SDI-12 for GP2

GP2 SDI12 UM 1

Delta-T Devices Ltd

Contents

Quick Overview

About SDI-12

SDI-12 is a communication protocol which enables sensors with a built-in microprocessor to share a single 3-wire cable to send data to a data logger. SDI-12 stands for serial digital interface at 1200 baud.

It is widely used by the water industry, typically for monitoring water catchment areas and for measuring soil moisture and other environmental data.

Features and Benefits of SDI-12

- Reduced system costs
- Simplified and lower cost cabling requirements (can be 3-core)
- Use of a single data logger for multiple sensors on one cable
- Power is supplied through the same cable
- Sensors can be interchanged without re-programming the logger with calibrations and other parameters
- Use of a 'standard' interface eliminates complexity in logger design
- Level of interoperability between different manufactures' devices
- Battery powered operation, with minimal current drain
- The SDI-12 standard enables a sensor to store and provide some meta-information about itself (e.g. manufacturer, product name, serial number). This can be of benefit in permitting the interchangeability of sensors and obtaining higher accuracy.

GP2 SDI-12 Features and Benefits

- SDI-12 measurements are available for recording and processing in DeltaLINK 3.2, alongside 'conventional' analogue and digital measurements. They can be:
  - added to recordings
  - used in Scripts, Conditions, and Calculations
  - viewed via Read Now, to check sensor operation.
- Many third party SDI-12 sensors are predefined in a sensor library add-in for DeltaLINK. They are easily added to a program, but first each needs a unique address. (The GP2 SDI-12 Transparent Mode is suitable for doing this)
- SDI-12 cuts down the amount of sensor cable you need – one daisy chain instead of a star network.
- Delta-T's cabling with 5-way M8 connectors can be used.
- The same cable can supply 12V power to all the sensors.
- Up to 62 SDI-12 sensors can be connected to a GP2 logger in addition to its standard analogue and digital sensors (limited by the number of SDI-12 addresses available).
- Up to 300 different measurements can be recorded at a time (limited by the GP2's capability) .
  For example you can connect up to 50 PR2/6 6 channel sensors.

- The serial communications format avoids many of the problems typically associated with long cable runs from sensors with analogue output signals.
- The SDI-12 protocol allows for the use of self-calibration algorithms within the sensor itself.
- Existing GP2s are in-field upgradeable (no need to return to Delta-T):
- All GP2s are fitted with SDI12-ready hardware.
- Free of charge upgrade,
  requires firmware 2.10 (or later) and DeltaLINK 3.2
  Download from www.delta-t.co.uk

DeltaLINK SDI-12 Transparent Mode

Type in commands to a sensor via a command box and see it reply in an output box. This way you can do the following:

- Discover and change a sensor address
- Change a sensor configuration
- View optional diagnostic detail
- Power up the SDI-12 bus.
  When you issue a command the logger turns on the SDI-12 power supply before sending the command.
  If a sensor takes longer to power up the logger re-issues the command.

SDI-12 Cabling System Features and Benefits

- The existing Delta-T M12 x 5-way cable system can be used.
  See page 8.
- Re-wireable connectors (i.e. with internal screw-terminal connectors) are available to interface 3rd party sensors to the Delta-T cable system.
- Re-wireable connectors are also available to interface the PR2 SDI-12 sensor with third party loggers.
  See page 32.

See DeltaLINK's context sensitive online **Help.**

Install DeltaLINK

You need DeltaLINK version 3.2 running on a PC.
Download it from www.delta-t.co.uk or install it from the Software and Manuals DVD.
If upgrading see Compatibility on page 24.

Upgrade GP2 Firmware

1. Identify the COM port of the USB adapter used by the GP2:
   a. Start DeltaLINK 3.2.
   b. In **DeltaLINK Logger** view select **Connection Details** (at the bottom of the page).
   c. **Add** or **Edit** the Connection and select **Connect to logger using: Serial port.**
   d. Select **Details** and **Detect USB port.**
   e. Follow the instructions to disconnect and reconnect the USB serial port adapter.[1]
   f. Note the COM port number.
2. Check your GP2 firmware version, displayed in DeltaLINK.
   a. If it is not at version 2.10 or later proceed as below to updgrade your firmware.
   b. Close DeltaLINK.
3. In Windows Start menu click on "All Programs", open the **DeltaLINK 3.2** folder and start **Firmware Upgrade**.
4. Select (or type) the COM port name.
5. Click **Upgrade**
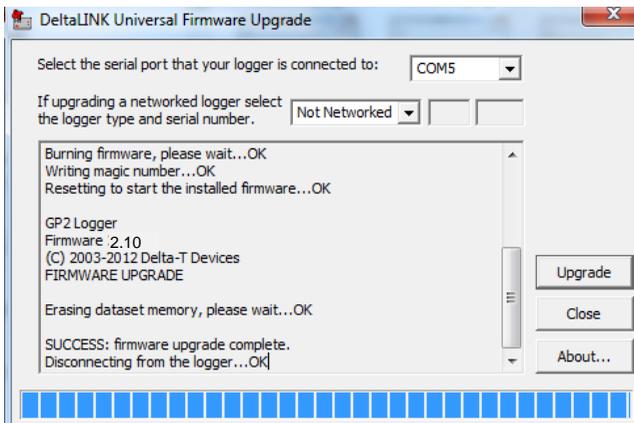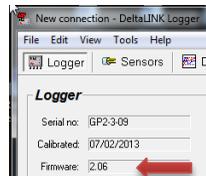
6. Wait while the upgrade is completed, then   the Firmware Upgrade

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[1] Slower PCs may struggle with this, if so, please use your Device Manager to identify the COM port

Cabling Connection Options

Use of SDI-12 sensors with a GP2 Logger and Controller

GP2-NTP

EXT/5w-01
EXT/5w-05
EXT/5w-10
EXT/5w-25

GP2-NPC

Connectors with screw terminals

CON/5W-M-S-LD

CON/5W-M-NS-SD

CON/5W-M-NS-LD

SMSC/sw-05

Limits:
600m cable
62 SDI-12 sensor addresses
300 measurements in logging program,
depending on complexity

Many third party
SDI-12 sensors
supported
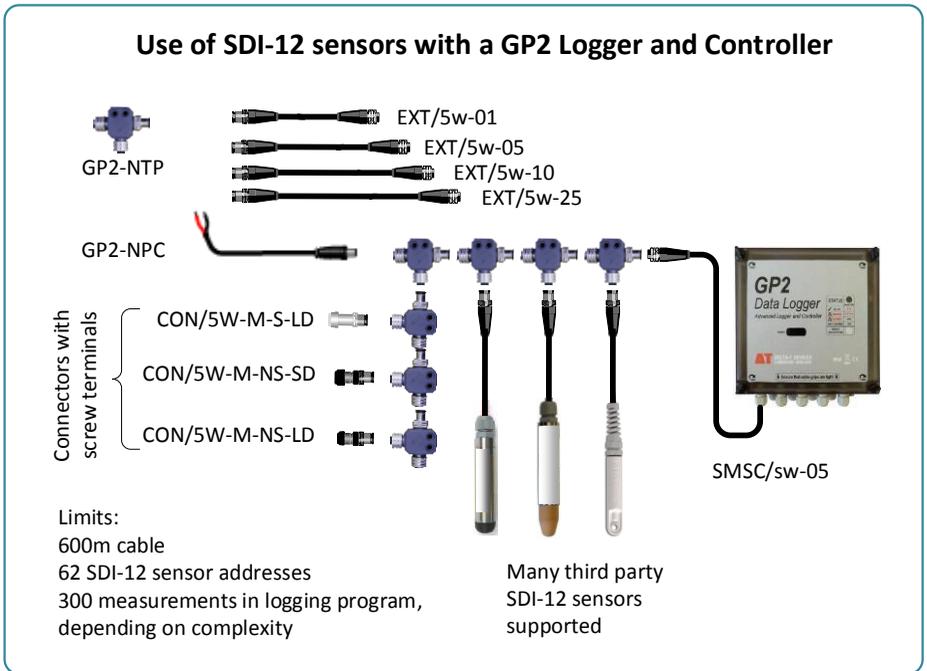
Figure 1: Wiring system used to connect SDI-12 sensors to the GP2 Logger
controller, using cables with integral 5-way M12 connectors.

You can use this system to reliably connect 10 SDI-12 sensors on a total cable
length of 600m (2000 feet). In many cases more sensors and/or longer cable
lengths are possible.
See also **Wiring and Connector Requirements** on page 10.

SDI-12 Cabling Options and Accessories

5-way M12 connector serial communication + power extension cables (**EXT/5W-xx** where xx = 1, 5,10 or 25m)	
5-way M12 connector (f) 5m cable to 100mm long flying leads with bare wires **SMSC/sw-05** for connecting SDI-12 network of EXT/5W-xx cables to GP2 logger	
GP2-NTP 3-way network T- Piece for connection to EXT/5W-xx cables	
GP2-NPC Network Power Cable – to supply power via a GP2-NTP and/or EXT/5W-xx cable	
CON/5W-M-S-LD In-line M12 male 5-way connector to screw terminals, with screened metal shell, for connecting SDI-12 sensors fitted with screened cable to GP2 logger. Accepts cable 4-9 mm diameter.	
CON/5W-M-NS-SD In-line M12 male 5-way connector to screw terminals, with unscreened plastic shell, for connecting SDI-12 sensors fitted with unscreened cable to GP2 logger. Accepts cable 3-6.5 mm diameter.	
CON/5W-M-NS-LD In-line M12 male 5-way connector to screw terminals, with unscreened plastic shell, for connecting SDI-12 sensors fitted with unscreened cable to GP2 logger. Accepts cable 4-8 mm diameter.	

Plugs with screw connectors are available for adding to the M12 connector system. See Page 8 and 32.

Wiring and Connector Requirements

SDI-12 uses a 3 wire cable with sensors attached along it – as in a daisy chain. The wires are used for Power (12V DC), Ground (0V) and Serial Data (5V).

The SDI-12 specification states…

"*The SDI-12bus is capable of having at least 10 sensors connected to it, each with 200 feet of cable. With fewer sensors, longer cable lengths are possible.*"

But note also…

"…*the voltage drop between the data recorder and all sensors [should be] less than 0.5 volts during the maximum combined sensor current drain.*"

For further technical detail on requirements see SDI-12 standard (v1.3) at www.sdi-12.org

Worked Example of an SDI-12 Cable Length Calculation

The SDI-12 cable provided by Delta-T has a resistance of 0.06 ohms per metre, so to meet the 0.5V voltage drop restriction the maximum length of cable, in metres, between each sensor and the GP2 is

$$1000 * 0.5 / (0.06 * I_{ma}) = 8333 / I_{ma}$$

…where, for **Sequential** measurements (see page 25), I_{ma} is the sensor supply current in mA when it is active.

For **Concurrent** measurements I_{ma} is the combined active supply current of all sensors in a Concurrent group (see page 25) and the formula provides a worst case estimate of maximum length of cable between the GP2 and the most distant sensor in the Concurrent group.

For further technical detail on requirements see SDI-12 standard (v1.3) at www.sdi-12.org

Wire SDI-12 network cable to GP2 logger controller

Wire colour SMSC/sw-05		GP2 terminal	Function	M12 Connector Pins
Black		SDI-12 DATA	SDI-12 Data	4
Blue		GND	Sensor ground power return	3
Green			Screen	Screen
White		12V	Sensor power	2

SDI-12 Power supply requirements

GP2 provides switched +12V @ 500mA either from its internal batteries or from an external source.

To avoid rapidly depleting the GP2 battery an external GP2 power supply is recommended if sensors need several 10's of mA or are intended to operate below 10 °C.

Alternative methods of powering sensors are:-

- Use of GP2 relays to switch in external power.
- Permanent power supply to sensors which don't tolerate power cycling.

SDI-12 to GP2 logger wiring connections- using logger power
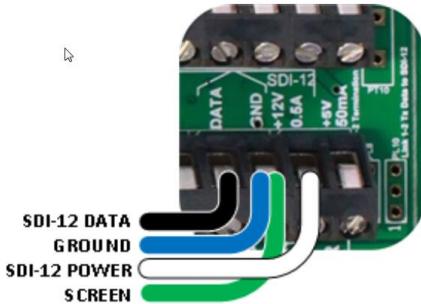
Figure 2: Sensor connection to the SDI-12 channel in the GP2 logger, using the logger's internal 12V Power channel.

Colours shown are for cable type SMSC/sw-05.

SDI-12 to GP2 logger wiring connections- using external power

SDI-12 DATA
GROUND
SDI-12 POWER
SCREEN

POWER SUPPLY or BATTERY

GROUND

+12VDC
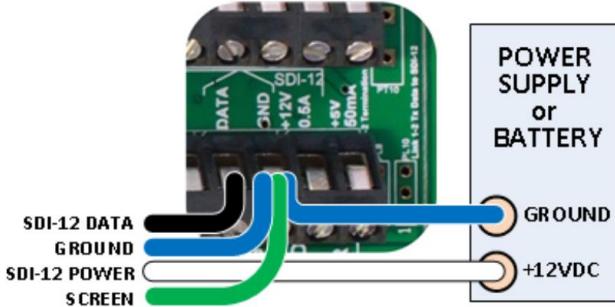
Figure 3: Sensor connection to the SDI-12 channel in GP2 logger, using an external permanent (i.e. un-switched) power supply or battery connection. Colours shown are for cable type SMSC/sw-05.

M12 connector sensor wiring connections for SDI-12

GROUND
SDI-12 DATA
SDI-12 POWER
SCREEN (if present)

GROUND
SDI-12 DATA
SDI-12 POWER

4a. Pin connections for connector type CON/5W-M-S-LD, for sensors with screened cable*

4b. Pin connections for connector types CON/5W-M-NS-(LD or SD) for sensors with unscreened cable
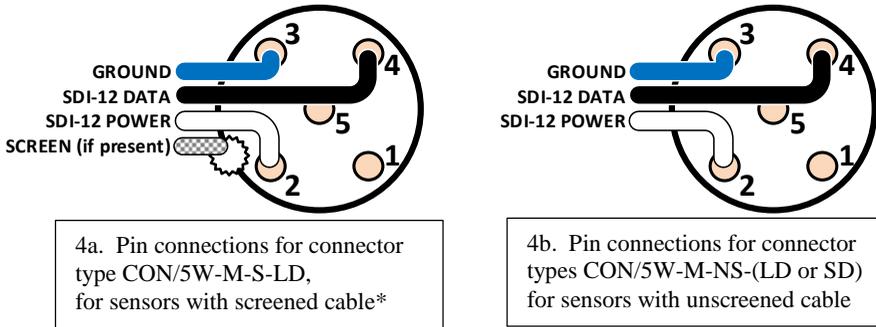
Figure 4:   Pin connection diagrams for field attachable 5-way M12 connectors used as part of the Delta-T M12 SDI-12 cabling system to connect to the SDI-12 channels of the GP2 logger as shown in in Figures 2 or 3

*Note: When using screened cable take care to clamp the screen securely to the metal shell of the connector.

See also **Screw terminal cabling** on page 32.

Give each Sensor a Unique Address

Know this

Give each SDI-12 sensor a unique address **<u>before</u>** connecting it into a network of other SDI-12 sensors.

Delta-T DeltaLINK Logger software provides a mean for doing this, called the **SDI-12 Transparent Mode**.

☹ Note: If two sensors have the same address the SDI-12 network will not work.

A new sensor will typically have the address set to 0 (number zero).

Give each sensor a unique address.

This can be one of the following 60 addresses:-

0 to 9, a to z, or A to Z.

(Other printable characters such a punctuation marks are permitted but think carefully before using such characters).

Open DeltaLINK Transparent mode

You need a GP2 connected to a PC running DeltaLINK v3.2 or later.

With no other sensors on the network connect the sensor to the GP2 SDI-12 channel.

In DeltaLINK select **Tools**, **SDI-12**, **Transparent mode** to open the SDI-12 Transparent mode terminal as shown below.
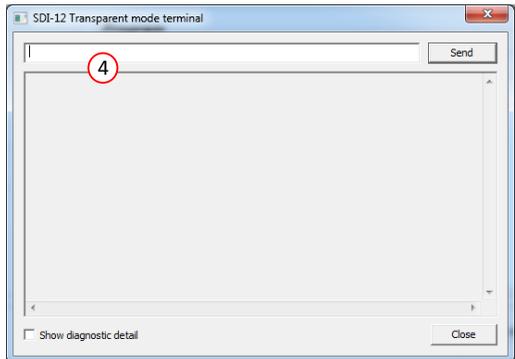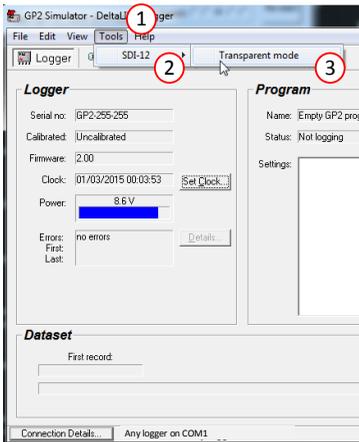
Once the SDI-12 Transparent mode terminal is open, as shown above, the GP2 behaves as a transparent serial link between sensors on the SDI-12 network and the PC.

About the SDI-12 Transparent Mode

The SDI-12 Transparent mode terminal can be used to make changes to sensor configurations and discover and change their address.

Use this terminal window by typing in the command box at the top, and the response from the sensor will be displayed in the output box below.

When you issue a command the logger with turn the 12V power supply on before sending the command.

Some sensors takes longer to power-up, and so you will see the logger resend the command. It will also add the command terminator "!" if you forget it.

Here the output box shows the logger tried 7 times before the sensor has replied - with address "0".

Ensure only one sensor is connected on the SDI-12 network.

Example Use Transparent mode to set an address

We assume the SDI-12 Transparent mode in DeltaLINK, Tools has been selected, as shown above, and is running, so your PC keyboard is communicating transparently through the GP2 directly with the SDI-12 network.

We also assume you only have one sensor on the SDI-12 network, and it is your new sensor, and we want to give it a unique new address.

1. Display sensor's address using the Query "?!" command

This identifies the address of a sensor.

The sensor must be alone on the bus … otherwise all sensors will 'shout at once' and send their own address.

In the Transparent mode command box type **?!** followed by Enter.

In the output box you see[2] the following response from the sensor

We would normally expect this address to be zero for a new sensor, but it might not be.
Here the address reported is "a" (It could be a-z, A-Z or 0-9)
You may already have another sensor with this address.

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[2] There is also a hidden <Carriage Return> <Line Feed> string at the end of each message, which just acts to display the next reply on a new line.

2. Confirm it works: tell sensor to identify itself.

The command **I!** displays a sensor's identification: manufacturer's name, model and other details.

Note: SDI-12 commands are case sensitive.

Note: All SDI-12 commands start with an address (apart from **?**) and finish with **!**
DeltaLINK is quite forgiving and will add the terminating **!** if you forget.

You type	aI!
Response	a13Delta-T PR2SDI00200000000010001

The logger asks the sensor at address "a" to identify itself.
It replies with a long string of characters which is **different for each manufacturer.**

a13Delta-T PR2SDI0020000000010001<CR><LF>

Serial number
Version
Sensor model number
Manufacturer
SDI-12 standard version 1.3
Sensor address
Carriage return, linefeed
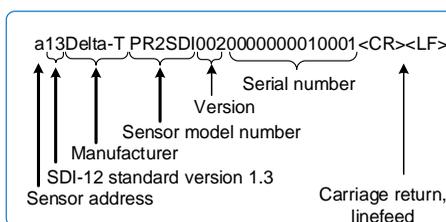
3. Change its address

You type	**aAb!**
Response	**b** <CR><LF)

Your sensor now has the address "b"

Before putting a sensor on the SDI-12 network ensure it has a unique address, or you will bring the network down.

SDI-12 Sensor Types for use in DeltaLINK

A custom SDI12 Sensor Library resource file containing a range of other manufacturer's sensors is freely available for download from the Support/ Software Downloads pages at www.delta-t.co.uk.
We provide this free of charge and have confirmed that the sensors work with the GP2 but we make no claims on the suitability of the sensors or the sensor type code and do not generally provide technical support for them.

Generic SDI-12 sensor types (powered and unpowered) are provided in DeltaLINK. These can be copied and adapted to suit your sensor. You will need to read the supplier's data sheets and may also need to read the SDI12 standard at www.sdi-12.org.
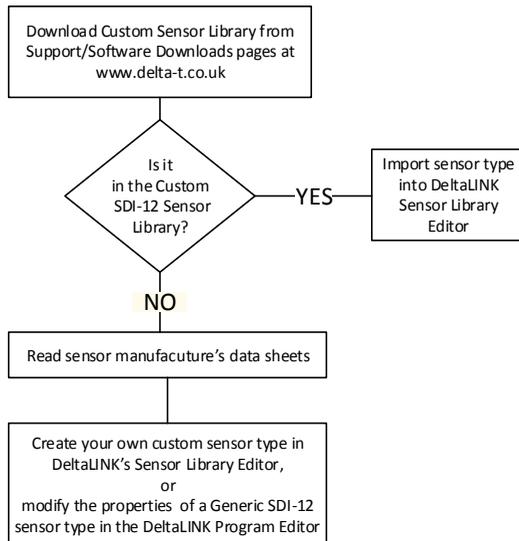
Figure 5 Decision Tree on obtaining Sensor Types for DeltaLINK for use with SDI-12 sensors from other manufacturers

Import the Custom SDI-12 Sensor Library

1) Ensure DeltaLINK v3.2 or later is installed and running on your PC.
2) Connect a GP2 running firmware version 2.10 or later,
   or select **Edit**, **New Program**, **GP2 Multifunction Program.**
3) Select **Program** tab and wait for the current program to appear
4) Select **Edit, Sensor Library Editor.**
5) Select **Edit.**
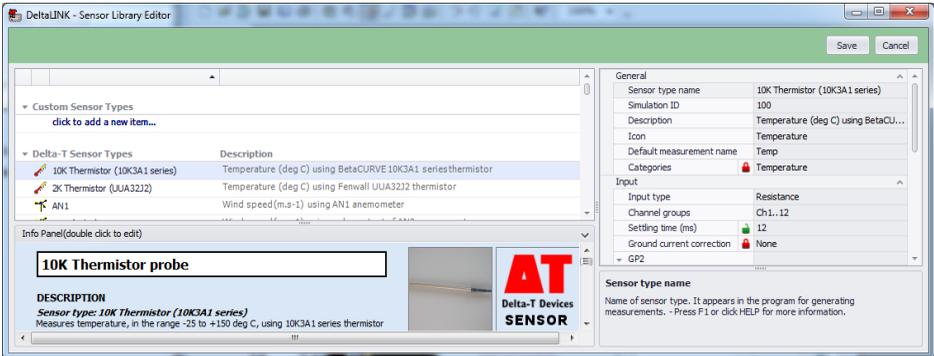
6) Under Custom Sensor Types, Right click to display a list of options
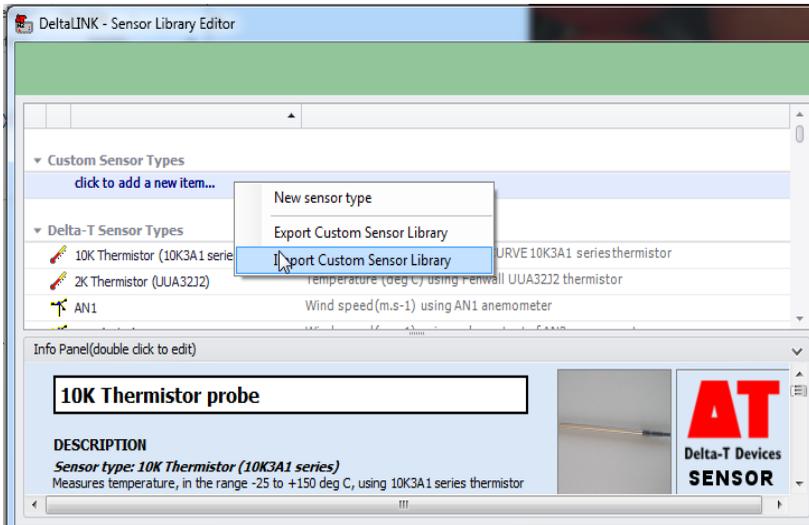
7) Select **Import Custom Sensor Library.**
8) **Browse to the downloaded copy of the sensor library file and click on Open.**
   (Usually at C:\Program Files (x86)\Delta-T\DeltaLINK 3.2

9) Choose and select which sensors you wish to import and click on **Import selected sensor types.**

10) Click to close message announcing the process succeeded and examine the sensors now listed under Custom Sensor Types in the Sensor Library Editor.
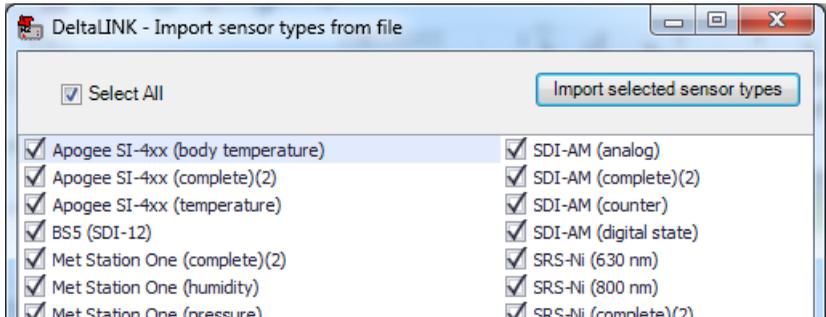
Figure 6 Showing a typical choice of sensors to be imported into DeltaLINK from the SDI 12 library.

Custom SDI 12 Sensor Types

Figure 7 SDI 12 Sensor types as displayed in DeltaLINK after importing the entire SDI 12 library.
Note: This list is liable to change without notice. One example of each third party sensor is tested to see if it worked with a GP2 but Delta-T do not distribute and do not support them.
The one exception to this rule is the BS5 pressure sensor, which we do sell and support.

Create a Generic SDI-12 measurement in DeltaLINK

1. Start **GP2 Program Editor.**
2. Click **Change.**
3. In **Measurements list** select **Click to add a new item.**
4. Select the **Generic** menu
5. Select **SDI-12, powered**
   or select **SDI-12, not powered** if providing an independent (i.e. not switched) power supply.

Note: Each GP2 measurement holds a single value. Multiple GP2 measurements are required to hold a collection of values from a multi-parameter sensor.
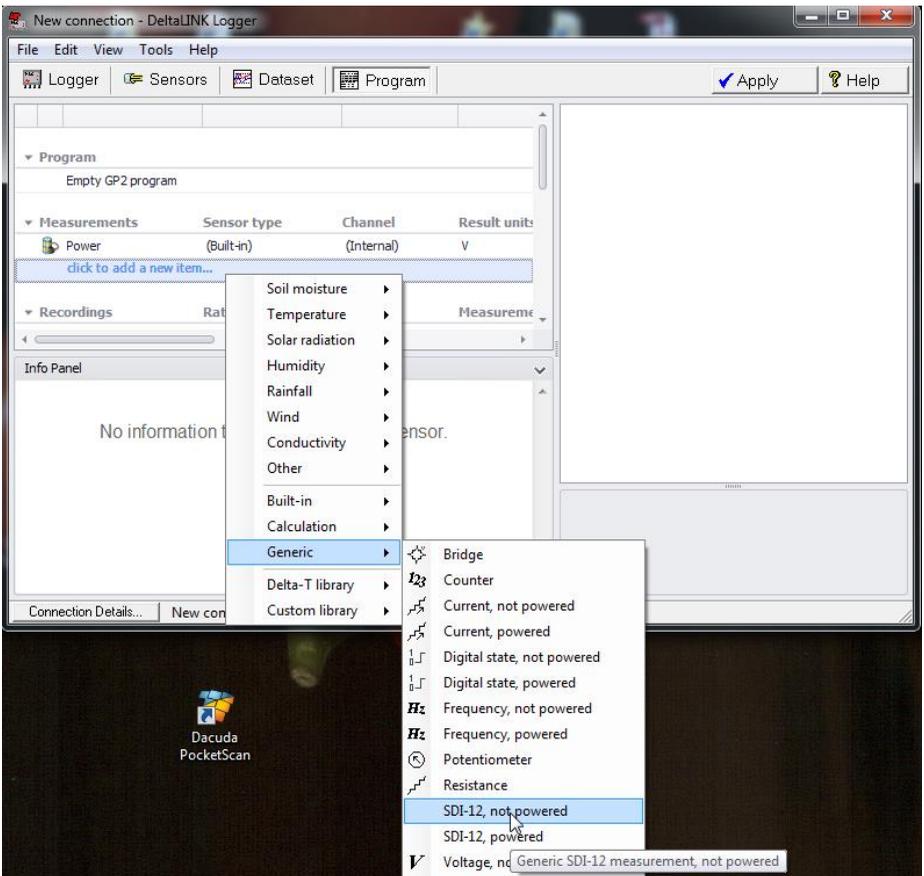
Set Measurement's Input Properties

To continue you may now need to cross-refer to the references section on **SDI12 Input Properties** on page 25

In particular **you must set the correct address** for the sensor (see 6 below).
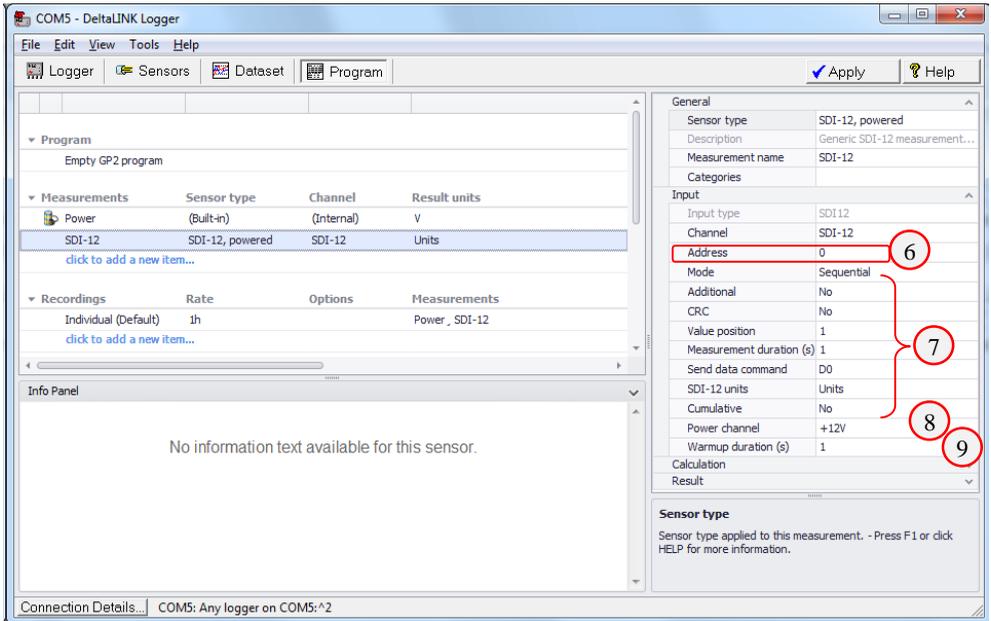
Here an SDI-12 measurement has been added.

On the right in the Properties panel you can see the sensor measurement properties, including **Input** properties:

Some settings are common to all measurements such as Measurement name, Calculation, Result, Power channel, Warmup duration, Sensor type, Input type, and Channel are given default options by DeltaLINK.[3]

6. Earlier, using the DeltaLINK SDI-12 Transparent mode you will, or should have, ensured the SDI-12 sensor has a unique address, see page13.
   Now set the measurement input **Address** field to the same address.

7. **Refer to the sensor manufacturer's data sheets** for information on the other SDI-12 properties that need to be set.
   See also:
   SDI-12 Input Properties on page 25
   SDI-12 Standard (v1.3) at www.sdi-12.org

8. Specify the **Power channel**.
   The GP2 **+12V** supply is designed for SDI-12 sensors.
   All other options are available, including the use of relays to switch an external supply.

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[3] Requires DeltaLINK 3.2 or later

9. Specify the **Warmup duration**. This defines the time between the turn on of power and the sensor being able to receive commands. Do not confuse it with the Measurement duration. Sometimes this is not specified in data sheets. Use 1s unless a sensor requires longer than this.

Set Calculation and Results Properties

Expand the Calculation and Results properties by clicking on the down arrow as displayed the right.

The default measurement calculation offered by the generic DeltaLINK SDI12 Measurement is displayed. It says "No calculation" which means that DeltaLINK will simply pass on the measurement it receives from the SDI12 sensor.

From here on the SDI12 sensor output can be treated like any other sensor connected. So at this stage if you wish you can use the full power of the GP2 to do complex maths on this measurement.
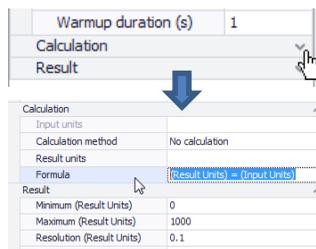
Result properties

As with all DeltaLINK sensor measurements ensure the permitted range resolution needed for your readings are appropriate.

For further help highlight a parameter and then press F1.

Logging interval

The minimum logging interval may vary depending on how many sensors you have connected to the SDI-12 network. DeltaLINK gives you an option of logging every 1s, which may be fine for analogue readings but not with SDi-12.

SDI-12 sensors can have a measurement duration which may last longer than 1s. In addition to this it is prudent to allow at least another half a second per SDI-12 measurement.

If a reading cannot complete in the time available then the previous SDI-12 reading for that sensor will be reported. So one way of discovering how fast you can take reading is to vary the relevant environmental parameter increasingly quickly and find out at what recording rate the readings fail to keep up with the rate of change.

Technical Reference

GP2 Program and Sensor Library Editor

In the **GP2 Multifunction Program Edito**r, the Measurements list pop-up menu offers Generic SDI-12 Sensor types ('powered' and 'not powered' variants). SDI-12 Sensor types, from other suppliers are available for importing into the sensor library. These are free to download from the Support/Software Download pages at www.delta-t.co.uk.

To import these into the **Sensor Library Editor** click **Edit**, right-click in **Custom Sensor Types** and select **Import Custom Sensor Library**.

These all have 'SDI-12' as their Input type, a collection of SDI12-specific properties (such as SDI-12 Address) which can be assigned in the same way as properties of other Input types, together with the same General, Calculation and Result properties as other measurements.

Measurements based on these SDI-12 Sensor types can then be selected in Recordings, and entered into Custom formulae, Conditions and Scripts in the same way as other measurements.

In the Sensor Library editor, the 'SDI-12' Input type can be selected to create custom SDI-12 sensor types.

SDI12-specific properties allow default or 'Additional' SDI-12 measurements to be selected, in Sequential or Concurrent mode (i.e. aM, aMn or aC, aCn commands), with or without CRC[4]. Each GP2 measurement holds a single value, so the position in the list of values returned by the sensor has to be specified. Multiple GP2 measurements are required to hold a collection of values from a multi-parameter sensor.

The GP2's +12V output is intended for powering the SDI-12 bus and can source 500 mA. Other GP2 outputs can be selected as the Power channel, or <none> if using an independent power supply. Concurrent measurements can be assigned to 'Concurrent groups', which are measured separately, to avoid overloading the SDI-12 power supply.

SDI-12 firmware operation

GP2 Programs perform program actions (Recordings, Scripts, etc.) on 1s clock ticks. This means that all measurements which the program needs to process need to be complete within 1s of the time when they are due. Thus for analogue measurements, the GP2 schedules warmups to occur in advance so that sensors are powered up, settled and ready to be measured when required.

Similarly, the GP2 accommodates SDI-12 measurements, which can take several seconds (or even minutes) to complete, by performing them in advance. This ensures that measurement values are ready for processing when required, but there is inevitably a delay between the measurement itself and the time when it is used by the program. The SDI-12 'bus latency' is the maximum delay incurred by any SDI-12 measurement: it is the time required to complete all the SDI-12 measurements in the program, plus a contingency for retrying – as explained below.

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[4] Cyclic Redundancy Test is a method of checking the reliability of serial data

In general, the delay between any SDI-12 measurement and the time when its value is used in the program may be as long as the bus latency – but no longer. If a program requires SDI-12 measurements more frequently than the bus latency, it may use duplicate values – but these will be no older than the bus latency. Similar behaviour occurs in DeltaLINK's 'Read Now', where duplicate values are shown until an updated value becomes available.

The SDI-12 specification stipulates that a SDI-12 recorder is required to retry several times if a command does not receive an error-free response. The GP2 provides a contingency for retrying, so sequences of SDI-12 measurements normally complete several seconds before the programmed time. It is not practical to allow for the worst case – where all SDI-12 commands fail in the most time-consuming manner. The time allocated by the GP2 for retries guarantees a 99.99% success rate, if 10% of SDI-12 commands randomly fail.

Transparent mode terminal

A Transparent mode terminal is a requirement of the SDI-12 specification, and is normally required at least to configure the addresses of SDI-12 sensors.

The **Tools** > **SDI-12** > **Transparent mode** command opens the 'SDI-12 Transparent mode terminal' window. Type a SDI-12 command in the command box, click Send and observe the response in the output box.

If the GP2 is programmed for SDI-12 measurements and a Power channel is selected, the GP2 activates the SDI-12 Power channel before transmitting the command. Otherwise, the GP2 activates the default +12V output.

The command is transmitted immediately, so if a sensor is slow to start up, the command may fail. The Power channel remains powered for 30s after completing any command, so clicking Send a 2nd time normally succeeds.

The GP2 transmits the command, including <break> and retries, according to the rules of the SDI-12 protocol. The output box displays all SDI-12 commands and responses.

Enable 'Show diagnostic detail' to view timings and result codes for each transmitted command.

SDI-12 Sensor requirements

Sensors should conform to the SDI-12 standard v1.3 at www.sdi-12.org. Some third party sensors can be unstable unless powered continuously. These can be accommodated by arranging the sensor cabling with two power lines, one switched by the logger, the other permanently connected to a second supply.

Each SDI-12 sensor must be assigned a unique address before putting it on the SDI-12 network. This can be done using the DeltaLINK Transparent Mode.

Versions

SDI-12 support is introduced in GP2 firmware version 2.10, which is distributed as the firmware upgrade in DeltaLINK 3.2.

	DeltaLINK 3.2		DeltaLINK 3.1.1	
Firmware	**2.10**	**2.00**	**2.10**	**2.00**
• **Logger and Sensors views, Read Now**	✓	✓	✓	✓
• **Datasets**	✓	✓	✗	✓
• **Programs, View and Save**	✓	✓	✗	✓
• **Programs, Change and Apply**	✓	✗	✗	✓

Compatibility

GP2 <u>programs</u> created in DeltaLINK 3.2 require GP2 firmware 2.10 (or later), and are not compatible with earlier firmware versions.

<u>Datasets</u> created by firmware 2.10 require DeltaLINK 3.2 (or later) and are not compatible with earlier DeltaLINK versions.

DeltaLINK 3.2 installs 'side by side' with earlier DeltaLINK versions, so an earlier version can be retained for working with earlier GP2 firmware versions.

All GP2s are built with SDI12-capable hardware and firmware 2.10 is fully compatible with all existing GP2s.

SDI-12 Input Properties

Channel groups (in Sensor Library editor)

Select the SDI-12 sensor channel group to **SDI-12**.

Address

Select the SDI-12 address of the sensor.

Each SDI-12 sensor must have a unique address. Type the aAn type command in the DeltaLINK's SDI-12 Transparent mode terminal to set a sensor's SDI-12 address.
See also **Give each Sensor a Unique Address** on page 13

Mode

Select **Sequential** or **Concurrent**.

In Sequential mode, the sensor will be the only active SDI-12 sensor when making its measurements; all other SDI-12 sensors will be in low-power quiescent mode.

In Concurrent mode, other SDI-12 sensors can be active and making measurements at the same time.

Concurrent mode speeds up throughput of SDI-12 measurements because it allows sensors to make measurements in parallel. However, this requires all active sensors to be powered up at the same time and may impose a large load on the SDI-12 power supply. To avoid overloading the SDI-12 power supply, Concurrent measurements can be separated into Concurrent groups. To minimize loading of the SDI-12 power supply select Sequential mode.

Sequential mode uses the SDI-12 'M' (start measurement) commands. Concurrent mode uses the 'C' (start concurrent measurement) commands. Some SDI-12 devices don't provide concurrent measurement commands - refer to the manufacturer's documentation.

Concurrent group

This applies to: Measurements, if the Concurrent mode is selected.

Assign measurements to different groups if you need to avoid overloading the SDI-12 power supply.

If required, enter the name of the group that you want to assign the measurement to, for example 'Group 1', 'Group 2'. All measurements in the same Concurrent group are performed in parallel, but separately from measurements in different Concurrent groups.

In any case, Concurrent measurements are performed separately from Sequential measurements.

Additional

Select **Yes** to use a SDI-12 'additional' measurement or concurrent command and select the Measurement number (below), or **No** to use the default measurement or concurrent command.

Refer to the manufacturer's documentation for details of the measurement that you need.

One example of the use of the Additional property is its use when sensors can present data in different units. For example a soil moisture sensor may be able to output data in units of permittivity $\dot{\varepsilon}$, or as volumetric water content in $m^3.m^{-3}$ or as a percentage.

If this is the case with your sensor then it should say what to do in the sensor's user manual. If it does not say anything then leave this option as **No.**

If these or other additional options are available then select **Yes,** then chose the relevant **Measurement number** as described in the next section.

Measurement number

Applies if: **Additional** is **Yes**

Select the SDI-12 additional measurement number.
This could be used, for example, to express the data in different units, as described above under **Additional.**

CRC

Select **Yes** to request the sensor to provide a CRC (cyclic redundancy checksum) with its measurement results. The logger checks the CRC to confirm it has received the measurement results correctly.

Some SDI-12 devices don't provide a CRC - refer to the manufacturer's documentation.

Value position

Multi-parameter SDI-12 sensors may provide more than one value for each measurement. Refer to the manufacturer's documentation and select the position of the result which you require in the list of values provided by the SDI-12 measurement.

If the SDI-12 measurement requires more than one SDI-12 'send data' command to send a complete set of values, enter the cumulative position of the value which you require. For example, a profiling moisture sensor may provide the values for 10, 20, 30 and 40 cm depths in the first 'send data' command and the 60 and 100 cm values in the 2nd 'send data' command. To obtain the 60cm value, select **Value position** '5'.

Measurement duration (s)

Enter the number of seconds that the SDI-12 measurement takes.

If the information isn't provided in the manufacturer's documentation, enter the measurement command (of type aM, aMn or aC, aCn) in the DeltaLINK SDI-12 Transparent mode terminal. The Measurement duration is in digits 2 to 4 of the sensor's response. For example, if the response is '10024' the Measurement duration is '002', i.e. 2 seconds.

Send data command

Select the SDI-12 'send data' command which provides the required result.
If the sensor provides the result in the first 'send data' command, the Send data command is 'D0'.

In the profiling sensor example above, the appropriate Send data command for the 60 cm or 100 cm values would be 'D1'.

SDI-12 units

Enter the units of the result provided by the SDI-12 measurement.

You can perform additional calculations on the SDI-12 measurement result by selecting **Calculation properties**.

Power channel

The GP2's +12V channel is designed to provide up to 500 mA for powering the SDI-12 bus.

If your SDI-12 sensors have a high current consumption it is advisable to power the GP2 from an external power supply - otherwise, the +12V channel may be unable to power the sensors as the internal battery ages and at low temperatures.

Peak current consumption can be reduced by selecting Sequential mode (above) for power-hungry SDI-12 measurements, or separating Concurrent mode measurements into Concurrent groups (above).

You can choose to power SDI-12 sensors from any of the other GP2 power channels if they don't require +12V supply. If you don't want to risk power-hungry SDI-12 sensors draining the GP2's battery, you can choose one of the GP2's relay channels to switch an independent external power supply.

Some SDI-12 sensors are designed to be permanently powered and don't respond well to 'power cycling' between measurements. If a manufacturer advises against power switching, select **<none>** and connect the sensor to a permanent power supply.

It is possible to power some sensors from a GP2 **Power** channel and others to a permanent supply and select a Power channel or <none> accordingly. However, only one Power channel can be used to power all SDI-12 sensors, so the selected Power channel (if it is not <none>) applies to all SDI-12 measurements in a program.

Warmup duration

Applies if: Power channel or Power channels (above) is not None

For a SDI-12 sensor, the Warmup duration is the time required by the sensor to power up, initialize and become ready to receive SDI-12 commands. It is applied before issuing any commands to the sensor and is distinct from the Measurement duration (s) - which is the time required by the sensor to complete a measurement after receiving a 'start measurement' command.

SDI-12 sensors in a program may have different Warmup duration; if so, the program allows the longest Warmup duration before issuing a command to any sensor, to ensure all sensors are ready to receive commands.

Further information

- **SDI-12 Commands** on page 28.
- DeltaLINK online **Help.**

SDI-12 Commands

When using the GP2 and DeltaLINK the only SDI-12 you must know are the Query "?!" and Change Address "aAb!" commands – because you must first ensure each sensor has a unique address.

In addition the Identification command "aI!" is useful to help you identify what type of sensor and who made it.

Apart from that the SDI12 standard includes a lot of commands about instructing sensors to start taking readings or to send the data. Fortunately DeltaLINK knows these commands and makes a pretty good job of shielding you from them. The default DeltaLINK SDI-12 sensor types provided for a range of third party SDI-12 sensors should help you quickly start to take readings.

The sensor Address Query "?!" command

This requests any sensor to send its address.

The sensor must be alone on the bus … otherwise all sensors will 'shout at once' and send their own address.

In the DeltaLINK Transparent mode command box type **?!** followed by **Enter** or click the **Send** button.

In the output box you see[5] the following:

We would normally expect this address to be zero for a new sensor, but it might not be.
Here the address reported is "a" (It could be a-z, A-Z or 0-9).

Terminating commands and automatic retries

SDI-12 commands sent to a sensor must end with a **!**

DeltaLINK will do this for you, it adds the "!" command terminator to any command that you type.
So if you just type ? and press Enter you will see "?!" sent.

What follows the ! is the sensor's reply, which is "0" in the example below

If the sensor does not reply quickly then DeltaLINK will send the command again.

---

[5] There is also a hidden <Carriage Return> <Line Feed> string at the end of each message, which just acts to display the next reply on a new line.

All commands (apart from "?!") begin with the sensor address

All SDI-12 commands apart from the "?!" adress query start with an address and finish with an exclamation mark '!'

Change Sensor Address "aAb!"command

In this example we change the address from "0" to "P".

In the DeltaLINK Transparent mode command box type **0AP!** followed by **Enter** or click the **Send** button.
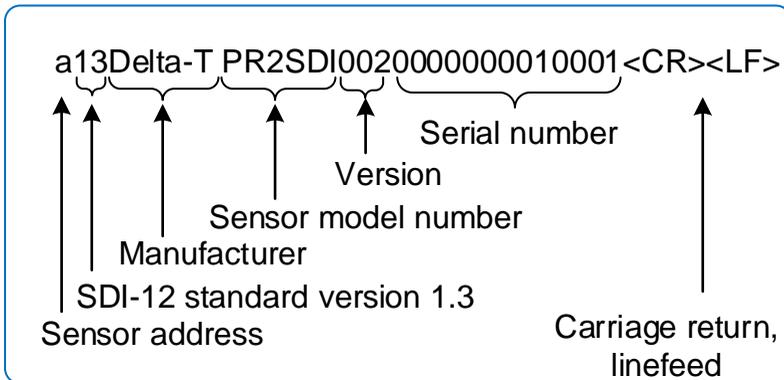
In the output box you see[6] the following:

0AP!P

Command   Reply

Command terminator

Sensor Identification "aI!" command

In this example we ask the sensor at address "P" to send its Identity.

In the DeltaLINK Transparent mode command box type **PI!** followed by **Enter** or click the **Send** button.

If you were sending this to a Delta-T SDI-12 PR2 Probe at address P then in the output box, following the PI! command, you would see the following reply:

a13Delta-T PR2SDI00200000000010001<CR><LF>

Serial number

Version

Sensor model number

Manufacturer

SDI-12 standard version 1.3

Sensor address

Carriage return, linefeed

Note: This information is different for each sensor manufacturer

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[6] There is also a hidden <Carriage Return> <Line Feed> string at the end of each message, which just acts to display the next reply on a new line.

"Start Measurement" Command

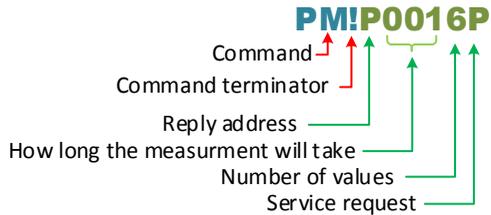The "M!" command tells a sensor to start taking measurements.

The sensor responds with the following:

- Measurement duration how long the measurement will take (0 to 999 s)
- Number of values that the measurement will produce (up to 9).

In this example a PR2-SDI sensor is assumed to be at address P

In the DeltaLINK Transparent mode command box type **PM!** followed by **Enter** or click the **Send** button.

The output box displays:…

PM!P0016P

Command

Command terminator

Reply address

How long the measurment will take

Number of values

Service request

Other measurement commands are also available, to do with the type of measurement. See also Concurrent measurements and CRC (Cyclic Redundancy Checking).

"Send Data" Command

The "D0" Send Data command is sent to retrieve the results when the sensor is ready. Other commands D1! To D9! are available for retrieving additional results if needed.

In the DeltaLINK Transparent mode Command box type **PD!** followed by **Enter** or click the **Send** button.
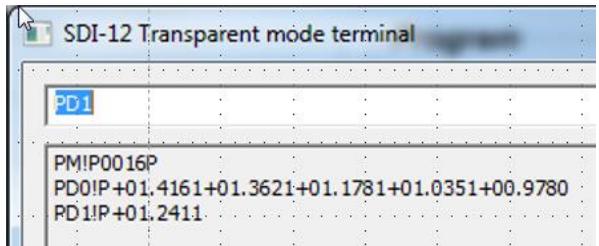
Typical replies are shown

SDI-12 Transparent mode terminal

PD1

PM!P0016P
PD0!P+01.4161+01.3621+01.1781+01.0351+00.9780
PD1!P+01.2411

Figure 8 In this example a PD0! command is followed by the PD1! Command.

Sequential and Concurrent Measurement Commands

M! starts a 'sequential' measurement

- One sensor is active
- All others in low power quiescent mode

C! starts a 'concurrent' measurement

- Several sensors can be active and measuring at the same time
- More rapid throughput
- But more loading on SDI-12 power supply
- … which may be a problem with high current consumption sensors
- Can provide up to 99 values

More measurement command variants…

Many sensors also provide additional measurement commands
i.e. M1! … M9! and C1! … C9!
These provide alternative measurement methods
Each can provides up to 9 (or 99) values

MC! and CC! commands provide a 'CRC' checksum with measurement results.
This is recommended for optimizing data integrity.

Extended 'X' commands

M, C, and D commands are 'standard' SDI-12 commands.
X commands may be provided by manufacturers for configuring the sensor.
These are often used to modify behaviour of measurement commands, for example, to change measurement units.
Manufacturers can use X commands to provide a 'Factory reset' command to restore the sensor to a known configuration.
Refer to the manufacturer's data sheets for further information.

Screw terminal cabling

Unshielded screw terminal connector kits

Figure 9 Showing the parts supplied with the screw terminal kits for use with unscreened SDI-12 sensor cables

M12 male 5 way connector kit with screw terminals and plastic shell for attaching SDI-12 sensors which use unshielded SDI-12 sensor cable.

Two cable gland size options are available:

CON/5W-M-NS-SD In-line M12 male 5-way connector to screw terminals, with unscreened plastic shell, for connecting SDI-12 sensors fitted with unscreened cable to GP2 logger.
Accepts cables of **3-6.5 mm diameter**.

CON/5W-M-NS-LD In-line M12 male 5-way connector to screw terminals, with unscreened plastic shell, for connecting SDI-12 sensors fitted with unscreened cable to GP2 logger.
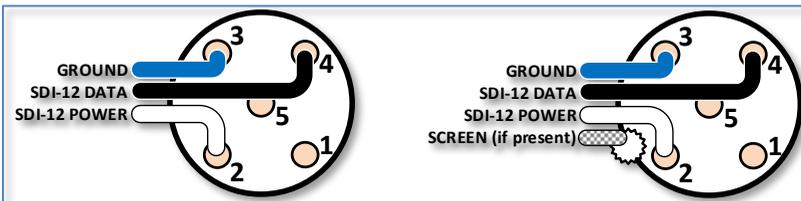Accepts cables of **4-8 mm diameter**.

Figure 10 Wiring schemes used with the screw terminal kits, unshielded on the left, shielded on the right

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Shielded Screw terminal connector

CON/5W-M-S-LD

This in-line M12 male 5-way connector to screw terminals, with screened metal shell, for connecting SDI-12 sensors fitted with screened cable to GP2 logger.
Accepts cable 4-9 mm diameter.

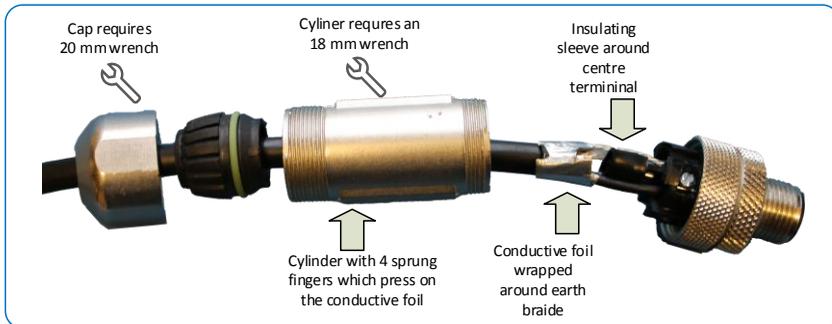Figure 11 Copy of manufacturer's wiring instructions.

Figure 12 Exploded-view of an example of an SDI-12 sensor cable wired-up using the shielded connector.

Technical Support

Don't get your Networks muddled

WARNING: Do not confuse the GP2 **Logger to Logger** Network Cabling options with the **SDI12 sensor to sensor** network cabling options on page 8.

Fault Finding SDI-12

No SDI-12 sensors appear to be working on the network

If one SDI12 sensor fails it can bring down the whole network.

1) Isolate each SDI12 sensor by disconnecting all others from the SDI-12 network
2) Use the Transparent Mode to interrogate the one remaining sensor.
3) If it appears to be responding with the correct address and meta-data about itself see if it gives sensible readings.
4) If the sensor appears to be working, remove it from the network and connect the next SDI-12 sensor and repeat the above.

The isolated single SDI-12 sensor is not responding

Divide and conquer. Swap with other components that you know are working.

- Check the wiring
- Check the sensor power supply
- Toggle the power supply off and on.
  Some third party sensors are known to lock up (intermittently) unless the power is permanently on.
- Check the polarity of the power supply is correct for the sensor
- Check the logger is working.

If you can prove to your satisfaction the rest of the system is working OK, then the sensor must be faulty or incorrectly connected or incorrectly configured

Sensor unreliable if power cycles on and off

The GP2's internal sensor power sources help save battery life by only providing warmup power to sensors when needed.

We have found some third party manufacturer's sensors (not supplied by us) are not reliable unless powered up continuously.

Please check with the manufacturer whether it requires continuous power and if so you will need to provide this separately.

Warranty and Service

Terms and Conditions of Sale

Our Conditions of Sale (ref: COND: 1/07) set out Delta-T's legal obligations on these matters. The following paragraphs summarise Delta T's position but reference should always be made to the exact terms of our Conditions of Sale, which will prevail over the following explanation.

Delta-T warrants that the goods will be free from defects arising out of the materials used or poor workmanship for a period of two years from the date of delivery.

Delta-T shall be under no liability in respect of any defect arising from fair wear and tear, and the warranty does not cover damage through misuse or inexpert servicing, or other circumstances beyond their control.

If the buyer experiences problems with the goods they shall notify Delta-T (or Delta-T's local distributor) as soon as they become aware of such problem.

Delta-T may rectify the problem by replacing faulty parts free of charge, or by repairing the goods free of charge at Delta-T's premises in the UK during the warranty period.

If Delta-T requires that goods under warranty be returned to them from overseas for repair, Delta-T shall not be liable for the cost of carriage or for customs clearance in respect of such goods. However, Delta-T requires that such returns are discussed with them in advance and may at their discretion waive these charges.

Delta-T shall not be liable to supply products free of charge or repair any goods where the products or goods in question have been discontinued or have become obsolete, although Delta-T will endeavour to remedy the buyer's problem.

Delta-T shall not be liable to the buyer for any consequential loss, damage or compensation whatsoever (whether caused by the negligence of the Delta-T, their employees or distributors or otherwise) which arise from the supply of the goods and/or services, or their use or resale by the buyer.

Delta-T shall not be liable to the buyer by reason of any delay or failure to perform their obligations in relation to the goods and/or services if the delay or failure was due to any cause beyond the Delta-T's reasonable control.

Service, Repairs and Spares

Users in countries that have a Delta-T distributor or technical representative should contact them in the first instance.

Spare parts for our own instruments can be supplied and can normally be despatched within a few working days of receiving an order.

Spare parts and accessories for products not manufactured by Delta-T may have to be obtained from our supplier, and a certain amount of additional delay is inevitable.

No goods or equipment should be returned to Delta-T without first obtaining the return authorisation from Delta-T or our distributor.

On receipt of the goods at Delta-T you will be given a reference number. Always refer to this reference number in any subsequent correspondence. The goods will be inspected and you will be informed of the likely cost and delay.

We normally expect to complete repairs within one or two weeks of receiving the equipment. However, if the equipment has to be forwarded to our original supplier for specialist repairs or recalibration, additional delays of a few weeks may be expected. For contact details see below.

Technical Support

Users in countries that have a Delta-T distributor or technical representative should contact them in the first instance.

Technical Support is available on Delta-T products and systems. Your initial enquiry will be acknowledged immediately with a reference number. Make sure to quote the reference number subsequently so that we can easily trace any earlier correspondence.

In your enquiry, always quote instrument serial numbers, software version numbers, and the approximate date and source of purchase where these are relevant.

Contact Details:

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