Race Technology

DL1

Instruction manual

Version 1.0

www.race-technology.com

Table of Contents

1 INTRODUCTION 4

1.1 WHAT IS THE DL1? 4
1.2 WHO IS THE DL1 DESIGNED FOR? 4
1.3 WHAT DOES THE DL1 DO? 4
1.4 WHY USE GPS? 4
1.4.1 Track Mapping 4
1.4.2 Speed Measurement 5
1.5 INTRODUCTION TO THE DL1 DATA LOGGER 5

2 ADVICE FOR THE FIRST/INITIAL TESTING OF RACE TECHNOLOGY PRODUCTS 6

3 INSTALLATION 7

3.1 MOUNTING 7
3.2 POWER 7
3.3 CORRECT MOUNTING OF THE GPS ANTENNA 8
3.4 RECOMMENDED MOUNTING POSITIONS 9
3.5 TEMPERATURE AND VIBRATION CONSIDERATIONS 9
3.6 FITTING A CABLE TO THE CONNECTOR USED TO POWER THE DL1 10
3.7 CONFIGURING AND ZEROING ACCELEROMETERS 11
3.8 CONNECTING A SWITCH 14
3.9 CONNECT A LOGGING INDICATOR 15

4 OPERATION 15

4.1 DESCRIPTION OF THE PLUG/CONNECTIONS/LIGHTS ETC ON THE DL1 15
4.2 SAMPLING DATA WITH THE DL1 17
4.2.1 To stop data logging: 17
4.2.2 Advanced operation 17
4.3 REAL TIME OUTPUT 17
4.4 IMPORTANT NOTES ABOUT COMPACT FLASH 17
4.5 IMPORTANT NOTES ABOUT COMPACT FLASH 17
4.6 READING DATA COMPACT FLASH CARDS 18
4.7 AUTOMATIC LOGGING 19
4.8 CONTROLLING SERIAL PORT DATA 20

5 EXTERNAL SENSORS 21

5.1 CONNECTING GPS 21
5.2 EXTERNAL SENSORS 21
5.3 CONNECTING A WHEEL SPEED SENSOR 21
5.4 CONNECT A MAGNETIC LAP STRIP SENSOR 22
5.5 REMOTE START/LOGGING INDICATOR 22
5.6 FURTHER READING 22
5.7 CONNECTING A RPM SENSOR 23
5.8 CONNECTION METHODS 24
5.9 CONNECTING A 1 OR 2 WIRE SENSOR 25
5.10 CONNECTING A WHEEL SPEED SENSOR 27
5.11 DL1/DL2 27
5.12 GENERAL POINTS ON USING WHEEL/SHAFT SPEED SENSORS 27
5.13 FITTING THE SENSOR 28
5.14 USING THE ABS SENSORS ALREADY FITTED TO CAR 28
5.15 NOTES REGARDING ALL EXTERNAL INPUTS 28
5.16 AVOIDING NOISE 28
5.17 INPUT REQUIREMENTS 28

5.18 SUITABLE SENSORS 28
6 READING DATA FROM AN ECU 29
7 FAQS 29
7.1 WHAT IS THE DIFFERENCE BETWEEN THE DL1 AND THE DL90 DATA LOGGER? 29
7.2 WHAT IS THE MAXIMUM G-FORCE/SPEED THAT CAN BE MEASURED? 29
7.3 HOW OFTEN DO YOU GET GPS SPEED UPDATES? 29
7.4 HOW OFTEN DO YOU GET GPS POSITION UPDATES? 29
7.5 HOW ACCURATELY IS SPEED MEASURED? 30
7.6 HOW ACCURATELY IS POSITION MEASURED? 30
7.7 WHAT HAPPENS TO THE DATA IF YOU DRIVE UNDER A BRIDGE/TUNNEL/TREES ETC? 30
7.8 WHERE CAN I BUY IT? 30
7.9 IS IT UPGRADEABLE? 30
7.10 HOW MUCH DATA CAN YOU LOG TO A COMPACT FLASH CARD? 30
7.11 WILL IT WORK WITH ANY COMPACT FLASH CARD? 30
7.12 IS IT EASY TO USE? 31
7.13 WHAT SPECIFICATION OF COMPUTER IS REQUIRED? 31
7.14 IS THE DL1 RELIABLE AND WELL MADE? 31
8 CONNECTIONS 31
8.1 CONNECTIONS FOR DL1 MK1 (FOR MK2 SEE BELOW) 31
8.1.1 Front Panel 31
8.1.2 Rear Panel 32
8.2 CONNECTIONS FOR DL1 MK2 (FOR MK1 SEE ABOVE) 33
8.2.1 Front Panel 33
8.2.2 Rear Panel 33
9 TECHNICAL SPECIFICATION 35
9.1 IDENTIFYING YOUR UNIT 36

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1 Introduction

1.1 What is the DL1?

The DL1 is a state of the art, highly robust, compact "black box" data logging system. Put in the simplest terms, it stores a wide range of vehicle data for later analysis on a computer - the system does not include an in-vehicle display, Race Technology has a number of dashboard solutions available for the DL1.

1.2 Who is the DL1 designed for?

The DL1 was initially 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 do?

The DL1 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.

1.4 Why use GPS?

One of the key features of the DL1 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 Introduction to the DL1 data logger

The DL1 is an all-new, 2nd generation, data logger system from Race Technology. Whilst the DL1 builds on the strengths of our highly successful DL90 system, it is a brand new design in almost every respect. Some of the most noteworthy features include:

- Built in GPS. The new GPS unit is based on our own high accuracy GPS3 technology and calculates position and speed 10 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.
- Built in accelerometers. Built in 3-axis accelerometer with 2g full scale (optional 6g full scale).
- Logging to compact flash memory. Compact flash memory is robust, economical and ideal for use in data logging products. The advantages of using compact flash memory include incredibly fast download times (using a suitable card reader) and huge storage capacities.
- 8 analogue inputs. The DL1 has 8 very high accuracy analogue inputs. One of these inputs is connected to the DL1 power supply input to measure the battery voltage; the other 7 are available for connection to external sensors. All the inputs are 12-bit accuracy (4096 different levels), 3 of the external inputs have a maximum input of 12v, the remaining 4 have a maximum input of 5v.
- 2 RPM inputs. The DL1 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 HT leads or 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.

- Serial data (RS232) input. The serial port can be configured to accept data from an external source - possible examples are data from the engine management unit, OBDii or CAN data (with a suitable adapter).
- Serial data (RS232) output. As well as logging the data to compact flash it is also available from the serial port. We are already working on a dashboard unit which will accept and display this data.
- Lap beacon input. For some applications it is desirable to use a lap beacon, so we have included a dedicated input for it. This channel can also be used as a general-purpose digital input if required.
- Small and tough. It's the most compact logger in it's class, at just 110mm x 75mm x 30mm (4.3" x 3" x 1.2") it can be fitted into the smallest single seater, motorbike or go kart. The DL1 is housed in a 2mm thick aluminium enclosure and carbon fibre end panels for very high impact resistance, we even use stainless steel screws!
- Simple operation. A single button to start or stop logging, it's as simple as that! If the button is inaccessible from the drivers seat then a remote button and status indicator can be added if required.
- Power supply requirements. The power supply to the DL1 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 ensuring its performance is highly robust and stable.
- 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, screw terminals to ensure that connections do not fail at the critical time. Nothing is indestructible - but the DL1 comes close!
- Powerful. The 2 processors in the DL1 are the very latest generation RISC processor that features both higher speed operation and flash upgradability - so as we add new features to the DL1 you can upgrade yours to the latest specification for free.

2 Advice for the first/initial testing of Race Technology products

Race Technology products are designed and produced to the highest standards, but if they are installed or used incorrectly then the results will be disappointing. If the logger is to be used on a race car, then it is strongly suggested that the logger is initially tested and used in a road car, with an absolutely minimal configuration with no external connections and power from the cigar lighter if appropriate. Alternatively this test can be done on the desk if a power supply is available. This will allow you to check the logger is operating correctly and give you the opportunity to get familiar with the software.

Once you've successfully tested the system in a road car, the the next sensible step is to test the logger in the vehicle it is to be installed on/in, but again in an absolutely minimal configuration with no external sensors or connections. Again, once the loggers operation has been checked in this mode, add sensors one at a time checking operation under normal operating conditions.

If the first time you test/use the logger it is installed with all it's sensors and there are operational difficulties then it is going to be very difficult to isolate the problem which is frustrating for all parties involved.

Before proceeding with the installation please read the following sections thoroughly and make sure that the installation requirements are met. If you feel uneasy fitting the logging system to the vehicle, or have very limited experience with electrical systems, you may consider getting the help of an experienced technician to help.

3 Installation

3.1 Mounting

As the DL1 contains accelerometers, it is important that the unit is mounted on a flat, fairly level surface in the vehicle. A small amount of tilt can be compensated for in the software, however, large tilt angles cause loss of resolution and increased noise due to vertical vibration. Click here for instructions on compensating for accelerometer tilt.

Just as importantly, the logger must be mounted "squarely" in the vehicle with the buttons facing towards the back of the vehicle. If the unit is mounted at an angle to the direction of travel for the vehicle, then the unit will be measuring longitudinal accelerations when you are cornering and vice versa. Acceleration errors caused by mounting the unit at an angle to the direction of travel cannot be compensated for, so it is important to get it right.

If the logger is to be fitted permanently in the vehicle, then the logger can be secured using the two mounting lugs supplied. These are fitted by sliding them down the slots in the side of the logger and then screwed into the vehicle. The logger can be removed from the vehicle by loosening the mounting screws which hold the lugs to the vehicle, and then sliding the meter backwards or forwards to remove it from the lugs. There is no need to completely remove the screws. Please note, no screws are supplied with the DL1.

If the logger is to be moved frequently from one vehicle to another, then BluTak™ or Velcro™ tape can be used as an alternative to the mounting lugs, these are supplied with the unit. Alternatively, additional mounting lugs are available from Race Technology. Contact sales@race-technology.com for more information.

3.2 Power

The DL1 Unit is supplied with a cigar lighter based power supply. The centre pin connects to +12V and the outer connects to the vehicle ground. This method is convenient if you are temporarily connecting the unit to the vehicle (typically on a road car).

If you want to permanently wire the DL1 Unit directly into the engine wiring loom, rather than using the cigarette lighter socket, then you must use a fused supply with a fuse rating of no more than 1 amp. It is also highly recommended that the unit has it's own external power switch so it

can be easily turned off. This is to prevent any draining of the battery, or any damage to the unit when the engine is turned on or when the car is being cranked over. It is recommended that you only turn the unit on once the engine is running. It is possible that leaving the DL1 turned on during cranking may corrupt the data in the logger.

Also please note that in all cases the GPS receiver is powered on whenever there is power to the main unit - it does not turn on and off with the main unit, so if the DL1 is left connected to the battery it will flatten it.

Alternatively, the DL1 can be powered from a separate battery if required - this is often appropriate for temporary installations where a cigar lighter is not available. The DL1 requires a minimum of 10v and draw about 100mA-200mA, so the size of the battery should be chosen to give sufficient run time. For example a 1Ah battery would give about 5 hours operation. Because of the current supply requirements only rechargeable batteries should be used, you cannot use disposable batteries. If you do require a battery pack, Race Technology keep a wide selection in stock - call us with your requirements.

Start the vehicle, wait a few seconds then connect the power lead to the unit. After a few seconds, the "Power" LED will come on and the "status" light will flash. Wait for a few minutes to enable the GPS to obtain a good positional lock. Once the receiver has a lock, the GPS status light on the DL1 will start flashing every second, first a slow flash, then a fast "blink" for each satellite it has locked on to. The first time the DL1 is used it will take a while to lock on, subsequent times the process will be faster.

3.3 Correct Mounting of the GPS Antenna

For correct, accurate operation of the GPS receiver it is absolutely essential that the antenna is mounted correctly. No correspondence will be entered into with regard to the system accuracy unless the GPS antenna has been mounted as specified.

There are several important aspects to 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 see 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 must be mounted on the highest point on 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 tapes.
- The antenna must not be subjected to high levels of vibration. Although the antenna is physically robust to vibration, it can and does effect 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 biggest source of radio interference is a petrol 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 or 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 guarantee! - so don't try and fit it into a shut gap that is too small or compress it with a door seal etc.
- 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 the better. It 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 does take a minute or two to lock on to all the available satellites. The time to lock onto satellites varies significantly with conditions but is minimised if the vehicle is stationary.

3.4 Recommended mounting positions

If the vehicle has a roof, this is ideal, alternatively the best mounting position on a car may be the roll over bar or the top of the windscreen. On a motorbike, mounting is a little more difficult, but the best compromise is on a flat area of the fairing, just behind the rider. Poor mounting positions on a car include behind the front or rear windscreens.

Note that 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 accuracy will be disappointing.

3.5 Temperature and Vibration considerations

All Race Technology products are built using the latest surface mount components and the latest methods. All electronics are designed, built, checked and calibrated in the UK under our direct control to ensure that the quality is the best available. However, the electronics can only operate within limits of temperature and vibration.

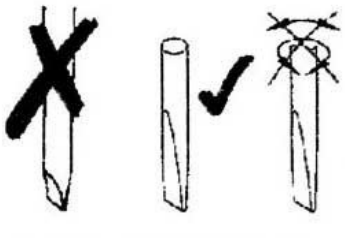
The temperature specification of the electronic components is 0°C to 70°C during operation, -20°C to 85°C during storage. However, there are other considerations that may limit the temperature range. Care must be taken where the enclosure is made of, or contains, plastic.

While the plastics don't melt within the storage temperature range, it can distort significantly. If there is an LCD display on the product this also has a fairly limited temperature range over which it will operate correctly, most notably at low temperatures the display will be very slow to change.

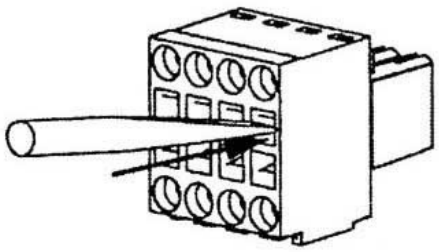
Vibration is another important issue which can effect the long term reliability of the electronics. The exact level of acceptable vibration cannot be readily defined by the user, but a good rule of thumb is that if it looks like it is vibrating, then some sort of isolation would be beneficial. Typically, road cars and bikes don't normally require any additional isolation. Karts and single seater racing cars often benefit from some vibration isolation. The method of vibration isolation depends on the situation, but, generally, rubber mounts do not offer sufficient isolation, something softer and more compliant is required.

3.6 Fitting a cable to the connector used to power the DL1

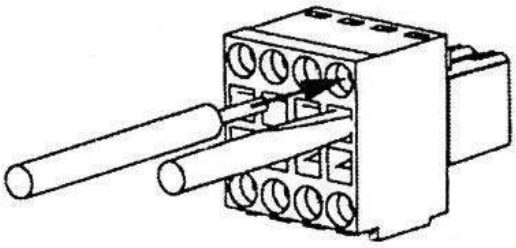
Select a small, Philips, screwdriver.



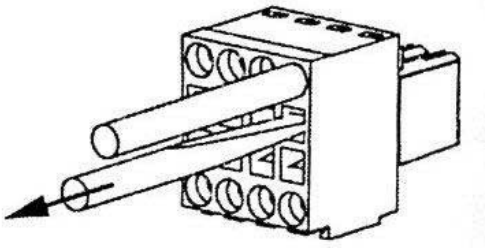
Insert the end of the screw driver into the square aperture, underneath the hole into which you wish to fit the wire. You will need to push the screw driver in quite firmly.



With the screwdriver still in place, insert the stripped and tinned end of the wire.



Now remove the screwdriver, leaving the wire to be gripped in place.



3.7 Configuring and Zeroing Accelerometers

All Race Technology's current products have the accelerometers embedded in the main body of the unit. The accelerometers are designed to measure acceleration in a particular direction. So to measure accelerations accurately it is essential that the logger or meter is accurately aligned in the car. In practice, this means that the unit must be mounted squarely in the vehicle and as level as possible. More details about mounting can be found here.

To allow for situations where the logger/meter cannot be mounted absolutely flat, there are a couple of options in the software that allow the accelerometer readings to be "adjusted" for the offset from horizontal. This is important since, if the accelerometers are not correctly adjusted for angle, then the accelerations will be wrong. For example, if the accelerometer is mounted at 10 degrees from the horizontal, then the acceleration reading will be offset by:

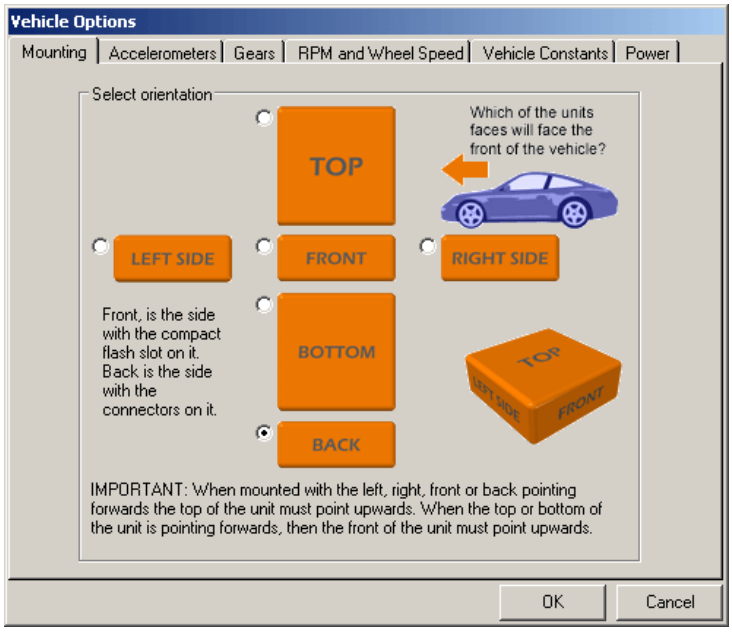
1g x sin(10 degrees) = 0.17g

and sensitivity will be reduced by:

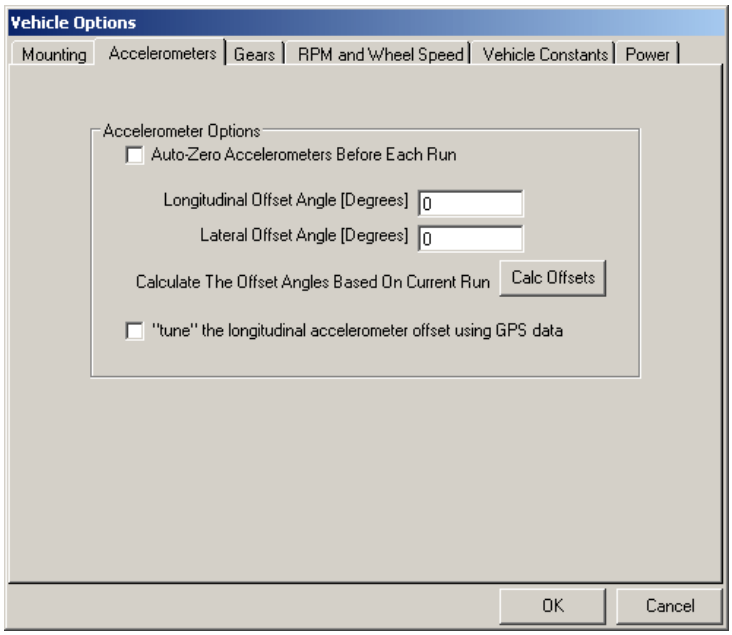
1 - cos(10 degrees) = 2%

Clearly, such a large error on acceleration must be corrected. If in the case above nothing was done to correct the readings, then the acceleration reading would be almost meaningless. Further, the incorrect acceleration readings would also have knock on effects on the other acceleration-derived measurements, such as speed and power estimates and track mapping.

The zeroing options are available in the Vehicle Options. To access them, go to **> Data > Vehicle Options**, and click on the Accelerometers tab. This will show the following:



The Analysis software can be configured depending on the orientation of the DL1 data logger in the car. Simply selecting the correct mounting orientation from the menu will adjust the readings from the accelerometer.



There are two methods that allow the accelerations to be corrected:

- "auto zero" the accelerometers at the beginning of the run.
- manually fix the mounting angles and "hardcode" this into the analysis.

In general, if the logger/meter is moved from the vehicle on a regular basis, then it is probably best to use the "auto zero" option. If the unit is to be permanently mounted in a vehicle, then entering fix angles into the analysis software will probably be more convenient.

If auto-zeroing is enabled, then the analysis software assumes that, for the first second of each run, the vehicle was standing stationary on a level surface and uses this information as a basis for calculating the mounting angle. This information is then used to correct the accelerations for the entire run.

Be particularly careful with the auto-zero option if you trim a run, if the start of the resultant trimmed run contains data with the vehicle moving or not level, then the accelerations will be incorrect.

If auto zeroing is enabled in the analysis and the vehicle is moving or the vehicle not level for the first second of the data then the accelerations (and derived variables) for the whole run will be incorrect.

The second method of entering angles manually obviously requires that you know the angle that the unit is mounted at. The simplest way of doing this is to park the car stationary on a level surface (or as near as possible) and log a few seconds of data. Disable the "auto zero" option in the analysis software and load in the data. With the data loaded and processed click the “auto calculate” option to automatically calculate the mounting angles. Once this has been done these mounting angles can be used for subsequent run analysis and the angles will remain valid unless the unit is moved.

Finally is it worth mentioning about the maximum angle that you should mount the logger/accelerometer at; it's a common question that we get asked, and not one there is a simple answer to. Mathematically it is possible to correct the accelerations for any mounting angle except vertical, but in practice errors in the accelerations reading increase quite rapidly with mounting angle - as a rule of thumb it is best to limit the mounting angle to less than 10 degrees if possible. The problem with large mounting angles is 2 fold. Firstly in the equation above we assumed an offset of 1g x sin(10)=0.17g, but in practice the vertical acceleration is not a constant 1g as the vehicle has some vertical movement due to bumps and vibration. The errors due to the extra vertical accelerations cannot be removed from the data and look like noise on the data - filtering helps, but it does not eliminate the problem. The other problem is that with increasing mounting angles the sensitivity is reduced, so to compensate the acceleration measurements have to be multiplied up increasing noise and decreasing resolution.

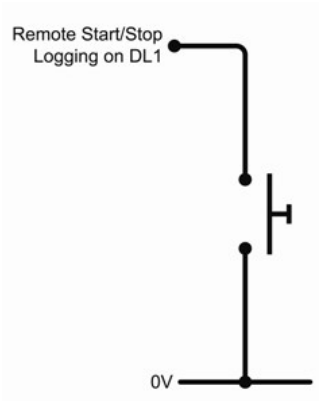
Option to "tune" the longitudinal accelerometer offset using GPS data

This option uses the GPS information to "fine tune" the last remaining error from the accelerometers to ensure that you have the highest possible accuracy. If this option is enabled then the longitudinal accelerations are calculated from both the GPS speed information and the accelerometers, these 2 acceleration levels are compared and based on the result the accelerometers reading are corrected for small offsets. Please note that this option is not intended

as a replacement for manually zeroing the accelerometers as described above - it should be used in addition and is only suitable for removing small residual errors. It is recommended that this option is used when accurate power figures are required.

3.8 Connecting a Switch

To connect a start/stop switch, wire as shown in the diagram below:



How do I connect a start/stop button to the DL1? 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 four 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:

Green should be connected to "GND",

Red should be connected to "12v",

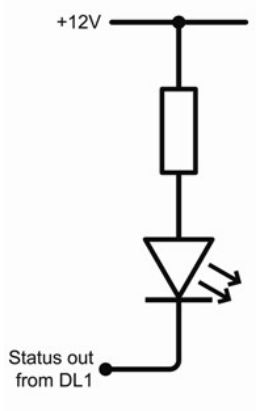
Blue should be connected to "Stat",

and Yellow should be connected to "Trig".

step 2: 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.

3.9 Connect a logging indicator

To connect a logging indicator, wire up as shown in the diagram below:



4 Operation

4.1 Description of the plug/connections/lights etc on the DL1

Front		
	Start/Stop Logging Button	Press once to start logging, again to stop logging.
	Status Light	This light flashes to indicate that the DL1s processor is operating normally
	GPS Lock Light	This light flashes when the internal GPS system is locked on. It flashes once slowly then a quick "blink" for each satellite it has locked onto. Details about mounting the GPS antenna are here.
	Power On	This light illuminates when the DL1 is connected to a valid power supply. Advice about connecting a power supply is here.
	Logging	This light illuminates when the DL1 is actually logging data to the compact flash card. When this light is illuminated YOU MUST NOT TURN THE DL1 OFF, OR EJECT THE COMPACT FLASH CARD!
	Compact Flash Slot	This is the slot for the compact flash card. There are more details here.

Rear		
	Analg 1 [5v]	Analogue input 1, for use with external sensors maximum input 5v.
	Analg 2 [5v]	Analogue input 2, for use with external sensors maximum input 5v.
	Analg 3 [5v]	Analogue input 3, for use with external sensors maximum input 5v.
	Analg 4 [5v]	Analogue input 4, for use with external sensors maximum input 5v.
	Analg 5 [12v]	Analogue input 5, for use with external sensors maximum input 12v.
	Analg 6 [12v]	Analogue input 6, for use with external sensors maximum input 12v.
	Analg 7 [12v]	Analogue input 7, for use with external sensors maximum input 12v.
	Ground	Ground, recommended for grounding analogue sensors.
	Ground	Ground, recommended for grounding analogue sensors.
	+5v Ref out	+5v output, maximum current output 100mA. This can be used for powering external sensors
	+12v Power	ESSENTIAL! This is the power supply for the DL1, it needs 10v-15v and about 150mA minimum. Details here.
	Power Ground	ESSENTIAL! This is the ground for the power supply to the DL1. Details here.
	RPM [5v]	This is the "low level" rpm input that triggers about 5v - this MUST NOT be connected to the ignition coil. Details here.
	Spark In	This is the "high level" rpm input that connects to an HT lead or the low voltage side of the coil. Details here.
	Spark Ground	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.
	Start Logging	Grounding this pin has the same effect as pressing the start/stop logging button on the front of the DL1.
	Lap Beacon	This input can be used with our "yet to be released" lap beacon product for specialist applications.
	Log Status	This pin is switched by the DL1 at the same time as the sample light on the front of the DL1.
	Frequency 1	Frequency input 1, for connection to an external shaft or wheel speed. Triggers at 5v. Details here.
	Frequency 2	Frequency input 2, for connection to an external shaft or wheel speed. Triggers at 5v. Details here.
	Frequency 3	Frequency input 3, for connection to an external shaft or wheel speed. Triggers at 5v. Details here.
	Frequency 4	Frequency input 4, for connection to an external shaft or wheel speed. Triggers at 5v. Details here.
	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.
	Serial Port	This single connector actually connects to 2 serial ports. The first port allows access to the DL1 processor for upgrading the internal firmware and streaming data. The second serial port allows direct access to the GPS module for either updating it's firmware or monitoring it's output directly either for the purposes of checking the GPS functionality or for 3rd party applications e.g. navigation software.

4.2 Sampling Data with the DL1

If used, connect a GPS antenna to the rear of the DL1 Connect the DL1 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 compact flash card into the slot, the status light will stop flashing for a second or 2 then start again when the DL1 is ready to log data Press the "Start/Stop Logging" button on the front of the DL1, the "Logging" light will come on indicating that the DL1 is writing data to the compact flash card

4.2.1 To stop data logging:

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

4.2.2 Advanced operation

You can set the DL1 to automatically start and stop logging based on external inputs or on a timed basis. for more information on how to do this, see the DL1 Configuration software section here.

4.3 Real Time Output

Practically the whole time the DL1 is powered up it is outputting data in real time to it's external serial port, this can be used for a number of applications included a new dashboard product that is being developed, and for checking the logger inputs using the monitor software.

4.4 Important notes about compact flash

click here

4.5 Important notes about compact flash

The DL1/AX22 products can only use 32MB-2GB type I compact flash cards.
The larger and far less common type 2 cards do not fit!

Compact flash is ideal for use in data logging applications as it is robust, cheap and can hold lots of data on a small format. Race Technology has tested a wide variety of cards from various manufacturers and in different sizes - however we cannot guarantee that our products work with cards from all manufacturers and sizes, simply because some cards do not conform to the full compact flash standard. This is not a situation particular to Race Technology; digital camera and MP3 player manufacturers are faced with the same problem. Manufacturers that we have used ourselves include:

- **Kingston**
- **PNY**
- **Crucial**
- **Integral**
- **Viking Interworks**
- **Memory Gold**

If in doubt choose a card from a quality manufacturer that you have heard of, and avoid unbranded media.

There are a couple of other points that should be borne in mind when using compact flash in Race Technology Products:

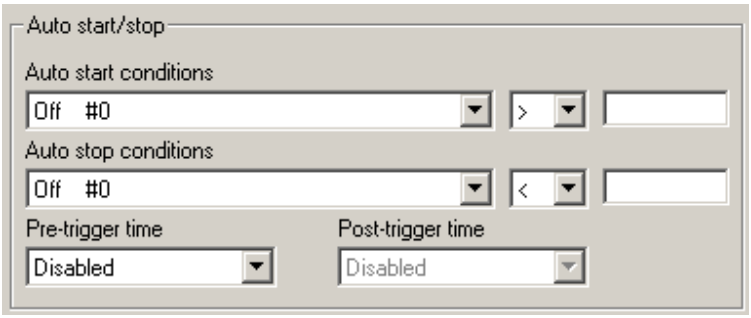
- Because the DL1/AX22 write data using the FAT16 file format only cards between 32MB-2GB can be used, cards outside of the range might not be recognised or may cause unexpected behaviour.
- NEVER remove a file from compact flash card without reformatting the card. Race Technology products have to write the data to the CF card in real time and writing to a card that has had files deleted from it causes delays, which in turn can cause corrupted files and lost data. After deleting a file the card should be reformatted on the PC.
- NEVER add your own files to the CF card. Again this can cause problems similar problems to those above.
- NEVER eject the CF CARD whilst logging data, if you do then you will lose the file that is being written and quite possibly corrupt the entire card. If you do this the card must be reformatted even it appears to be intact.
- Don't turn the DL1/AX22 off until you have stopped logging data to the CF card - if you do there is a risk the data will be corrupted or lost. In this situation there is nothing we can do to recover it.
- We have had problems with compact flash cards losing data or getting corrupted when exposed to temperature extremes or x-rays. The susceptibility of the cards to these problems should be documented by the card manufacture, but you should be aware it can cause occasional problems.

4.6 Reading data compact flash cards

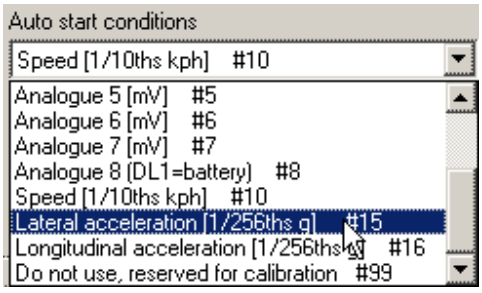
There are many card readers commercially available, the "best" or most suitable depends on your application and computer specification. At the Race Technology offices we tend to use external USB2 readers for desktop use and "PC card" adapters for use with laptops. In either case they are very reasonably priced from your local computer store. Please note that Race Technology doesn't support any card readers, if you have problems installing or using them then please contact the reader manufacturer - not us!

4.7 Automatic Logging

step 1: Enter the DL1 configuration software. In the top right hand corner of the configuration window, you will find the "Auto start/stop" feature.



step 2: To set the DL1 to automatically start logging, enter the drop down menu labelled "Auto start conditions". Now choose the variable that you wish to act as a trigger. (In this example, lateral acceleration has been chosen).

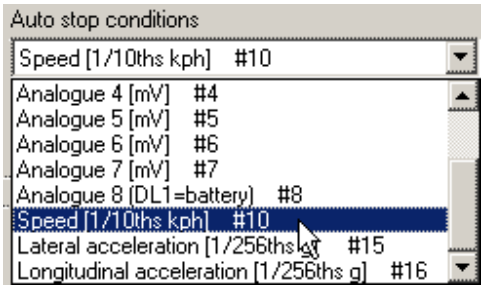


step 3: Using the drop down menu directly to the left of this, select either a left or right pointing arrow. An arrow pointing left will commence logging when inputs drop below a certain level, an arrow pointing right will start logging when inputs exceed that level.

step 4: Enter the value of the input that you wish to act as a trigger in the final box in this row.

In this example, the DL1 will commence logging when lateral acceleration exceeds 25/256ths g.

step 5: A similar process is required to set the DL1 to automatically stop logging. Enter the "Auto stop conditions" menu and select the variable of your choice;



step 6: Define whether you want the DL1 to stop logging when readings decline below or exceed a certain value;

step 7: and define what that value is.

30

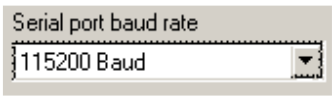
In this example, the DL1 will stop logging when the vehicles speed drops below 3kph.

step 8: When you are satisfied, transfer your configuration to the DL1.

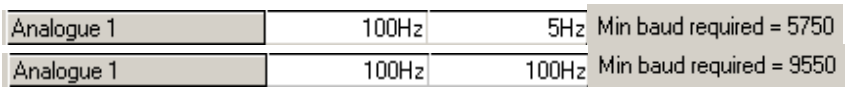
4.8 Controlling Serial Port Data

How do I control what information comes out the DL1 serial input?

step 1: Enter the DL1 configuration software. In the bottom, right hand corner of the window, you will see the miscellaneous section. Here, you will find a drop down menu displaying the serial port baud rate. You may select the baud rate that you desire from this menu.



In the left hand side of the screen you will find a table displaying the sampling rates of each of the analogue channels.



Clicking on the channels will allow you to specify the sampling rate. It must be noted, however, that as the sampling rate increases, so too does the minimum baud rate required.

5 External Sensors

5.1 Connecting GPS

For the DL1, the GPS antenna comes with 5 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 Unit. Once the GPS antenna has been connected, it will turn on automatically when there is power to the DL1 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, [click here]. 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.

5.2 External Sensors

The DL1 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 8 analogue channels (12v input). The DL1 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, one of the pins on the analogue connector side supplies this. You can have more than one sensor attached to the ground and reference output.

If you wish to connect an RPM sensor, see here for more details.

The 12v input is a nominal maximums which the channels are calibrated for, the absolute maximum is about 50% higher. Exceeding this upper voltage limit will cause other channels to read incorrect voltages.

5.3 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.

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

5.4 Connect A Magnetic Lap Strip sensor

The magnetic lap strip pickup is used in kart installations where there is typically an embedded magnetic strip in the track to indicate the start/end of the lap. The metal sensor should be mounted with the flat metal section pointing down towards the track using the bolt provided. There are 3 wires coming from the sensor:

- The black wire that should be connected to the ground terminal of the DL1
- The red wire that should be connected to the +5v output of the DL1
- The white wire that should be connected to the "Lap Beacon" input of the DL1

5.5 Remote start/logging indicator

The DL1 has the option to have a remote start/stop input. On the connectors for the unit, one is labelled Start Logging. If you connect a switch to this, each time you trigger it, it will toggle the logging. There is also an output called Log Status. This output can switch on a small LED, bulb or relay up to a absolute maximum of 50mA. 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 unit is mounted in a position that cannot be seen from the drivers seat.

Please read the following notes regarding all external inputs: click

If you have any queries on how to connect a specific sensor to the unit, email support@Race-Technology.com

5.6 Further reading

For more information, click on the following links:

- Reading data from the ECU
- Connecting an RPM input
- Fitting a cable to the black connector that is used to power the Mk II DL1

5.7 Connecting a RPM sensor

IMPORTANT:

*** If you connect a "high level" signal to the "low level" RPM input, you will damage the DL1**
*** Never connect anything directly to the output of the coil, this will almost certainly destroy the DL1!**

In this file you can learn how to connect an RPM to the Data Logging Units. Information will also be given on connecting the RPM to your vehicle. Please check the RPM connections carefully. Due the power output of the ignition system, it is possible to damage the data logger unit if it is connected incorrectly. Damage caused by incorrect installation is not covered by the product guarantee.

DL1

For more information on the DL1 connectors, click here.

The DL1 can be used with either a "high level" input or a "low level" input for maximum flexibility. In both cases, the maximum frequency is in excess of 1kHz so even if you are detecting on the king lead of a V8 with a distributor then the maximum is >12000rpm.

If you are detecting the RPM using the high level pickup, then it should be connected to the DL1 on its "Spark In" and "Spark Gnd" inputs. Alternately, the DL1 can detect RPM from a low level source by connecting to the "RPM [5v]" input. This is suitable for connecting to RPM outputs from an ECU or Tacho signal. This input requires a minimum input of 5v to trigger it, but it is protected up to the battery voltage (15v).

Because the number of different ways that you can connect the DL1 to RPM sources, there are no "standard" leads shipped with our products - if you require a particular lead for you application, then please contact sales@Race-technology.com

Please be aware that it's simply impossible for Race Technology to answer questions like:

- has my ECU got an RPM output, and is it suitable
- which wire should I use on my coil pack or sensor

We just don't have access to that type of information. If you are unsure then the Internet - particularly car user forums - is a great resource that we would refer you to use.

5.8 Connection methods

Type of RPM pickup connection	Input Used	Reliability. (*=Bad, *****=good)	Ease of installation. (*=difficult, *****=simple)	Guaranteed available including during over reving etc	Additional notes
Dedicated tacho output from ECU or ignition box (not a feed to a coil pack)	low level	****	*****	yes	
Clip attached to an HT lead on a distibutor or "remote coil pack" distributorless system	high level	*	**	no	Requires care and maybe experimentation to get a 100% reliable signal
Attached to a coil on a distributor system	high level	**	***	no	
Attached to a low power signal on a "remote coil pack" or "coil on plug" system	low level	**	****	no	
Attached to a high power signal on a "remote coil pack" or "coil on plug" system	high level	**	***	no	
Connected to the switched side of a fuel injector	low level	***	****	no	
Using a wheel speed sensor to detect RPM directly	low level	*****	*	yes	
Output from a flywheel pickup	low level	*****	****	yes	must be a hall effect sensor (not an inductive pickup), and only suitable for installations up to about 20 teeth
Output from a camshaft pickup	low level	*****	****	yes	must be a hall effect sensor (not an inductive pickup)

5.9 Connecting a 1 or 2 wire sensor

The DL1 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:

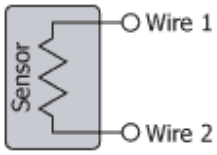
- voltage supply
- 0v or ground
- signal out

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.

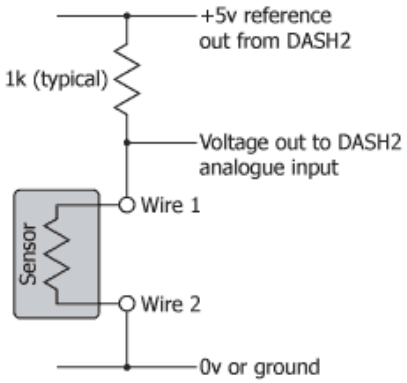
In this case the signal out can be connected directly to the one of the analogue inputs on the DL1.

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

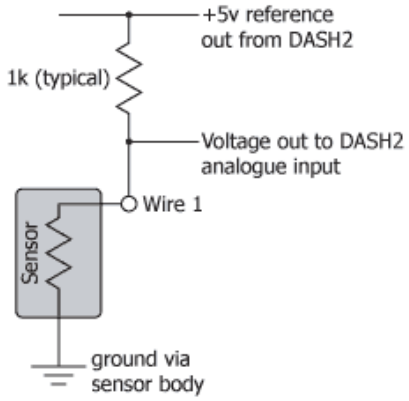
For a sensor with 2 wires it is typically a variable resistor with both ends of the resistor available:



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 with the pull up resistor then it can be calibrated in the normal way. For more information on this, please refer to this section.

- Connecting my own sensor

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)	

5.10 Connecting a wheel speed sensor

Disclaimer: Please note that Race Technology Ltd takes no responsibility or liability, explicit or implied, for the customer inappropriately fitting any type of sensor to a vehicle. Further, any modifications and or additions to the vehicle are done completely at the customers own risk. Any advice given by Race Technology is given on an as-is basis and is simply our opinion - it remains the customers responsibility to carry out work to a suitable standard and in a safe manner. If in doubt please get a professional to carry out the work, particularly in areas that may have safety implications.

5.11 DL1/DL2

The DL1 has 4 separate frequency inputs that can be used for wheel speeds or shaft speeds as required. In the software you are given complete freedom of what to use each input for - so there is no particular recommended use for each. Each of the inputs has a 100k pull down resistor and requires an absolute minimum of about 5v to trigger the input, no more than battery voltage (12v nominal) should be applied. The DL1 can record up to about 2kHz on it's frequency inputs based on a square wave input. If you require more than this contact support@race-technology.com for instructions on how to do so. The DL1 has an internal filter to prevent excessively high frequencies being recorded, this filter requires a minimum low time of around 0.25mS to "reset" - so if the signal input is normally a low voltage and only goes high briefly when sensing a pickup on a wheel for example then the maximum frequency would be about 4KHz, alternatively if the signal is normally a high voltage but is pulled down briefly then the maximum frequency will be very low, or the signal might not be sensed at all - so this situation should be avoided.

5.12 General points on using Wheel/shaft speed sensors

There are 2 types of wheel speed sensor that can be supplied by Race Technology:

- Hall effect - This type of sensor senses a metal moving within a few millimetres of it and outputs a voltage pulse. This type of sensor is "active", i.e. it requires a voltage supply to it for it to work. The sensors supplied by Race Technology run off +5v and this can be taken from the units external voltage output. The advantages of the hall effect switches are that they are very robust and can be triggered by a moving wheel bolt (or similar), they don't require magnets attached to the wheels. The disadvantage is that they are a bit more expensive than other types.
- Reed switch - This type of sensor is really just a mechanical switch that operates with a magnet. This sensor is "passive", i.e. it doesn't require a power supply of any kind. This type of sensor is cheaper, but required that a magnet is fitted to a moving part for it to sense - so it can be more difficult to fit and test.

NOTE: It is not possible to use inductive type proximity detector switches. This type of sensor normally has an analogue output which is unsuitable for use with either the DL90, DL1 or DL2 without some additional external signal processing.

5.13 Fitting the sensor

Typically hall effect sensors are fitted to detect a moving bolt, common examples would be detecting the bolt on the back of a brake disk or on a drive-shaft. The bolt MUST pass within just 2mm of the face of the sensor - any more than this and the sensor will not work at low speeds. Also make sure that the sensor is mounted securely and cannot vibrate and touch any moving parts. If possible mount the sensor in a position that protects it from road debris that might damage it.

Route the wires from the sensor to the logger using suitable triple core wire, shielded if possible.

5.14 Using the ABS sensors already fitted to car

It is possible on some cars to use the existing ABS sensors to detect wheel speed - this should only be done on race cars where the ABS unit has been removed/disabled and if you are absolutely sure that the signals are appropriate type. Don't touch any of the ABS sensors if you are in any way unsure of what you are doing - please do not contact us for assistance in attaching to the ABS sensors, for obvious reasons we cannot advise on how to proceed.

5.15 Notes regarding all External Inputs

5.16 Avoiding noise

The automotive environment is electrically very noisy and without care the signals that you log will also be noisy. There are a couple of things that you can do to reduce this noise to a minimum. Firstly don't run long lengths of wire around the car, if you do need to run a long length of cable then use "shielded twisted pair" cable and use the other cable to connect to earth at the logger and on the sensor.

5.17 Input requirements

All the DL# units are equipped with high impedance inputs, meaning they be connected to most analogue inputs without causing a problem. The input impedance of all the inputs is over 100kohm.

5.18 Suitable sensors

There are literally 1000's of sensors that can be used with the DL# units, as long as they output a few volts then they can normally be used. Sensors that output current (5-20mA loop for example) are not suitable for direction connection. Sensors with very low outputs for example thermocouples are also unsuitable for direct connection. If you require advice on supplying or connecting sensors then please contact Race Technology.

6 Reading data from an ECU

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

7 FAQs

7.1 What is the difference between the DL1 and the DL90 data logger?

The DL1 is based around some of the same technologies as the DL90 and they share the same physical dimensions - but that is where the similarities end. All the components inside the DL1 are new and there is no way to physically upgrade a DL90 to a DL1.

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

The standard DL1 is configured for a maximum of 2g acceleration, 10g is a factory option. The maximum measurable speed is about 1000mph.

7.3 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.

7.4 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.

7.5 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%.

7.6 How accurately is position measured?

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

7.7 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.

7.8 Where can I buy it?

Check www.Race-Technology.com for an up-to-date list of stockists

7.9 Is it upgradeable?

The DL1 is upgradeable in a number of ways; please check www.race-technology.com for an up-to-date list of options. Software and firmware updates, including new features, are freely available as we introduce them.

7.10 How much data can you log to a Compact flash card?

The DL1 logs about 18MB of data per hour, so for a 64MB card you could get up to about 3.5 hours of data, for a 2GB card you could get about 5 days!

7.11 Will it work with any Compact Flash card?

Whilst we cannot guarantee that the DL1 works with all compact flash cards, we have successfully tested many makes and sizes of compact flash card, we haven't yet found one it won't work with. A list of flash cards that have been tested is available on the website.

7.12 Is it easy to use?

The DL1 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.

7.13 What specification of computer is required?

As with most programs, the analysis software will run on just about any PC with windows 95 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 compact flash cards, there are many options available – normally a USB reader is most convenient.

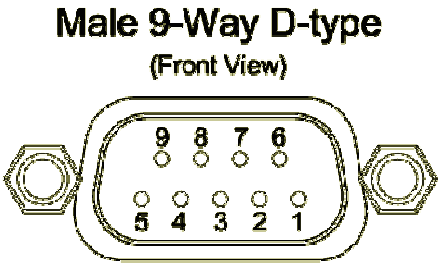
7.14 Is the DL1 reliable and well made?

The DL1 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 and lifetime email support.

8 Connections

8.1 Connections for DL1 Mk1 (For Mk2 See below)

8.1.1 Front Panel



PIN	DESCRIPTION
1	N/C
2	RX - Main Data In
3	TX - Main Data Out
4	TX - GPS Data Out
5	GND
6	RX GPS Data In
7	+12v Out (50 mA limit)
8	N/C
9	N/C

8.1.2 Rear Panel

LABEL	DESCRIPTION	
+12vPower		
Power Gnd		
RPM [5v]	5-15v Trigger - ECU or Tacho Use.	
Spark In	1KHz HT Input - See Connecting RPM	
Spark Gnd	See Connecting RPM	
Start Logging	Active Low (Take to GND) - Toggles Logging ON/OFF	
Lap Beacon		
Log Status	50mA Max, Active High, indicates logging	Out

	status	
Frequency 1	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
Frequency 2	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
Frequency 3	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
Frequency 4	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
GPS RF +3.3v	GPS Antenna Connection (3.3v)	
Analg 1	0-5v 16-Bit	In
Analg 2	0-5v 16-Bit	In
Analg 3	0-5v 16-Bit	In
Analg 4	0-5v 16-Bit	In
Analg 5	0-12v 16-Bit	In
Analg 6	0-12v 16-Bit	In
Analg 7	0-12v 16-Bit	In
GND		
GND		
+5v Ref Out	50mA Max	Out

8.2 Connections for DL1 Mk2 (For Mk1 See above)

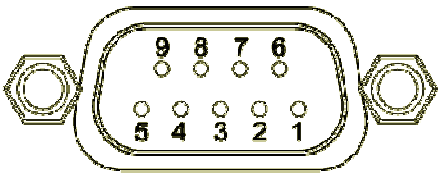
8.2.1 Front Panel

The Mk2 DL1 connections are all on the rear panel

8.2.2 Rear Panel

Male 9-Way D-type

(Front View)



PIN	DESCRIPTION
1	N/C
2	RX - Main Data In
3	TX - Main Data Out
4	TX - GPS Data Out
5	GND
6	RX GPS Data In
7	+12v Out (50 mA limit)
8	N/C
9	N/C

LABEL	DESCRIPTION	
Analg 1	0-12v 16-Bit	In
Analg 2	0-12v 16-Bit	In
Analg 3	0-12v 16-Bit	In
Analg 4	0-12v 16-Bit	In
Analg 5	0-12v 16-Bit	In
Analg 6	0-12v 16-Bit	In
Analg 7	0-12v 16-Bit	In
Analg 8	0-12v 16-Bit	In
rL - RPM Low Level	5-15v Trigger - ECU or Tacho Use.	
GND		
rH - RPM High Level	1KHz HT Input - See Connecting RPM	
rG - RPM High Level Ground	See Connecting RPM	
Lap	Lap Beacon	
Trig	Active Low (Take to GND) - Toggles Logging ON/OFF	
Frequency 1	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
Frequency 2	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In

Frequency 3	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
Frequency 4	100KΩ Pull Down Included. 5-12V I/P 2KHz Max.	In
+5v Ref Out	50mA Max	Out
Stat	50mA Max, Active High, indicates logging status	Out
STx	Serial data out	out
Gnd		
SRx	Serial data in	In
+12vPower		
GPS RF +3.3v	GPS Antenna Connection (3.3v)	

9 Technical Specification

Memory	Compact flash type I. Data in FAT16 PC format. Minimum card size 32MB, maximum card size 2GB (limited by FAT16).
GPS	Outputs position, speed, position accuracy and speed accuracy every 200ms with no interpolation. GPS tracking loops optimised for applications up to about 4g. tracking of all satellites in view.
GPS Antenna	Magnetic base, 3.3v active antenna with SMA connector.
Analogue Inputs	7 external inputs, all 12 bit resolution. 3 inputs are 12v full scale, 4 inputs are 5v full scale. All inputs are protected to twice maximum input voltage. 1 internal analogue input connected to the power supply voltage to measure battery voltage.
Frequency Inputs	4 external frequency inputs with a maximum input frequency >2kHz. Hardware dividers of 4 or 16 to average readings if required. Triggering voltage requires a low input of <1v and a high input of >4v and 15v maximum.
Lap Beacon Input	Triggering voltage requires a low input of <1v and a high input of >4v and 15v maximum.
Start Sample Input	Input requires grounding to start sampling and again to stop sampling.
Sample Status Output	Open collector output with a maximum current of 50mA.

Power Supply Requirements	12v nominal input, minimum of 10v, maximum of 15v. Current consumption of about 180mA including GPS, dependant on compact flash card size +5v Reference Out Maximum current draw 100mA, tolerance 1%.
Ignition In Signal (High Level)	Triggered by fast voltage transients. Can be connected directly to the low tension side of the ignition coil, or capacitively coupled to the high-tension side.
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	Extruded aluminium anodised black, nominal case thickness 2mm. End panels CNC cut carbon fibre.
Connector Type	3.5mm pitch screw connectors
Main Processor	24MHz RISC with embedded flash program memory
GPS Serial Port	User configurable for baud rate and messages. Factory set at 4800 baud and outputting NMEA messages of $GPRMC and $GPGGA,
DL1 Serial Ports	Port 1 fixed at a baud rate of 115200 baud. Whilst logging outputs all data from all channels at 100Hz. Also used for re flashing, diagnostics and configuration. Port 2 used for inputting RS232 data for storage during a run, from an ECU, OBDII adapter or any other compatible device.
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.
Vibration	Factory tested at 25g, 50Hz sinusoid for 5 minutes (without compact flash card inserted).
Temperature	Factory tested from -20oC to 70oC

9.1 Identifying Your Unit

Several different versions of the DL1 have been released. For information on identifying your unit, please click on the following link:

- Identifying your unit