

PART 1

The explosion of data logging equipment has made the technology accessible to the club competitor, but where on earth do we start when we are looking to buy? Graham Templeman guides us through the minefield in the first article of a new series

IN RECENT years, data logging has moved into the range of things that any club competitor could reasonably aspire to. Using the traditional unit of currency of a set of new tyres, entry level systems now start at less than two sets and climb from there.

Six sets buy you all the information you could ever want. On the other hand, if you look round any collection of competition cars you will quickly find ones fitted with loggers that are not being used.

Over the course of the next few issues, we will be looking at whether or not it is worth making the investment and if you do,

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how to maximise the payoff and avoid being stuck with another expensive shiny bit that does not earn its keep.

Do not forget that the costs are not only financial but also in terms of effort. Time spent managing the system and the data is time not available for other activities. There is no sense in knowing exactly how fast you were in the few minutes leading up to the accident that happened because you did not have time to do a spanner check.

However, the benefits can be enormous. You quickly build up a

bank of data that is invaluable for both preparation and competing on the day. Before the event, and wearing the engineer's hat, you can look at the data for guidance on gearing (speed and revs), suspension settings (damper travel, g force and corner radius) brake cooling (time under braking and time for cooling) and a whole lot of other things.

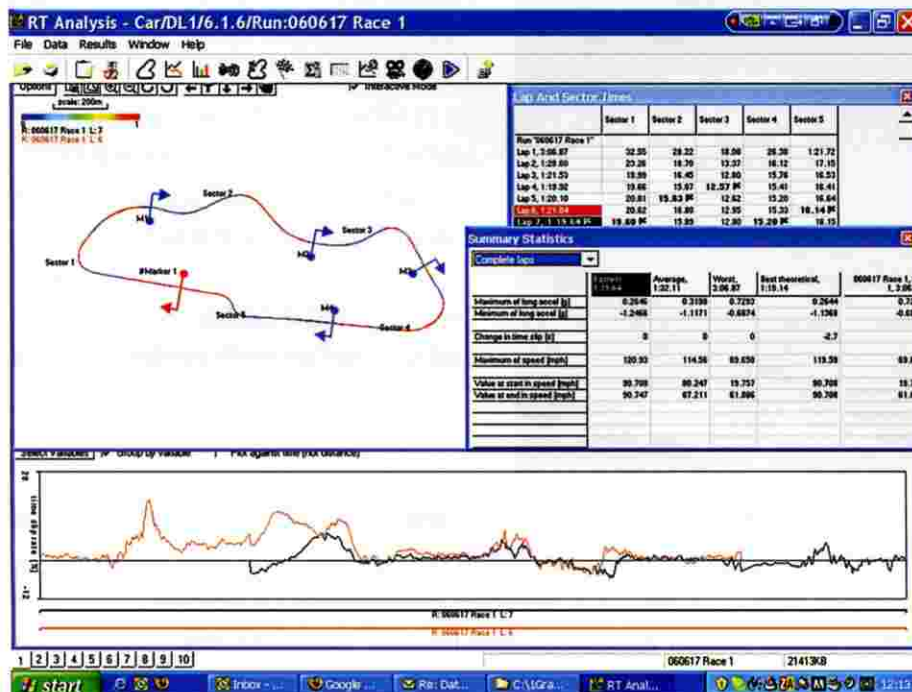
As driver, you will be able to look at braking points, early or late apexes, cornering speeds, sector times, gears and target revs for the straights and which corners caused you the most trouble the

last time you were at that circuit. This and much more will be available before the event and it will all be based on hard evidence, not hazy recollection.

At the event, you can compare performance with the last time at this track and with what you now

expect of the car and the driver. You can even check the old driver's excuse that the engine lost power through the day.

To help you select the right system for your application, we have put together a chart that shows facts about what each manufacturer calls their entry level system. The unit in currency is deliberately vague because, as ever, there are all sorts of side issues involved in making such a major purchase. Do your own negotiation and do not overlook important issues such as whether trackside beacons are necessary and ▶



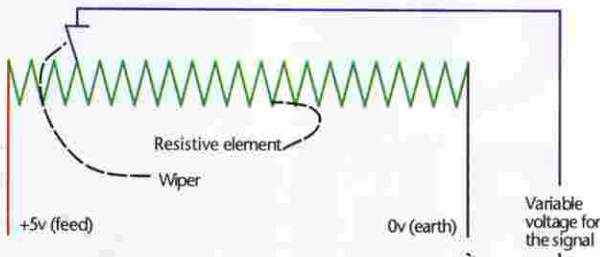
LEFT The analysis software can offer huge benefits to club competitors, but it makes more sense if we understand how the data got there in the first place

HOW TO AVOID BEING DAZZLED BY DATA

QUICK GUIDE TO ENTRY-LEVEL UNITS

Model	Price (Sets of Tyres)	Dash?	Standard (built in) Channels	Number of External Inputs	Resolution (Bits)	Sampling Rate (Hz)	Memory
Aim XGLog	2.25	Yes including lap times	lat + long g/ rpm/ wheelspeed	5 Analogue 2 Wheelspeed	12	200	8Mb
Astra Microlog	2.5	Slimline readout of 2 channels	speed/rpm	2 Analogue	8	10	21 minutes
Motec ADL 2	7	Yes including lap times	lat + long g/ rpm/speed/ lap timing/ pressures etc.	8 Analogue 2 Wheelspeed 4 Thermocouple	12	1000	8Mb
Pi X-Sport Dash and Compact Logger	5	Yes including lap times	lat + long g/ speed/rpm/ pressure/ temp	None (other models provide for external inputs)	8 and 10	1 (temp + pressure) and 10	Compact Flash
Race - TechnologyDL1	1.75	Extra	lat + long g/ speed/rpm	4 Frequency 8 Analogue	16	200	Compact Flash
Stack ST8802S	7	Yes with predictive lap timing	Lat g/rpm/ wheelspeed/ lap timing/ pressures & temps	9 Analogue	8	1 to 20	Up to 240 minutes

A Potential Divider

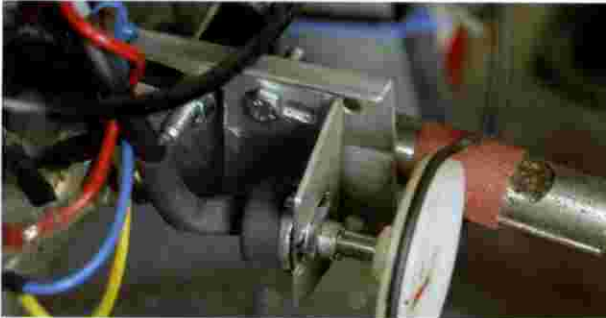


A meter connected across these terminals would show a voltage proportional to how far along the resistive element the wiper is

ABOVE The magic that converts movement into voltage



LEFT & BELOW A variable resistor being used to measure throttle position (left) and steering position (below)



care about this is that it is one of the things that determines the level of precision that the system can achieve. Eight bit accuracy is common and adequate for many uses although 12 bits are beginning to appear in entry-level loggers.

In the case of a throttle position sensor that measures the 90-degree rotation of the throttle spindle, 8 bit accuracy will split this 90 degrees into 256 separate values – or less than half a degree – which is more than adequate. In fact we could probably understand what the driver was doing using a simple five point scale of no throttle/a bit of gas/half throttle/almost full/flat to the floor.

On the other hand, if we are trying to understand the suspension behaviour of an off-roader with 250 mm of total suspension travel, 256 divisions will only tell us to the nearest millimetre. Given that we are unlikely to be able to create a mechanical linkage that takes advantage of the full range of sensor movement, we might only use 75% of the available measurement so we would be down to a maximum resolution of 1.3 mm. Add in the fact that because we are converting from smooth analogue values to discrete digital steps, the voltage that the ADC translates into 26 mm could represent anything between 25.35 mm and 26.65 mm.

So three consecutive readings that the system interpreted as 26 mm could have been 25.4 mm, 26 mm and 26.6 mm. If we

“We could end up with an impressive set of numbers that we ought not to trust at all”

what sensors are included in the package.

Before making the choice, we need to look at some basic concepts. The logger itself is simply a device for reading analogue data – voltages and frequencies – and storing them as numbers that can be read in a software package. The pretty pictures of the analysis software will make much more sense if we understand the way that the data got there in the first place. So let’s look at how it happens.

RESOLUTION

The analogue data is converted into number form by a process known as analogue to digital conversion or ADC. A logging system uses binary digits to optimise the use of the sometimes limited memory on board the logger unit. This keeps the file sizes low and reduces download times.

Computers love binary numbers because the ones and zeros make the best use of the on/off states of computer memory but we should think about the form of the number. An eight bit number consists of a mixture of eight ones and zeros and is capable of registering up to 256 separate values. Ten bits will count to 1,024 and 12 bits to 4,096. The reason that we should

then want to go on and examine damper shaft speed and acceleration we are building-in errors upon errors because the position data will be used to calculate the speed and acceleration numbers. We would end up with an impressive set of numbers that we ought not to trust at all.

THE POTENTIAL DIVIDER

The magic that converts movement into voltage is nothing more complicated than a variable resistor. This is configured as a potential divider so that the voltage input at one end, usually 5v but sometimes 12v, is reduced to a signal voltage that is proportional to the position of the linkage. The diagram shows what happens.

The supply voltage is fed into one end of the variable resistor and the other end is grounded. The third wire – attached to the resistor’s wiper – sees a voltage that varies according to how far along the resistive element it is. At one end there is the full supply voltage – because the resistance does not come into play – and at the other there is no voltage. Guess what happens in between. Attach a mechanical linkage to turn the resistor and we have a way of measuring movement. The photographs show variable resistors being used to measure throttle position and steering. ▶



ABOVE Sampling rates are important. Ten samples a second are fine for driver inputs but even 100 samples a second will give sketchy suspension data if the car is covering 50 metres per second

SAMPLING RATE

The sampling rate can also be important. There is a difference between the rate at which a parameter is sampled and at which it is displayed in the software. To do the job properly we should be sampling at least twice the rate at which things happen in order to be sure of capturing all the events, but again it depends on what you are trying to measure.

Many loggers will tell you the battery voltage but you really do not need that figure updating more than once per second. Driver inputs – steering and throttle – are OK at 10

take 100 readings per second, we still only know what is happening every half-metre. This gives us some insights about roll and pitch but it falls far short of being a substitute for a seven-post shaker rig.

FREQUENCY

Data loggers also sense frequency to enable them to count engine revs and wheel speeds. The methods used are more complex than for sensing movement and some systems are capable of cleaning up a noisy signal where others will only deal with a nice sharp signal. It is a case of following the manufacturer's instruction.

From the point of view of choosing a system, the maximum frequency, as opposed to the sampling rate, that the system can read is not usually significant. The manufacturers measure this in Hertz (cycles per second) and it will generally be

“Keep an eye open for whether or not your shortlisted suppliers provide free updates of the software”

samples per second and acceleration traces – lateral and longitudinal g – look very jagged when displayed at more than tenth of a second intervals.

However, if you are looking at suspension movement, 100 samples per second is only at the lower end of what is reasonable. This makes sense if you think about it. The car might be travelling at 50 metres per second, so even if you

a big number. Wheels rotate relatively slowly – not more than 50 revolutions per second – and even 16,000 rpm motor cycle engines are only running at 267 Hz. Do not forget to factor in the number of pulses per revolution, so a wheel speed sensor looking at 4 bolts would be in the 200 Hz range but trying to measure engine speed by pointing a sensor at a 20 tooth crank pulley lifts us into the 5,000 (5 kHz) range.



LEFT & BELOW The opposite ends of the spectrum for entry-level systems: Race Technology's DL1 (left) and Stack's ST8802S. The DL1 will be used to collect illustrative data for future articles in this series

MEMORY

It is a bit difficult to be prescriptive about the amount of memory you need. More is obviously better than less, but much depends on how big are the run files that the system generates. Some loggers have less memory because they need less and the important question becomes not how many megabytes, but how many minutes of logging can be achieved between downloads. This is one enormous advantage of loggers with removable memory cards – the other being that the data geek simply removes the card and leaves the car to the engineers.

SOFTWARE

Most manufacturers are now prepared to put their software and some sample data on the net so that it is possible to test drive the package before buying. This gives you a chance to play with it but it is still not the same as getting to know the

software in detail. However, at least you will get some feel for what you can and cannot do. Keep an eye open for whether or not your shortlisted suppliers provide free updates of the software or whether you have to pay for updates

SHOPPING TIME

With the basic understanding in place, it is time to look at the table and the manufacturers' websites and brochures. It is the usual price, performance and features trade-off to find the systems that best meet your needs.

Once you have narrowed the choice, phone the manufacturer and ask to talk to a sales engineer. You are bound to learn things and will get a feel for how good the after sales service is going to be – and these systems are complex enough to guarantee that you will need some external help at some time or other.

Next month we will look at what data is available and how to make sense of it. ■

