Race Technology

DL1 PRO

Instruction manual

Version 1.1
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- Calculate timeslip live
- Control external systems on the vehicle
- GPS data logger with integrated accelerometers and powerful processing

1.1 What is the DL1 PRO?

The DL1 PRO offers the same features as the DL1 MK3 but is encased in a water resistant enclosure with high specification water resistant connectors and an aluminium enclosure for more demanding environments.

1.2 Who is the DL1 PRO designed for?

The DL1 PRO is designed for autosport applications including drag racers, single seater racing cars, rally cars or road cars - however it is also ideal for use on power boats, go karts and motorbikes. It is also an ideal platform for use in the auto industry for car testing of all types, from long term monitoring to competitor benchmarking.

1.3 What does the DL1 PRO do?

The DL1 PRO can store data from a number of sources including its built in high accuracy GPS and accelerometers, wheel speeds, shaft speeds, engine speeds, temperatures, pressures, lap times, sector times etc. The DL1 comes packaged with the excellent Race Technology data analysis package for Windows. The software allows super accurate track mapping, user defined channels, powerful graphing and allows direct comparison of up to 10 data sets (races) simultaneously with almost unlimited laps. The DL1 PRO can also be used to supply data to dashboard displays and to drive auxiliary outputs to control fans, pumps, or lights.

1.4 Why use GPS?

One of the key features of the DL1 PRO is its built in high accuracy GPS system - this gives the DL1 advantages over other data loggers in 2 key areas - greatly improved track maps and far more accurate speed data.

1.4.1 Track Mapping

Conventional data loggers require a "closed circuit" to enable them to calculate the track map; the shape of the track is estimated from a combination of the lateral acceleration and speed. This works adequately in some situations but it becomes increasingly inaccurate for long tracks and impossible for open circuits, motorbikes or boats. In contrast, the GPS will produce high accuracy track maps in almost any situation.

1.4.2 Speed Measurement

While speed is probably the most important parameter that anyone wants to measure using the data logging system, it is also the most inaccurate in a "conventional" system. The normal way to measure speed is to simply attach a pickup to a wheel to detect how fast it is rotating - but the rolling circumference of a tyre changes by 4% just with wear and temperature. Even worse, the error increases significantly under race conditions where the tyre is under load - typically the tyre slips by up to 20% under hard braking going into a corner. Measuring speed using GPS is now common practice in high-end systems - under typical conditions speed error is well under 1%!

1.5 DL1 PRO Features

The DL1 PRO is an all-new, 3rd generation, data logger system from Race Technology. It is a complete redesign of the DL1, retaining all the best features and improving and adding where possible. Some of the most noteworthy features include:

- **Robust enclosure**

  The DL1 PRO is housed in an aluminium enclosure with rubber seals around all connectors and the card slot to provide an element of water protection to the electronics. All connections to the unit are through two large multi way connectors and a single GPS connection for easy removal from the vehicle

- **Built in GPS**

  The new GPS unit is based on our own high accuracy GPS3 technology and calculates position and speed 5 times every second. This is easily the fastest, most accurate GPS system available for under $1500. The measurements from the GPS and accelerometers are combined to calculate very high accuracy positions and speeds at 100 times a second. Optional storage of raw GPS data for post processing at 20Hz is also possible.

- **Built in accelerometers**

  Built in 3-axis accelerometer with 2g full scale (optional 6g full scale).

- **Built in yaw gyro for slip angle measurement (optional)**

- **Logging to SD cards**

  Works with SD and SDHC, for up to 32GB storage.

- **Up to 12 analogue inputs**

  The DL1 PRO has 12 very high accuracy analogue inputs. All inputs have a maximum of 25V input

- **Up to 4 output drivers**

  Low side driver outputs are available for controlling pumps, fans, lights.

- **2 RPM inputs**

  The DL1 PRO has 2 RPM inputs, only one of which can be used at any one time. One input is designed to be connected to "high level" sources, such as the ignition coil. The other input is designed for low level signals such as a feed from the ECU.

- **4 wheel/shaft speed inputs**

  The DL1 features 4 totally independent wheel/shaft speed inputs. These can be used to measure the speed of all four wheels, or slip ratios across a torque converter for example.

- **Two RS232 ports**

  Either port can be used to receive data for logging; one port is always used for outputting data for storage to a VIDEO4 or to a DASH display.

- **CAN port**

  CAN port enable receiving and transmitting of messages at configurable rates up to 1Mbit/s

- **Remote start/stop and add marker inputs**

- **Dual 5v reference outputs**

  Two independent 5v outputs can be used to drive up to 500mA each for sensor outputs.

- **Simple operation**

  A single button to start or stop logging, it's as simple as that! If the button is inaccessible from the driver's seat then a remote button and status indicator can be added if required.

- **Power supply requirements**

  The power supply to the DL1 PRO data logger can be taken directly from the vehicles 12v supply, or it can be powered from it's own battery if required. The power supply is smoothed and regulated within the DL1 PRO ensuring its performance is highly robust and stable.

- **USB interface**

  USB connection for direct connection to a PC for configuration

- **Testing**

  Very high reliability is ensured by calibrating, temperature testing and vibration testing each unit on an individual basis. Autosport applications make tremendous demands on electronic systems and we take great care to make sure our products are up to the task. All the connections to the units are vibration proof, high strength to ensure that connections do not fail at the critical time.

- **Powerful**

  The DL1 PRO has the latest 150MHz processor for maximum expandability and functionality

2 Technical Specification

Memory	SD memory card, can be SD or SDHC. Up to 32GB
GPS	Outputs position, speed, position accuracy and speed accuracy at 5Hz with no interpolation. GPS tracking loops optimised for applications up to about 4g. tracking of all satellites in view. 20Hz raw data storage for post-processed operation
GPS Antenna	Magnetic base, 3.3v active antenna with SMA connector.
Analogue Inputs	12 external inputs, all 12 bit resolution and 0-25v. All inputs are protected and filtered.
Frequency Inputs	4 external frequency inputs with a maximum input frequency >2kHz. Triggering voltage requires a low input of <1v and a high input of >4v and 15v maximum.
Lap Marker Input	Triggering voltage requires a low input of <1v and a high input of >4v and 25v maximum.
Start Sample Input	Triggering voltage requires a low input of <1v and a high input of >4v and 25v maximum
Low level outputs	4 low side drivers, each capable of driving 500mA.
Power Supply Requirements	12v nominal input, minimum of 10v, maximum of 25v. Current consumption of about 180mA including GPS, dependant on SD card requirements. +5v Reference Out Maximum current draw 500mA x 2.
Ignition In Signal (High Level)	Designed to connect directly to negative terminal of ignition coil. Can also fire from fuel injectors and from CD ignition systems.
Ignition In Signal (Low Level)	Triggering voltage requires a low input of <1v and a high input of >4v and 15v maximum. Suitable for connection directly to most ECU tacho outputs. Maximum input frequency >300Hz.
Case Construction	Custom aluminium housing with integral mounting holes.
Connector Type	19 way and 24 way Binder connector
Main Processor	150MHz TI Digital Signal Processor
Serial Port 1	User configurable for messages. Transmission and reception of RT format messages at 115200 baud
Serial Port 2	Used for reception of RT messages at a fixed baud rate of 115200
CAN Port	Message reception and transmission up to 1MBit/s
Computer communication	USB port for reflashing and reading/writing configuration

Accelerometers	3 axis, precision digital output. Guaranteed 2g minimum full scale on both axes. Resolution of 0.005g. Optional 6g sensor available as a factory option.
Gyroscope	Single axis yaw rate gyro with a maximum rate of 300 degrees / sec.
Vibration	Factory tested at 25g, 50Hz sinusoid for 5 minutes (without compact flash card inserted).
Temperature	Factory tested from -20oC to 70oC

"WARNING": To avoid any possible damage to the car paintwork, please take care when mounting magnetic GPS antennas. In particular make sure that there are no dust or grit under the antenna. In some cases it maybe required to add additional protection to the paintwork prior to mounting the antenna to avoid damage.

3 Installing the unit

3.1 Mounting

117mm

⌀4.2mm

DL1 PRO
Data Logger
www.Race-Technology.com

6mm

Power   Logging

USB

Do NOT Remove if in Use

SD
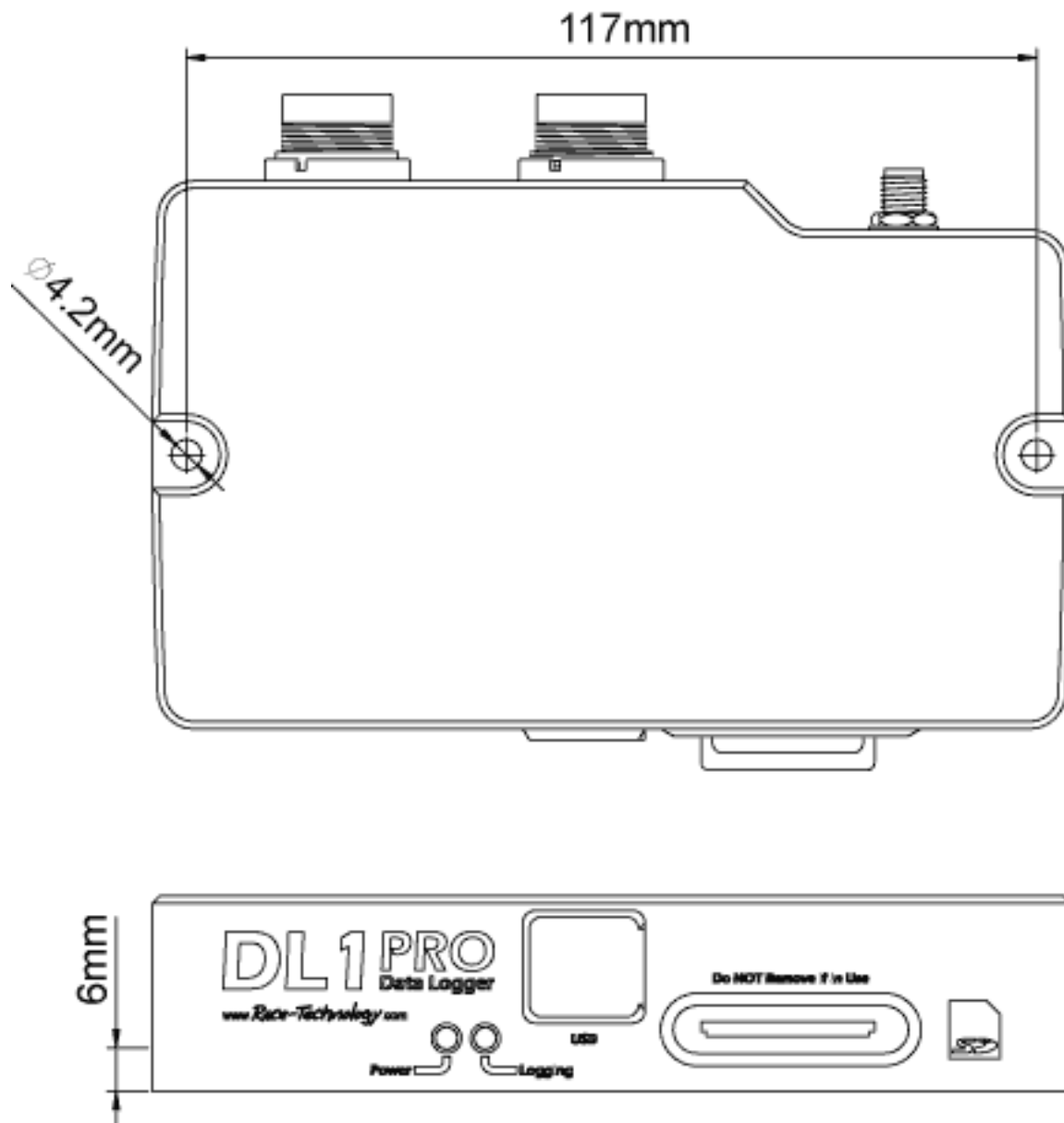
4 Quick Start Guide

This short guide is intended as a quick introduction to enable you to install the DL1 PRO in a vehicle and log your first set of data. It is certainly not intended as a full set up guide. There are three sections to the quick start guide: Installing the DL1 PRO into the vehicle, logging some sample data and looking at the data for the first time using the software.

4.1 Installing the DL1 PRO in the vehicle

4.1.1 Mounting the DL1 PRO in the vehicle

The DL1 PRO should be mounted in the vehicle on a flat horizontal surface. For temporary installation you can just use the Dual-LockTM tape supplied, or for a more permanent installation the mounting brackets. The DL1 PRO must be mounted with the buttons and lights facing either directly towards the back or the front of the car. Avoid any extremes of temperature and vibration for both the DL1 PRO module and the GPS antenna. In particular, if the DL1 PRO is exposed to vibration then the GPS data will become inaccurate.

4.1.2 Correct Mounting of the GPS Antenna

"WARNING": To avoid any possible damage to the car paintwork, please take care when mounting magnetic GPS antennas. In particular make sure that there are no dust or grit under the antenna. In some cases it maybe required to add additional protection to the paintwork prior to mounting the antenna to avoid damage.

For correct, accurate operation of the GPS receiver it is absolutely essential that the antenna is mounted correctly. There are several important aspects to consider when mounting the antenna:

- The antenna must have a clear view of the sky in all directions. Note that it is NOT enough that the antenna can see vertically upwards towards the sky, it must also be able to see all the horizons as well. The GPS system actually gets very little positional or speed information from the satellites directly above, it gets far more information from satellites on or near the horizon. For example if the antenna was mounted in the bottom of a "bucket", so it could upwards but no horizons, then the GPS system would lock and provide positional information - but the accuracy would be very poor. In practice this all means that the antenna should be mounted on the highest point of the vehicle.

- The antenna must be mounted on a horizontal surface. The antenna must be mounted on a horizontal orientation facing directly up. The underside of the antenna cannot receive GPS information, similarly don't mount the antenna on a vertical surface.

- The antenna must not be covered in tape, in particular dark coloured tapes. Many tapes absorb the weak GPS radio signal. In general, black tapes are the worst in this respect as they contain high amounts of carbon - however, to be safe, avoid using any tape at all.

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- The antenna must not be subjected to high levels of vibration. Although the antenna is physically robust to vibration, it can and does affect GPS reception, so isolate it as much as possible.

- The antenna must be physically remote from sources of electrical noise. The GPS radio signal is very weak and can easily be blocked out by radio interference, so to get a good signal the antenna must be as far away from radio interference as possible. By far the strongest source of radio interference is a gasoline engine's ignition system, so keep the antenna away from all aspects of it including the engine management system, coil, leads, distributor etc.

- Avoid trapping, pinching or kinking the antenna cable. The lead from the GPS antenna to the receiver is a special very high frequency cable and it is not normally practical to repair it - so if you do trap, pinch or cut it then the antenna will have to be replaced and this isn't covered by the warranty. Do not try to feed the antenna cable through a closure gap that is too small or compress it with a door seal or window seal.

- If at all possible, mount the antenna on a metal platform. The GPS radio signal is amplified if the antenna is mounted on a metal plate (termed a ground plane), and the bigger this plate is the better it will be for GPS reception. This is not essential for correct operation, but it is desirable.

- Allow time for the GPS system to lock on before sampling data. The GPS receiver typically takes one to two minutes to lock on to all the available satellites. The time to lock onto satellites varies significantly with conditions but is minimised when the vehicle is stationary.

4.1.3 Recommended mounting positions for the GPS antenna

- If the vehicle has a roof, this is the ideal place to mount the antenna.
- Alternatively, the best mounting position on a car may be the roll over bar or the top of the windscreen frame.
- On a motorbike, mounting is a little more difficult, but the best compromise is on a flat area of the tail unit, behind the rider.
- Poor mounting positions on a car include behind the front or rear windscreens.

Note: If you fail to adhere to the guidelines above, the GPS will still probably perform "adequately" "most" of the time, however when conditions are more challenging (with tree cover or bad weather etc) the positional accuracy will be significantly reduced.

4.1.4 Connecting the GPS module (if used)

Place the GPS antenna on the roof of the car, and screw the antenna connector onto the gold connector on the back of the DL1 PRO.

4.1.5 Connecting the power cable

If there is a cigarette lighter socket available on the vehicle, then the power lead provided can be used as a simple convenient way to supply power to the DL1 PRO. If not, connect the DL1 PRO to a fused power source, which is available when the ignition is turned on. Connecting to a permanent power source will cause the DL1 PRO to drain the battery continuously. Please do not connect anything to your car unless you are confident in what you are doing!

4.2 Default Configuration

The DL1 MK3 can be configured by direct connection to a PC through the USB port or by loading the configuration file on to the SD card which is put in to the unit. The unit has a default configuration from the factory. This configuration has the following settings for the analogue channels:

1. Spare input
2. Fuel level
3. Boost pressure
4. Air temperature
5. Oil pressure
6. Oil temp
7. Water temp
8. Start / stop control

- If the output driver option is enabled, the port 12 is used as the status output.
- Frequency inputs are set to map to wheel speeds 1-4, the high level RPM input is enabled.
- All channels are transmitted on the serial port and all channels are logged to the SD card.
- Automatic starting and stopping of logging are disabled.

If you need to change any of these configurations, start up the DL1 MK3 configuration software.

Full instruction on how to configure the unit can be found in the online help which is installed with the Analysis software package.

NOTE: The default configuration will need to be changed if the unit is used with an ECU interface, failure to change this will result in no readings for any of the channels listed above.

4.3 Logging data using the DL1 PRO

4.3.1 Powering up the DL1 PRO

Start the vehicle, wait a few seconds the "Power" LED will come on. Wait for a few moments while the GPS receiver acquires a good positional lock. Once the GPS has a lock, the GPS LED on the front of the DL1 PRO will light up.

4.3.2 Insert an SD card

Take an SD or SDHC card and format it in the PC – the card must be formatted as "FAT32" formatting it as "NTFS" or any other file system will cause unexpected behaviour. When formatting is complete, remove the card and place it in the DL1 PRO slot. Once it is inserted wait a few seconds and the status light should start flashing indicating that the DL1 PRO is ready to start logging data. If the status light does not start flashing, power down the DL1 PRO and repeat the above steps. If the status light does not flash on / off in equal measure then it could be one of the following problems:

9. SD Card detection error - one quick flash and off period

10. FAT file system initialize error – two quick flash and off period

11. SD card write error – three quick flash and off period

12. SD card read error – four quick flash and off period

4.3.3 Sampling data

To sample some data, simply press the "Start/stop logging" button on the front of the DL1 PRO. After a short pause, the "Logging" LED will illuminate, indicating that data is being stored on the memory card. Drive the vehicle around for a while (slowly, safely and in a responsible manner). To stop sampling press the "Start/stop logging" button again. When you have stopped sampling data you can turn off power to the DL1 PRO unit. Never remove the card from the DL1 PRO whilst it is logging data. This can corrupt the card and the data will be lost.

4.4 Analysing data from the DL1 PRO

Please note that the analysis software supplied with the DL1 PRO is very powerful and flexible and in most cases there are several ways that the same information can be accessed or generated. This guide is intended to be a very brief introduction to the software to enable you to get up and running as quickly as possible. When you require more information, or find a problem carrying out any of the following procedures, please refer to the on line help system that comes supplied with the DL1 PRO.

4.4.1 Installing the SD card reader

If required, install the SD card reader according to the manufacturers instructions. On many laptop computers the card reader is already built in and the external reader is not required.

4.4.2 Installing the software on the PC

Before you can analyse the data from the DL1 PRO you must install the software from the supplied CD onto your PC. When you insert the CD-ROM, the installation program should start automatically. Follow the onscreen instructions to install the software.

4.4.3 Loading the data into the software

To load the data from the SD card, remove the card from the slot in the front of the DL1 PRO (after stopping logging) and place it in the card reader connected to your PC. The data files on the SD card will appear in Windows Explorer as ".run" files separated into directories named with the date on which they were recorded. Your test data file can either be opened by "double clicking" on a ".run" file, or alternatively you can start the software and go to "File" -> "Open". The data will now download – once it has done so, click "yes" when you are asked if you want to process the data.

4.4.4 Display the track map and a graph of speed for the entire run

To view a map of the current data that is loaded select the "Results" -> "Track map" menu, use the zoom button to navigate around the map. To display a simple graph of speed for the entire run, select the "Results" -> "Graph" menu, and under the "Setup" tab select "GPS Speed [mph]" as the first variable. Then click back on the "Graph" tab to view the data.

4.4.5 Display your acceleration and braking times.

To display a full table of the acceleration times go to the "Results" -> "Performance Calculations" menu and then select the "Timings" tab. A table of acceleration times extracted from the data will be generated automatically.

4.4.6 Displaying lap and sector times

The first stage of the process is to add a "lap marker" to the track map. This is done in the "track map" window by selecting the "add track marker" tool from the top right hand corner of the track map window and adding a marker across a section of the track.

Next, go to the "Window" -> "Show Lap/Sector times" menu and you will be presented with a list of lap times in a spreadsheet style table. You can add and name sectors manually on the track map, but for this example we will add the markers automatically. To do this go to the "Data" -> "Laps and Sectors" menu, select the "Sector setup" tab and then click the "Automatically add sectors now" button. After a short pause, the sectors will be shown in the table. Close the "Lap and Sector options" dialog box. If you look at the track map you will see that a number of track markers and named sectors have been added, also if you check the "Lap and Sector Times" table, you will see that sector times are now displayed alongside the lap times.

4.4.7 Automatically generating a graph comparing speeds on two laps

You can automatically generate a graph showing the speeds for 2 laps most easily from the "Lap and Sector times" table. Simply select the lap times of interest on the "Lap and Sector times" table, as they are selected the cells will turn red. After selecting the laps of interest, click the "graph" button at the top left hand side of the table. You will be prompted for the type of graph you wish to generate, select "Speed versus Distance" and click "Ok". After a short pause a graph will appear with speed information for the laps selected.

5 Operating the DL1 PRO

5.1 Description of the plug/connections/lights etc on the DL1 PRO

<table>
<tr><td rowspan="6">F
R
O
N
T</td><td>Start/Stop Logging Button</td><td>Press once to start logging, again to stop logging.</td></tr>
<tr><td>Status Light</td><td>This light flashes to indicate that the DL1 PRO's processor is operating normally and is ready to log data.

In an error situation, it blinks with specific patterns. Different error states and there blinking patterns are describe in below.

13. SD Card detection error - one quick flash and off period

14. FAT file system initialize error - two quick flash and off period

15. SD card write error - three quick flash and off period

16. SD card read error - four quick flash and off period</td></tr>
<tr><td>GPS Lock Light</td><td>This light will be on when the GPS receiver has a lock. Please see the following page for details about mounting the GPS antenna are:

http://www.race-technology.com/wiki/index.php/Common/MountingAGPSAntenna</td></tr>
<tr><td>Power On</td><td>This light illuminates when the DL1 PRO is connected to a valid power supply. Advice about connecting a power supply is on following page:

http://www.race-technology.com/wiki/index.php/Common/PowerSupplyRequirements</td></tr>
<tr><td>Logging</td><td>This light illuminates when the DL1 PRO is actually logging data to the SD card. When this light is illuminated YOU MUST NOT TURN THE DL1 PRO OFF, OR EJECT THE SD CARD!</td></tr>
<tr><td>SD card Slot</td><td>This is the slot for the SD or SDHC card.</td></tr>
</table>

R **E** **A** **R**	**A1**	Analogue input 1, for use with external sensors maximum input 25v.
	A2	Analogue input 2, for use with external sensors maximum input 25v.
	A3	Analogue input 3, for use with external sensors maximum input 25v.
	A4	Analogue input 4, for use with external sensors maximum input 25v.
	A5	Analogue input 5, for use with external sensors maximum input 25v.
	A6	Analogue input 6, for use with external sensors maximum input 25v.
	A7	Analogue input 7, for use with external sensors maximum input 25v.
	A8	Analogue input 8, for use with external sensors maximum input 25v.
	A9	Analogue input 9, for use with external sensors maximum input 25v. Low side driver output, maximum 0.5A
	A10	Analogue input 10, for use with external sensors maximum input 25v. Low side driver output, maximum 0.5A
	A11	Analogue input 11, for use with external sensors maximum input 25v. Low side driver output, maximum 0.5A
	A12	Analogue input 12, for use with external sensors maximum input 25v. Low side driver output, maximum 0.5A
	GND	Ground, recommended for grounding analogue sensors.
	Ground	Ground, recommended for grounding analogue sensors.
	+5v1	+5v output, maximum current output 1A. This can be used for powering external sensors.
	+5v2	+5v output, maximum current output 1A. This can be used for powering external sensors.
	+12v Power	ESSENTIAL! This is the power supply for the DL1 PRO, it needs 10v-15v and about 150mA minimum. For More details read *http://www.race-technology.com/wiki/index.php/Common/PowerSupplyRequirements*
	GND	ESSENTIAL! This is the ground for the power supply to the DL1 PRO. Details are in the following page: *http://www.race-technology.com/wiki/index.php/Common/PowerSupplyRequirements*
	rL	This is the "low level" rpm input that triggers about 5v - this MUST NOT be connected to the ignition coil. Details here: *http://www.race-technology.com/wiki/index.php/Common/ConnectingRPMSensors*

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R **E** **A** **R**	**rH**	This is the "high level" rpm input that connects to the low voltage side of the coil. Details here: *http://www.race-technology.com/wiki/index.php/Common/ConnectingRPMSensors*
	rG	This is the ground for the "high level" rpm input that connects to an HT lead or the low voltage side of the coil. Details here: *http://www.race-technology.com/wiki/index.php/Common/ConnectingRPMSensors*
	F1	Frequency input 1, for connection to an external shaft or wheel speed. Triggers at 3v. Details here: *http://www.race-technology.com/wiki/index.php/Common/AddingWheelSpeedSensors*
	F2	Frequency input 2, for connection to an external shaft or wheel speed. Triggers at 3v. Details here: *http://www.race-technology.com/wiki/index.php/Common/AddingWheelSpeedSensors*
	F3	Frequency input 3, for connection to an external shaft or wheel speed. Triggers at 3v. Details here: *http://www.race-technology.com/wiki/index.php/Common/AddingWheelSpeedSensors*
	F4	Frequency input 4, for connection to an external shaft or wheel speed. Triggers at 3v. Details here. *http://www.race-technology.com/wiki/index.php/Common/AddingWheelSpeedSensors*
	GPS RF +3.3v	GPS antenna connection (gold SMA type). This feeds 3.3v out to the active GPS antenna and takes in the GPS rf signal.
	Data Port	This single connector actually connects to 2 serial ports and a CAN port. One of the serial ports is generally used to connect to a display unit, such as a DASH2, the other to an ECU interface.

"WARNING": To avoid any possible damage to the car paintwork, please take care when mounting magnetic GPS antennas. In particular make sure that there is no dust or grit under the antenna. In some cases it maybe required to add additional protection to the paintwork prior to mounting the antenna to avoid damage.

5.2 Sampling Data with the DL1 PRO

- If used, connect a GPS antenna to the rear of the DL1 PRO.
- Connect the DL1 PRO to a valid power supply. After a short pause the power light on the front of the unit will come on and the status light will start flashing rapidly.
- Insert a freshly formatted SD card into the slot, the status light will stop flashing for a second or 2 then start again when the DL1 PRO is ready to log data.
- Press the "Start/Stop Logging" button on the front of the DL1 PRO, the "Logging" light will come on indicating that the DL1 PRO is writing data to the SD card.

5.2.1 To stop data logging:

- Press the Start/Stop Logging button on the front of the DL1 PRO; the "Logging" light will go out.
- ONCE THE LOGGING LIGHT HAS GONE OUT, eject the SD card from it's slot. Power can now be disconnected if required.
- Put the SD card in a suitable reader and check a file has been written to it.

5.2.2 Advanced operation

You can set the DL1 PRO to automatically start and stop logging based on external inputs or on a timed basis. For more information on how to do this, read the following section on the web:

http://www.race-technology.com/wiki/index.php/Configuration/DL1MK3Configuration

5.3 Real Time Output

Practically the whole time the DL1 PRO is powered up, it is outputting data in real time to the external serial port. This can be used for a number of applications including monitoring the data on a PC or streaming to a dashboard or video logger.

5.4 Further Reading

For more information on operating the unit, please Read the following pages on the Race Technology knowledgebase:

- *http://www.race-technology.com/wiki/index.php/HowDoI/ManuallyCommenceLoggingOnDL1MK3*

- *http://www.race-technology.com/wiki/index.php/DL1MK3Configuration/AutomaticLoggingControl*

6 Connecting external sensors to the DL1 PRO

6.1 Connecting GPS

For the DL1 PRO, the GPS antenna comes with 3 metre cable, which will allow you to position the module almost anywhere on a road car. The GPS antenna connects via a co-axial screw connector on the back of the DL1 PRO Unit. Once the GPS antenna has been connected, it will turn on automatically when there is power to the DL1 PRO unit.

The best place to position the GPS antenna will change depending on the vehicle type. The GPS needs a good clear view of the sky to be able to lock onto the satellites to give the best results. As such, if there is a roof to the vehicle, this will always be the best place to place the antenna. If you are on a vehicle like a kart or a bike, then you will have to find the best location which gives a constant view of the sky.

For more detailed information on GPS antenna positioning, read the following page:

http://www.race-technology.com/wiki/index.php/Common/MountingAGPSAntenna

Please note that if your GPS antenna gets damaged, you can buy a replacement antenna from Race Technology. Email sales@Race-Technology.com for further details if you need a replacement antenna.

"WARNING": To avoid any possible damage to the car paintwork, please take care when mounting magnetic GPS antennas. In particular make sure that there is no dust or grit under the antenna. In some cases it maybe required to add additional protection to the paintwork prior to mounting the antenna to avoid damage.

6.2 External Sensors

The DL1 PRO allows you to attach several external sensors for logging. These can be frequency or analogue inputs. There are 4 frequency inputs, generally used for shaft or wheel speeds, and 12 analogue channels (25v input). The DL1 PRO is supplied with connectors for the external inputs. For each input, the positive wire connects to the input, and the ground to one of the ground connectors. If the sensor needs a 5v reference supply, there are two available on the back of the unit. You can have more than one sensor attached to the ground and reference output.

If you wish to connect an RPM sensor, see the following page for more details:

http://www.race-technology.com/wiki/index.php/Common/ConnectingRPMSensors

The 25v input is a nominal maximums, exceeding this upper voltage limit will cause other channels to read incorrect voltages.

6.3 Connecting A wheel speed sensor

Allow a few hours to mount and test the wheel speed sensor correctly, there is no simple/universal solution to fitting the wheel speed pickup and in some applications it can be problematic. The wheel speed sensor supplied by Race Technology is a high quality "Hall Effect" type, it is the same type of sensor that is used in high quality ABS and traction control systems on high performance production cars. This type of sensor does not require a magnet to trigger it, just something metal - typically, the sensor is mounted so it is pointing at a moving bolt head. The sensor should be rigidly mounted using the bolt hole though the sensor and with the end less than 3mm from the moving metal object. The closer to the metal object the sensor is mounted, the better the slow speed performance of the sensor. There are 3 wires connected to the wheel speed sensor: More information on the following page:

http://www.race-technology.com/wiki/index.php/Common/AddingWheelSpeedSensors

 The black wire that should be connected to the ground terminal of the DL1 PRO

- The red wire that should be connected to the +5v output of the DL1 PRO
- The white wire that should be connected to the wheel speed input (one of the frequency inputs) of the DL1 PRO

6.4 Remote start/logging indicator

The DL1 PRO has the option to have an external start/stop logging switch and an external indicator fitted. There are no dedicated pins on the DL1 PRO to do this. It is done by using one of the analogue inputs as the logging control input and one of the low side driver outputs (Analogue 9-12) as the logging status output.

- Connect a momentary switch between Analogue input 11 and one of the 5v references. This will put a 5v pulse on the analogue input which will trigger the start/stop.
- Connect the **-** terminal of an indicator lamp / LED to Analogue input 12 and the **+** terminal to either one of the reference outputs or to the main 12v supply.

This means that not only can you start and stop the logging remotely, you can also monitor whether the device is currently logging - useful when the DL1 PRO unit is mounted in a position that cannot be seen from the drivers seat.
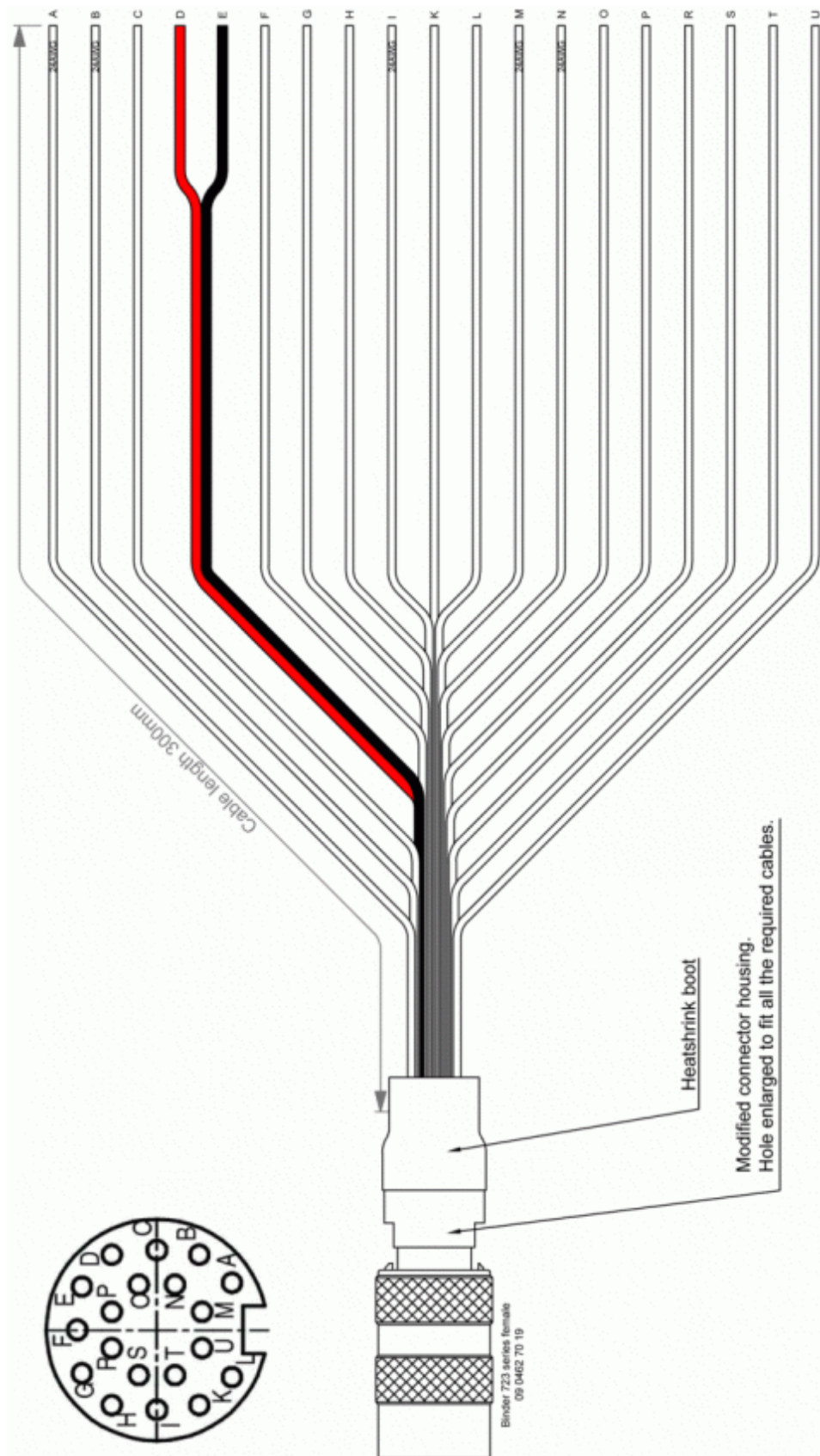
7 Connections
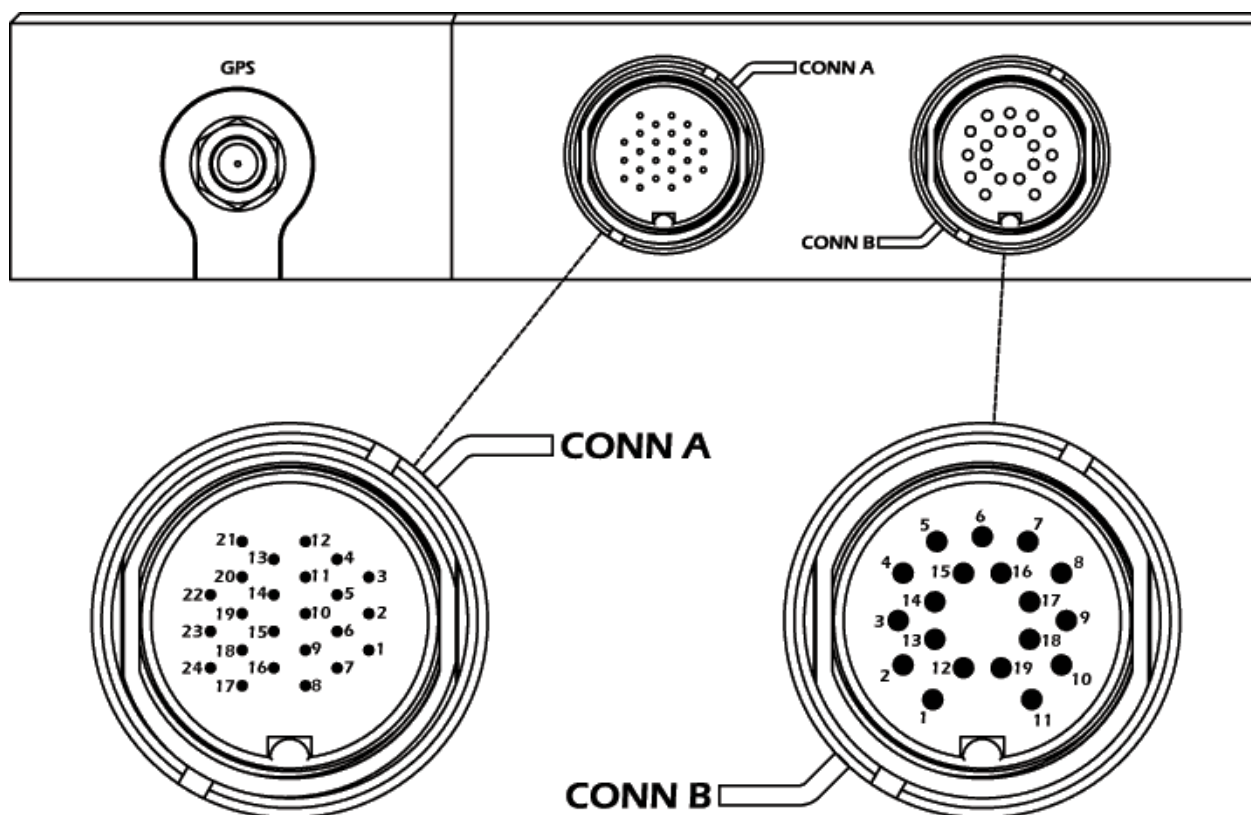
7.1 DL1 PRO 24 Way Cable
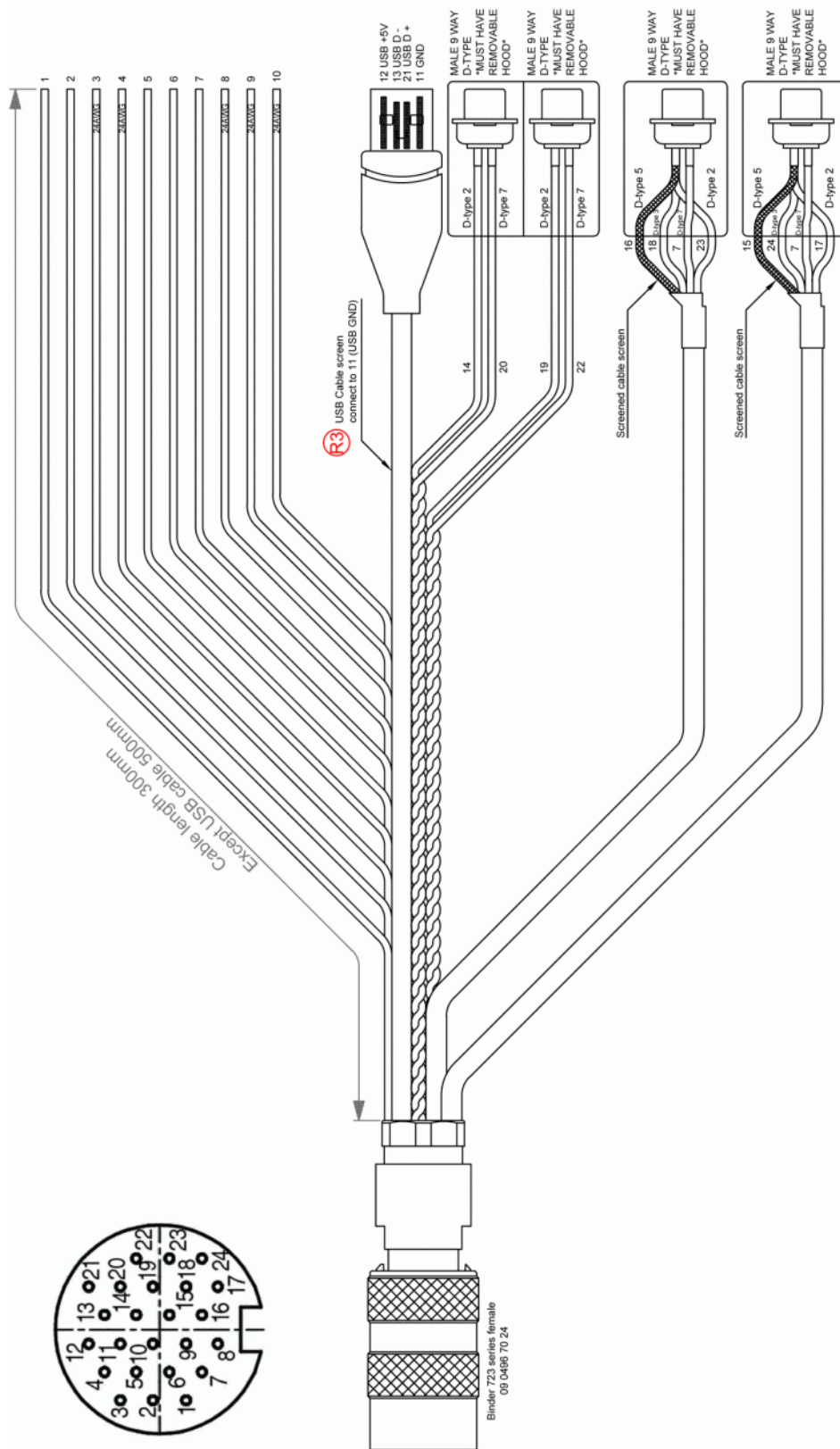
24 way	Name	Description	Connector or wire colour
1	ADC7	0-25v 12 bit analogue input	white
2	ADC5	0-25v 12 bit analogue input	black
3	ADC10 Out2	0-25v input, low side output 0.5A	red-black
4	ADC 9 Out1	0-25v input, low side output 0.5A	gray
5	ADC6	0-25v 12 bit analogue input	blue
6	ADC8	0-25v 12 bit analogue input	green
7	12v	12v supply for serial peripherals	RS232-1-2 d-type plug pin 7
8	5v ref 2	0.5A reference output	brown
9	ADC12 Out4	0-25v input, low side output 0.5A	red
10	ADC11 Out3	0-25v input, low side output 0.5A	orange
11	GND	USB GND	USB connector
12	USB5V	USB 5v	USB connector
13	USB D-	USB Data -	USB connector
14	CAN1 L	CAN port 1 low	CAN[1] d-type plug pin 2
15	GND	Serial port 1 GND	RS232[1] d-type plug pin 5
16	GND	Serial port 2 GND	RS232[2] d-type plug pin 5
17	RS232 2 in	RS232 port 2 RX	RS232[2] d-type plug pin 2
18	RS232 1 out	RS232 port 1 TX	RS232[1] d-type plug pin 3
19	CAN2 L	CAN port 2 low	CAN[2] d-type plug pin 2
20	CAN1 H	CAN port 1 high	CAN[1] d-type plug pin 7
21	USB D+	USB Data +	USB Connector
22	CAN 2 H	CAN port 2 high	CAN[2] d-type plug pin 7
23	RS232 1 in	RS232 port 1 Rx	RS232[1] d-type plug pin 2
24	RS232 2 out	RS232 port 2 Tx	RS232[2] d-type plug pin 3

7.2 DL1 PRO 19 Way Cable

Cable length 300mm

Heatshrink boot

Modified connector housing.
Hole enlarged to fit all the required cables.

Binder 723 series female
09 0462 70 19

19 way	Name	Description	Connector or wire colour
A	ADC1	0-25v 12 bit analogue input	black
B	ADC2	0-25v 12 bit analogue input	brown-black
C	GND	Sensor ground	red-black
D	12v	System power 9-24v	figure-8 cable black-white
E	GND	Power ground	figure-8 cable black
F	High level RPM	1kHz HT input	orange-black
G	RPM_GND	See Connecting RPM	yellow-black
H	GPS LED	Active low GPS LED driver (20mA	green-black
I	5v ref 1	0.5A Reference output	blue-black
K	Frequency in 3	5-12v input >2khz max (100k pulldown)	grey-black
L	Frequency in 4	5-12v input >2khz max (100k pullldown)	white-black
M	ADC4	0-25v 12 bit analogue input	brown
N	ADC3	0-25v 12 bit analogue input	red
O	Power LED	Active low Power LED driver (20mA)	orange
P	Low level RPM	5-15v Trigger - ECU or Tacho use	yellow
R	Logging LED	Active low Logging LED driver (20mA)	Green
S	Status LED	Active low Status LED driver (20mA)	blue
T	Frequency in 1	5-12v input >2khz max (100k pullldown)	gray
U	Frequency in 2	5-12v input >2khz max (100k pullldown)	white

8 Live Speed option

The DL1PRO and DL1WP models are available with optional output of live speed. This option takes the data from the GPS system and the built in accelerometers and combines them using a kalman filter to provide a real time output of speed with is updated at up to 100Hz and which is resistant to brief GPS outages such as bridges or buildings.

To use the option, the DL1 is installed in the standard way, paying particular attention to align and level the unit correctly in the car, and with the GPS antenna on the car roof.

The output rate of the live speed output is set in the serial output, the logging rate, and the CAN output rate as needed.

Typical applications are general speed testing, a traction control signal for an ECU or a live speed signal to other instrumentation in the vehicle. If higher accuracy is required, then please refer to the SPEEDBOX product.
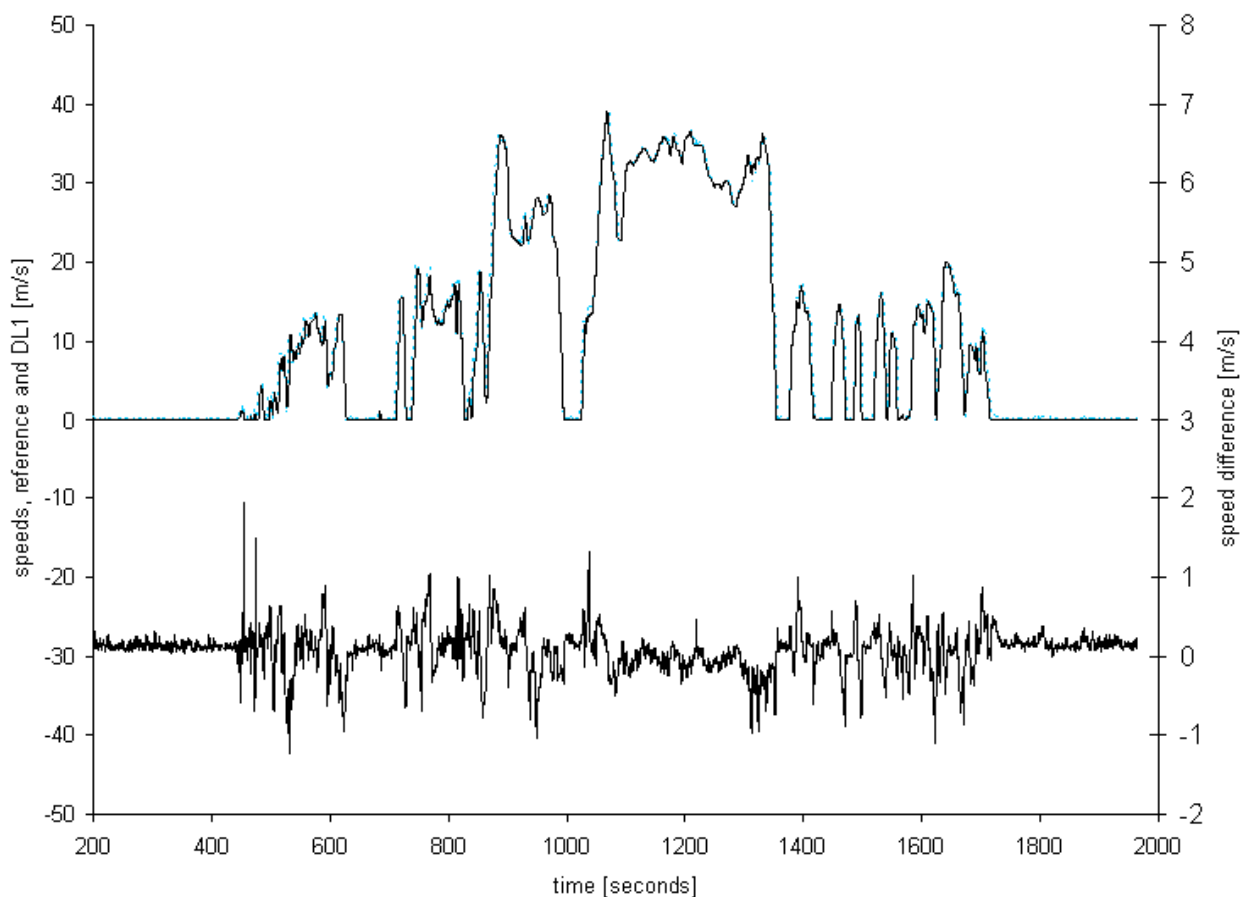
8.1 Live speed accuracy

To validate the accuracy of the DL1s live speed output it was installed in a road car along side a production SPEEDBOX unit which was used as a reference. The speeds measured by both units were compared for 2 hours of driving in a mixture of rural and urban conditions. The distribution of errors are shown below, for this extended test the standard deviation of the errors was 0.21m/s. Based on this it would be expected that for a test track conditions the error would be significantly lower, and for very built up urban errors, or testing with significant GPS outages (e.g. tunnels) the results would be worse.

Speed error in m/s
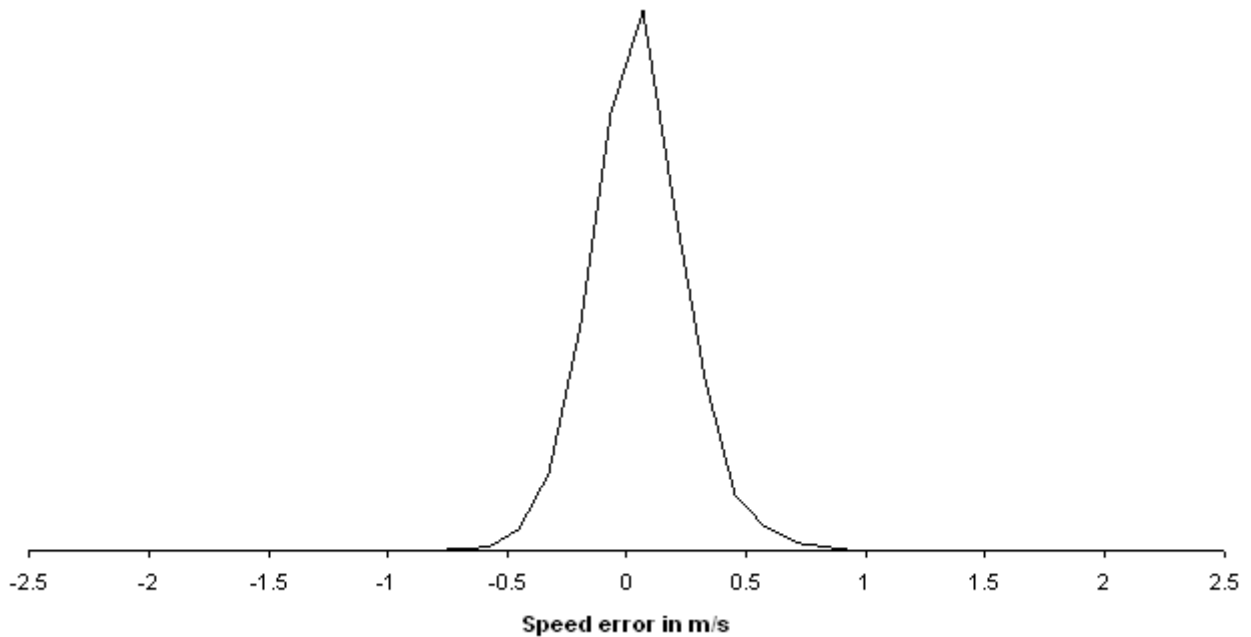
9 How Do I?

9.1 How do I manually start and stop logging on my DL1 PRO?

When the DL1 PRO is not logging, the "logging" LED will not be illuminated. Make sure that the status LED is flashing, this indicates that the unit has a valid memory card inserted and is ready to start logging. If the LED is not lit, check that the memory card is not full and is correctly formatted.

Press the Start/Stop Logging button. The Logging LED will illuminate and logging will start. To stop the logging, press the button again.
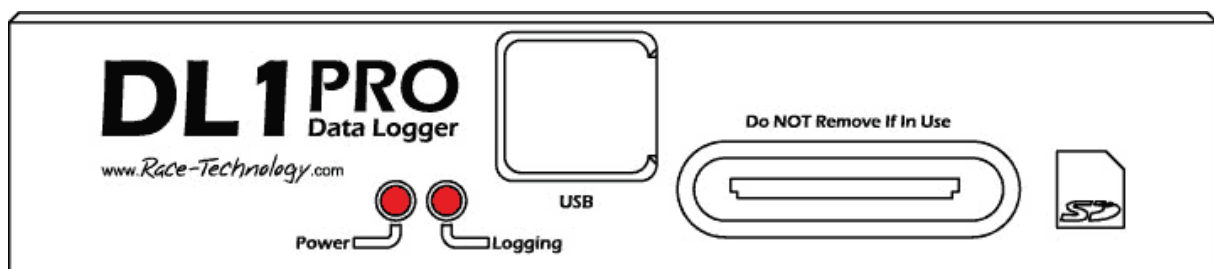
9.2 How do I connect a start/stop switch with indicator?

To connect a start/stop switch, wire as shown in the diagram below:
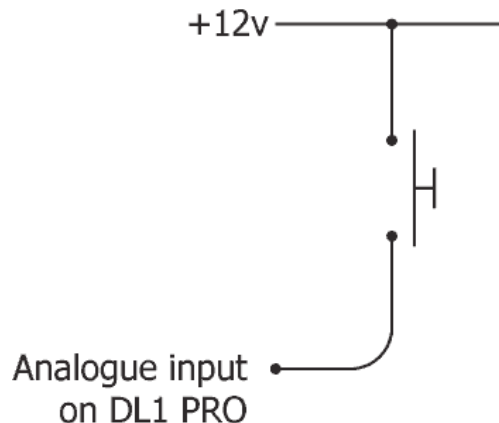
The "start/stop" button gives the driver the option of starting/stopping logging on the DL1 without having to press the button on the unit itself. Unlike the sensors that may be connected to the DL1, the start/stop button has three connecting wires, and needs to be connected differently.

Step 1:

Connect the wires on the start/stop button to the black, block connector that is on the end of the DL1 power cable. Once the block connector is plugged into the back of the DL1, the orange writing on the unit will tell you where to put the wires:

- Red should be connected to **12v**
- Blue should be connected to **A8**
- Yellow should be connected to **A12**

Step 2:

The DL1 will need to be configured to use Analogue 8 as the trigger input, and to use Analogue 12 as the status output. For instructions on how to do that see here:

- Configuring inputs on the DL1 PRO

http://www.race-technology.com/wiki/index.php/DL1MK3Configuration/AnalogueInputs

- Configuring output drivers on the DL1 PRO

http://www.race-technology.com/wiki/index.php/DL1MK3Configuration/OutputDrivers

Once the button is properly connected, test that it is working. A red LED should light up in the buttons' centre to show when the unit is logging.

9.3 How do I connect a logging indicator?

To connect a logging indicator, wire up as shown in the diagram below:
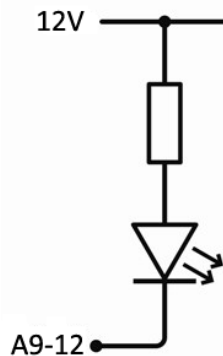
As well as wiring up the LED, the DL1 will need to be configured to use one of the low side driver outputs as a status output. See the following page for more information:

http://www.race-technology.com/wiki/index.php/DL1MK3Configuration/OutputDrivers

9.4 How do I connect a 1 or 2 wire sensor to the DL1 PRO

The DL1 PRO requires a voltage input on it's sensor inputs that goes from a minimum of 0v to 12v maximum.

For sensors with 3 wires, typically you have:

- voltage supply
- 0v or ground
- signal out

Note that in some cases the ground connection maybe via the body of the sensor in which case there will only be 2 wires coming out of the actual sensor - however this is relatively unusual.
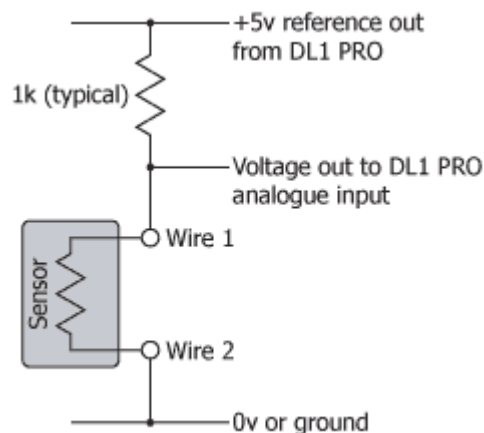
In this case the signal out can be connected directly to the one of the analogue inputs on the DL1 PRO.

For sensors with 1 or 2 wires, it is slightly more complicated.

For a sensor with 2 wires it is typically a variable resistor with both ends of the resistor available:
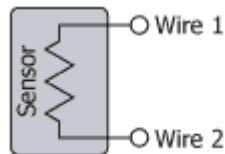
In this case we need to use a "pull up" resistor to convert the changing resistance to a changing voltage:

1 wire sensors are the same, but in this case the 2nd wire on the sensor is ground and made via the sensor body earthing to the engine casting etc.
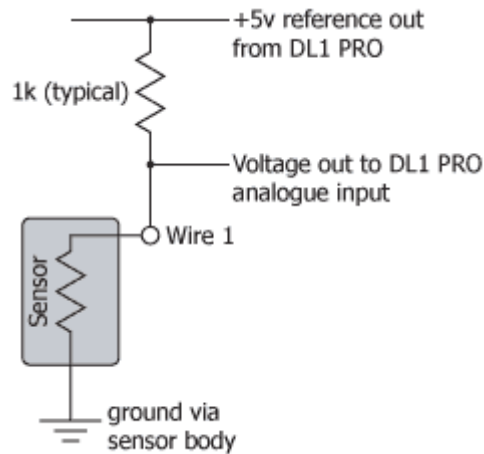
Once the sensor is connected to the DL1 PRO with the pull up resistor then it can be calibrated in the normal way. For more information on this, please refer to this section.

http://www.race-technology.com/wiki/index.php/HowDoI/ConnectMyOwnSensor

9.4.1 Choosing a value for the pull up resistor

Please note that it is the installer responsibility to choose the correct value of "pull up" resistor when using 1 or 2 wire sensors with Race Technology products. For a particular sensor type there is no "correct" value of resistor however it must be selected to be "somewhere near" to ensure:

- There is a reasonable voltage swing, ideally this wants to be a "few volts" rather than a few "milli volts". A small signal can get easily lost in "noise".

You cannot take to much current from the 5v reference output, depending on the product typically this cannot be more than a total of 100mA.

The table below gives a indication of suitable pull up resistor values:

Sensor	Pull up resistor	Notes
100 ohms or lower (typical for low cost/quality VDO sensors)	100 ohms	With such a low pull up resistor you will only be able to have a maximum of 2 sensors before you use 100mA
Between about 100 ohms to 500 ohms	Between about 100 ohms to 500 ohms 500 ohms	
Between about 500 ohms to "a few" kilohms	1 kilohm (1k)	This is the normal setup for Race Technology Supplied sensors
Between "a few" kilohms and "a few" 10's kilohms	10 kilohm (10k)	

9.5 How do I read data from my ECU and display it on my DASH1/DASH2 or log it on my DL1/DL2?

To do this, you will require a Race Technology ECU interface.

Over recent months we have developed a wide range of ECU interfaces, that are compatible with various models of ECU used in the modern, automotive industry.

Some of our interface units are currently going through Beta testing, whist others are in the development stage.

Please do not hesitate to contact the Race Technology sales department to check the availability of our units for the make and model of your ECU.

You can contact us on:

+44 (0)1773 537620

or email us at:

sales@race-technology.com

9.6 Log DASH2 Analog Inputs

This section explains how to configure the DL1 PRO to receive DASH2 analogue channels

1. Configuring the DL1 PRO to expect the messages on the serial port

   ▪ Open the DL1 PRO configuration software
   ▪ If you already have a configuration for the DL1, load in the relevant configuration.
   ▪ Click on the 'Variable Mapping' tab.
   ▪ Set Analog 17-20 to be from Serial Port 1 Only:

Variable	Serial port 1 only	Serial port 2 only	Any serial port	Take from units built in inputs and sensors	Calculate from a combination of inputs using equation	Custom equation
analog 8	○	○	⦿		○	
analog 9	○	○	⦿		○	
analog 10	○	○	⦿		○	
analog 11	○	○	⦿		○	
analog 12	○	○	⦿		○	
analog 13	○	○	⦿		○	
analog 14	○	○	⦿		○	
analog 15	○	○	⦿		○	
analog 16	○	○	⦿		○	
analog 17	⦿	○	○		○	
analog 18	⦿	○	○		○	
analog 19	⦿	○	○		○	
analog 20	⦿	○	○		○	
analog 21	○	○	⦿		○	
analog 22	○	○	⦿		○	
analog 23	○	○	⦿		○	
analog 24	○	○	⦿		○	
analog 25	○	○	⦿		○	
analog 26	○	○	⦿		○	
analog 27	○	○	⦿		○	
analog 28	○	○	⦿		○	

If you wish to take RPM data from the DASH2, scroll up and set the RPM to also come from the same serial port. If the option is greyed out for taking RPM data from the serial you will first need to disable the internal RPM sensor on the DL1 PRO.

2. Set the storage rate for the data on the Flash Card Storage tab.

Flash card storage

Variable Storage		File Namimg	
Data messages	**Maximum sample rate**		
Analogue 5	100Hz		
Analogue 6	100Hz		
Analogue 7	100Hz		
Analogue 8	100Hz		
Analogue 9	100Hz		
Analogue 10	100Hz		
Analogue 11	100Hz		
Analogue 12	100Hz		
Analogue 13	100Hz		
Analogue 14	100Hz		
Analogue 15	100Hz		
Analogue 16	100Hz		
Analogue 17	25Hz		
Analogue 18	25Hz		
Analogue 19	25Hz		
Analogue 20	25Hz		
Analogue 21	100Hz		
Analogue 22	100Hz		
Analogue 23	100Hz		
Analogue 24	100Hz		

○ Set all channels storage rate (Except GPS channels)   ○ Set GPS channels storage rate   Disabled

Set

Ok   Cancel

3. Save the configuration file and transfer it to the DL1 PRO.

9.7 Why won't my DL1 PRO work?

There may be a number of reasons why the DL1 PRO will not start logging. You should check for the following things:

- Is your SD card full?
- Is your SD card correctly formatted? (It must be FAT, FAT32 or FAT16, and NOT NTFS)
- Is the Status LED flashing on the front of the unit
- Is the unit configured to automatically start/stop logging?
- Has your SD card been dropped/damaged/exposed to high temperatures?

These are the most common faults. If you have eliminated these, and your DL1 PRO will still not log, please visit the support page on the website for further advice:

http://www.race-technology.com

9.8 Connect an RPM input

The high level RPM input on the DL1 PRO can be used to connect to the negative terminal of an ignition coil. The Red wire must connect to the rH terminal, and the black wire to the rL terminal.

To configure the DL1 PRO for the RPM input, start the configuration software and go to the RPM inputs tab.

RPM Inputs

Channel name	Maximum rate of change [RPM per second]	Smoothing filter time [seconds]	Pulses per revolution	Enabled/Disabled
High RPM	0	0	1	☑
Low RPM	0	0	1	☐

Ok   Cancel

- Enable the High RPM input, set the number of pulses per revolution, depending on the ignition system you are using. If you are having issues with noise on the signal you can also set filtering for smoothing and maximum rate of change here.
- Click on the Flash Card Storage tab and set the speed at which the RPM input will be logged to the memory card.

- If you are using the serial output of the DL1 PRO to drive a dashboard or other display, also set up the output rate for the Output Serial Data tab in the same way.
- Save the configuration file and load it on to the DL1 PRO.

9.9 How do I find out why my logger stopped logging during a race?

Step 1: Load up the data that was logged into the analysis software, and enter the "Run Manager" feature in the data menu (this can be found in the top, left hand corner of the screen).
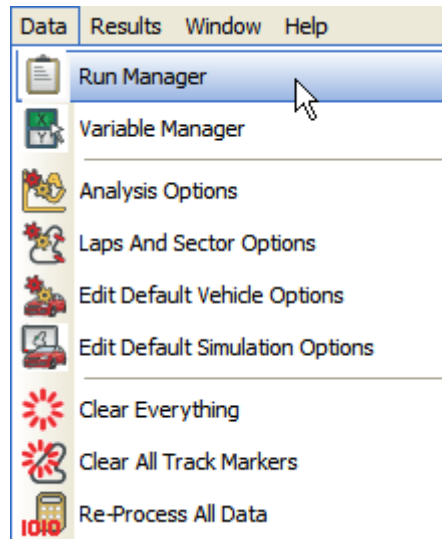
Step 2: this will open up a window. At the bottom of the window, under the heading "Run Details", you will find a breakdown of the details of the run. The reason why the unit stopped logging data will be stated at the end of this breakdown. In this example, the stop logging button was pressed.
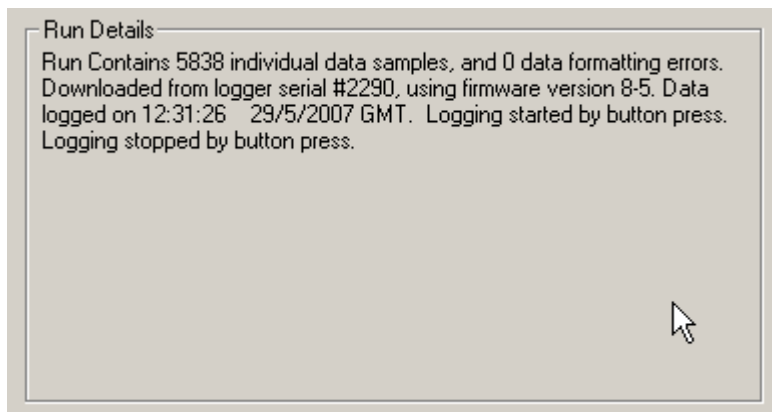
10 Frequently Asked Questions

10.1 What is the difference between the DL1 PRO and the DL1 MK1/2?

The DL1 PRO is a complete redesign of the DL1. It uses the same GPS receiver, accelerometer, and gyro, but pretty much everything else has been changed. It now operates with SD card instead of Compact Flash, it has a much more powerful processor, more analogue inputs, output drivers, dual serial ports.

Specification	DL1 MK2	DL1 PRO
GPS	5Hz, 20Hz optional	5Hz, 20Hz optional
Analogue inputs	8	12*
Frequency inputs	4	4
Accelerometers	3 axis	3 axis
Serial ports	1	2
CAN ports	0	1
USB ports	0	1
6G accelerometer option	yes	yes
Input voltage	10-15v	9-24v
Reference output	5v 50mA	5v 500mA x 2
Output drivers	0	0.5A low side driver x 4 *
Memory card	Compact Flash, up to 1GB	SD or SDHC, up to 32GB
Enclosure	Extruded aluminium with carbon fibre front and back panels	Injection moulded ABS with polycarbonate front and back panels
Auto start / stop	Limited to analogue inputs and speed	Can use any channels of data
RPM input	High and low level inputs	High and low level inputs
Gyroscope	Optional	Optional

* Some features share pins on the connector, so not all can be used at the same time.

* Not all features are standard

10.2 What is the maximum g-force/speed that can be measured?

The standard DL1 is configured for a maximum of 2g acceleration, 6g is a factory option. The maximum measurable speed is about 1000mph.

10.3 How often do you get GPS speed updates?

The GPS system calculates speed every 200ms (5 Hz), however this data is combined with the data from the accelerometers to calculate speed 100 times every second with very high accuracy.

10.4 How often do you get GPS position updates?

The GPS system calculates position every 200ms (5 Hz), however this data is combined with the data from the accelerometers to calculate position 100 times every second with very high accuracy.

10.5 How accurately is speed measured?

With average GPS reception, speed accuracy is about 0.1mph (or 0.1% if greater) when you are just driving along at fairly constant speed, and about 0.2mph (or 0.1% if greater) during fast accelerations or braking. The only exception is at very low speeds (under 10mph) where the error increases to about 1mph. Do not be fooled by exaggerated claims from other manufacturers... this is as good as it gets! In contrast, a standard wheel speed pickup is only accurate to about 4% at constant speeds, and under high accelerations or braking, the error increases up to about 20%.

10.6 How accurately is position measured?

With good GPS reception, positional accuracy is about 3m (CEP).

10.7 What happens to the data if you drive under a bridge/tunnel/trees etc?

Because speed and position are calculated from both the GPS data and accelerometers, even if the GPS data "disappears" for a number of seconds, you won't be able to tell from the data in the software. Only if GPS data disappears for an extended time (20+ seconds) will the data start to degrade noticeably.

10.8 Where can I buy it?

Check the following page for an up-to-date list of stockists:

http://www.race-technology.com

10.9 Is it upgradeable?

The DL1 PRO is upgradeable in a number of ways; please check the following page on the web for an up-to-date list of options. Software and firmware updates, including new features, are freely available as we introduce them.

http://www.race-technology.com

10.10   How much data can you log to an SD card?

The DL1 logs about 25MB of data per hour, so for a 8GB card you could get up to about 2 weeks of data

10.11   Will it work with any SD card?

Whilst we cannot guarantee that the DL1 PRO works with all SD and SDHC cards, we have successfully tested many makes and sizes of SD cards, we haven't yet found one it won't work with.

10.12   Is it easy to use?

The DL1 PRO has one button to start and stop logging, how much simpler could we have made it? We have kept the software as simple as possible whilst making it as flexible as we can to ensure that you can do what you need to with it. As with all computer programs, the first time you use it there is a lot to take in - after you've become familiar with it, you will be able to analyse data quickly and efficiently.

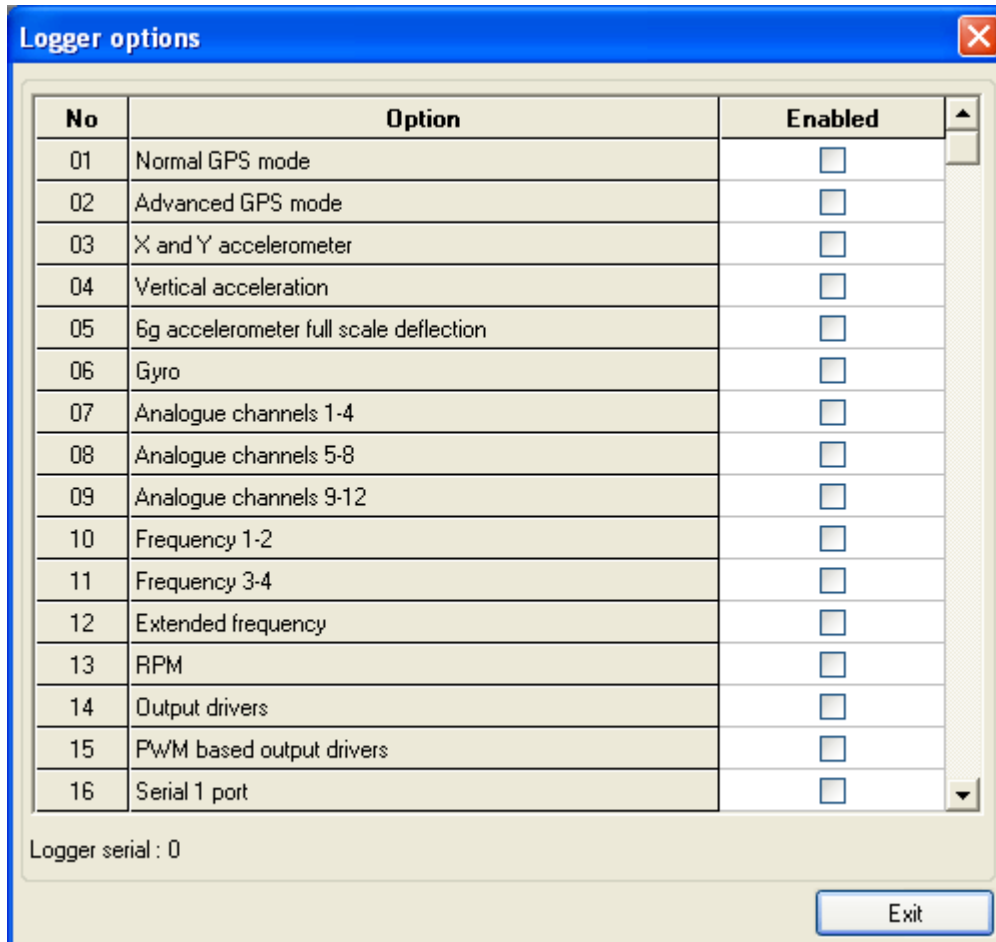## 10.13   What specification of computer is required?

As with most programs, the analysis software will run on just about any PC with windows 2000 or later – however, the faster the PC, the faster the program will run. The main restriction is the memory required for long runs; typically we recommend that your PC has an absolute minimum of about 30MB of memory installed for each hour of data loaded. The PC also requires some means of downloading the data from the SD cards, there are many options available – normally a USB reader is most convenient.

10.14   Is the DL1 PRO reliable and well made?

The DL1 PRO is absolutely class leading in terms or component quality, build quality and reliability – this is a very high quality professional instrument, entirely designed in-house and manufactured in England. The unit carries the normal 12 month guarantee against manufacturing defects.

10.15   What options does my DL1 PRO have installed?

To find this, open the DL1 PRO configuration software, connect to the DL1 PRO through the USB port in the usual way to read the configuration data, then go to Options / Logger options. The list of available and enabled options will be displayed:

Logger options

No	Option	Enabled
01	Normal GPS mode	☐
02	Advanced GPS mode	☐
03	X and Y accelerometer	☐
04	Vertical acceleration	☐
05	6g accelerometer full scale deflection	☐
06	Gyro	☐
07	Analogue channels 1-4	☐
08	Analogue channels 5-8	☐
09	Analogue channels 9-12	☐
10	Frequency 1-2	☐
11	Frequency 3-4	☐
12	Extended frequency	☐
13	RPM	☐
14	Output drivers	☐
15	PWM based output drivers	☐
16	Serial 1 port	☐

Logger serial : 0

Exit

10.16   Can I add extra options to my DL1 PRO?

All options except for the Gyro can be added by a software update file. If you wish to purchase any options please see read the following section for the list of options and prices.

http://www.race-technology.com/dl1_2_27.html

11 DL1 PRO Software

11.1 The Analysis Software

The analysis software is the main package that is supplied with all Race Technology products capable of logging data. The analysis package is used to load, view and analyse the data using a variety of tools. For more information on the Analysis software read the following section:

http://www.race-technology.com/wiki/index.php/Software/MainAnalysisSoftware

11.2 The Realtime Monitor

The realtime monitor software is intended to view the serial output of our products in real time. The monitor software is particularly useful for checking that the hardware is installed correctly, and that all the signals are operating correctly. For information on the real-time Monitor software, read the following section:

http://www.race-technology.com/wiki/index.php/Software/Monitor

11.3 The Lite Monitor

The Lite Monitor can be used to display live serial data from a number of RT products, including the DL1, AX22 and SPEEDBOX. More information on the Lite Monitor software can be found here:

http://www.race-technology.com/wiki/index.php/Software/LiteMonitor

11.4 The Configuration Tool

The configuration software is required to read or write the configuration on your DL1 PRO, or to reflash it through the USB port. For information on the Configuration tool, read the following section:

http://www.race-technology.com/wiki/index.php/Configuration/DL1MK3Configuration

11.5 Re-Flashing Your Unit

At Race Technology, we are constantly improving our products. This means that, from time to time, you may wish to re-flash your unit with the latest firmware.

For information on re-flash your unit, read the following section:

http://www.race-technology.com/wiki/index.php/ReflashingDataLoggerDevices/ReflashingTheDL1MK3