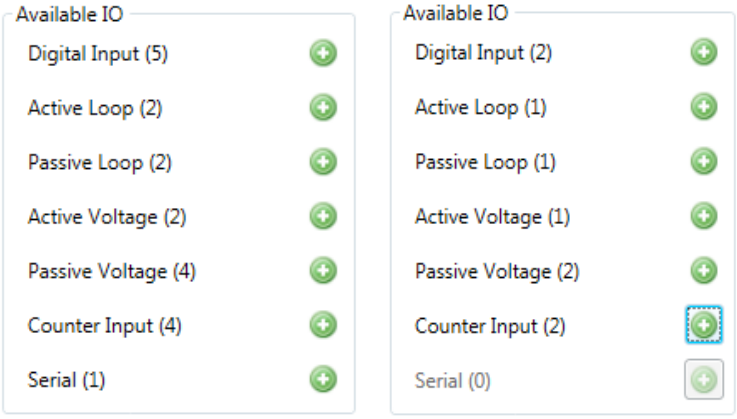


Figure 4: Available IO

Clicking this button will add a channel of that type. As channels are added the available IO list is updated automatically. The number of channels of a particular type is displayed in brackets after each IO type i.e. with no IO configured a Point Colour can have up to 5x digital inputs, 2x Active loops, 2x passive Loops etc. These numbers are updated as IO channels are added. Figure 4 shows a comparison the IO available with no channels added and after an active loop, digital input, and counter have been added. Figure 3 shows these configured channels

- *Note: The serial port can only be assigned to a particular set of pins, so upon selection the availability of other pin types is reduced.*

Pin Table

Below the Available IO box is the pin table:

Pin	IO Channel
Pin1	Not Used
Pin2	Not Used
Pin3	Ground
Pin4	Not Used
Pin5	Not Used
Pin6	Not Used
Pin7	Not Used
Pin11	Not Used

Pin	IO Channel
Pin1	AI0+
Pin2	Not Used
Pin3	Ground
Pin4	Ground
Pin5	AI0- (Ground)
Pin6	DI0
Pin7	Not Used
Pin11	CI0

Figure 5: Available IO

This table lists the pins that are allocated to the configured IO channels. As channels are added the table is updated, with the pins used highlighted in the colour of the RTU. Using the same example as Figure 4, Figure 5 shows how the pins are allocated when an active loop, digital input and a counter have been added.

- *Note: Pin 3 is always allocated to ground.*

Removing Configured Channels

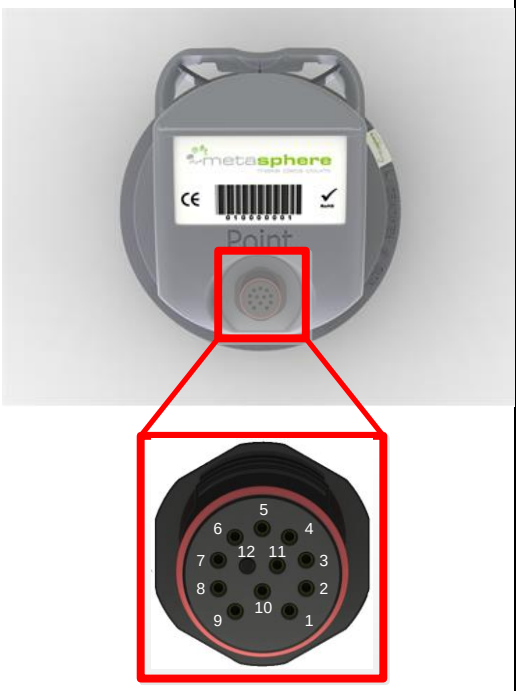
To remove a configured IO channel, click on the red cross next to the IO channel to be removed. After clicking this button, the channel is deleted, and any configuration for the point is lost. The Available IO table is updated to reflect the removal.

- *Note: The options remaining on the left automatically reduce in quantity, or are greyed out, depending on what has already been selected.*

- *Note: At the bottom of the screen, the pin-out for the main connector is given. This pin-out corresponds to the combination of IO specified in the "Configured IO Channels" section.*

Connector pin-out

The pin numbering scheme of the single 12-pin connector on Point Colour is shown in the following table. Note that many of the pins have multiple uses, depending on how they are configured in Poco+ as discussed above.

Pin	Usage	Pin numbering
1	IO – as configured by Poco+	
2	IO – as configured by Poco+	
3	Ground.	
4	IO – as configured by Poco+	
5	IO – as configured by Poco+	
6	IO – as configured by Poco+	
7	IO – as configured by Poco+	
8	USB port.	
9	USB port	
10	USB port	
11	IO – as configured by Poco+	
12	External power source positive terminal.	

Digital inputs

The Point Colour can be configured to read up to 5x digital inputs (DI). Each of these inputs is defined as volt-free. i.e. no whetting voltage is required for the change in state to be detected. The DI's will also accept a 0-2V signal as a digital input. This makes the DI's suitable for connecting to a wide range of sensors, including switches. Figure 6 shows a wiring example.

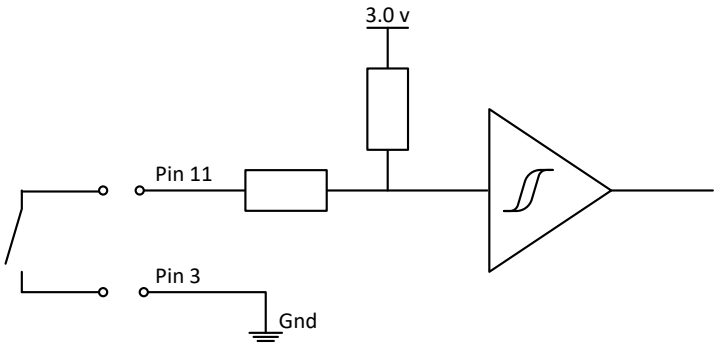


Figure 6: Example DI connection circuit

- *Note: Whilst the Point Colour is protected against voltages up to 24V if external voltages are expected to be greater than 2V, it is recommended that an external circuit is used. E.g. a potential divider or relay.*

- *Note: Four of the five digital inputs can record state transitions up to 100Hz, although it should be noted that this can generate a significant amount of data over a prolonged period and will have adverse effects on the expected battery life.*

- *Note: The fifth digital input, using pin 7, cannot support state transitions above 0.5Hz.*

Count of Digital

There are five counter points (CI26 to CI30) that record the number of times each respective digital input has turned on and off. These five counters of the digital inputs also have associated flow calculation points (AI41 to AI45).

- *Note: Digital inputs and counters are considered separate points; CI0 is not the same as DI0 and will not keep track of how many times DI0 has been toggled. CI26 is the count of how many times DI0 has been toggled.*

Poco+ Configuration

The digital inputs do not have any additional settings.

Figure 7: Digital Input configuration

Counter inputs

The Point Colour can be configured to read up to 4x counter inputs (CI). Like the DI channels, they are defined as volt-free. The counters can count at up to 100Hz and include a debounce filter for use with mechanical switches. The counter value will increment on the falling edge of a pulse. The wiring for counters is the same as DI's.

Flow calculations

There are four analogue points (AI24 to AI27) showing the number of pulses for a particular counter during a trend period. For example, if CI0 has a 15-minute trend, then AI24 (the corresponding analogue point) will display the number of pulses on CI0 in the previous trend period.

The calculation is as follows, if at t0 CI0 = x and at t1, CI0 = y, then the value displayed in the analogue point is y-x. If the value is negative, then it will be reported as 0.

Poco+ Configuration

The counter inputs have two parameters to be configured: initial and rollover. The initial setting specifies the starting value of the counter. The default is 0 but can be any value from 0 – 4,294,967,295.

The rollover value is the number at which the counter will reset to zero. For example, if set to 999, the counter will go up to 999 and on the next pulse it will rollover back to 0. This can be useful for keeping track of meter readings.

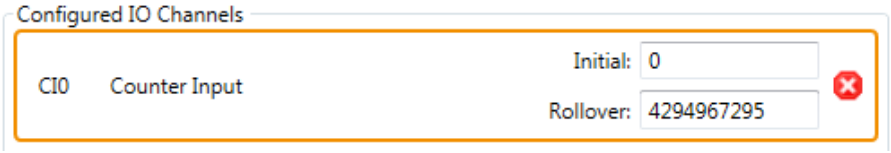


Figure 8: Counter configuration

Analogue Inputs

The Point Colour supports four distinct types of analogue input, listed below with the maximum number per type in brackets;

- Active Loop (Max 2)
- Active Voltage (Max 2)
- Passive Loop (Max 2)
- Passive Voltage (Max 4)

The first two, active loop and active voltage configure the Point Colour to supply power to the external sensor. The Point Orange can supply up to 80mA at 12V to power an external sensor. This maximum power would need to be shared if there were more than one sensor connected and powered up at any one time. The Point Blue is limited to 22mA per channel.

The second two, passive loop and passive voltage do not power the external sensor and are to be used where a secondary power supply is used to power the sensor, or the sensor is self-powered. The loop channels accept a 4-20mA current loop and the voltage channels can accept a 0-2V signal.

Ground Connections

When an analogue input is configured on the Point Colour, Poco+ will attempt to assign a ground connection to ease the installation of sensors. However, it does not specify which ground connection to use, as any can be used.

Poco+ will always try to add a ground pin for each input, but as the number of channels added increases, this is not always possible, and some ground sharing may have to occur for larger IO configurations.

Active loop

The Point Colour can be configured to read up to two active loop inputs. An active loop channel provides a 12V DC power supply to power an external sensor and can read a 4-20mA signal from the sensor. Figure 9 shows a typical connection for this 2-pin interface.

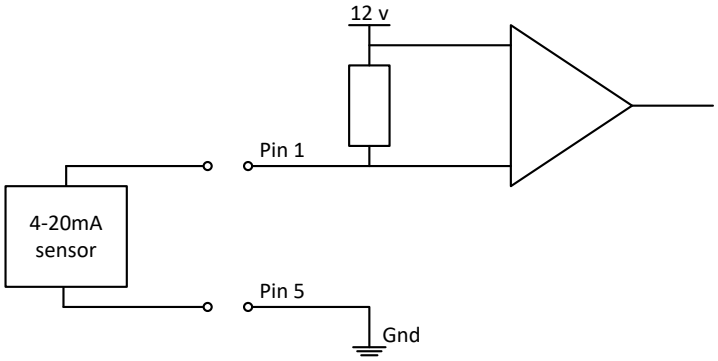


Figure 9: Typical active loop connections

Each channel can measure a maximum current of 40mA, the headroom can be used by some instruments that support out-of-band signalling. The Point Colour can turn on the power supply for a configurable time to allow the sensor to complete any power up sequence and

the readings to stabilise, before any values are recorded for use by the RTU. This period is called the settle time and can be configured for each active loop channel independently.

➢ *Note: Some smart sensors have a high surge current requirement when first powered on. If this is the case, then it might be necessary to either limit the number of such sensors that can be connected or else to use an external loop power supply.*

As each channel can be configured independently each connected sensor can be controlled as required. For example, one sensor could be sampled at 15-minute intervals and the other sensor at 20-minute intervals, and only the sensor being read will be powered and sampled.

Poco+ Configuration

The active loop inputs require the user to specify a settle time (in milliseconds) for the sensor to be connected to this channel. This is normally the time for the sensor to provide an accurate reading after power up, as specified by the sensor manufacturer. The minimum settle time is 1000ms.

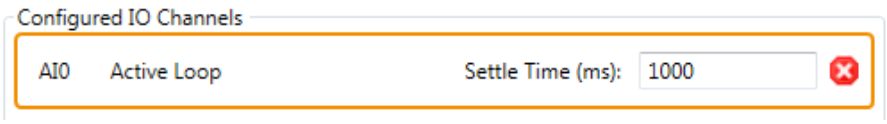


Figure 10: Active Loop configuration

Active voltage

The Point Colour can be configured to read up to two active voltage analogue inputs. An active voltage channel provides a 12V DC power supply to power an external sensor and can read a 0-2V signal from the sensor. Figure 11 shows a typical connection for this 3-pin interface.

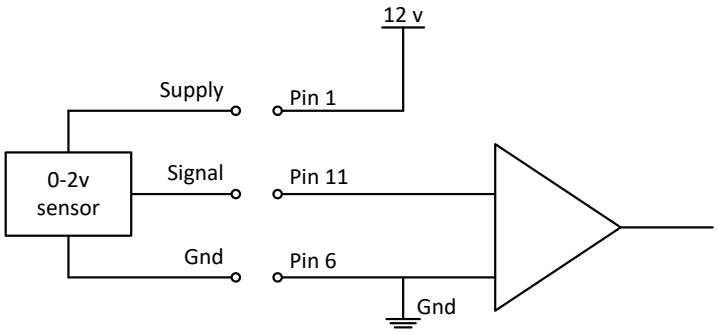


Figure 11: Typical active voltage connections

Similar to the active loop channels, each active voltage channel can provide a maximum current rating of 40mA per channel to power the sensor. Again, these channels can be controlled independently, with different settle times sample periods as required.

Poco+ Configuration

The active voltage inputs have the same settle time setting as the active loop inputs, again specified in milliseconds. The minimum settle time is 1000ms.

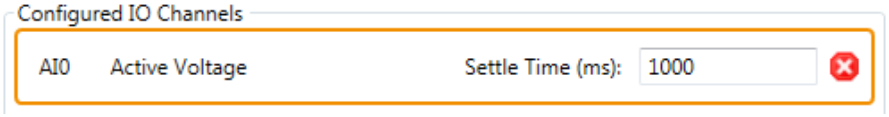


Figure 12: Active Voltage configuration

Passive loop

The Point Colour can be configured to read up to two passive loop analogue inputs. A passive loop channel can read a 4-20mA signal from the sensor, the RTU requires a minimum loop supply voltage of 12V to read correctly. Figure 13 shows a typical connection.

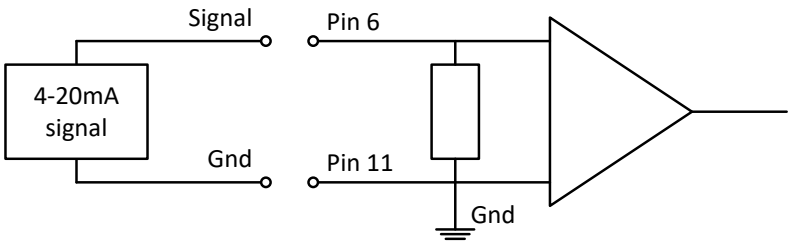


Figure 13: Typical passive loop connections

Poco+ Configuration

The passive loop inputs have no additional configuration settings, as it is assumed that the sensor is being powered by an external supply, which is beyond the control of Point Colour.

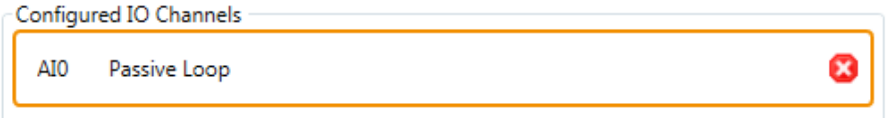


Figure 14: Passive Loop Configuration

Passive voltage

The Point Colour can be configured to read up to 4x passive voltage analogue inputs. A passive voltage channel can read a 0-2V signal from the sensor. Figure 15 shows a typical connection

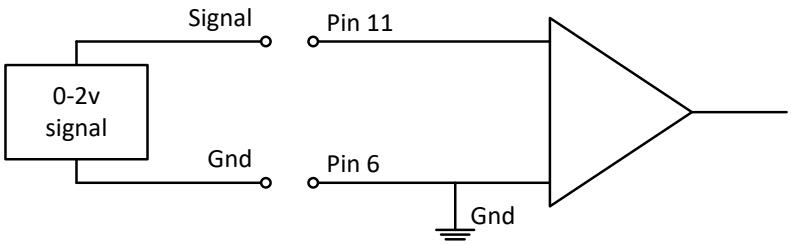


Figure 15: Typical passive voltage connections

Poco+ Configuration

The passive voltage inputs do not have any additional settings.

Figure 16: Passive Voltage configuration

Serial

Overview

The Point Colour can communicate with external serial devices using a serial interface. Multiple protocols are supported as detailed in the following sections.

- *Note: Serial will always use specific I/O pins, and thus may not be available depending on the current I/O allocation.*

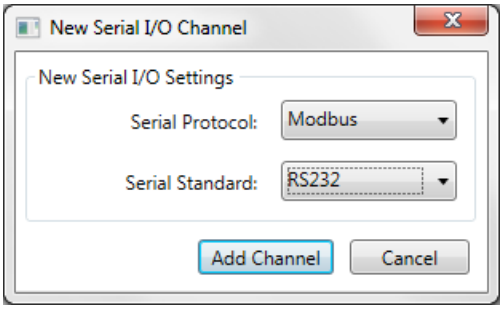


Figure 17: Serial I/O configuration

Clicking on the '+' button for Serial will show the dialog in Figure 17, from which Modbus, SDI-12 or Mainstream can be selected.

Connecting to sensors

The Point Colour can be connected to a wide range of serial devices each of which require a specific cable. For example, the cables for RS232, RS485 and SDI-12 are all different. Users should ensure the cable they are using is correct for their application.

The Point Orange can supply up to 80mA at 12V to power a serial sensor. The Point Blue can supply up to 22mA at 12V to power a serial sensor.

Reading values

To conserve power, the Point Colour will only communicate with the serial slave device at the specified trend frequency. This trend frequency is the fastest trend frequency configured on any of the serial points. On every serial communication, all configured serial values will be read, and the corresponding points will be updated. Values for all configured serial points are read whenever any of them are trended, but only the values for those points being trended are stored.

Error handling

The serial communications are monitored to ensure the integrity of data and log errors to aid diagnostics. The monitoring varies depending on serial protocol and sensor connected but typically consists of ensuring responses are received in a given time, monitoring for error codes that are reported, and checking data integrity.

Errors found during communication with serial devices are reported using the Serial Error Code Analogue Input Point. Please see the Points List section of this User Guide for complete details on all the errors that are monitored. This point can be used to diagnose communication problems and ensure that field-bus data is valid during measurement.

Modbus

The Point Colour can be configured to communicate with a Modbus Slave via RS232 or RS485 (half or full duplex). This is done using a specially designed cable connecting to the main connector (see the IO cable section for details).

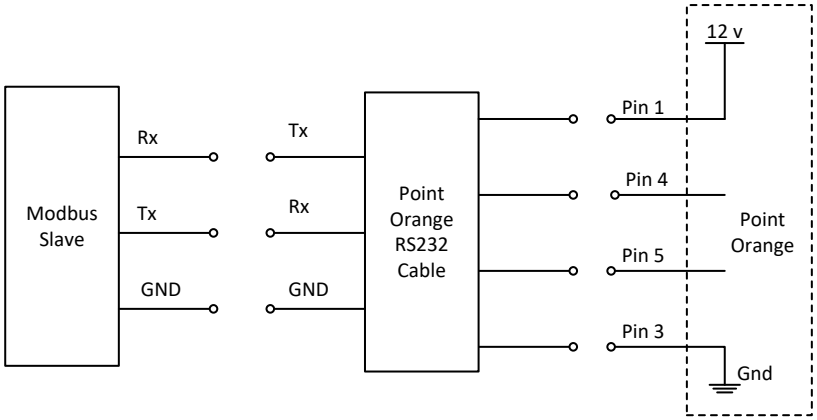


Figure 18: Modbus RS232 connections

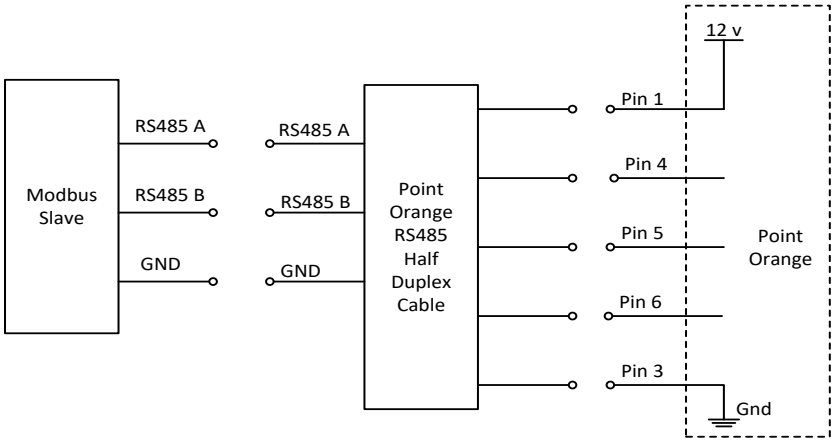


Figure 19: Modbus RS485 Half Duplex connections

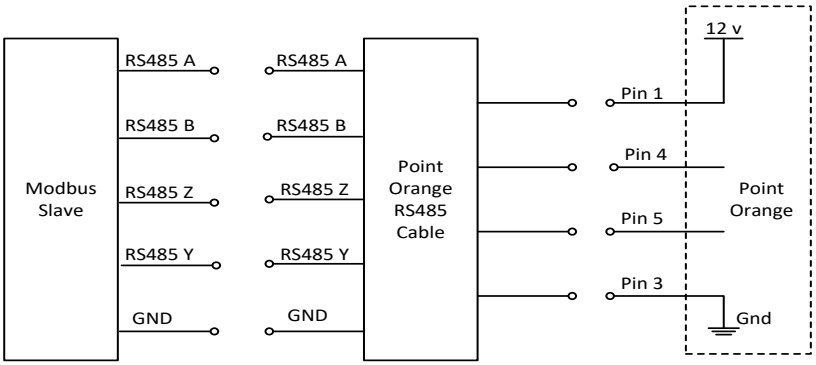


Figure 20: Modbus RS485 Full Duplex connections

The Point Colour reads various configured coils and registers and records these values as digital, analogue, counter and string points on the Point Colour. Specific Modbus points have

been added to the points list to record the values read from the Modbus slave these include 10x digital points, 10x analogues points, 10x counter points and 5x string points.

Communications with a Modbus slave will be started before the trend time to ensure that all points have been read and values updated. This is determined by the number of configured Modbus points multiplied by the response timeout.

Modbus can be configured to operate using RS232, RS485 full duplex or RS485 half-duplex. There are several settings that can be configured including baud rate, number of data bits and parity.

Poco+ Configuration

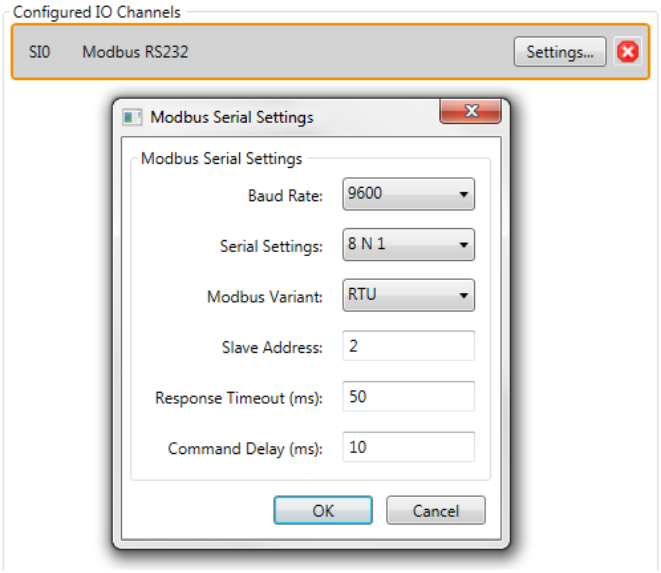


Figure 21: Modbus configuration

Once added as a serial channel there are several settings that need to be configured correctly for successful communication with the Modbus slave. These settings are common for RS232 and RS485;

Setting	Description
Baud Rate	The baud rate to be used by the Modbus serial interface
Serial Settings	A string representation of data bits, parity and stop bits (in that order). For example, “8 N 1” would equate to 8 stop bits, no parity, and 1 stop bit.
Modbus Variant	The Modbus communication type to be used; RTU or ASCII
Slave Address	The Modbus slave address to be used
Response Timeout	The length of time the Point Colour will wait for a response from the slave to single command. i.e. to read each register. Care must be taken to ensure this timeout is not too long
Command Delay	The delay needed between the Point receiving a response from the slave and sending the next command.

Digital points

The 10x Modbus DI points are assigned as DI16 to DI25. The configuration settings for each point include the Modbus register address and the register type; Coil or Discrete Input.

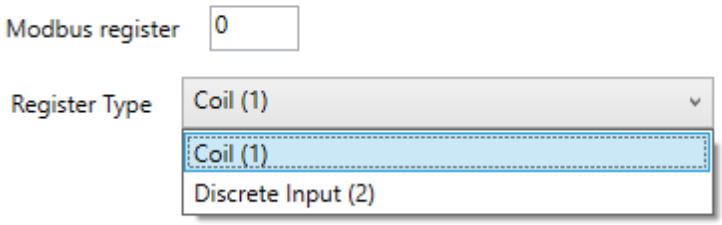


Figure 22: Modbus DI configuration

Analogue points

The 10x analogue points are configured to read holding or input registers from the Modbus slave. The configuration options are summarised in the table below;

Parameter	Details	
Register Type	Holding Register or Input Register	
Modbus Registers	Start	The register address of the value to be read
	Length in bytes	Calculated dependent on the Modbus format
Modbus Format	Int16	16-bit integer data contained in 1 register
	Int32	32-bit integer data contained in 2 consecutive registers
	Int64	64-bit integer data contained in 4 consecutive registers
	Float32	IEEE-754 32-bit floating point data contained in 2 consecutive registers
	Float64	IEEE-754 64-bit floating point data contained in 4 consecutive registers
	Siemens Totaltype	32-bit integer data contained in 2 consecutive registers followed by 32-bit integer data for fractional component contained in 2 consecutive registers
Modbus Endian	The byte ordering of the registers to be read from the slave.	Big endian registers, big endian bytes in register
		Little endian registers, big endian bytes in register
		Big endian registers, little endian bytes in register
		Little endian registers, little endian bytes in register

Counter Points

The 10x counter points are configured to read holding or input registers from the Modbus slave. The configuration options are summarised in the table below;

Parameter	Details	
Register Type	Holding Register or Input Register	
Modbus Registers	Start	The register address of the value to be read
	Length in bytes	Calculated dependent on the Modbus format

Parameter	Details	
Modbus Format	Int16	16-bit integer data contained in 1 register
	Int32	32-bit integer data contained in 2 consecutive registers
	Int64	64-bit integer data contained in 4 consecutive registers
Modbus Endian	The byte ordering of the registers to be read from the slave.	Big endian registers, big endian bytes in register
		Little endian registers, big endian bytes in register
		Big endian registers, little endian bytes in register
		Little endian registers, little endian bytes in register

String points

The 5x string points are configured to read holding or input registers from the Modbus slave. The configuration options are summarised in the table below;

Parameter	Details	
Register Type	Holding Register or Input Register	
Modbus Registers	Start	The register address of the value to be read
	Length in bytes	Specify the length of the string to be read to maximum of 32 characters
Modbus Endian	The byte ordering of the registers to be read from the slave.	Big endian registers, big endian bytes in register
		Little endian registers, big endian bytes in register
		Big endian registers, little endian bytes in register
		Little endian registers, little endian bytes in register

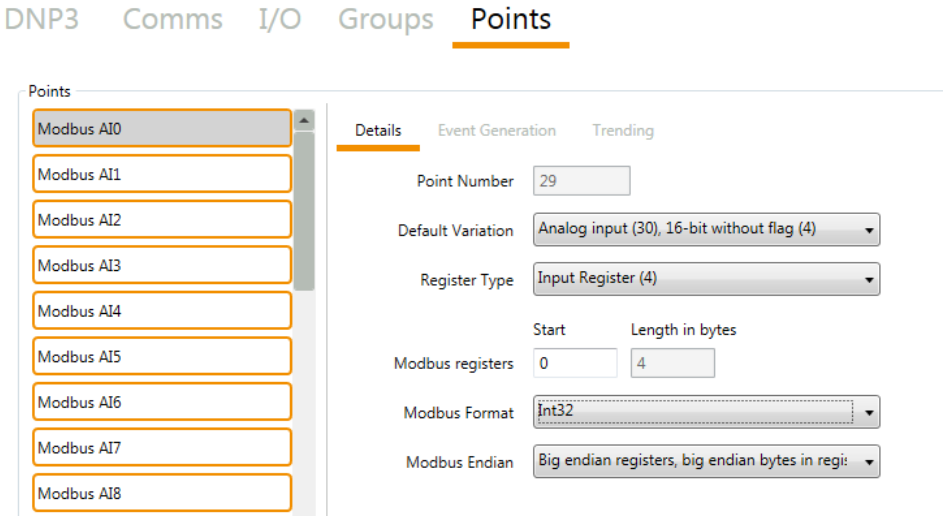


Figure 23: Modbus register configuration

SDI-12

The Point Colour can be configured to communicate with one SDI-12 sensor using a specially designed cable connecting to the main connector (see the IO cable section for details).

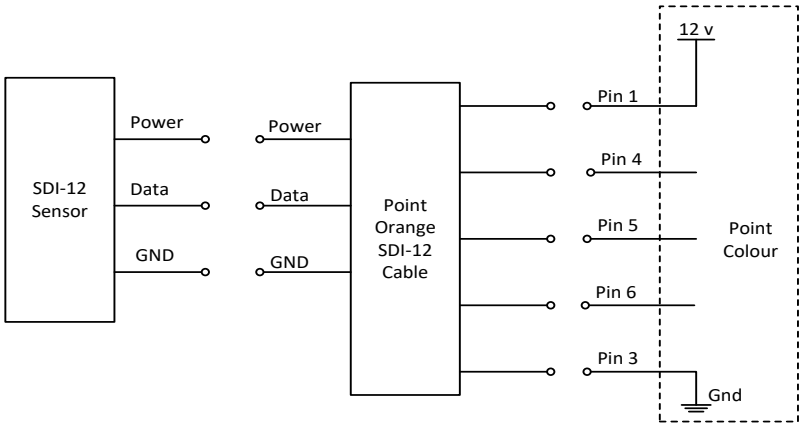


Figure 24: SDI-12 connections

The Point Colour will initiate the measurement and retrieve the data from an SDI-12 sensor. Up to nine serial analogue input points can be read from the sensor, dependant on what is available from the sensor.

Communications with an SDI-12 sensor will be started before the trend time to ensure that all points have been read and values updated prior to the trend value being stored. The longest time of all previous successful queries serves as a reference of how long the data acquisition takes and requests are started that amount of time before the trend is required. This value is reported in the SDI-12 Response Time Analogue Input point (AI46).

Poco+ Configuration

The SDI-12 serial interface has the physical parameters specified by the standard, therefore less configuration is required.

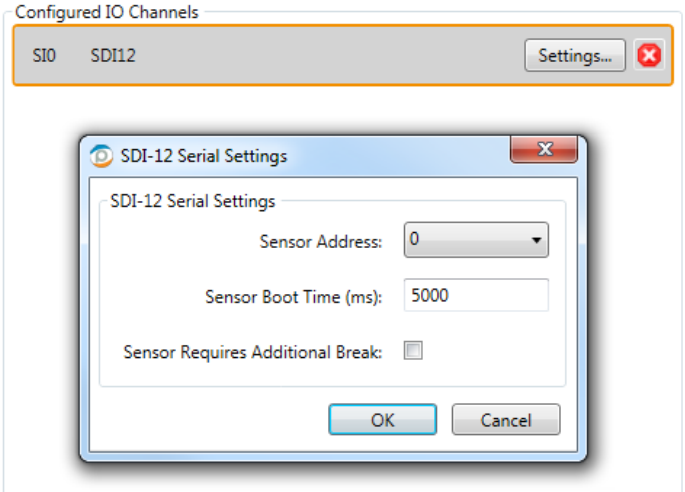


Figure 25: SDI-12 configuration

Once added as a serial channel there are several settings that need to be configured correctly for successful communication with the SDI-12 slave;

Setting	Description
Sensor Address	The SDI-12 address of the sensor connected.
Sensor Boot Time	A settle time required by the sensor before communication can be initiated.
Additional Break	A checkbox option to specify if an additional break character is required to be sent before data is returned from the sensor to the Point Colour.

SDI-12 Points

The Point Colour has 9x serial analogue input points that are used to store SDI-12 data. There is no specific configuration as SDI-12 always uses a floating-point format.

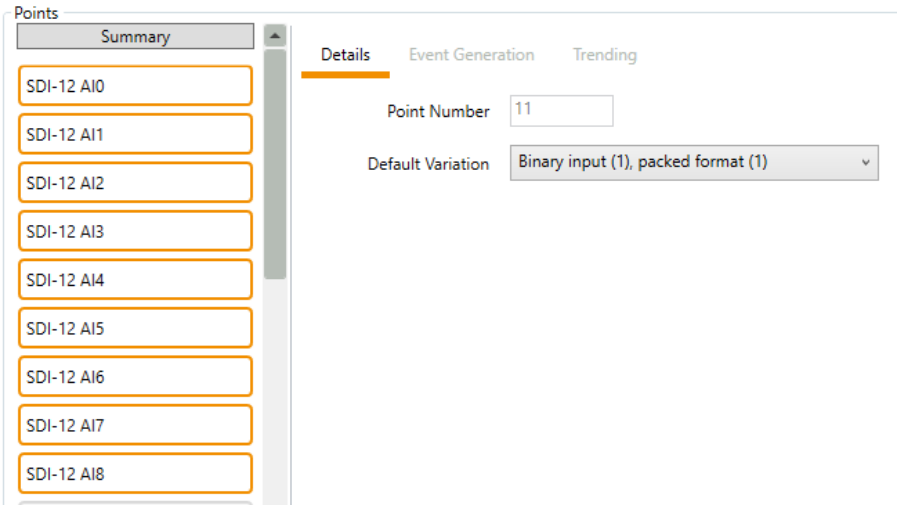


Figure 26: SDI-12 point configuration

Mainstream

The Point Colour can be configured to communicate with one **Mainstream AV-Flow Transmitter** sensor using a specially designed cable connecting to the main connector (see the IO cable section for details).

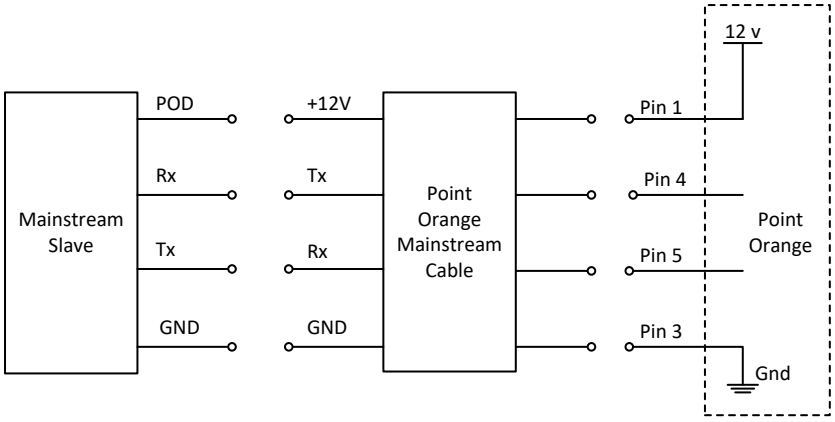


Figure 27: Mainstream connections

The Point Colour will initiate the measurement and retrieve the data from a Mainstream sensor. The data updates 8 predefined serial analogue input points.

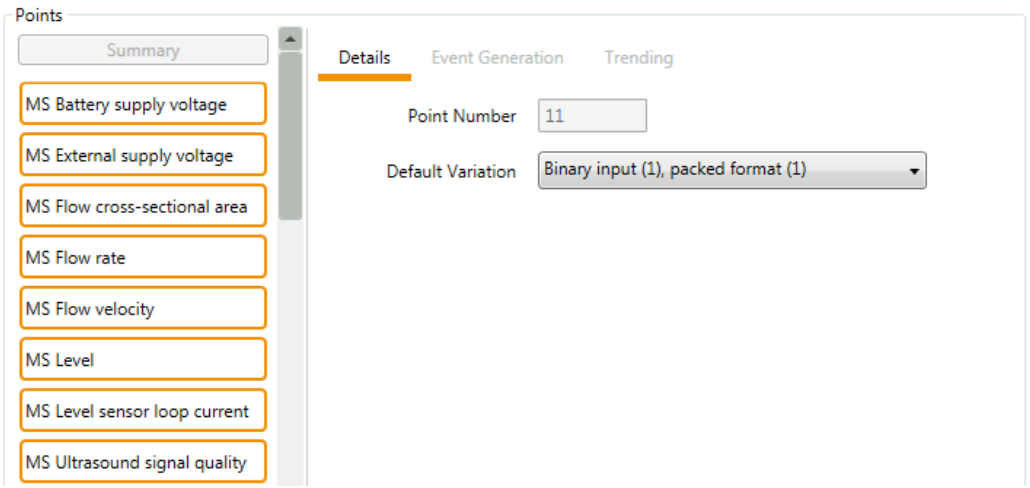
Communications with a Mainstream sensor will be started 7 seconds ahead of when the trend is to be taken to ensure it completes in time.

Poco+ Configuration

Once added as a serial channel, the Mainstream interface requires no additional configuration parameters.

Mainstream Points

When configured to communicate with a Mainstream AV-Flow Transmitter, the Point Colour has eight analogue points that are used to store the retrieved data. The data is stored with a floating-point format.



Internal IO

The Point Colour has a wide range of internal points that can be measured such as battery voltage, or whether the unit is submerged or not. These conditions are mapped to points and are always available.

The full list of points is given in the Points section of this guide. These points include integrated sensors e.g. ambient temperature, measured conditions e.g. GSM signal strength and diagnostic information, e.g. number of successful connections. Each of these points, how and when they are updated is summarised and described in more detail below.

Local monitoring

Internal temperature (AI5)

The Point Colour has an onboard temperature sensor that measures the temperature inside the enclosure. The sensor has not been designed to compensate and calculate the temperature external to the enclosure and is provided as an indication only.

The sensor is accurate to +/- 1°C and has a range of -40°C to +125°C, although this is well beyond the operational range of Point Colour (-20°C to +80°C). As with other Metasphere battery powered RTU's the ambient temperature can be recorded at regular intervals to give an indication of the temperature on site.

Battery voltage (AI6)

The Point Orange has an internal 2-cell lithium thionyl chloride (LTC) battery pack, with a nominal pack voltage of 7.2V. This voltage is measured when the RTU is awake, and the point value updated.

The Point Blue has either an internal battery or an external battery dependant on version. Both versions will report the battery voltage as this point.

Battery monitor (AI39)

The battery voltage varies dependant on load, and a single reading is not an accurate indication of battery condition. The battery monitor point records the average voltage of the battery during the last communications session, which is when the unit is under the most load. This point can be used to assist in determining the condition of the battery.

External supply voltage (AI7)

If an external supply is connected to the Point Orange, the voltage level of this supply is sampled when the RTU is awake and the point value updated. This point is not updated on the Point Blue.

Sensor supply voltage (AI8)

If configured for active loop, active voltage, or serial connections the sensor supply voltage is measured. Similar to the sensor readings this point is only updated once at power up and then when the active IO point is trended.

Submersion Sensor (AI9)

The Point Colour has an onboard submersion sensor. This point returns the analogue value of the submersion sensor (see Submersion sensor (DI12) for more information on how the submersion sensor works).

Trend Delta (AI24 – AI27 and AI41 – AI45)

These points are updated after any configured trend is taken on one of the four external counter inputs or five counters of external digital inputs. The value is the number of pulses for the previous trend period. If no trend is configured on the counter point, then the respective AI point will be zero. The table below shows an example.

CI0	AI24
0	0
50	50
150	100
325	175
350	25
400	50

The table below indicates the relationship between trend delta, counter and digital input points (where applicable).

Trend Delta point	Counter point	Digital point (where applicable)
AI24	CI0	
AI25	CI1	
AI26	CI2	
AI27	CI3	
AI41	CI26	DI0
AI42	CI27	DI1
AI43	CI28	DI2
AI44	CI29	DI3
AI45	CI30	DI4

Trend delta was previously known as “flow rate”.

External Power (DI5)

When an external supply is connected to the Point Orange the RTU automatically switches to the new external supply. When this occurs, this point is set to 1. If the external supply is removed, or the power source has depleted such that it can’t power the RTU, the Point Orange will automatically switch back to the internal battery and set this point to 0.

Point Blue does not set this point, and it will always return 0.

Reed Switch (DI10)

The Point Colour has a reed switch that can be activated using a magnet, and if configured, it will force the RTU to contact the master. The reed switch is located on the side of the RTU as shown in Figure 28. This is the opposite side to the external antenna connector. To trigger a dial in the magnet must be held against the enclosure for 3 seconds.

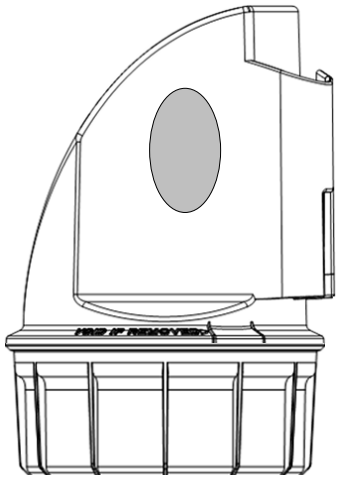


Figure 28: Point Colour reed switch location

The current value of this point is updated by interrupt, so if a dial in is triggered using the reed switch, unless the magnet is held in position for the duration of the connection, the current value reported to the master will be zero. However, it can be useful, when using the "Monitor points" window in Poco+ to know that the switch has been closed successfully.

Submersion sensor (DI12)

The Point Colour has an integrated submersion sensor that can be used to determine if the Point Colour is submerged. The sensor is located in the cap of the enclosure, therefore the water level must be higher than this to trigger the sensor. Figure 29 shows the threshold, left showing unsubmerged, and the right showing submerged.

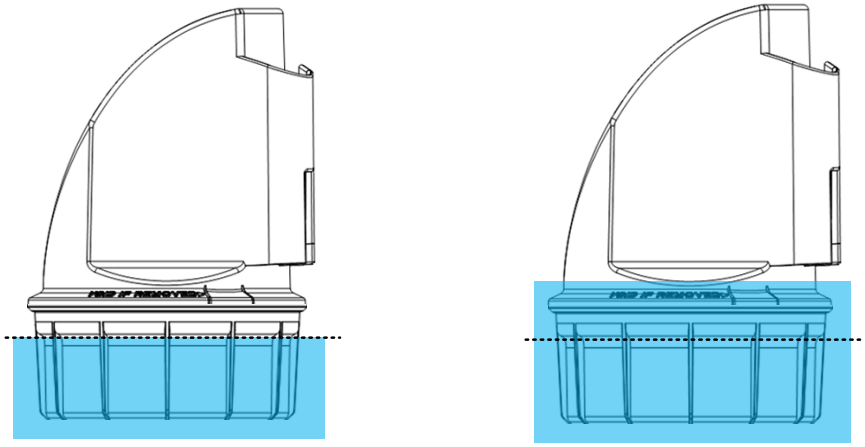


Figure 29: Point Colour submersion threshold

The sensor is sampled each time the RTU wakes up from sleep. This is normally done at the fastest trend frequency, however, if an alarm is configured on the DI point then the sensor

will be sampled at the alarm check frequency. This allows for more frequent sampling of the sensor if desired.

Once a submerged reading has been detected, the Point Colour will take a further five samples at 10 second intervals. If the average of these six samples has a deviation greater than the threshold, then the unit is considered submerged and the binary point for submersion is set to true (one) indicating that the Point Colour is submerged. If the average is lower, the Point Colour assumes that the first reading was erroneous and waits until the next wake time to sample the sensor again. The same algorithm is used to determine when the unit is no longer submerged, setting the binary point to false (zero).

- *Note: The submersion sensor is not read while the modem is switched on.*

- *Note: The submersion detection algorithm is not activated when it is configured for sleep mode, to conserve battery power.*

Calibration and Recalibration

The submersion sensor is calibrated by the RTU if no calibration exists. This calibration process takes approximately 5 minutes, after which the sensor is sampled at regular intervals depending on the configuration of the RTU.

Recalibration of the submersion sensor can be handled by Poco+. The RTU must have a sleep configuration during calibration of the submersion sensor. To ensure that the calibration is successful, no additional Poco+ windows, such as the monitoring of points should be open during the process.

From Poco+, select the Calibrate Submersion Sensor from the Device menu.

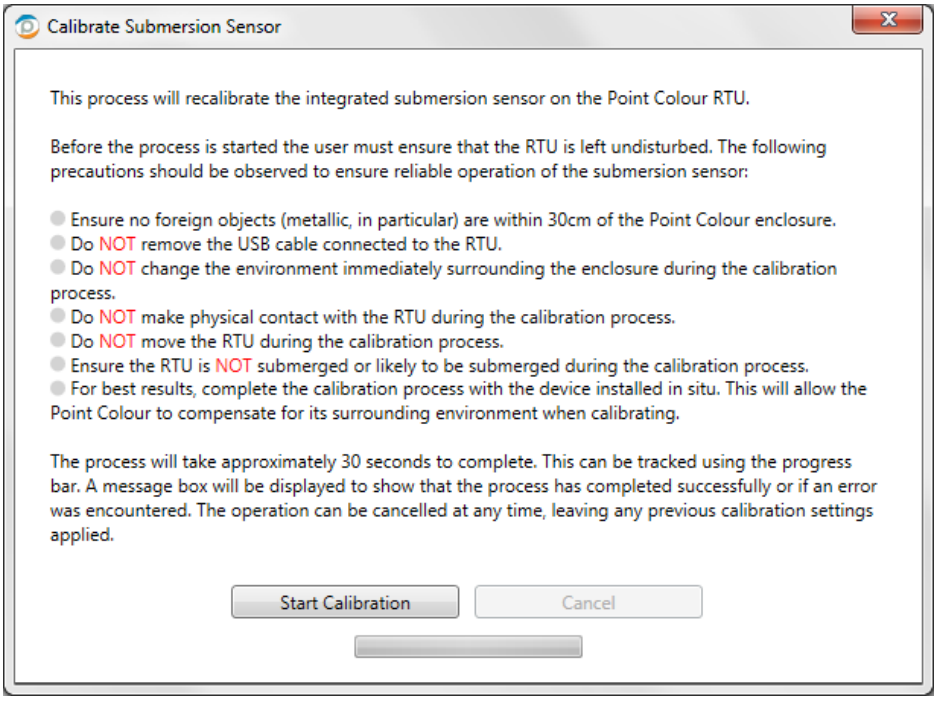


Figure 30: Poco+ submersion calibration

- *Note: If the precautions are not adhered to then resulting performance of the submersion sensor may vary.*

WARNING

The Point Blue ATEX/IECEx certificate specifies that the USB connection should NOT be used in the hazardous area. All users should adhere to these instructions along with the other guidelines in the Point Blue Safety Guide provided with every Point Blue.

USB Connected (DI13)

This digital point is updated by interrupt and is set to 1, when a USB cable is connected between the Point Colour and a PC. This can be used as a tamper detection to determine if and when a local connection is made to the RTU.

Loop on (DI15)

This digital point indicates if the 12V loop supply, used to power active loop and active voltage IO, is on or not. 0 = loop supply off, 1 = loop supply on.

Modem Points

The internal modem in the Point Colour offers a wide range of information that can be extracted and reported. This information can be useful for debugging purposes or for just locating a unit.

In addition to the data extracted from the modem there are some additional points associated with the modem that are useful for monitoring the performance of the battery life. Some of these points are updated before communicating with the master so can be read as current values, whilst others are only updated at the end of the connection attempt so the value is not available until the next connection. The following sections describe each point including when the point value is updated.

Modem CSQ (AI10)

This point is the received signal strength indication (RSSI) recorded during the current connection attempt and is updated before contacting the master. The CSQ reading is sampled several times during the connection attempt and an average calculated to give a more accurate picture of the signal strength.

- *Note: The reported signal strength whilst useful should only be used as an indication of the network strength at the time of the connection attempt.*

Modem Bit Error Rate (AI11)

This point is the Bit Error Rate (BER) recorded during the current connection attempt and is updated before contacting the master. The reading is sampled a number of times during the connection attempt and will only show the latest value.

Modem Fail Code (AI12)

This point is the failure code for the last connection attempt. The point value is updated at the end of the connection attempt and is only set to zero if there were no errors during the connection. The possible error codes are listed below.

Code	Description	Possible cause of error
0	No error detected	-
50	Couldn't create modem driver.	Point Colour firmware errors please contact Metasphere.
51	Couldn't install modem driver	Point Colour firmware error please contact Metasphere.
52	Invalid modem serial port	Point Colour firmware error please contact Metasphere.
53	Unknown modem	The Point Colour firmware cannot determine which modem is connected. Please contact Metasphere.
101	Can't communicate with modem.	Possible connection problem between the processor and modem. Please contact Metasphere.
102	Couldn't register on GPRS network	Check the SIM card activation and consider increasing the GPRS registration timeout period.
103	Couldn't attach to GPRS network	Check that SIM card supports GPRS M2M communication
104	Activate PDP failure	Check APN settings and retry. Consider increasing the start bearer timeout.
105	Socket creation failed	Check destination IP address and port number. Ensure that firewalls are configured to allow incoming connections on the configured port number.
106	Could not connect to IP	Check destination IP address and port number. Ensure that firewalls are configured to allow incoming connections on the configured port number.
107	Start bearer timeout	Consider increasing the start bearer timeout. The default setting of 30 seconds is normally sufficient, but in some instances 60 or 90 seconds may be required, especially if the SIM card has just been replaced.
108	Failed to read SIM ID	Check that the SIM card has been inserted correctly, is locked securely and is active.
110	GPRS Network deregistration failed	At the end of each connection attempt the Point Colour attempts to deregister the modem from the network. This process can occasionally fail, however the connection may have been completed successfully.
199	Socket closed by remote host	The modem could contact the destination IP address, but the socket was unexpectedly closed. The server might not be configured to accept communication from the Point Colour. Check the server and application software settings.
201	Connection closed by remote host	The remote server unexpectedly closed the connection during an established comms session.
202	Could not connect to phone number (GSM)	The modem failed to connect to the configured number.
301	Could not connect to FTP server	Check destination IP address and port number for the FTP server. Ensure that firewalls are configured to allow incoming connections on the configured port number. If using FTPS, PEM file may be invalid or expired.
302	FTP data read ended	Currently unused

Code	Description	Possible cause of error
303	FTP Command failed	The modem was unable to open an FTP connection. Check the FTP settings (IP address, port number, username and password) and that the server is available.
304	Bad FTP Command starting state	The modem was not in data mode. Point Colour hardware or firmware errors, please contact Metasphere.
305	FTP failed to open local file	The file on the Point Colour could not be opened.
306	FTP failed to read from local file	Data could not be read from the file on the Point Colour. Point Colour hardware or firmware errors, please contact Metasphere.
307	FTP failed to write to local file	Data could not be written to the file on the Point Colour. Point Colour hardware or firmware errors, please contact Metasphere.
308	FTP data connection failed	The data connection failed during data exchange. If this is seen repeatedly, increase last poll and overall timeout connection parameters.
309	FTP data connection timed out	Timeout during data transfer.
310	FTP not supported on this Modem	FTP is currently only supported on Telit modems. Check the point Modem Type (AI23).
311	FTPS PEM file not found	When configured for FTPS, no PEM file has been downloaded to the Point Colour
312	FTPS Error using PEM file	Error in writing the PEM file to the Point Colour modem
401	NTP failed to connect to server	FTP filed to get time from network or from NTP server

Registration Code (AI13)

This point reports the registration code returned by the modem during the registration attempt and is applicable to the current connection attempt. This can be particularly useful for SIM cards that are able to roam from their home network to determine, how often the home network is used.

Code	Description
0	Not registered, modem is not currently searching a new operator
1	Registered, home network
2	Not registered, but modem is currently searching for a new operator to register to
3	Registration denied
4	Unknown
5	Registered successfully on guest network

Connection Seconds (AI14)

This point is updated at the end of a connection attempt, and is the time taken (in seconds) for the connection attempt. This point is useful for determining the average connection duration.

Mobile Country Code (AI16)

This point is updated during the connection attempt so can be read as a current value by the master. This point reports the mobile country code for the network with which the modem has registered. The codes are administered by the CCITT.

Mobile Network Code (AI17)

This point is updated during the connection attempt so can be read as a current value by the master. This point reports the mobile network code for the network with which the modem has registered. The codes are administered by the CCITT.

Radio Band (AI18)

This point is updated during the connection attempt so can be read as a current value by the master. This point displays the current GSM/GPRS modem radio bands currently used by the modem.

Code	Description
17	Radio bands for use in the Americas
12	Radio bands for used by the Rest of the world

External CSQ (AI19)

This point is updated during the connection attempt so can be read as a current value by the master. This point shows the last signal strength read when the external antenna was in use.

Typical signal strength values and their meaning

Point Value	Signal Strength Meaning
2-9	Marginal signal quality. Review antenna position and signal coverage. Communication will be impacted and retries seen.
10-14	Acceptable signal quality. Occasional retries will be seen.
15-31	Good coverage.

Internal CSQ (AI20)

This point is updated during the connection attempt so can be read as a current value by the master. This point shows the last signal strength read when the internal antenna was in use.

Typical signal strength values and their meaning

Point Value	Signal Strength Meaning
2-9	Marginal signal quality. Review antenna position and signal coverage. Communication will be impacted and retries seen.
10-14	Acceptable signal quality. Occasional retries will be seen.
15-31	Good coverage.

Modem Types (AI23)

This point shows which modem is installed in the Point Colour.

Point Value	Modem
0	None
1	Unknown
2	Wismo 2G
3	Telit 3G
4	Telit 2G

Modem Power (DI6)

This digital point reports if the modem is on or off to allow users to monitor a connection locally. 0 = Off, 1 = On

Antenna (DI11)

This digital point indicates which antenna is being used for the current connection attempt. 0 = External, 1 = Internal

Network Technology (DI14)

This digital point indicates which network technology is being used by the Point Colour. 0 = 2G, 1 = 3G.

Last Contact Time (CI5)

This point is updated at the end of a connection attempt and displays the last time the RTU made contact with the master station (in Unix time – i.e. number of seconds since 01/01/1970 00:00:00).

Successful Connections (CI6)

This point is updated at the end of a connection attempt and is a count of the number of successful connections made to the master.

Unsuccessful Connections (CI7)

This point is updated at the end of a connection attempt and is a count of the number of unsuccessful connections made to the master.

Registration Failures (CI8)

This point is updated at the end of a connection attempt and is a count of the number of times the modem failed to register on the network.

Modem Seconds (CI14)

This point is updated at the end of a connection attempt and indicates how many seconds the modem has been powered up since the RTU was last reset.

Number of Start Bearer Timeouts (CI15)

This point is updated at the end of a connection attempt and is a count of the number of times the modem timed out while trying to start the bearer.

GSM Network (ST1)

This point is updated during the connection attempt so can be read as a current value by the master and shows the name of the network used by the modem.

Modem IMEI (ST2)

This point is updated during the connection attempt so can be read as a current value by the master and shows the IMEI number of the modem.

Modem Firmware (ST3)

This point is updated during the connection attempt so can be read as a current value by the master and shows the firmware version of the modem.

SIM Card Number (ST4)

This point is updated during the connection attempt so can be read as a current value by the master and shows the SIM card number.

Location Area Code (ST5)

This point is updated during the connection attempt so can be read as a current value by the master and shows the Location Area Code (LAC) for the GSM network currently used by the modem. This point together with the Cell ID, the Mobile Country Code and Mobile Network Code can help in locating the position of the RTU.

Cell ID (ST6)

This point is updated during the connection attempt so can be read as a current value by the master and shows the Cell ID of the cell used by the modem.

RTU diagnostic points

Configuration Version (AI15)

This is the configuration file version number and is used by Poco+ to determine what fields in the configuration file expect.

Configuration Error Code (AI22)

This analogue point can be used to indicate if a recently downloaded configuration file has been applied or not. The table below shows the possible values for this point and the flow chart in Figure 41 shows when they are set.

Code	Description
0	Not configured No new configuration found
2	Not configured New configuration invalid
4	Configured No new Configuration found
6	Configured New configuration invalid

Code	Description
7	Configured New configuration valid

Awake Seconds (CI11)

This is the number of seconds that the Point Colour has been awake for. i.e. running at full power processing data. The clock is stopped each time the RTU goes to sleep.

Serial Number (ST0)

This is the serial number of the Point Colour unit and will match the number located on the top of the enclosure. This can be useful for tracking where units are.

Date of Manufacture (ST7)

This point contains a numeric string representing the date that the Point Colour was manufactured. It uses DDMMYYYY format.

Valid Config (DI9)

This digital input is set to 1 if the current configuration file is valid and set to 0 if the configuration file is invalid.

RAM Used (AI40)

This analogue input reports the percentage of the memory that has already been used for data storage and diagnostics. Values outside of 0 to 100% indicate errors as detailed in the following table:

Code	Description
201	No free space
202	Too much free space

SDI-12 Response Time (AI46)

This analogue input reports the highest number of seconds taken for successful communication with an SDI-12 sensor and includes the configured sensor boot time. The response time indicates how long before a trend is taken that the SDI-12 read must be initiated to ensure it is completed.

The value is used to schedule the start of the communication with the SDI-12 sensor before a trend is taken. This ensures that under normal operation the trend value is up to date.

XLP Version (AI47)

This analogue input reports the extra low power (XLP) counter firmware version being used, with a multiplication factor of 10.

LVD Reset Count (AI48)

This analogue input reports the number of Low Voltage Detect **(LVD)** resets. This value is incremented when the RTU resets due to low voltage, and decremented when a connection to a master is successful. If this value reaches five (indicating repeated LVD resets) the RTU will enter a battery recovery state. In this state, the RTU will sleep for 30 minutes to give the

battery a chance to recover enough to resume normal operation. Entering the battery recovery is a sign that the battery is reaching end of service.

DNP3 Diagnostic Points

When configured as a DNP3 slave the Point Colour maintains several local points that can help show the current state of the RTU.

DNP3 IIN Bits (AI21)

This point shows the current state of the IIN bits for the slave. The point is an analogue point (16-bit number) which is a bit array where the LSB represents IIN1 and the MSB represents IIN2, see section 4.5 of the DNP3 standard for more information. The following shows what each bit being set in the point represents:

Bit number	Description
0	Broadcast Message received
1	Class 1 events available
2	Class 2 events available
3	Class 3 events available
4	Time Synchronisation required
5	At least one output point is in local operation mode
6	Abnormal condition exists on Outstation (Trouble)
7	Device restart
8	Function not supported
9	Object not supported
10	Parameter error (Outstation is unable to parse the Application Layer fragment)
11	Event buffer Overflow
12	Operation already executing
13	Configuration Corrupt
14	Reserved
15	Reserved

DNP3 Events (CI12)

This point shows the number of currently unreported events that are held on the Point Colour. At the end of a connection with a DNP3 or WITS-DNP3 master, this value should have returned to zero.

This value includes Data Set Events as used by WITS-DNP3.

DNP3 Points (CI13)

This is the total number of points that are available to read by a DNP3 or WITS-DNP3 master.

Events and Alarms

The Point Colour can be configured to raise events based on certain conditions. These events are stored by the RTU and reported back to the master or stored in a CSV file for FTP mode. An alarm is a critical event that causes the RTU to make immediate contact with the Master. Alarms are referred to as contactable events for RTU's in DNP3 or FTP mode.

The configuration determines the conditions under which alarms, or events are raised. When using the Medina protocol these are configured at the master using the workstation or Palette. On initial communication, the master configures the RTU. This allows reconfiguration whenever the Point Colour communicates with the master.

For DNP3 and FTP all configuration is done using Poco+ and downloaded directly to the Point Colour. It is then fixed until the configuration is replaced.

Events and alarms are supported in WITS-DNP3, although they are termed as actions. An event is equivalent to action 2 to *raise event*, while an alarm is equivalent to action 3 to *raise event and contact master*.

The WITS-DNP3 protocol allows for configuration of actions for more items than with DNP3 or Medina. Actions can be generated when there are changes to DNP3 flags, the point has been reconfigured or when point has changed state. This change of state is either for a digital, or an analogue crossing a boundary. For details of configuration of the Point Colour when using WITS-DNP3, see the WITS Configuration section. The WITS-DNP3 Application Notes contain full details of all functionality.

- *Note: The detection of these alarms and events, how and when they are reported is dependent on the point types and is described below. Note: For DNP3 and WITS-DNP3 if a point has an event class of 0, no events will be generated.*

Digital Inputs

The external DI's on Point Colour are interrupt driven. This means that if configured with an external DI the RTU will sleep until the point value changes. Upon detecting the change in state, the RTU will wake and assess what action to take. Depending on the configuration of the RTU digital events can be created on the change of state of a particular digital input.

Of internal DI's only the USB connection (DI8) the reed switch (DI10) and the external power (DI11) are interrupt driven. All the other DI's are set based on other readings and are calculated when the RTU is awake. Whilst alarms can be configured on these 'calculated' DI points, the alarm or event generation is based on the timings according to the other data used. For example, the submersion sensor DI uses the analogue readings from the sensor to determine when the RTU is submerged and is only set when a number of criteria are met.

The process for determining when these alarms are raised is dependent on the 'Alarm Check' configuration option.

Counter Inputs

Counter input events are created in DNP3 and FTP modes. A counter input event will occur when a counter rolls over and will therefore only occur on external counter points.

- *Note: Neither Medina or WITS-DN3 generate counter input events.*

Analogue Inputs

When alarms are raised, analogue inputs fall into one of two categories, active or passive points. Active points are those that require the Point Colour to power an external sensor i.e. active loop or active voltage.

Active points

Active points are only sampled on a specified trend frequency, and once at power up. If an alarm is configured on an active AI channel and an alarm condition is detected, with no time or level deadband then it is raised by the Point Colour immediately.

With a time deadband on the alarm will only be raised if the alarm condition is present at the next sample and the time between samples is greater than the configured deadband. For example, an active loop is configured with a 15 minute trend and a 10 minute time deadband. The sensor is powered up at 14:15 and an alarm condition is detected, however an alarm is not raised as there is a time deadband configured. At 14:30 the sensor is powered up again and another reading taken. If the alarm condition is still present, then an alarm is raised. If the alarm condition is no longer present, then no alarm is raised and the time deadband check reset.

Passive points

Passive points are sampled every time the RTU wakes up and every 2s thereafter as long as the RTU stays awake. If there is an alarm configured on any of the passive points the Point Colour will wake up at the frequency specified by the 'Alarm Check' setting in Poco+. Otherwise if there are no alarms configured the RTU will wake at the minimum trend frequency.

Models

When configured for DNP3, Point Colour supports two event generation models for analogue inputs, value change and level change. When configured for Medina or FTP, the Point Colour follows the Medina alarm model.

Level Change Events/Alarms (Medina, DNP3 & FTP)

The level change model is used with Medina and DNP3 masters as well as FTP servers. This model has six discrete levels, Overrange, HiHi, Hi, Lo, LoLo, and Underrange that can be configured to generate events and alarms.

HiHi, Hi, Lo and LoLo are set at limit and cleared through limit. This means that they will create an event when the limit is reached, and only clear it when the value is back past the limit. The Overrange and Underrange limits are set through limit and cleared at limit.

- *Note: Medina does not support Overrange and Underrange on the Point Colour. They should be disabled for all analogue points within Master Control.*

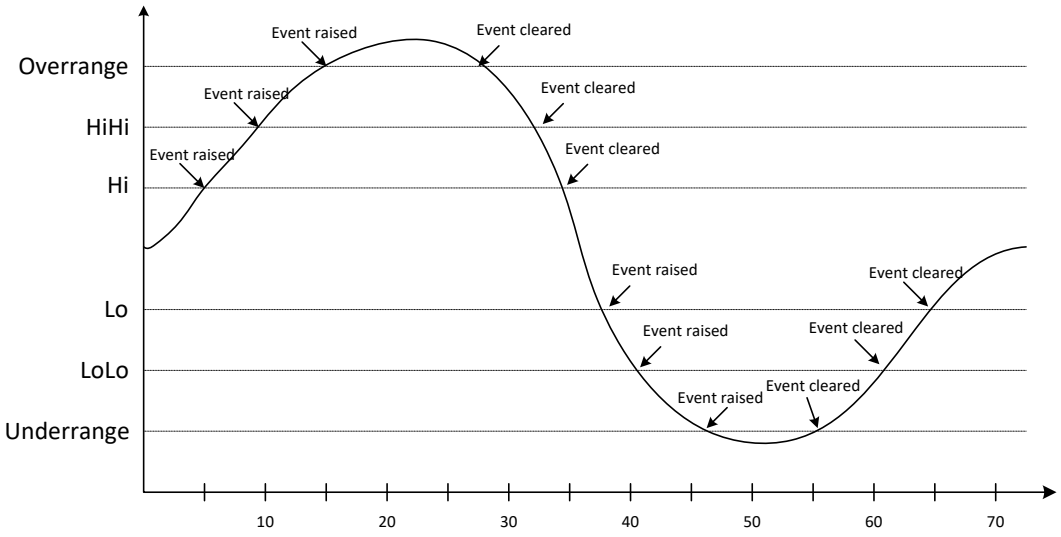


Figure 31: Level Change event example

Value Change Events/Alarms (DNP3)

The value change model is used with DNP3 masters. This model generates an event when an analogue input value changes by the configured amount (deadband) between samples.

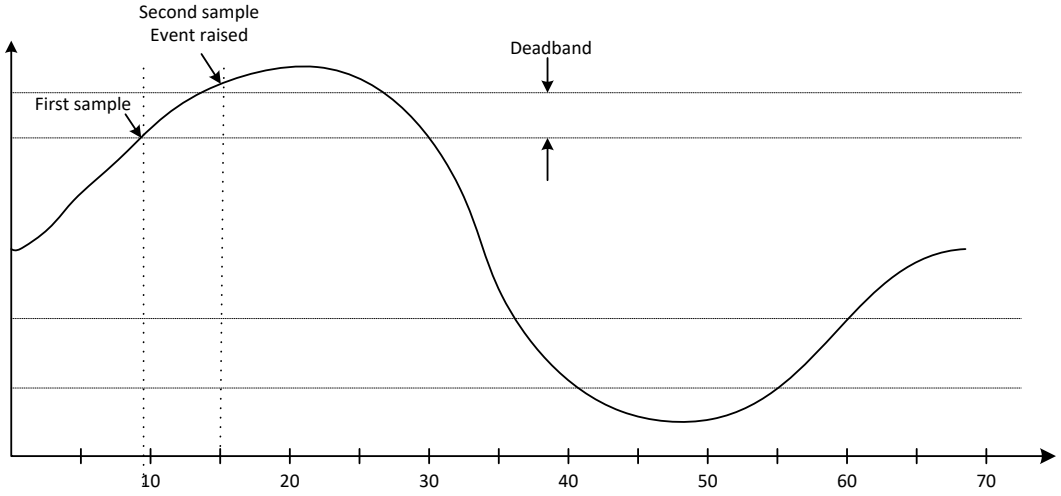


Figure 32: Value Change event example

- *Note: A value deadband of zero will disable event generation.*

Deadbands

When configuring alarms, the concept of deadbands is applicable to AI and DI points. There are two types of deadband that are used by the Point Colour, time deadbands and level deadbands. Time deadbands can be applied to both digital and analogue points. Level deadbands are only applicable to analogue points.

- *Note: The WITS protocol terms define time deadbands as persistence, and level deadbands as hysteresis.*

Time deadbands

A time deadband is the time period after an alarm condition has been detected that the event or alarm is raised. If the alarm condition is cleared within this time deadband then the alarm or event is not raised. Figure 33 shows a when an alarm is raised for a digital point with a 10 second deadband.

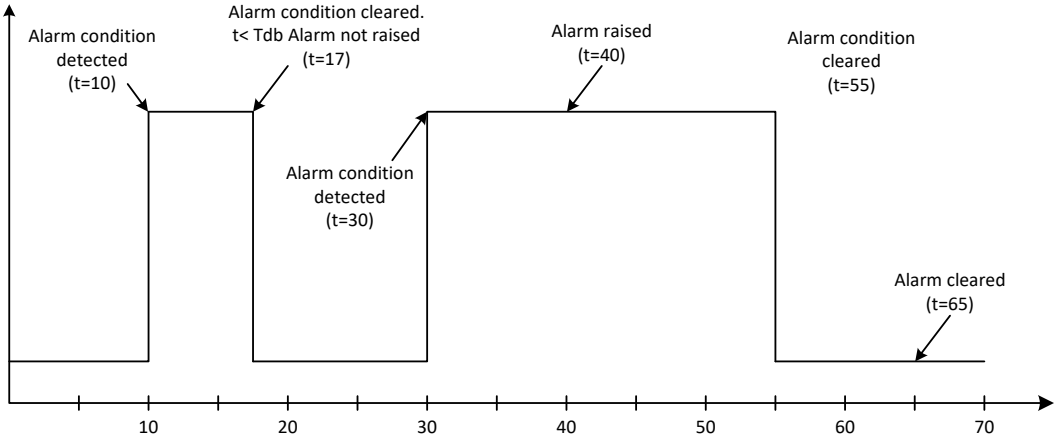


Figure 33: Digital time deadband example

The same principle applies to analogue inputs, i.e. the value must be above the alarm level continuously for the time deadband period for the alarm to be raised.

Level deadbands

Level deadbands apply only to analogue points and can be used with or without time deadbands. Typically, analogue points measured using an ADC will exhibit minor variations about a nominal value. This means that as an analogue value approaches one of the alert levels the RTU is likely to see a very large number of duplicate alerts being raised and cleared as the value fluctuates about the level. To minimise this problem, each analogue can be independently configured with a level deadband.

With a level deadband in place, the current value of an analogue must equal or exceed the event level value to raise the event. However, to clear the event the current value must be more than level deadband value below the event level. Figure 34 shows a when an alarm is raised for an analogue point with a level deadband.

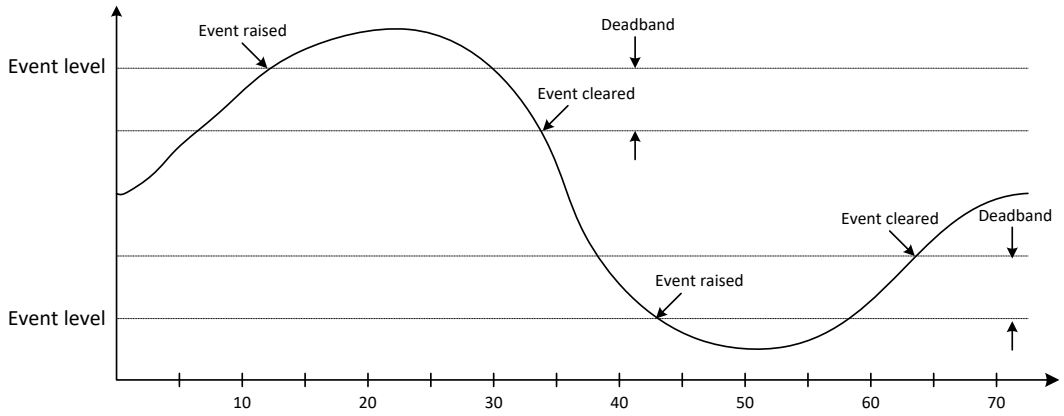


Figure 34: Analogue level deadband example

Analogue events can be configured with time and level deadbands. Figure 35 shows a when an alarm is raised for an analogue point with a level deadband and a 5s time deadband.

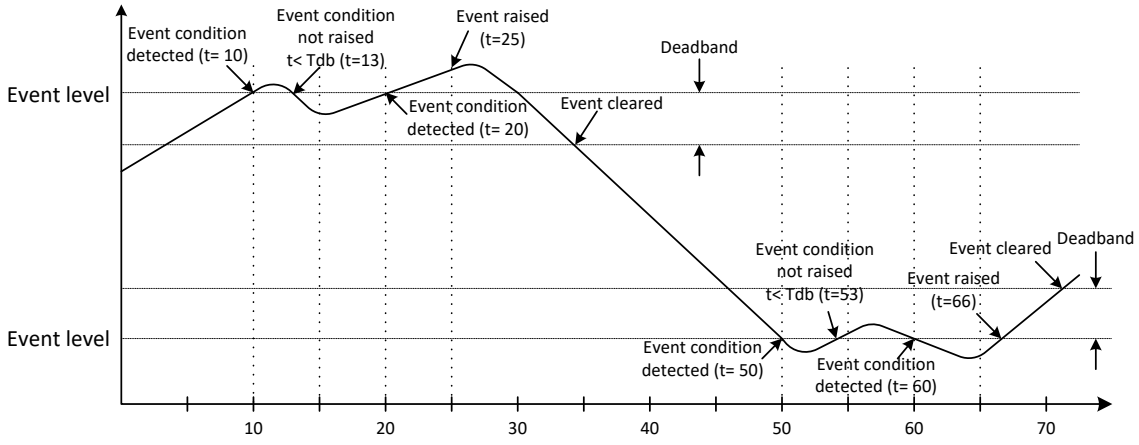


Figure 35: Analogue level and time deadband example

WITS Alarm Model

The alarm model for WITS-DNP3 is defined in the Application Notes as the *analogue limits*. When configured for WITS-DNP3, the Point Colour adheres to that model.

A limit is defined as the boundary separating states. The states are numbered from 0 (normal) to the maximum configured rather than given names. As the Point Colour offers a maximum of two negative limits and two positive limits, Poco+ avoids the WITS numbering system and uses the same naming as with other stacks.

A state is either between two limits or is above or below all other states. There is a single hysteresis (known as deadband in other stacks) as well as enter and leave persistence values that are shared for all limits (known as raise and clear deadbands in other stacks).

Separate Underrange and Overrange handling is performed. The alarm model is fully detailed in the WITS-DNP3 Application Notes and will not be expanded in this User Guide.

Trending

Point Colour can sample measured values at periodic intervals and store these samples (with a time-stamp) and then report these values. This sampling is referred to as trending.

Digital, analogue and counter points can be trended. The frequency at which the point is trended is a user configurable value. For a pulse counter point, the data recorded is the instantaneous value at the end of the trending period. In addition, points AI24 – AI27 and AI41 – AI45 are updated with the difference in counter values allowing the change rate to be easily monitored.

- *Note: Please note that loop powered points (such as Active loop, Active voltage and serial) will not be trended during user initiated file transfers. Once the file transfer has completed the points will continue to be trended as normal.*

Medina

For RTU's with a Medina master this frequency can only be configured from the master and is automatically downloaded to the Point Colour when it powers-up and contacts the master. A Medina Point Colour can hold up to 32 trend streams, identified by a unique combination of point derivation, type, and number. When a trend stream is created, the trend period and time/date for the first value are configured by the message. Only Current Value trends are supported.

The Point Colour has 400kB of volatile memory available to store events and trends. When the data is read successfully and acknowledged by the master, the read data is deleted. If the Point Colour's trend data area becomes full, the device will stop taking new values to avoid deleting old data. The percentage of memory used is available in the AI40 point.

- *Note: Master Control will receive all trend data, and it is up to the configuration as to the length of time that the Data Gatherer (DG) will retain this data. Thus, if more data is transferred than the DG will retain, it will be lost before it is transferred to the Data Server (DS).*

DNP3

If a Point Colour is configured as a DNP3 slave, the maximum number of events that can be stored for each class can be configured in the configuration file. If the Point Colour reaches this maximum number of events it will attempt to dial-in to the master and continue to collect events.

The maximum number of events for each DNP3 group can also be configured however if this is reached the Point Colour will not dial-in and it will not continue to collect events until the events have been read by the master. This functionality can be disabled by setting the maximum number events stored by each group to 0. The Point Colour supports one trend per DNP3 point and can hold up to approximately 15,000 events.

WITS Logging

The equivalent to trending in WITS-DNP3 is known as Data Logging. It uses a file transfer method to retrieve the logged data in a standard format. This format is detailed in the WITS-DNP3 Application Notes and will not be expanded in this User Guide.

The Point Colour uses periodic Logging for analogue and counter input points. When the Point Colour is unable to store further data, it can either maintain the existing data and discard new data or remove the oldest data to make room for new data. This is the discard mode and is configurable using Poco+.

Dynamic Trending

Point Colour is able to change its trend frequency based on the alarm state for any analogue input. If the value of a point indicates that it is in an alarm state, and it has been configured to dynamically trend, the sample period for that point is changed, from the normal trend frequency, to the dynamic trend frequency.

DNP3 & FTP

An example configuration is given below followed by a description of how the trending frequency changes. To keep the example simple, all deadbands (time and level) have been disabled. To enable dynamic trending, an analogue point must have trending and level change events enabled.

Dynamic trending can be used to take fewer readings from an active sensor when in a normal state to assist with prolonging battery lifetime. For DNP3 and FTP configurations, trends values are only recorded when needed, allowing more data to be collected under specific circumstances.

Parameter	Setting
AI0	Active loop input
AI0 Trend frequency	5 mins
AI0 Dynamic trend frequency	1 min
Apply dynamic trending for	Overrange, HiHi, LoLo, and Underrange
Deadbands	None

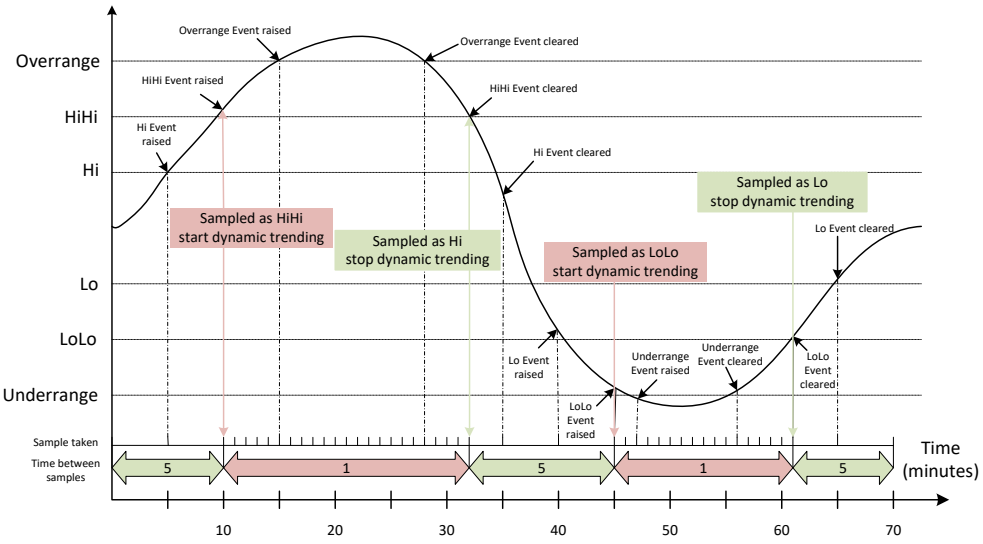


Figure 36: Dynamic Trending example

With reference to Figure 36, when the point value is greater than LoLo and less than HiHi, the loop is powered and AI0 is sampled (trended) at the normal trend frequency of 5 mins. When the value of AI0 goes above HiHi, (at 10 mins in Figure 36) the dynamic trend frequency is applied and the loop for AI0 is powered and sampled at the faster rate of 1 min. When the point value of AI0 goes back below the HiHi threshold, (at 32 mins in Figure 36) the trend frequency reverts back to the normal trend frequency of 5 mins.

Medina

How dynamic trending works and is therefore configured slightly different when the RTU is used in Medina mode. When the RTU is configured for Medina, all trends are configured and controlled by the Medina master. To use the dynamic trending on the Point Colour, the Medina master should be configured with the dynamic trend frequency and the Point Colour, using Poco+ should be configured with the regular trend frequency. The significant difference for Medina is that the trend stream specified at the DG must be quickest.

When the RTU contacts it is configured with the trend frequency as specified on the Medina master (i.e. the quickest), which in the example above is 1minute. The RTU now has a 1minute trend stream that must return a value for each minute slot to the Medina master to ensure a continuous trend stream is maintained.

However, to preserve battery life, when the value of AI0 is greater than LoLo and less than HiHi, the loop is only powered and AI0 sampled at the regular trend frequency of 5 mins, configured in Poco+. This value is then used for the next four slots after which AI0 is sampled again. When the value of AI0 goes above HiHi, (at 10 mins in Figure 36) the loop for AI0 is powered and sampled at the Medina master trend frequency of 1 min. When the point value of AI0 goes back below the HiHi threshold, (at 32 mins in Figure 36) the value of AI0 is updated at the slower 5 minute frequency.

Time

Time on the Point Colour is maintained in UTC. No provision is made for local time. This means that all events files and records that have a timestamp use the UTC time and date. The Point Colour has an integrated RTC that is responsible for maintaining time.

When the Point Colour is first powered up or is reset, the time is initialised to the start of Unix time, i.e. 01/01/1970: 00:00:00. When configured for Medina, the time is reset to 01/01/1976, 00:00:00.

- *Note: No DNP3 events or Medina trends or alerts are raised before the time has been set by the master.*

Synchronisation

During the first connection to a master, either Medina, DNP3 or WITS-DNP3, the time on Point Colour is set as specified in the respective set time polls. Once this has successfully completed, the RTC will maintain the time on the Point Colour. During the next communications session with the master, a set time poll will be issued again to the Point Colour. If the time on the Point Colour is more than 1 second away from the server time, the time nudge process is started.

The time nudge process, allows the time on the Point Colour to be adjusted without any jumps in time that could cause synchronisation issues with trend or event data. If the time needed to be nudged, the Point Colour will wake up at 1 minute intervals and nudge the clock either forwards or backwards 1 second. The process is stopped when the time has been synchronised. So, to make up an 11 seconds difference it will take 11 minutes.

FTP Time Synchronisation

A Point Colour configured in FTP mode will attempt to retrieve the time from the mobile network to set and maintain the RTC. If the network is unable to provide the time, then the Point Colour will attempt to retrieve the time from an NTP server hosted by Metasphere. In both cases the time uses UTC rather than the local time. The Point Colour will not function if it cannot retrieve the time from either source.

WITS Logging with Time Jump, If the Point Colour is configured to jump time, and a time jump is required, the WITS-DNP3 logging will restart and lose all previously collected data. Therefore, it is suggested that the drift mode is always used.

Communications

Point Colour is designed as a battery powered RTU and as such needs to preserve power wherever possible. The Point Colour cannot be permanently connected to the master as use of the GSM/GRPS modem requires substantial power. The Point Colour therefore primarily contacts the master on a configurable schedule, and by exception.

Power up connection

When a Point Colour powers up or is reset, it will attempt to read its configuration file, and if configured with a communications route, will attempt to contact the appropriate master. During this first connection, a number of parameters are initialised by the master including the time. If for any reason the RTU does not get it's time set, the Point Colour will consider this to be a failed connection and will enter the retry regime.

A GPRS/3G configuration will set the modem to use the best network technology available. A GSM configuration will set the modem to use 2G to enforce CSD. If this is different from the previous configuration, the mode will be changed, which may record a failed connection. In this case the retry regime will be entered.

Scheduled connections

Point Colour can be configured with a specific connection schedule. After the initial power up connection the Point Colour will follow this schedule for future connections, unless there is an alarm or a connection fails. This schedule is aligned to the 'Starting On' time in the configuration file.

For example, if the Point Colour has a configured 'Starting On' time of 09:00, is configured to 'Communicate Every' 10 minutes and the current time is 09:25, the next connection will be at 09:30, then at 09:40, 09:50 and so on.

If the 'Starting On' time is in the future the RTU will not communicate, except for the initial connection, until the 'Starting On time. If the 'Starting On' time is configured as 'Don't Care' the schedule will start from the nearest minute after the initial connection has finished, subject to the hold-off period. If a connection fails, the Point Colour will enter the retry regime.

Alarm connection

When an alarm is detected on the Point Colour, the RTU will attempt to contact the master using the last known good route. If successful, the Point Colour can be polled for other data as well, but this is left at the discretion of the master station configuration. If the connection fails, the Point Colour will enter the retry regime.

DNP3 Event Buffer Overflow

If configured to do so, the Point Colour will attempt to contact the master when it is unable to add an event to the buffer. This overflow condition will also set the Internal Indication bit.

Terminating a connection

DNP3

DNP3 is master/slave protocol, and the Point Colour has been designed to be a DNP3 slave. (For more information about the specific DNP3 functionality supported see the DNP3 device profile.)

As there is no native connection termination method for DNP3, if no frame is received from the master within a certain timeout period, the 'Last Poll Timeout', the Point Colour will assume that the master no longer needs to communicate, and it will terminate the connection. Additionally, if the master terminates the connection the Point Colour will shut down the modem and set the DNP3 stack ready for the next scheduled connection.

Medina

When configured as a Medina slave, the Point Colour will terminate the connection if instructed to terminate the connection by a poll from the master. However, the Point Colour also uses the 'Last Poll Timeout' setting to terminate a Medina connection if it does not receive a poll from the master within this timeout period.

FTP

When the Point Colour uses FTP, the connection is terminated after the last file has been sent. If the overall timeout is exceeded before the last file is sent, the file currently being transferred will be completed before the connection is terminated.

WITS-DNP3

The WITS-DNP3 protocol provides a mechanism so that the master can inform the outstation before the connection is terminated. This is the HCDS Close Comms Link bit.

Retry regime

When attempting to contact a master the Point Colour will try each configured IP address or phone number starting with the last successful address or number. For example, the Point Colour completed its power up sequence using the first IP address in its configuration. However, at the next connection attempt, the first IP address failed, so the Point Colour moved to the second IP address, which succeeded. At the next connection attempt, the Point Colour will use the second IP address in the list.

If after trying all IP addresses, the Point Colour cannot contact the master, or if the attempt fails for another reason, such as GSM registration failure, or APN logon failure, then the Point Colour will enter the Retry Regime. If the connection is terminated halfway through the connection for some reason, then the Point Colour will not consider this a failed connection and won't enter the Retry Regime. Figure 37 shows the retry regime as a flowchart.

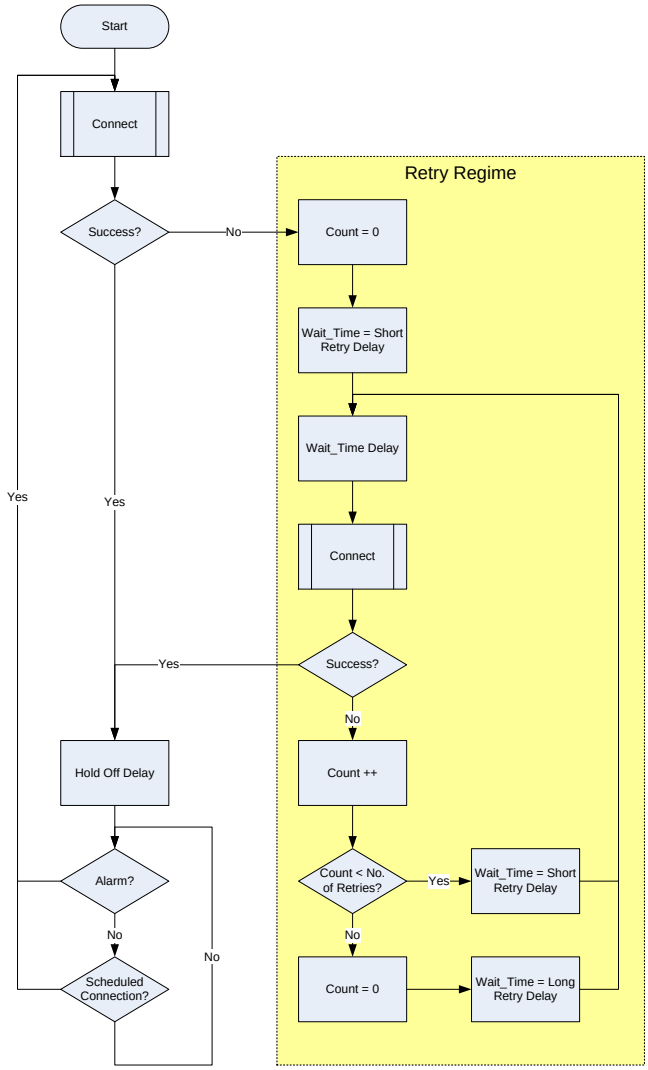


Figure 37: Retry regime flow chart

Figure 38 is a graphical representation of the retry regime. In the retry regime the RTU attempts to connect to the DG a number of times (number of retries), where each attempt is separated by a short delay (short retry time). If it is still unsuccessful in doing this the RTU performs a longer delay (long retry time). After this delay the RTU retries the number of retries connection attempts where each connection attempt is separated by the short retry time. This repeats until a successful connection is obtained. The short retry time, long retry time and number of retries are all configurable parameters and are set using Poco+. Some default values are specified by Poco+ and will be used if not changed by the user.

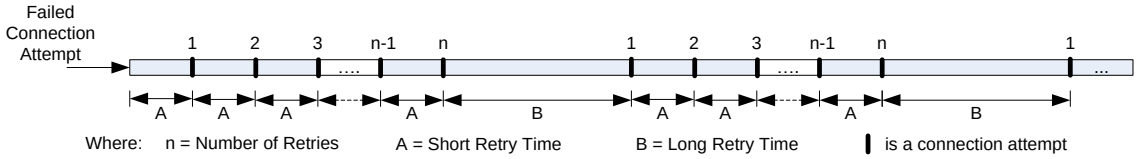


Figure 38: Short & Long retry times

➢ *Note: The Point Colour will continue to sleep and collect data as normal between connection attempts when in the retry regime.*

- *Note: If an alarm occurs or the Reed switch is activated while the RTU is in a retry regime the RTU will dial-in immediately and the retry regime will reset.*

- *Note: When the Point Colour enters the retry regime, this will always override the configured dial in schedule, regardless of settings.*

External Antenna

The Point Colour has two antenna options internal or external. The selection of which to use is controlled by software and the user has three options, Internal only, External only, or Automatic. The first two options fix the antenna selection to either the internal or external antenna. However, the automatic switching uses an algorithm to determine which antenna to use.

On power up, if configured for automatic the Point Colour will always try to use the internal antenna first; it will then follow the flow chart shown in Figure 39.

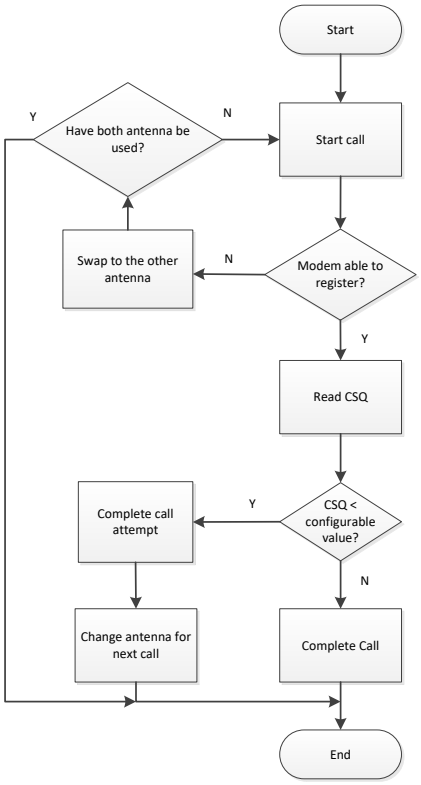


Figure 39: Automatic antenna selection

The threshold signal quality is a configuration setting and can be adjusted using Poco+ according to the user's requirements, however as a starting level, a signal quality (CSQ) of 10 is recommended for reliable GPRS communications.

FTP

The FTP mode on the Point Colour allows the RTU to be used without a traditional SCADA master station. Instead of storing data on the RTU in binary format and then reporting to the master station using the relevant protocol messages, the Point Colour stores the data in human readable Comma Separated Value (CSV) files.

- *Note: FTP mode is only available for Point Colour RTUs with Telit modems. Point AI23 indicates which modem is fitted.*

CSV Files

Depending on the configuration, the Point Colour can create two different types of CSV file. One for the storage of trend data and the other for recording alert data.

For every 24 hour period (starting at 00:00:00 UTC), a new trend and alert file is generated with the date and a user configurable identifier added to the file name to specify when the file was created. Any files from the previous day are transferred to non-volatile storage. Each filename uses the following format:

<identifier>_<type>_<date>.csv

identifier	User configurable up to 8 characters
type	T for Trends A for Alerts
date	In YYYYMMDD format

For example, Orange_T_20150503, is a trend file for an RTU with the identifier Orange on 3rd May 2015.

Trend File

This file stores all trend data collected by the RTU as configured using Poco+. The first line of the file is a header with all the points that are being trended. Each subsequent line contains a date and time stamp (in UTC) and then the values that are required at that time. If a value is configured to be trended with a longer interval than other points, then it will not contain data in each row. An extract from an example file is shown below. This file has been configured with three trends, AI0 @15 mins, AI5 (temperature) and AI6 (battery voltage) @60mins.

```
Date & Time         AI0     AI05 I      AI06 (I…
2015/05/20 09:16    12734   24.15685    7.16210
2015/05/20 09:31    12799
2015/05/20 09:46    12669
2015/05/20 10:01    12589
2015/05/20 10:16    12734   24.08437    7.16209
2015/05/20 10:31    12762
2015/05/20 10:46    12796
2015/05/20 11:01    12569
2015/05/20 11:16    12799   24.32522    7.19713
2015/05/20 11:31    12665
2015/05/20 11:46    12661
...
```

Alert File

This file stores all event and alarm values (collectively known as alerts) as configured by Poco+. The first line is a header indicating that each following line will use the format of date and time, point and value.

The alert model is the same as the DNP3 and Medina modes and is detailed in the Events and Alarms section. When an event or alarm condition is detected, the details are added to the alerts file. If any of these alerts are configured as alarms the RTU will attempt to contact the FTP server to report the data by transferring the alert file.

All points use a two-character type and a two-digit numeric identifier, e.g. AI06 for battery voltage. An extract from an example file is shown below.

```
Date & Time         Point   Value
2015/05/20 09:16    AI0     3799
2015/05/20 13:21    AI5     7.162005
2015/05/20 16:46    AI0     8453
```

Communication

Setting the Time

The Point Colour will attempt to get the current time at the start of every communication session. This uses the mobile network time (adjusting to UTC), and if this fails then it will attempt to contact a Metasphere NTP server to receive the time in UTC. An initial connection is made after a new configuration is downloaded to set the date and time and create initial files. These initial files only contain the header information and are transferred to the FTP server to allow the user to confirm that the configuration is correct. Subsequent connections will use the time to correct for any drift

- *Note: If both the time from the mobile network, and the time from the Metasphere NTP server fail during the initial connection, then the RTU will not have a time set and will not collect any data. In this instance it is possible to set the time from Poco+.*

File Transfer

Subsequent communications transfer the files from any previous days, before transferring the files for the current day. This is done with the alert files first. Any existing files with the same name on the FTP server are overwritten. Once a file from a previous day has been successfully transferred it is deleted from non-volatile storage.

If communication cannot be established with the FTP server, then the CSV files are retained on the Point Colour until communication is possible. The overall call timeout should be configured to a suitable value to allow for the transfer of all data.

The last poll timeout should be configured depending on the amount of data to be logged. Many points being logged, frequent logging or many alerts will generate larger files. These larger files require a longer transmission time. Therefore, the last poll timeout must be set to a suitable value, e.g. 60 seconds for FTP. Signs that the value is too small will be partial files being transferred. As FTP does not support reconfiguration over-the-air it is advised to set this value to at least 60s.

Configuration

The following parameters are configurable in addition to the communications parameters.

Parameter	Details	Length
FTP username	Used to log into the FTP server	Maximum 64 characters
FTP password	Used to log into the FTP server	Maximum 64 characters
Identifier	Used as a prefix in generate d filenames	Maximum 8 characters
CSV Location	Relative path on the FTP server where the CSV files are to be transferred to	Maximum 32 characters
Protocol	FTP or FTPS	-

If the file identifier in the configuration is changed, and previous data stored on the RTU has not been transferred to the FTP server, it is assumed this data is no longer wanted and will not be transferred. If the file identifier remains the same, then reconfiguration and subsequent connection to the mobile network will overwrite the earlier data for that day but, leave previous days data to be transferred. The FTP server address and port should be configured along with the other communications parameters.

- *Note: In FTP mode the Point Colour cannot be configured remotely. This includes RTU configuration and firmware upgrades.*

- *Note: Passive mode is always used for FTP transfers, and so the server must support this.*

FTPS

A secure login to an FTP server can be made by configuring FTPS. This requires a PEM file to be downloaded to the Point Colour using the Poco+ configuration application. The PEM file must have a maximum size of 2047 bytes, and only use line feeds. It should include the -----BEGIN CERTIFICATE----- and -----END CERTIFICATE----- strings.

Details on how to generate a PEM file and configure an FTPS server are outside the scope of this document.

WITS

This section details functionality that is specific to the WITS-DNP3 implementation on the Point Colour, and its supporting configuration application, Poco+.

Device Profile

The WITS-DNP3 device profile details in a standardised way the capabilities of the Point Colour. It is an XML document that is available from Poco+ when exporting a WITS pack. Further details regarding the Device Profile can be found in the WITS Application Notes available from the WITS protocol website.

Version

The Point Colour supports WITS-DNP3 protocol version 1.1.

Configuration

As for other communication stacks, The Point Colour can be configured for WITS-DNP3 operation using Poco+. Alternative configuration methods that are standard for WITS-DNP3 are detailed below.

Bulk Configuration File (BCF)

The Bulk Configuration File (BCF) is produced by the Poco+ Configuration Application (CA) for use by the WITS-DNP3 master station. It is no different from a standard Point Colour Configuration (.pcc) file, just with a WITS-DNP3 compatible extension of .bcf. It is created by using Poco+ and exporting as a WITS pack.

When the WITS-DNP3 master downloads and activates a BCF the Point Colour will reset following termination of the connection.

BCF Type

Poco+ can create three types of BCF in accordance with the WITS standard. These are named Normal, Comms Configured and Template, and between them, allow the Point Colour to meet all aspects of the field device states as defined in the WITS-DNP3 Application Notes.

A Normal configuration contains a full configuration and will always fully overwrite the existing configuration.

A Comms Configured configuration, contains the communication settings to allow the Point Colour to contact a WITS master. After this file has been downloaded to the Point Colour, it will set the CONFIG_CORRUPT DNP3 IIN bit and then attempt to contact the WITS-DNP3 master. This instructs the master to download a BCF to the RTU, which should be a Normal or Template configuration. The communications details are specified as the following sections in the configuration: Comms, Retry, DNP3, Group 0, Unsolicited, Classes 1/2/3.

A Template BCF is a full configuration that will not overwrite the existing communications details. It will be merged by the RTU to create a Normal configuration.

BCF Type	Details	Used For
Normal	Fully replaces existing configuration	Full reconfiguration
Comms Configured	Configuring individual Point Colour with enough information to communicate with a Master Station	Large scale roll-out at RTU
Template	Updates configuration except communications	Large scale roll-out from master

Incremental Configuration (IC)

Incremental Configuration (IC) is a binary file format specified in the WITS-DNP3 Application Notes. It is used to configure common functionality for WITS field devices and is made up of multiple records, each relating to a specific configuration item. Being a common format to WITS-DNP3, a master station can parse a provided IC file to configure itself ready for the field device.

Poco+ will generate a corresponding IC file when exporting the BCF. This will contain configuration settings that are present in the BCF in IC file format. The IC file will contain the following information:

- Device On/Off Scan
- Connection Detail
- Scheduled Connections
- Point On/Off Scan
- Analogue Range/Scaling
- Analogue Limits
- Point Archives
- Binary States
- DNP3 Object Flag Actions

The IC file should be imported into the WITS-DNP3 master station. It may choose to send this initial IC file to the Point Colour, although the BCF will contain all required configuration. When a change to configuration is made at the master, a new IC file is created which can be sent to the Point Colour. When the WITS-DNP3 master station downloads and activates the IC the Point Colour will apply the revised configuration it contains. The internal configuration is regenerated, and so previously sent IC records cannot be retrieved.

- *Note: If an IC file contains unsupported records, unsupported configuration in a record or errors, the Point Colour will reject the IC. A log file is generated for every application of IC detailing if any errors were found. The format of this is defined in the WITS-DNP3 Application Notes.*

- *Note: If a BCF and accompanying IC are sent and activated in the same communications session, the IC will not be applied until after the Point Colour has reset to update to the new BCF.*

- *Note: User defined scaling can only be applied to AI0 to AI4. Any other attempt to change scaling on other points using IC 1002 records will be rejected. Other points have either default scaling (e.g. temperature is in °C), or 1:1 scaling.*

On/Off scan

The complete Point Colour, as well as each point can be set to be on or off scan. This is as detailed in the WITS-DNP3 Application Notes. Once configured this can be changed with the appropriate IC record.

The following table indicates that it's only possible for a point that is on scan to generate log and/or event data when the device is on scan.

Device	Point	Point generates log and/or event data
Off Scan	Off Scan	No
Off Scan	On Scan	No
On Scan	Off Scan	No
On Scan	On Scan	Yes

- *Note: A state change that would generate an event (i.e. an action of 2) or generate an event and initiate a connection to the master (i.e. an action of 3), will not do so when the point is off scan, or the whole device is off scan.*

- *Note: When the field device is off scan, it will continue to connect to the configured WITS-DNP3 master with the scheduled connection.*

Connections

Point Colour WITS-DNP3 only supports IPv4 connections that are initiated by the RTU.

Health Check Data Set

WITS-DNP3 defines a DNP3 Data Set for use in reporting information regarding to the condition of Field Device, the status of the data log file, handling the connection, scan state and action inhibits. The following sections detail the supported bits for the Point Colour.

Bit 0 - Supply failure

This bit is the inverse of DI5 to indicate the failure of the external supply. When powered by the battery this will be set.

- *Note: All variants of the Point Blue will always report as supply failed as set.*

Bit 1 - Battery voltage low

The battery voltage is monitored and if it falls below the configured value this bit will be set. This can be configured using the Poco+ CA.

Bit 2 - I/O failure

This is not set by the Point Colour and will always be clear.

Bit 3 - Scheduled connection occurrence

This bit is set when the Point Colour is making a scheduled connection.

Bit 4 - Local user device attached

This bit will be set when the Point Colour has its USB connected to a computer. This is irrespective of whether the Poco+ CA is running.

Bit 5 - Log file filling

The threshold percentages for log file filling and log file no longer filling are configurable using the Poco+ CA. They are determined as a percentage available of shared memory in the device. This is exposed as AI40 for RAM Used.

Bit 6 - Log file has discarded some information

If the logging is unable to store new data while retaining existing data it will set this bit. The discard mode, oldest or newest data, can be configured using the Poco+ CA.

Bit 7 - Close comms link

The Point Colour will always set this bit to indicate that it wishes the link to be closed when the master has completed its actions.

Bit 8 - Configuration changed

If the configuration has been changed locally using the Poco+ CA this bit will be set.

Bit 9 - Device off scan

When the Point Colour is off scan as a complete device, this bit will be set.

Bits 10 and 11 - Highest permitted action for all points

This has not been implanted on the Point Colour, so in accordance with the WITS specification both bits will always be set.

Data Set Events

The WITS-DNP3 protocol defines seven different Data Sets, of which the Point Colour implements four; Analogue, Counter and Binary Events and the Health Check.

The events are stored in the same manner as DNP3 events, and so the same limitation of a maximum of 15,000 events as described in DNP3 Trending is maintained.

Actions

The following actions are supported:

- 0 = No Action
- 2 = Raise Event
- 3 = Raise Event and Contact Master

Action Inhibits

These are not supported.

DNP3 Object Flags

WITS actions can be configured to be performed when the following DNP3 object flags change. All other DNP3 object flags are not supported.

DNP3 Object Flag	Details
ONLINE	All points can configure the action to perform on a change of the ONLINE DNP3 flag.
COMM_LOST	Only serial points can configure the action to perform on a change of the COMM_LOST DNP3 flag.
OVER_RANGE	Only analogue points can configure the action to perform on a change of the OVER_RANGE DNP3 flag.
STATE	Only digital points can configure the action to perform on a change of the STATE DNP3 flag.

Powering the Point Colour

Internal Battery

The Point Orange is supplied with an internal battery pack as standard. The Point Blue is supplied with either an internal or external battery pack. These battery packs are capable of powering the RTU and external sensors for up to 5+ years. The internal battery pack is not user replaceable and the Point Colour internal battery pack should never be opened by the user.

WARNING

This equipment contains lithium thionyl chloride batteries which must not be short circuited, punctured, crushed, deformed, recharged or exposed to water, moisture or high temperatures. Batteries should not be removed from this housing.
Replacement packs are available from Metasphere Ltd.

External Battery

The Point Colour external battery packs are based on the internal battery pack and can be used to extend the operational life of the unit. For example, high frequency of reading multiple externally powered sensors or to allow lots of calls per day.

External DC source

Rather than using an external battery, the Point Orange can instead be powered by an external DC source. This power supply must be between 5V DC and 8V DC maximum. The source should be capable of providing 7.5W to allow for the high power required for GPRS/3G communications. It is highly recommended to fit a 1.5A fuse to the supply and follow the IET wiring guidelines.

Power source switching

When an external power source, either an external battery or a DC source, is connected to the Point Orange, the RTU uses this power source to power the RTU. The internal battery pack is preserved, and DI5 is set to 1 to indicate that the external supply is being used.

In the event that this external source fails (falls below ~5V), either DC supply failure, or external battery expires, the Point Orange, detects this removal of power and automatically switches to the internal battery without any interruption to the operation of the unit. DI5 is set to zero to indicate that the internal pack is being used. As and when the external source is replaced, the Point Orange again switches back to the external source.

- *Note: To counter the effect of battery voltages fluctuating as loads are added and removed, any alarms configured on DI5 should have a long time deadband > 3minutes.*

This function allows for seamless battery changes, removing the risk of data or operational loss due to battery failure. It also allows for rapid battery pack changes, as time on site is minimal and no RTU monitoring is required.

The Point Blue can only have a single battery, internal or external and therefore this functionality is not present. DI5 will always be set to 0 to indicate an internal battery, whether it is internal or external.

Configuring Point Colour

Before installing the Point Colour, it needs to be configured with contact details for the master, external IO and various other options. These configuration options are stored on a file and downloaded onto the Point Colour.

If Point Colour does not have a valid configuration it will go into a sleep mode when unplugged from the PC. The Point Colour can only be woken from this mode when connected to the PC via a USB programming cable.

Local Configuration

Point Colour can be configured by using the Poco+ configuration application. For more information about Poco+ please see the relevant user guide.

Programming cable

A programming cable can be provided as a standard Metasphere part (PN 4-107). This connects the Point Colour to your PC using the USB connector.

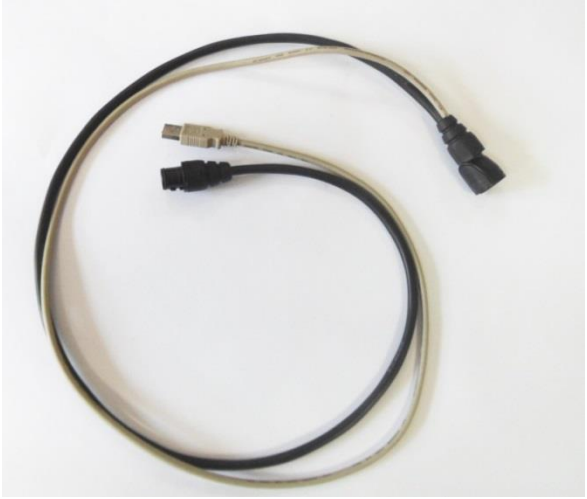


Figure 40: Programming cable (now standardised to 2m length)

WARNING

Connecting the Point Colour to the PC using the USB cable will leave the Point Colour on for the duration of the connection. This will drain the battery and prolonged periods of connection should be avoided.

WARNING

The Point Blue ATEX/IECEx certificate specifies that the USB connection should NOT be used in the hazardous area. All users should adhere to these instructions along with the other guidelines in the Point Blue Safety Guide provided with every Point Blue.

Remote Configuration

The Point Colour supports remote configuration where the configuration file is downloaded to the Point Colour from the master. The configuration file must be called 'rtucfg.pcc' and can be downloaded from the master using file download and activation functions. The configuration file adheres to a strict format and may fail if the format is invalid.

- *Note: The Point Colour does not support remote configuration when using FTP*

The following flow chart shows the various states that the Point Colour can be in with regards to configuration file download. In the flow chart reference is made to AI22. This is a RTU diagnostic point displaying the current configuration code. Each time the Point Colour is reset the process illustrated in the following diagram is run.

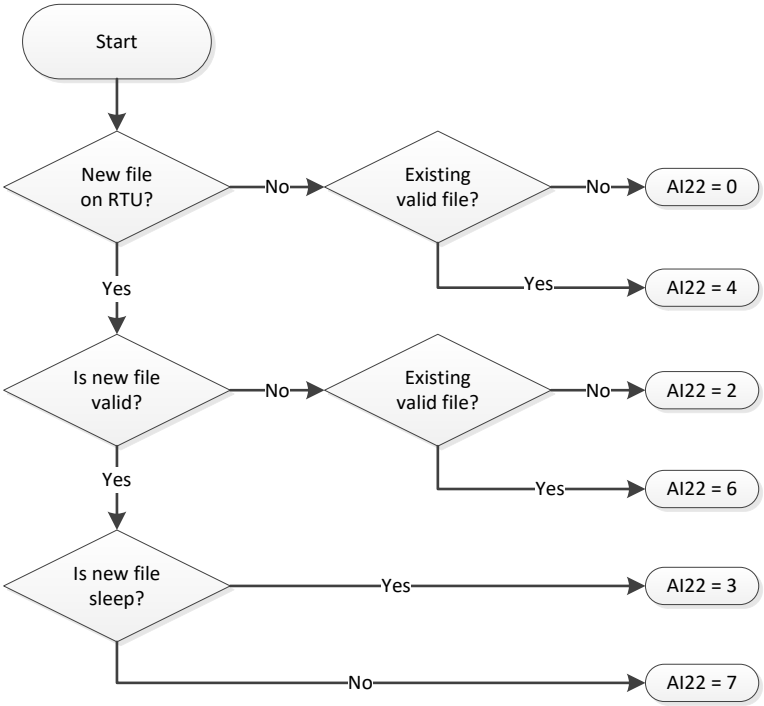


Figure 41: Flow chart showing the configuration file download states of the Point Colour

Installing/upgrading firmware

Point Colour supports firmware upgrades, either remotely from a Medina, DNP3, or WITS-DNP3 master using file transfer, or locally via the USB cable from Poco+.

- *Note: The Point Colour does not support remote firmware upgrade when using FTP*

The Point Orange and Point Blue variants both use the same firmware.

Firmware upgrade from PC

In Poco+, select **Device** then **Download Firmware**. Browse to the firmware file issued by Metasphere – this will have an .rfu file extension.

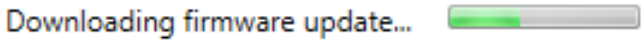


Figure 42: Downloading firmware

Poco+ will download the firmware to the unit. The unit will reset and communicate with Poco+ once the reset has been completed. If the upgrade process has been successful, the new version will be reported in the task bar.

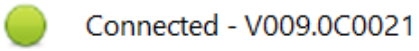


Figure 43: Firmware version

- *Note: The Point Colour RTU received a hardware modification that means newer hardware is not compatible with older firmware. Firmware since version V009.0c0019 supports all hardware. The hardware modification level is shown on the internal 'mod-label'. Hardware modification levels greater than those listed below are not compatible with older firmware:*

Product	Modification Label
Point Orange 3G	MOD 6
Point Blue 3Ge	MOD 5
Point Blue 3Gi	MOD 3

DNP3 File Transfer

The firmware on Point Colour can be updated remotely from a DNP3 or WITS-DNP3 master using DNP3 file download and activation functions. The firmware file must have an extension "*.rfu".

Medina Master Control

From version 8.2 of Master Control, the Data Gatherer "rfuload" tool is to be used to schedule the download of the RFU file. Details of this tool can be found in the Master Control Data Gatherer System Administration Manual.

- *Note: Loop powered points (such as Active loop, Active voltage and serial) will not be trended during user initiated file transfers. Once the file transfer is complete the points will continue to be trended as normal.*

Accessories

IO cables

Metasphere provide some off-the-shelf cables which are pre-wired for some common applications. These are described in the sections below. In addition, a cable with bare-ends can be supplied, allowing the user to wire their own sensor.

For applications with multiple IO and potentially an external battery pack, the off-the-shelf cabling comes in multiple parts:

- A splitter cable to split out the single connector on the Point Colour to multiple connectors for the sensors and potentially the external battery pack
- Individual cables which connect the individual sensors to the splitter cable

An example of this multi-part cable system is given below. The photos show the system both before and after the various connectors have been joined together. This particular setup gives two analogue inputs, and two pulsed inputs.

Figure 44: Example cable assembly

Point Colour Sensor cables

The table below lists the various fully terminated cables, which have been standardised to 2m cables, available for the Point Colour. More terminated sensor cables are available, please contact Metasphere for more information, or if you have a specific sensor requirement.

Part number	Part Description	IO	Picture	Common application usage
4-106	Point Colour Impress sensor + AI0 cable	AI0		Impress 10 bar 4-20mA pressure transducer terminated with Point Colour connector.

Part number	Part Description	IO	Picture	Common application usage
4-115	Point Colour Impress sensor + AI1 cable	AI1		Impress 10 bar 4-20mA pressure transducer terminated with Point Colour connector.
4-104	Point Colour Splitter – AI0 & Ext Battery	Splitter for single analogue and external battery		Connect a loop-powered analogue sensor to AI0 and an external battery pack
4-114	Point Colour UK mains PSU	None		Powers the test box and Point Colour from the mains supply
4-107	Point Colour service cable	Connect to a PC		Allows the user to program the unit
4-100	Point Colour Mainstream cable	Serial IO		Connects to a Mainstream Sensor

Point Colour Unterminated Cables

In addition to the full terminated cables, which have been standardised to 2m length cables, listed above a number of unterminated cables are available allowing users to connect any sensor to the Point Colour. The sections below describe these cables including pin outs and core colours.

- *Note: Users should ensure that any unused cores are suitably insulated to prevent shorting which could result in excessive current being drawn, shortening battery life.*

Point Colour Unterminated All cable (PN 4-101)

This cable has all IO pin cores exposed allowing any combination of sensors to be connected. An earlier revision included the external battery as a ninth core.

Signal	Core colour (9)	Core colour (8)	Picture
Pin1	Red	White	
Pin2	Blue	Brown	
Pin3 (Ground)	Green	Green	
Pin4	Yellow	Yellow	
Pin5	White	Grey	
Pin6	Black	Pink	
Pin7	Brown	Blue	
Pin11	Violet	Red	
External Battery	Orange	-	

Point Colour DI0 Unterminated cables (PN 4-102)

Signal	Core colour	Pin number	Picture
DI0	Brown	11	
Ground	White	3	

Point Colour AI0 Unterminated cables (PN 4-110)

Signal	Core colour	Pin number	Picture
AI0 (+ve)	White	1	
Ground (-ve)	Brown	5	

Point Colour AI1 Unterminated cable (PN4-111)

Signal	Core colour	Pin number	Picture
AI0 (+ve)	Brown	2	
Ground (-ve)	White	4	

Point Colour RS232 Unterminated cable (PN4-116)

This cable is for connecting a Modbus slave communicating via RS232.

Signal	Core colour	Picture
Tx	White	
Rx	Brown	
GND	Green	

Point Colour RS485 half-duplex unterminated cable (PN 4-108)

This cable is for connecting a Modbus slave communicating via RS485 half-duplex.

Signal	Core colour	Picture
RS485 A	White	
RS485 B	Brown	
GND	Green	

Point Colour RS485 full duplex unterminated cable (PN 4-117)

This cable is for connecting a Modbus slave communicating via RS485 full duplex.

Signal	Core colour	Picture
RS485 A	White	
RS485 B	Brown	
RS485 Z	Green	
RS485 Y	Yellow	
GND	Grey	

Point Colour SDI-12 cable (PN 4-119)

This cable is for connecting an SDI-12 sensor. The previous part number (5-142) had different core colours.

Signal	Core colour (5-142)	Core colour (4-119)	Picture
Power	Brown	White	
Data	Blue	Brown	
GND	Black	Green	

Test box

The programming cable incorporates an IO test box. This test box allows you to connect one or more sensors to the Point Colour in a user-friendly way, allowing you to trial different sensors for a given application. This facility can be used to check that IO arrangements work correctly before a final cable, suitable for use in the field, is made. The connector on the test box is labelled with the pins which correspond to the IO pins on the Point Colour main connector.

The test box also has the option for a DC input (7.5V). If connected to a DC source, the test box will power the Point Colour. If the DC input is not present, Point Colour will use its internal battery to stay awake for the period when the programming cable is connected.

Figure 45: Test Box

WARNING

Connecting the Point Colour to the PC using the test box, without the DC connection, will drain the Point Colour's battery. Long periods connected to USB should be avoided.

Connector Cap

The external IO connector on Point Colour is normally used to connect sensors to the RTU. However, in some applications, for example flood detection (using the internal submersion sensor) no external connections are required. In these examples a connector cap should be fitted to maintain the IP68 rating of the RTU.

Figure 46: Connector cap

Antenna Cap

Similar to the external IO cap, an antenna cap for the external antenna connector is also available. This cap is included as standard with a Point Colour. The purpose of this cap is to prevent debris from being caught in the connector that might damage the connection should an external antenna be needed at a later date. This cap should always be used unless an external antenna is fitted.

Figure 47: External antenna cap

External battery

Metasphere also provides an external battery pack that can be used to power the Point Orange. The battery pack is based on the internal battery pack and can be used to extend the operational life of the unit. For example, high frequency of reading multiple externally powered sensors or to allow lots of calls per day. It uses the same enclosure as the Point Orange but both parts are orange to allow easy identification. For more information on the Point Orange external battery, see the relevant documentation.

The Point Blue is available with an external battery pack for high demand applications, but this is instead of the internal pack.

Figure 48: Point Orange External Battery

Installation

Overview

The Point Colour has been designed to minimise the time required to install the unit enabling rapid deployment of the unit in the field. The Point Colour can be installed to a wide variety of sites thanks to its unique design offering three different methods: Pipe; Bracket; and Wall. The following sections describe each installation method and when you should consider employing the method.

Metasphere recommend that you use this information together with the latest installation regulations and guidance from both the Institution of Engineering and Technology (IET) and your own organisation's procedures and standards.

WARNING

This equipment contains lithium thionyl chloride batteries which must not be short circuited, punctured, crushed, deformed, recharged or exposed to water, moisture or high temperatures. Batteries should not be removed from their housing.
Replacement packs are available from Metasphere Ltd.

Safety precautions

Before describing the installation methods, the user should read and understand the following safety precautions.

- Except where statutory or local procedures are followed appropriate safety equipment should be worn. The Metasphere range of RTU's and ancillary equipment should be installed in a safe place away from areas where personnel may be at risk from falling, moving machinery, high voltage and or passing traffic.
- All installations must be performed by a competent professional to a standard at least compliant with BS7671 (see IET Wiring regulations 16th Edition) or other local standards where these may apply.
- Take care to avoid wiring mains inputs to any connection.
- It is the responsibility of the user to ensure that wider system safety implications have been considered and establish necessary risk mitigation measures.
- Unless explicitly stated, RTU's are not certified for installation in hazardous environments covered by the ATEX directive.
- Safety related equipment located in areas adjacent to Metasphere RTU's and ancillary equipment must be immune to electromagnetic radiation as specified by the EU EMC directive 2004/108/EC.
- Other equipment installed near an RTU must not produce electromagnetic interference at levels higher than those that the RTU is immune to as specified by the EU EMC directive 2004/108/EC.
- If the Point Colour is not used as specified in this manual the protection provided may be impaired.

WARNING

The Point Blue plastic enclosure may present a potential electrostatic ignition hazard and must not be rubbed or cleaned with a dry cloth.

WARNING

The Point Blue 3Ge can be used with one external battery pack (Point Blue External Battery) This device can be mounted and connected in a Zone 0 hazardous area.

WARNING

Ensure that any device which is connected to the Point Blue meets the safety parameters outlined in this manual. Please ensure that any cable between the Point Blue and connected devices is taken into account when performing intrinsic safety verification.

WARNING

Ensure devices which are connected to the Point Blue are made in accordance with the instructions given within this manual.

WARNING

Ensure that the terminals to the External Battery Pack are not shorted as this could damage the battery pack.

WARNING

The intrinsic safety parameters shown in the ATEX certificate must be observed at all times when connecting devices to the Point Blue. Safety parameters of connected devices must be verified by the user as being safe before connection to the Point Blue. Please also ensure that any cable between the Point Blue and connected devices is taken into account when performing intrinsic safety verifications.

Any connection to Poco+ using USB must be made outside of the hazardous area.

Overloading of equipment

RTU's are susceptible to damage if the inputs of the device are overloaded.

Hazards arising from static electricity

WARNING

RTU enclosures may be susceptible to electrostatic charges. Static handling precautions must be taken.

Hazards arising from overheating

WARNING

Overheating of RTU's can be caused by friction or impacts occurring when positioned near moving machinery. For example, frictional heating between materials and the RTU while rotating or vibrating.

Pipe

The first installation method for the Point Colour is to secure the unit to a pipe or pole. This is achieved by sliding a cable tie (or two) through the specially designed slot on the back of the enclosure before securing to a pipe. This installation method offers a quick clean installation, with no tools required and is normally employed when a suitable pipe or pole is in an easily accessible area.

Care must be taken to ensure that the pipe is suitable for mounting the unit. The purpose of the pipe, (i.e. water, gas etc.) should be determined before installation proceeds. It is the responsibility of the user to ensure that the pipe is suitable for installation. Metasphere accept no responsibility for damage to pipes or other damage as a direct or indirect result of the Point Colour being secured to a pipe. An example installation is given below:

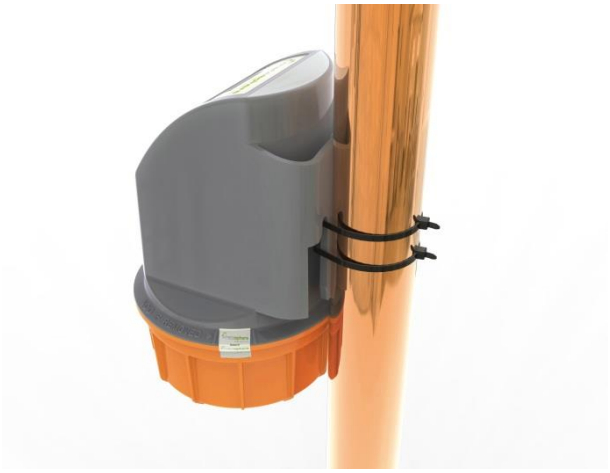


Figure 49: Point Colour installed on a pipe

Bracket

The second option available to the user is to use the bracket method. This option uses a plastic bracket that slides down the rear of the enclosure. The unit can then be secured to a flat surface using the two mounting holes in the bracket. The bracket is an optional accessory for the Point Colour and is not included as standard.

Wall

The third option available to the user is to use two screws in a wall, which the Point Colour can hang on. The bracket described above provides the perfect guide to the installer, allowing the mounting holes to be quickly and easily marked. The Point Colour can then 'hang' on the two screws.

- *Note: This method of installation is only suitable for sites where the unit is unlikely to be knocked or exposed to flooding. It is possible that the Point Colour can be dislodged from the mounting screws.*

Figure 50: Integrated mounting bracket with screw slots

Configure and Connect

To preserve the internal battery of the Point Colour, all units are manufactured with a default deep sleep configuration. In this mode, the unit is in permanent sleep with all peripherals turned off. The unit can be woken from this sleep connecting it to a PC using the service cable.

WARNING

Configuring the Point Colour in a deep sleep configuration will remove any previous configuration.

The USB configuration cable provides a spare IP68 connector that mimics the connector found on the Point Colour. This allows the user to configure and connect the sensor to a Point Colour simultaneously. Using the monitor facility offered by Poco+, the installer can ensure that both the Point Colour and sensor are operating as desired. The following steps describe a typical installation.

1. Install the Point Colour using the most suitable method for the site, Pipe, Bracket or Wall.
2. Connect the service cable to the Point Colour
3. Connect the sensor to the service cable
4. Run the Poco+ application and connect the USB cable to the PC. After a small delay the status bar in Poco+ should indicate that a Point Colour is connected.
5. Open, or create a suitable configuration using Poco+ and download to the Point Colour.
6. Use the Monitor window to check that the Point Colour has contacted the relevant server (Medina, DNP3, WITS-DNP3 or FTP/S), is reading the sensor correctly and that the battery voltage and GSM / GPRS signal are at a suitable level.

7. Wait for the last contact time (CI5) to be updated in the monitor points window in Poco+ and the modem turned off. Then disconnect the service cable from the sensor and the PC.
8. Connect the sensor cable to the Point Colour.
9. Installation is then complete.

WARNING

The service cable is not an IP68 cable. It only provides an IP68 style connector to assist with installation.

Points List

This section provides a summary of all points available on the Point Colour, including scaling information.

Analogue Inputs

Name	Point Index	Notes
AI0	0	Analogue input 0 (if configured) If configured as passive voltage or active voltage: Offset = 0, multiplier = 0.0000625 0V = 0 1.0V = 16000 2.0V = 32000
		If configured as active current: Offset = 0, multiplier = 0.00125 4mA = 3200 12mA = 9600 20mA = 16000
		If configured as passive current for Point Orange: Offset = 0 multiplier = 0.0012255 4mA = 3264 12mA = 9792 20mA = 16320
		If configured as passive current for Point Blue: Offset = 0 multiplier = 0.000625 4mA = 6400 12mA = 19200 20mA = 32000
AI1	1	Analogue input 1 (if configured) See above for scaling details
AI2	2	Analogue input 2 (if configured) See above for scaling details
AI3	3	Analogue input 3 (if configured) See above for scaling details
-	4	Reserved for future use
Temperature	5	Internal temperature of the unit. Offset = -40, multiplier = 0.01 -20°C = 2000 0°C = 4000 20°C = 6000 85°C = 12500 Min = 0, Max = 32767
Battery Voltage	6	Internal battery voltage Offset = 0, multiplier = 0.0019515

Name	Point Index	Notes
		0V = 0 5V = 2562 8V = 4095 Min = 0, Max = 32767
External Voltage	7	External source voltage Offset = 0, multiplier = 0.0019515 0V = 0 5V = 2562 8V = 4095 Min = 0, Max = 32767
Sensor Supply Voltage	8	Sensor supply voltage Offset = 0, multiplier = 0. 0032275 0V = 0 8V = 2479 13.22V = 4095 Min = 0, Max = 32767
Submersion	9	Submersion indication
Modem CSQ	10	Signal quality from the modem (CSQ). In the range 0-30. Offset = -113dBm, multiplier = 2 0 -113 dBm 15 -83 dBm 30 -53 dBm 99 Not known or not detectable
Modem BER	11	Bit Error Rate (in percent) 0 less than 0.2% 1 0.2% to 0.4% 2 0.4% to 0.8% 3 0.8% to 1.6% 4 1.6% to 3.2% 5 3.2% to 6.4% 6 6.4% to 12.8% 7 More than 12.8% 99 Not known or not detectable
Modem Fail Code	12	Modem failure code. Reflects the error status of the last connection attempt: 0 OK 50 Couldn’t create modem driver 51 Couldn’t install modem driver 52 Invalid modem serial port 101 Can’t communicate with modem 102 Couldn’t register on GPRS network 103 Couldn’t attach to GPRS network 104 Activate PDP failure 105 Socket creation failed 106 Could not connect to IP 107 Start Bearer Timeout

Name	Point Index	Notes
		108 Failed to read SIM card number 110 GPRS Network deregistration failed 199 Socket closed by remote host 201 Connection closed by remote host 202 Could not connect to phone number (GSM) 301 Could not connect to FTP server 302 FTP data read ended 303 FTP Command failed 304 Bad FTP Command starting state 305 FTP failed to open local file 306 FTP failed to read from local file 307 FTP failed to write to local file 308 FTP data connection failed 309 FTP data connection timed out 310 FTP not supported on this Modem 311 FTPS PEM file not found 312 FTPS Error using PEM file
Registration Code	13	If the modem is on this is modem registration code of the current connection attempt. If the modem is off this is the modem registration code of the last connection attempt. Possible values are as follows: 0 Not registered, modem is not currently searching a new operator to register to 1 Registered, home network 2 Not registered, but modem is currently searching a new operator to register to 3 Registration denied 4 Unknown 5 Registered, roaming
Connection Seconds	14	If the modem is on this is the number of seconds since it was switched on. If the modem is off this is the number of seconds the modem was on during its last switched on period.
Configuration Version	15	Version number of the configuration file format.
MCC	16	Mobile Country Code
MNC	17	Mobile Network Code
Radio Band	18	Current GSM/GPRS modem radio band selected; 12 Rest of world (EMEA, Australia and most of Asia) 17 Americas
External CSQ	19	The last recorded signal strength for the external antenna.
Internal CSQ	20	The last recorded signal strength for the internal antenna.
DNP3 IIN Bits	21	16-bit representation of the current status of the DNP3 IIN bits; **Bit** **Description** 0 Broadcast Message received 1 Class 1 events available 2 Class 2 events available

Name	Point Index	Notes
		3 Class 3 events available 4 Time Synchronisation required 5 At least one output point is in local operation mode 6 Abnormal condition exists on Outstation (Trouble) 7 Device restart 8 Function not supported 9 Object not supported 10 Parameter error (Outstation is unable to parse the Application Layer fragment) 11 Event buffer Overflow 12 Operation already executing 13 Configuration Corrupt 14 Reserved 15 Reserved
Configuration Error Code	22	Error code showing status of last configuration attempt; 0 Not configured No new configuration found 2 Not configured New configuration invalid 4 Configured No new Configuration found 6 Configured New configuration invalid 7 Configured New configuration valid
Modem Type	23	Current modem used by the Point Colour 0 None 1 Unknown 2 Wismo 2G 3 Telit 3G 4 Telit 2G
Trend Delta CI0	24	Number of pulses on counter 0 during the counter 0 trend period
Trend Delta CI1	25	Number of pulses on counter 1 during the counter 1 trend period
Trend Delta CI2	26	Number of pulses on counter 2 during the counter 2 trend period
Trend Delta CI3	27	Number of pulses on counter 3 during the counter 3 trend period
Serial Error Code	28	Failure codes from Serial connections (Modbus / SDI-12) 0 No Error Modbus Specific 1 Illegal Function 2 Illegal Data Address 3 Illegal Data Value 4 Slave Device Failure 5. Acknowledge Failure 6. Device Busy 7. Acknowledge 8. Memory Parity error 9. Not Configured

Name	Point Index	Notes
		10. Command not supported 11. Communication Timeout 12. Data Length incorrect 13. CRC error 14. Unsupported function 15 Incorrect address SDI-12 Specific 101 Parity error in response 102 Incorrect number of values 103 Timeout while waiting for response 104 Communication with sensor is in progress Partech WW1 Miller Argent WC1 Specific 111 Cannot open serial port 112 Buffer full 113 Timeout Metasphere CT Specific 121 Cannot open serial port 122 Buffer full 123 Timeout Mainstream Specific 130 No Error 131 Cannot open serial port 132 Timeout waiting for initial response 133 Timeout waiting for request confirmation 134 Timeout waiting for data 135 TL Command too long 136 UC Unknown command 137 IS Incorrect size 138 BC Bad checksum 139 CT Communications timeout 140 IA Illegal argument 141 PP Password protected
Serial AI0	29	Serial Analogue point 0
Serial AI1	30	Serial Analogue point 1
Serial AI2	31	Serial Analogue point 2
Serial AI3	32	Serial Analogue point 3
Serial AI4	33	Serial Analogue point 4
Serial AI5	34	Serial Analogue point 5
Serial AI6	35	Serial Analogue point 6
Serial AI7	36	Serial Analogue point 7
Serial AI8	37	Serial Analogue point 8
Serial AI9	38	Serial Analogue point 9
Battery Monitor	39	Average battery / external voltage during previous call

Name	Point Index	Notes
		Offset = 0, multiplier = 0.0019515 0V = 0 5V = 2562 8V = 4095 Min = 0, Max = 32767
RAM used	40	Percentage of RAM filesystem used, or specific error: 201 File system full 202 File system error
Trend Delta DI0	41	Number of pulses on DI0 during the CI26 trend period
Trend Delta DI1	42	Number of pulses on DI1 during the CI27 trend period
Trend Delta DI2	43	Number of pulses on DI2 during the CI28 trend period
Trend Delta DI3	44	Number of pulses on DI3 during the CI29 trend period
Trend Delta DI4	45	Number of pulses on DI4 during the CI30 trend period
SDI-12 Response Time	46	The time in seconds that a connected serial device requires to complete communication
XLP Version	47	Version of counter firmware
LVD Reset Count	48	Count of Low Voltage Detect Resets

Counters

Name	Point Index	Notes
CI0	0	Counter input 0 (if configured)
CI1	1	Counter input 1 (if configured)
CI2	2	Counter input 2 (if configured)
CI3	3	Counter input 3 (if configured)
-	4	Reserved
Last Contact Time	5	The time of the last contact with the master station (in Unix time – i.e. number of seconds since 01/01/1970 00:00:00).
Successful Connections	6	The number of successful master station connections since the unit was last reset
Unsuccessful Connections	7	The number of unsuccessful master station connections since the unit was last reset
Registration Failures	8	The number of GSM / GPRS registration failures since the unit was last reset
-	9	Reserved
-	10	Reserved
Awake seconds	11	The number of seconds the Point Colour has been awake since it was last reset

Name	Point Index	Notes
DNP3 Events	12	The number of unreported DNP3 events currently stored on Point Colour
DNP3 Points	13	The number of DNP3 points available to the DNP3 master
Modem Seconds	14	The total number of seconds the modem has been on for since reset. This value is updated after each connection is completed.
Number of Start bearer timeouts	15	The total number of times that the start bearer command has timed out.
Serial CI0	16	Serial Counter point 0
Serial CI1	17	Serial Counter point 1
Serial CI2	18	Serial Counter point 2
Serial CI3	19	Serial Counter point 3
Serial CI4	20	Serial Counter point 4
Serial CI5	21	Serial Counter point 5
Serial CI6	22	Serial Counter point 6
Serial CI7	23	Serial Counter point 7
Serial CI8	24	Serial Counter point 8
Serial CI9	25	Serial Counter point 9
DI0 Counter	26	Total count of pulses seen on DI0
DI1 Counter	27	Total count of pulses seen on DI1
DI2 Counter	28	Total count of pulses seen on DI2
DI3 Counter	29	Total count of pulses seen on DI3
DI4 Counter	30	Total count of pulses seen on DI4

Digital Inputs

Name	Point Index	Notes
DI0	0	Digital input 0 (if configured)
DI1	1	Digital input 1 (if configured)
DI2	2	Digital input 2 (if configured)
DI3	3	Digital input 3 (if configured)
DI4	4	Digital input 4 (if configured)
External Power	5	Indicates if the unit is using the external power source. 0= no external power being used 1 = using external power Point Blue will always indicate 0
Modem Power	6	Indicates if the modem is on. 0 = off 1 = on

Name	Point Index	Notes
-	7	Reserved for future use
-	8	Reserved for future use
Valid Config	9	Indicates if the RTU is using a valid configuration file 0 = Invalid configuration 1 = Valid configuration
Reed Switch	10	Indicates if the reed switch has been activated; 0 = Reed switch open 1 = Reed switch activated (closed)
Antenna	11	Indicates antenna currently being used; 0 = External antenna 1 = Internal antenna
Submersion	12	Indicates if the Point Colour has been submerged; 0 = Unsubmerged 1 = submerged
USB Connected	13	Indicates if local USB is connected to a PC; 0 = USB disconnected 1 = USB connected
Network Technology	14	Indicates the network Technology currently in use by the modem 0 = 2G 1 = 3G
Loop on	15	Indicates whether or not the loop has been turned on 0 = Loop is off 1 = Loop is on
Serial DI0	16	Serial Digital point 0
Serial DI1	17	Serial Digital point 1
Serial DI2	18	Serial Digital point 2
Serial DI3	19	Serial Digital point 3
Serial DI4	20	Serial Digital point 4
Serial DI5	21	Serial Digital point 5
Serial DI6	22	Serial Digital point 6
Serial DI7	23	Serial Digital point 7
Serial DI8	24	Serial Digital point 8
Serial DI9	25	Serial Digital point 9

String Points

Name	Point Index	Notes
Serial Number	0	Serial number of Point Colour
Network	1	Name of the network to which the modem is registered.

Name	Point Index	Notes
IMEI	2	IMEI number of modem
Modem Firmware	3	Firmware version string
SIM (ICCID)	4	SIM card number
LAC	5	Location Area Code
Cell ID	6	Cell Identity
Manufacture	7	Date of manufacture
Serial ST0	8	Serial String point 0
Serial ST1	9	Serial String point 1
Serial ST2	10	Serial String point 2
Serial ST3	11	Serial String point 3
Serial ST4	12	Serial String point 4

- *Note: String points cannot currently be read by Medina masters.*

Diagnostics

The Point Colour can be configured to record diagnostic information regarding its operation. This is useful in the event of unexpected operational characteristics.

Multiple files are generated with diagnostic information as the following table shows

Filename	Notes
diags.txt	General purpose diagnostics
sysdiags.txt	System diagnostics (e.g. firmware upgrade, reset)
meddiags.txt	Medina protocol diagnostics detailing the communication to a Medina master or Poco+
moddiags.txt	Modem diagnostics detailing commands sent to the modem
DNP3-index.log	Index for DNP3 diagnostics (see DNP3 Communication Logs)
DNP3-nnnnn.log	DNP3 diagnostics in the same format as ClearSCADA

Once a diagnostic file reaches 128kB, it is archived with a filename that includes an index number of five digits (e.g. diags00000.txt). Only the most recent 25 of each diagnostic file are retained as an archive (00000 to 00024). The numbering cycles through rather than being ordered. Diags.txt should be checked to identify the most recent archive file for all diagnostics.

The level of diagnostic information that is stored is configurable. Each level includes the information from the lower levels. The following table details the levels and what they will report

Level	Details
No Trace	No diagnostic information
Error	Only operational errors are reported
Warning	Important information (this is the default)
Notice	Useful information
Informational	Significant information
Debug	All information

- *Note: It is not advised to leave the diagnostics at Debug level unless a specific issue is being tracked. The use of diagnostics will have a small impact on performance and battery life.*

- *Note: The general-purpose diagnostics will contain any Modbus information and that when set to Debug level this will include the messages being transferred.*

DNP3 Error codes

Where issues arise in DNP3 communication, the following codes may be present in the diagnostic logs.

Number	Name	Notes
0	SDNPDIAG_OPER_OBJVAR	Object/variation not supported for operate request
1	SDNPDIAG_FREEZE_OBJVAR	Object/variation not supported for freeze request
2	SDNPDIAG_WRITE_OBJVAR	Object/variation not supported for write request
3	SDNPDIAG_SELECT_OBJVAR	Object/variation not supported for select request
4	SDNPDIAG_DIRECT_OBJVAR	Object/variation not supported for direct operate request
5	SDNPDIAG_ASSIGN_OBJVAR	Object/variation not supported for assign class
6	SDNPDIAG_REQ_PENDING	Request received with previous request still pending
7	SDNPDIAG_CANCEL_FRAGMENT	Cancelled current response fragment
8	SDNPDIAG_OPER_SELECT	Operate did not follow select
9	SDNPDIAG_CHNL_BUSY	Response deferred due to channel bus
10	SDNPDIAG_APPL_NO_RESP	Application error with no outstanding response
11	SDNPDIAG_ALLOC_EVENT	Error allocating space for event
12	SDNPDIAG_ADD_EVENT	Error adding event
13	SDNPDIAG_SELECT	Error processing select request
14	SDNPDIAG_OPERATE	Error processing operate request
15	SDNPDIAG_DIR_OPERATE	Error processing direct operate request
16	SDNPDIAG_FREEZE	Error processing freeze request
17	SDNPDIAG_ASSIGN_CLASS	Error processing assign class request
18	SDNPDIAG_WRITE	Error processing write request
19	SDNPDIAG_ENABLE_UNSOL	Enable/Disable unsolicited requests only support object 60
20	SDNPDIAG_ENABLE_UNSOL_VAR	Invalid variation for Enable/Disable unsolicited request
21	SDNPDIAG_ENABLE_UNSOL_NA	Enable/Disable unsolicited request not allowed
22	SDNPDIAG_RESTART_COLD	Performing Cold Restart
23	SDNPDIAG_RESTART_WARM	Performing Warm Restart
24	SDNPDIAG_UNSOL_CONF_SEQ	Invalid sequence number in unsolicited confirmation
25	SDNPDIAG_UNSOL_CONF_UNEXP	Unsolicited confirmation received when not expected
26	SDNPDIAG_RESPONSE_SEQ	Invalid sequence number in response confirmation
27	SDNPDIAG_RESPONSE_UNEXP	Response confirmation received when not expected
28	SDNPDIAG_APPL_TX	Application layer transmission failed
29	SDNPDIAG_TIME_NO_OBJECT	Record Current Time Request has no object data
30	SDNPDIAG_UNSOL_TO	Unsolicited confirmation timed out
31	SDNPDIAG_READ_POINT	Error reading point number from request

Number	Name	Notes
32	SDNPDIAG_REQUESTED_POINT	Requested point is not available
33	SDNPDIAG_PATTERN_QUAN	Invalid quantity for Pattern Control Block
34	SDNPDIAG_INV_QUAL_CTRL	Invalid qualifier for control
35	SDNPDIAG_INV_QUAL_PATTERN	Invalid qualifier for Pattern Control Block
36	SDNPDIAG_INV_QUAL_FILE	Invalid qualifier for file request
37	SDNPDIAG_INDICES_PATTERN	Invalid indices for pattern mask
38	SDNPDIAG_PATTERN_8_16	Pattern Mask qualifier must be 8 or 16 bit start stop
39	SDNPDIAG_CROB_STATUS	Status in CROB request not 0
40	SDNPDIAG_ANLG_STATUS	Analogue control status not equal 0
41	SDNPDIAG_VTERM_NOTFOUND	Virtual Terminal point not found or enabled for write
42	SDNPDIAG_VTERM_WRITE	Error writing to virtual terminal
43	SDNPDIAG_STR_NOTENABLED	String not enabled for write
44	SDNPDIAG_STR_WRITE	Error writing to string
45	SDNPDIAG_PATTERN_STATUS	Status must be 0 in Pattern Control Block request
46	SDNPDIAG_PATTERN_NOTRCVD	Pattern Control Block not received prior to Pattern Mask
47	SDNPDIAG_FILE_TO	File transfer timed out
48	SDNPDIAG_FILE_VAR	Invalid variation for file request
49	SDNPDIAG_FILE_AUTO_CLOSE	File automatically closed because of reopen of same filename
50	SDNPDIAG_FILE_AUTH	Error returned from authentication routine
51	SDNPDIAG_50_QUAL	Invalid qualifier for write Object 50 Variation 1
52	SDNPDIAG_50_QUANT	Invalid quantity for write Object 50 Variation 1
53	SDNPDIAG_50_NORECORD	Record Current Time request was not received
54	SDNPDIAG_FREEZE_QUAL	Unsupported qualifier or invalid point indices in freeze request
55	SDNPDIAG_SELECT_TO_MANY	Too many control objects in select
56	SDNPDIAG_PARSE_ERROR	Error parsing message
57	SDNPDIAG_XML_SIZE_ERROR	Object won't fit in XML buffer
58	SDNPDIAG_AUTH_BROAD_DISC	Critical broadcast message discarded
59	SDNPDIAG_AUTH_BADUPDMETHOD	Secure Authentication, unsupported update key change method
60	SDNPDIAG_AUTH_BADUPDSCS	Secure Authentication, Status Change Sequence Number must increment

DNP3 Communication Logs

The DNP3 communication can be captured into a series of log files. An index with timestamps of each is maintained. To retrieve a specific DNP3 communication log, the index should be retrieved first and consulted to identify the name of the log file. As with the other diagnostics, only the most recent 25 logs are maintained as an archive. To avoid rewriting the index, earlier files (which still appear within the index) are deleted and new files are created. A Maximum of 65535 files can be created after which the filename will reset to DNP3-00000.txt.File transfers are not captured to avoid amplification of the data (where reading the data creates more data that could lead to a never-ending feedback loop). Large file transfers would generate significant communications logging, which is not always helpful. If such information is required, it is advised to collect it from the DNP3 master.

WARNING

It is not advised to leave DNP Communication Logs enabled unless a specific issue is being tracked. The use of the logs is for diagnostic purposes and will have a small impact on performance and battery life.

- *Note: Before the time has been retrieved from the DNP3 master, the Point Colour will record the time as 1st January 1970 in the log.*

Technical details – Point Orange

Analogue Inputs	Up to 4 channels Type: Active Current, passive current, active voltage, passive voltage Current range: 0-20mA, Voltage range: 0-2V Active AI power supply (12V DC, 80mA) Input impedance: 10.2kΩ Accuracy: ±0.5% (Max ±2%) Absolute maximum ratings: 0-30VDC Resolution: 16-bits
Digital inputs	Up to 5 channels Volt free, Impedance: 50kΩ First 4 channels support change of state up to 100Hz Fifth channel supports change of state up to 0.5Hz
Counter inputs	Up to 4 channels Volt free, Impedance 50kΩ 32-bit counter support up to 100 Hz
Power	Internal lithium battery pack Optional external battery pack DC power input (5-8V DC) (Point Orange only)
Protocols	Medina DNP3 (Level 2+ elements of level 3 and 4) WITS-DNP3 V1.1 FTP, FTPS Modbus master (RS232, RS485 full and half duplex) SDI-12 master Mainstream
Memory	256MB flash memory 512kB static RAM
Comms	Internal tri-band 3G modem (850, 900, 2100 MHz) with quad band GSM/GPRS fallback (850, 900, 1800, 1900 MHz) Auto switching internal and external antenna
Local monitoring	Ambient temperature sensor (± 1°C) Integrated submersion sensor Battery, loop, and external supply voltages Automatic external power source detection and switching Antenna selection and performance
Remote management	Remote firmware upgrade Remote configuration
Dimensions	156mm × 110mm × 112mm (excluding mating cables) 0.6 Kg (fully assembled)
Environmental	Operating temperature -20°C to +80°C Relative Humidity up to 95% non-condensing Protection classification: IP68 4m for 4 days

Point Blue

Analogue Inputs	Up to 4 channels Type: Active Current, passive current, active voltage, passive voltage Current range: 0-20mA, Voltage range: 0-2V Active AI power supply (12V DC, 21mA per channel) Input impedance: 10.2kΩ Accuracy: ±0.5% (Max ±2%) Absolute maximum ratings: 0-30VDC Resolution: 16-bits
Digital inputs	Up to 5 channels Volt free, Impedance: 50kΩ First 4 channels support change of state up to 100Hz Fifth channel supports change of state up to 0.5Hz
Counter inputs	Up to 4 channels Volt free, Impedance 50kΩ 32-bit counter support up to 100 Hz
Power	Internal or external LTC battery pack
Protocols	Medina DNP3 (Level 2+ elements of level 3 and 4) WITS-DNP3 V1.1 FTP, FTPS Modbus master (RS232, RS485 full and half duplex) SDI-12 master Mainstream
Memory	256MB flash memory 512kB static RAM
Comms	Internal tri-band 3G modem (850, 900, 2100 MHz) with quad band GSM/GPRS fallback (850, 900, 1800, 1900 MHz) Auto switching internal and external antenna
Local monitoring	Ambient temperature sensor (± 1°C) Integrated submersion sensor Battery, and loop supply voltages Antenna selection and performance
Remote management	Remote firmware upgrade Remote configuration
Dimensions	156mm × 110mm × 112mm (excluding mating cables) 0.6 Kg (fully assembled)
Environmental	Operating temperature -20°C to +50°C Relative Humidity up to 95% non-condensing Protection classification: IP68 4m for 4 days
Certification	Ⓔx II 1G Ex ia IIB T4 Ga (-20°C ≤ Ta ≤ +50°C) Atex: Baseefa15ATEX0045X IECEx: BAS 15.0027X Test Report number GB/BAS/ExTR16.0050/00

Standards and Approvals

Directives	Council Directive 1999/5/EC Radio equipment and Telecommunications Terminal Equipment Council Directive 2004/108/EC Electromagnetic compatibility Council Directive 2006/95/EC Low Voltage
Standards	EN60950-1:2006 - Information technology equipment - Safety - Part 1: General requirements EN60950-22:2006 - Information technology equipment - Safety - Part 22: Equipment installed outdoors EN61010-1:2010 - Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements EN61326-1:2006 - Electrical equipment for measurement, control and laboratory use EN62311:2008 - Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz-300 GHz) EN301 489-1:v1.9.2 - Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements EN301 489-7:v1.31 - Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS) EN301 511:v9.0.2 - Global System for Mobile communications (GSM); Harmonized EN for mobile stations in the GSM 900 and GSM 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC) EN61131-2:2007 - Programmable controllers - Part 2: Equipment requirements and tests
Environmental	Operating temperature -20°C to +80°C Relative Humidity up to 95% non-condensing
Enclosure	IP68 rated enclosure made from ABS
Battery Pack	Lithium thionyl chloride. Certified to UN 38.3

Further information

For further information on the Point Orange, Point Blue or any of the other Metasphere products, contact Metasphere using one of the methods below:

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