DATRON TECHNOLOGY

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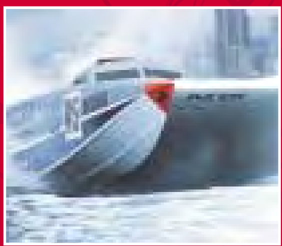
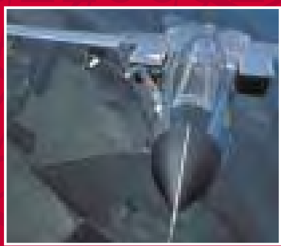

07|04

microsat

The complete GPS vehicle testing
solution for **land, sea and air**

NON-CONTACT GPS SENSOR

For acquisition of vehicle speed, distance travelled, altitude, heading and absolute position.

- All terrain
- Non-contact and slip free
- Absolute GPS information
- User defined test library
- Continuous speed and distance up to 1,850 km/h
- Online real-time graphic display via PC and Ipaq
- Onboard data recording via flash memory
- Outputs include CAN,TTL, etc

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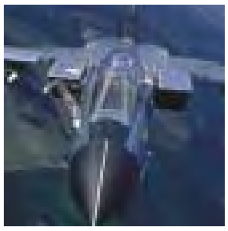


MicroSAT delivers the true potential of GPS

The innovative new MicroSAT GPS sensor from DATRON represents a major development in the evolution of global positioning technology for dynamic testing. As the company that brought you the world's first non-contact speed and distance sensor, Datron Technology is the most trusted name in the industry – a distinction we continue to earn each and every day with superior instrumentation and solutions-focused customer support you know you can depend on. The microSAT makes maximum use of the global positioning system satellites by employing patented PAC technology to give highly accurate position, distance and velocity measurements, all with unprecedented ease of use. Compact and rugged by design, the MicroSAT Sensor at last delivers the full, uncompromised potential of global positioning technology – with a level of accuracy and reliability that meets the rigorous standards of the most trusted name in vehicle testing technology – Datron Technology. The MicroSAT Sensor provides high-performance measurement capabilities for virtually any dynamic testing platform, including automobiles, heavy trucks, motorcycles, rail vehicles, watercraft and even aircraft. MicroSAT is the reliable new way to measure:

- vehicle speed
- distance travelled
- elapsed time
- lap times
- braking distance and time
- acceleration
- lateral acceleration
- longitudinal acceleration
- absolute position
- height
- heading

Easy to set-up, easy to use –

Set-up and testing have never been easier than with the MicroSAT sensor. Just make a few simple connections, place the quick-mount GPS antenna on the vehicle, and within a matter of seconds the MicroSAT sensor is ready to use. And because the new MicroSAT RT Windows-compatible software package has been engineered to automate important test functions, dynamic testing becomes a virtually hands-free process. Compared to the MicroSAT Sensor, anything else always comes up short.

- Fast, easy set-up takes just seconds.
- Uses the highest quality GPS signals available.
- Full accuracy on all test surfaces and in all atmospheric conditions.
- Measures speeds from 0 – 1,850 kp/h (0 – 1,152 mph).
- Measures distance to 0.05% accuracy, with resolution to 1 cm.
- Compact, lightweight, fully ruggedized.
- Easy connection to laptop via standard interface.
- Analogue, digital (TTL pulses) and CAN outputs for fast, easy connection to data acquisition.
- Analogue output for quick connection to optional compact display.
- Internal memory for stand-alone data logging capability.
- Aerodynamically inert.
- Available with optional DGPS (differential GPS).
- Test on public highways, tracks, off-road, on water, on rails and in the air.
- 6-18 V DC vehicle power supply, internal battery or optional external power pack.

How does the MicroSAT harness the power of GPS?

Orbiting the earth there are between 24 and 32 GPS satellites. Their position over the earth is constantly changing. They are not in geo-stationary orbits. Instead they orbit in about 12 hours at a height of about 20000km. In the normal constellation there are six orbit paths, each one is inclined at 60 degrees relative to the equator. Each path has space for 4 satellites, giving space for 24 satellites in a full constellation. Currently there are 27 or 28 satellites in orbit, some of the satellites are extras in case of failures.

Each satellite knows its exact position at any time, this is transmitted to GPS receivers on earth so that we can compute the satellite's position. The details of the satellite's position is called the ephemeris. Due to gravity variations across the earth the orbit of the satellite changes, so the ephemeris is adjusted every few hours. Five ground stations are responsible for measuring the precise position of the satellite and keeping the GPS system accurate.

The signal transmitted from each satellite is similar to a spread-spectrum radio. The satellite's data is mixed with a pseudo-random number sequence. This sequence is known as the satellite's PRN and the sequence is different for each satellite. All the satellites are at the same frequency (1575MHz), so it is only possible to pick up a GPS satellite if you know its PRN sequence. And if you are tuned to one satellite's PRN then you don't get any information from the other satellites.

The clever bit about the GPS signals is that the carrier-wave (at 1575MHz) and the PRN sequence are synchronised in time. To pick up the satellite it is essential to line-up your local copy of the PRN with the satellites; in carrier-phase tracking receivers (like the MicroSAT) the carrier-wave of the satellite is also lined up in time with the satellite's carrier-wave; this is essential for good velocity measurement.

Once our GPS receiver has lined up its local copy of the PRN with the satellite then we have some measure of time. But when we have lined up four or more satellites then we can solve for our XYZ position and our time error. Solving for the time error is important for two different reasons:

A It means that we don't need an atomic clock in our GPS. If we had an atomic clock then we would only need three satellite measurements, but they are big, power hungry and expensive. It is much better to just use an extra satellite.

B Since we solve for our time error it follows that we don't need to calibrate our timing. If our timing is wrong then it has no effect on the output of the signals, we still have the same XYZ positions. In other words, if we did have a calibration problem with our timing, we would end up with the same measurement. The output is independent of our clock.

When more than four satellites are available older receivers chose the best four and computed a position and a time. Now we have faster computers and so all the tracked satellites can be used. Using more satellites gives more immunity to noise. So, generally having 8 satellites is better than having 6; having 12 satellites is better than having 8.

Quantifying this is possible, but it also depends where the satellites are in the sky. For instance, if three satellites are very close together then they only really count as one: their errors are all very similar; any reflections from trees or buildings are the same for all three; any obstructions like buildings, trees and buildings tend to affect all three at the same time. Often people use the "DOP" (Dilution of Precision) instead of the number of satellites. This includes information about the positions of the satellites as well as the number of satellites.

Velocity Measurement

The term "Doppler Shift" has been used a lot in relation to obtaining accurate velocity measurements from GPS. The term is used loosely, there is no method of signal processing that can possibly measure the Doppler Shift of a GPS satellite directly. All measurements are performed by a filter (invariably a kalman filter) in the GPS receiver.

As the vehicle and the satellite move in relation to each other the time delay of the signal from the satellite changes. The GPS receiver has to continually change its local carrier-phase and PRN timing. If the local timing shifts away from the ideal position then the strength of the signal reduces and the GPS receiver cannot track it as well.

To track the signal accurately the GPS receiver makes excellent use of this. Since the signal strength reduces if the local PRN is wrong, a good option is to keep TWO copies of the PRN in the local GPS. These are positioned so that one is just behind the satellite and the other is just ahead of the satellite. If GPS receiver moves closer to the satellite then the "just behind" signal increases and the "just ahead" signal decreases. The GPS receiver can compare the strength of these two signals and keep itself accurately locked to the correct time.

One essential measurement used when tracking the GPS signals is a term in the kalman filter which represents the velocity of the satellite compared to the local GPS receiver. This term is called the Doppler Shift. It is essential because the satellites have velocities of about 10000km/h. If the Doppler Shift is not tracked then it is impossible to keep track of the Carrier-Phase and the PRN.

There is a choice that GPS manufacturers have to make regarding the dynamics of the vehicle and the noise of the velocity. A GPS receiver that can track higher accelerations and higher jerk rates is noisier. A compromise between noise and tracking has to be made by all GPS manufacturers.

All measurement systems can reduce their noise by reducing their bandwidth and GPS is no exception to this. The noise, tracking and bandwidth are all related. A GPS receiver with a 1Hz bandwidth has a lower noise than a 5Hz GPS receiver, but it cannot track fast changes to acceleration (like the end of a brake test). From the underlying physics 10Hz bandwidth is about the limit of what GPS can provide, beyond this the noise makes measurements guess-work. A 20Hz GPS receiver can capture all the information that GPS can provide.

Distance and GPS

Interestingly enough, the tracking process of GPS lends itself to accurate distance measurement, especially in open sky environments. The shift in the PRN and the change in the carrier-phase is a direct measure of the distance shift between the satellite and the vehicle. The carrier-phase measurements give excellent short-term position measurements. Drift of about 1m over a 10-minute period are typical in high-multipath environments; in open-sky 1m over a hour is more typical.

Differential GPS

It is fair to say that Differential GPS has little (or zero) effect on accurate velocity measurement. There is evidence to suggest that Differential GPS can increase the noise in some circumstances (for example, if there is multipath at the base-station).

Velocity measurements are made almost exclusively by observations of carrier-phase. Knowing that your carrier-phase is drifting by 1m (about 5 cycles) in 10 minutes would give you a correction of 0.006km/h. This is much smaller than the noise and wholey irrelevant to accurate velocity measurement. If your GPS receiver needs DGPS to measure velocity then there is something else wrong with it.

(When the US government was deliberately degrading GPS then their policy was to impose a carrier-phase drift equivalent to about 1m/s. So prior to Selective Availability being turned off, DGPS helped velocity considerably. Many GPS manufacturers still have not tested their GPS cards, nor have they revised their documentation.)

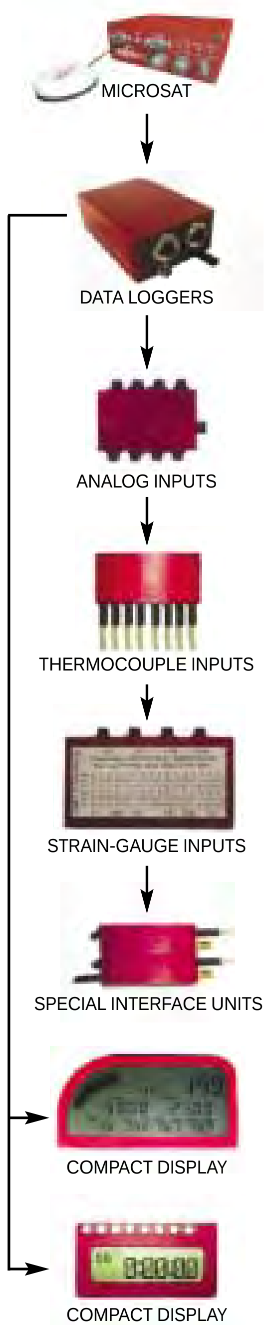
Configure complete CAN based test systems in just minutes –

Compact components make set-up fast and easy

- Displays – multiple units can be connected simultaneously for the display of numerous values.
- Online calculation units – for virtual channels.
- Memory units – available for CAN modules.
- Data loggers – wide variety of options available.
- Interface units Thermocouple amplifiers, Strain-gauge amplifiers, Analogue inputs / outputs and CAN to CAN, CAN to analogue, analogue to CAN...

The advantages of the Datron modular, CAN-based testing system

- Greater flexibility.
- Compact, light weight components – Datron offers a complete range of compact, lightweight CAN-based components designed to streamline test set-up and ensure consistent and reliable data.
- Fewer cables – a complete CAN-bus network can be configured with just 5 cables. A comparable configuration using traditional data logger technology requires as much as 18.
- Unlimited scalability and easy connection – a nearly unlimited number of CAN modules can be connected to the network, providing unprecedented scalability and ease of use.
- Massive input capability – current CAN architecture accommodates up to 256 channels



The MicroSAT advantage

Why is the MicroSAT Global Positioning Sensor the logical choice for your dynamic testing needs? The answer is simple: superior performance and reliability. MicroSAT is the product of an extensive research and development process, focused on the real-world demands of dynamic vehicle testing. With over two decades of intensive involvement in non-contact measurement of dynamic vehicle performance characteristics, Datron Technology Sensor systems offers a level of expertise and depth of experience that is unrivaled in the industry. The MicroSAT Sensor provides a new option in non-contact measurement that draws upon this experience to deliver a truly viable new tool that combines exceptional ease of use with outstanding measurement accuracy and reliability. With performance that satisfies the most demanding applications and rugged reliability that stands up to the rigors of racing and refinement testing, MicroSAT makes dynamic measurement faster, easier and more productive. Discover the difference. Put MicroSAT to the test. There's no better way to discover the many advantages of the MicroSAT GPS Sensor than to test one yourself. We're confident you'll get better data, and do so without the aggravation of signal loss, mechanical failure and other anomalous behaviours. MicroSAT, like every product we offer, is better because it works.

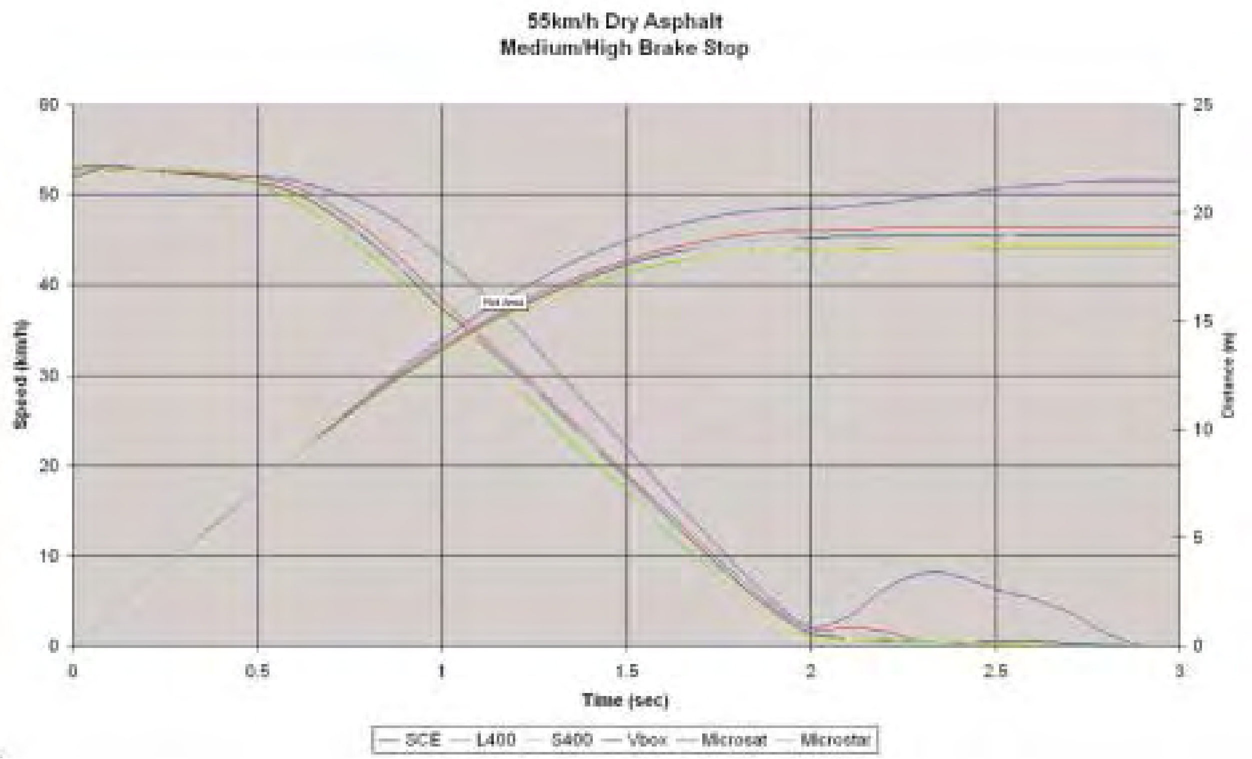
MicroSAT, like every product we offer, is better because it works. The MicroSAT is only part of our speed sensor range which comprises of Optical and Microwave based technologies, the graph on the page 09 shows a good correlation between our sensors during a brake test.

*Circular Error Probability (CEP) is defined as the diameter of a circle in which 50% of all readings occur.

The modular range of Datron sensors are as follows:

- New Optical 1 Axis: L-400 2 Axis: S-400
- Old Optical Technology (for information) 2 Axis: S-CE
- Microwave: Microstar

Datron will endeavour to supply you with the best sensor for your testing applications and in the event that you require a different sensor for a one off test we offer a comprehensive hire service



Speech Sensor Comparison Testing

Report Summary 30th April 2004

There is much confusion in the motor industry about which speed/distance measuring systems are the most accurate and which systems work best for particular tests. In reality it is not quite as black and white as the manufacturers tell you. This report aims to clarify the subject and allow test engineers to make informed decisions about the selection of systems for specific applications. It is also hoped that as a result of this report the manufacturers will be more open about their products, they will let people know the strengths and weaknesses of their systems leading to much less confusion for the engineers. In time this may lead the way to universally accepted methods of testing and analysing test results, which can only be a good thing for the transport industry. The report gives details of tests and results of an exercise conducted by Rob Marshall Engineering Ltd. on behalf of Datron Technology UK Ltd.

The exercise consisted of:
A comparison of commercially available speed/distance measuring equipment used by vehicle manufacturers and design consultancies when working on new and existing vehicles. Tests were primarily brake tests and concentrated on the issues of consistency, signal loss and total latency within the sensors and equipment and its effect on stopping distance.

Four main conclusions can be drawn from the tests:

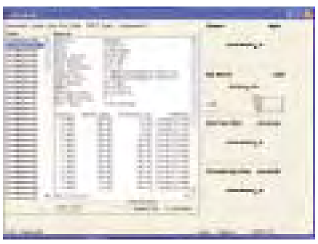
1. All systems tested are subject to significant and differing levels of latency.
2. There is a considerable difference in performance of optical sensors depending on the track condition – they are adversely affected in the wet and were subject to signal loss.
3. GPS based systems perform equally well in dry and wet conditions however, the total latency effects are greatest on GPS systems leading to less accurate results.
4. GPS based systems gave more repeatable results but only when there was sufficient satellite coverage.

The full report can be downloaded at www.datrontechnology.co.uk/site/download.php

MicroSAT RT Software provides powerful Real Time testing capability

MicroSAT RT real-time software provides a convenient, easy-to-use interface to the MicroSAT Sensor. It displays data output by the sensor and computes a variety of performance parameters required for vehicle testing. MicroSAT RT software can also be configured to automatically perform a series of tests when the sensor is powered on. All data is stored automatically as detailed spreadsheet files and can be saved for postest replay and analysis.

- Measure, record and display vehicle velocity, distance, time, acceleration, braking and position data.
- View measured values in formats that allow you to quantify vehicle performance in easily recognisable terms.
- Tabulated and graphical data.
- Measure braking performance (brake switch included).
- Perform acceleration tests, either from standstill or as an in-gear test when moving.
- Design custom tests with user-definable parameter and trigger settings.
- Create track maps for analysis of driving lines. This capability is particularly valuable in competition applications. Lap times can be compared to specific driving lines to optimise driver performance in competition and time-trials.
- Produce maps of the actual route followed by the vehicle during the test. Routes can also be displayed in real time on available digitized scale maps.
- Measure lap times with user-definable start-stop lines.
- Thorough analysis of every aspect of saved data.
- Select data segmants for even more in-depth analysis.

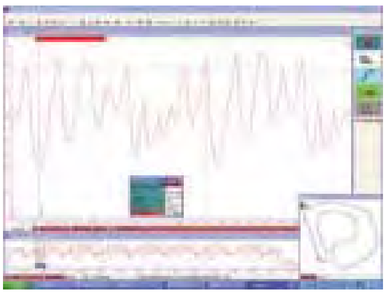


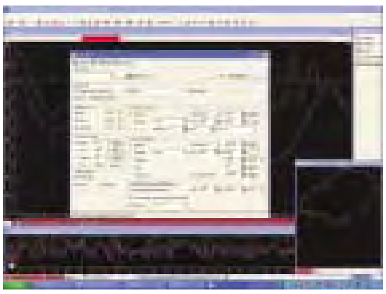
Analysis software from 2D

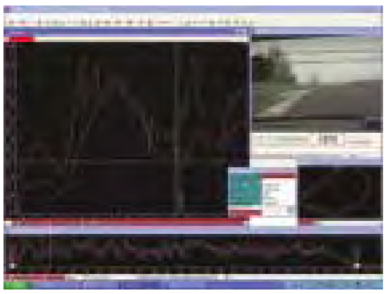
The software is a cut down version of the race proven 2D 'Analyser' software specially modified for the MicroSat. The new software takes the raw data files that the MicroSat creates to produce graphical and tabulated data. This software allows you to perform:

- Analyse raw microSat R1 files
- Toggle between graphical and tabulated results
- Performance Tables e.g. Accel &/or Braking easily configured
- Overlay graphical data, car to car, lap to lap etc. Whatever you desire
- Create and save trackmaps automatically from GPS data
- Start/Finish line automatically identified by new algorithm – Lap Beacon not required.
- Analyse lap and section speeds & times
- Identify fastest lap &/or section
- Profile track position against vehicle speed
- Export whole or partial data

This offers a lead-in to the extensive range of 2D data-logging & signal conditioning modules which can easily be added at any time.







upgrade required for video option

Download a Sample file at: http://www.ots.ndirect.co.uk/2D/Demo2.exe
The software is free, please contact us and we will send you a CD.

Enhancements

IPAQ with Enginuity-Lite

For the ever increasing health & safety requirements of proving grounds we have utilised the IPAQ palm PC to give the driver an easy to read display which will also log and display your test data. The IPAQ has a cut down version of the RT software called Enginuity-Lite that enables you to quickly do your tests. This software allows you to do:

- Brake Tests
- Acceleration Tests
- Raw Logging (R1 file)

The R1 datafile can be replayed in the full RT version. (Note: the IPAQ needs to have a serial port). In the event that you want to use both the laptop and the IPAQ a 'serial splitter' cable is available to feed both systems at the same time. Please contact us if you require the IPAQ software.

High speed radio modem

For remote operation of the MicroSat sensor.

The radio modems have been developed to transfer data via RS-232. There are two units that are used, one receiver & one transmitter. The transmitter is connected to the microSat 'comms' and the receiver is connected to the serial port of the laptop which can be at a remote location. The microSat software can now be operated remotely just as if you were inside the test vehicle. Ideal for tests where you don't want a laptop onboard e.g.handling or tyre tests.

Technical specifications

VELOCITY
Accuracy 0.1 kph
Units kph or mph
Update rate 20 Hz
Maximum velocity 1,850 kph
Minimum velocity 0.1 kph
Resolution 0.01 kph

DISTANCE
Accuracy 0.05% (<50cm per Km)
Units Meters/Feet
Update rate 20 Hz
Resolution 1 cm

ABSOLUTE POSITION
Accuracy 1.8 m CEP*
Accuracy with DGPS <1 m CEP*
Update rate 20 Hz
Resolution 1 cm

TIME
Resolution 0.01 s
Accuracy 1 part in 100,000

ACCELERATION
Accuracy 0.5%
Maximum 20 G
Resolution 0.01 G
Update rate 20 Hz

MEMORY
Internal 4 MB
Recording time approx. 1.5 hours

POWER
Voltage range 6-18 V DC
Power consumption 2.0 W
Internal battery 2 hours
Battery pack (optional) 16 hours

*Circular Error Probability is defined as the diameter of a circle in which 50% of all readings occur.