NPL National Physical Laboratory

Electromagnetic *News*

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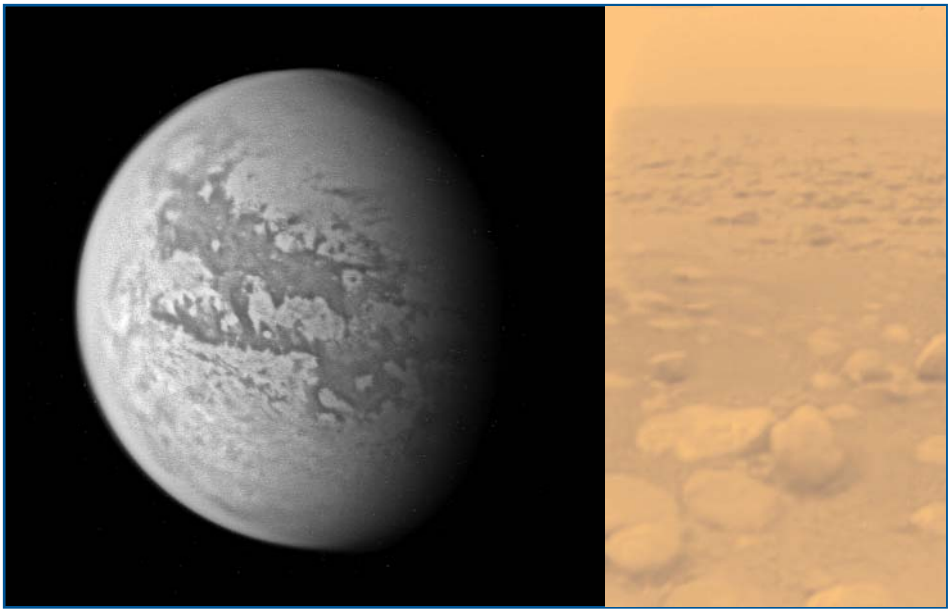

First Colour View of Titan's Surface. This image was returned January 14, 2005, by the European Space Agency's Huygens probe during its successful descent to land on Titan. This view includes processing to add reflection spectra data, and gives a better indication of the actual color of the surface. Credit: ESA/NASA/JPL/University of Arizona

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Cassini-Huygens – transmitting knowledge

On 14 January 2005 the Huygens probe descended through the atmosphere of Titan, the largest of Saturn's moons. After surviving temperatures of up to 1800 °C and travelling at speeds of 6000 m/s, the probe started transmitting data on the environment that it passed through, continuing for over an hour after touching down on the moon's surface. The Cassini spacecraft picked up these signals and relayed them to ground stations on Earth. The early images returned to earth stirred immense interest amongst the general public as well as the scientific community.

A detailed understanding of the properties of the antennas on both spacecraft was vital. This is why nine years ago Aerospatiale Espace France approached NPL to assist in testing vital components of the communication system. This required checking the gain, axial ratio, tilt, sense of polarisation and reflection coefficients of five different types of antenna. A mismatch of any of these properties could limit or corrupt the data received back on Earth.

David Gentle, the scientist who leads the antenna calibration team at NPL said: "This is a triumph for the European consortium that carried out this mission. NPL is proud to have been involved, and we look forward to the results produced by the data relayed".

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First accreditation of internet-enabled calibration

Agilent Technologies UK, based at South Queensferry in Scotland, was recently granted the first ever calibration accreditation that uses internet-enabled technology to make measurements of complex reflection and transmission coefficient parameters on radio frequency and microwave devices. The system is known as *i*PIMMS (Internet Primary IMpedance Measurement System) and is a service of the NPL.

The NPL *i*PIMMS service makes available extremely accurate traceable measurements to its clients, regardless of their geographical location. *i*PIMMS has been used successfully by organisations within Europe, the Americas and the Asia–Pacific region. The availability of highly accurate Internet-enabled measurement facilities, such as *i*PIMMS, together with international standards for their accreditation (i.e. ISO/IEC 17025) means that top tier measurement services can now be realised and assessed independently in a harmonious manner at any location in the world.

*i*PIMMS is NPL's first measurement service to make extensive use of the internet to provide a measurement capability. The internet forms an extended link between the client's measuring instrument, in this case a Vector Network Analyser – and NPL's dedicated software. The *i*PIMMS software performs several functions including controlling the measuring instrument, interfacing with the equipment operator and collecting readings from the instrument. It performs corrections during calibration and calculates the measurement results, including evaluation of the uncertainty of measurement. The result is a measurement capability that is of a comparable accuracy to the UK's primary national standard facility. Traceability to SI units is obtained by means of calibration data for an individual client's reference standard, which in this case is a short length of precision air-line. This data is stored on the NPL server and real-time corrections are applied during the measurement process. George Taylor, Site Manager for Agilent in South Queensferry, said: "Our highly skilled measurement and metrology engineers and a motivated team of technicians worked hard to achieve these standards, especially during the period in which they had to demonstrate their measurement process competence during the UKAS assessment. Congratulations to all involved!"

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Appliances may fail new standard

Changes to harmonics standard for appliances may give rise to new compliance failures

The standard that governs the design of harmonic analysers used in the testing of domestic appliances, has recently undergone radical change. Most electrical goods sold in the European Union must conform to harmonics emissions standards; failure of goods to comply can be costly for manufacturers.

The latest version of the IEC6100047 standard, that governs the design of harmonic analysers, calls for the interharmonic components, which exist between the mains harmonics, to be swept-up and combined with the nearest adjacent major harmonic component. Prior to this change, this interharmonic energy was ignored in compliance testing. Its inclusion in the harmonics measurement seems set to cause some appliances that would have previously passed compliance testing to fall outside the limits.

Most at risk of failing the new tests are appliances that cause rapid and intense current variations. Current fluctuations can be considered to be an amplitude modulation (*am*) process. Communications theory tells us that the *am* of a signal has an associated set of side-bands. It follows that if an harmonic component is fluctuating, it will be surrounded by a set of side-band frequencies. However, some of this sideband energy will "stray" into the adjacent harmonic regions and be swept-up with those harmonics.

A problem seems to exist when these "stray" interharmonics are combined with the even harmonic components. Even harmonics are almost always considerably smaller than the adjacent odd harmonics. When the side-bands associated with large fluctuating odd harmonics are combined with the small even harmonics, some very large differences between the old method and the new method result. EMC laboratories have started to notice this problem; in one case a vacuum cleaner that clearly complied when tested using the old method, failed by a large margin at even harmonics when tested with the new method. Simulations of both methods seem to confirm this, with differences of over 100% at even harmonics for some fluctuating waveforms.

NPL has recently upgraded its fluctuating harmonic analysis methods and can now characterise harmonic analysers using either interpretation of the international standard.

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Reliable sub-fA calibrations for the first time

A new system for calibrating commercial current measuring instruments has recently been commissioned at NPL. The requirement has become increasingly urgent, since several applications already require traceability of small currents. These include the measurement of dosages of ionising radiation used in hospitals, and the characterisation of semiconductor wafers on electronics' assembly lines. Whilst commercial instruments offer resolutions at sub-fA level (fA corresponds to a flow of only 6000 electrons per second) it has not previously been possible to reliably confirm their calibration at such low currents.

The picture shows a 10 nF air-dielectric capacitor and a typical high resolution commercial current measuring instrument. 10 nF is the largest capacitance value that can be practically achieved in a precise standard using interleaved metal plates.

Currents in the μA region and above are most easily measured by recording the voltage drop across a calibrated resistor. For currents in the nA region and below, this method is no longer satisfactory for two reasons: the very high value standard resistors required (10 GΩ and above) are usually not very stable; and the accuracy with which they can be calibrated falls rapidly with increasing resistance. A different approach, based on a capacitor rather than a resistor, is more suitable since capacitors in the range 1 pF to 10 nF can be calibrated much more accurately than high value resistors.

If a capacitor is charged with a constant direct current, a voltage which changes linearly with time is produced, and conversely if a constant voltage ramp is applied to a capacitor, a direct current can be generated. However, the non-ideal properties of a capacitor used in this way become very important. All real capacitors have a 'leakage' – that is, they behave as if they have a large resistor in parallel. For application in the current generation system, this leakage should be as small as possible.

The new system at NPL uses a selection of parallel plate air-dielectric capacitors to meet this requirement, in combination with low noise electronics to generate the voltage ramp. The speed of the voltage ramp applied to the capacitor is measured using a commercial high-resolution voltmeter. The system can be used to calibrate commercial ammeters (commonly referred to as electrometers when optimised for small currents) with currents from 1 nA to below 1 pA. The uncertainties offered depend on the instrument but at best range from 10 parts per million (ppm) at 1 nA to 1000 ppm (0.1%) at 1 pA.

For further information on this measurement service, please contact:
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If you would like further information on any aspect of **NPL Electromagnetic Metrology,** *please contact:*
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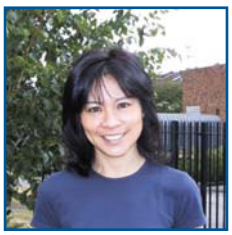
Traceability made easy

NPL has introduced a customer service team to provide you with a focussed point of contact for all calibration services. This has already increased accessibility to the measurement knowledge and facilities supported by the electromagnetic programme.

The team can give you information about NPL's services and take bookings, as well as putting you in direct contact with appropriate technical experts. For any questions on NPL's calibration and consultancy services, please contact the team direct:


Claire Lambeth


Rajni Tiwari


Jean Wong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Claire Lambeth

Calibration of PFD (power flux density), field strength probes, and loop antennas.

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Rajni Tiwari

Calibration of EMC antennas and horn antennas, oscilloscopes (risetime), pulse generators, laser power and energy meters, optical fibres, fibre optic test equipment. Time calibration and consultancy services.

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Jean Wong

DC and low frequency calibration services: voltage, resistance, capacitance and inductance, AC conductivity, AC/DC voltage and current transfer, IVDs, harmonic and flicker analysers/meters, and all magnetic measurements.

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George Andrews

Calibration of field free antennas (vhf, uhf, and EMC). RF and microwave guided wave calibration services, (noise, impedance, attenuation, power), dielectric measurements and the calibration of SAR probes.

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Forthcoming events

14 – 17 November 2005, British Electromagnetic Conference BEMC, NPL, Teddington
www.bemc2005.npl.co.uk

23 - 24 November 2005, Developing Advanced Scientific Engineering Spreadsheet Applications,
http://www.npl.co.uk/ssfm/training/dev_spread_apps_scieng.html

29 November 2005, FREEMET club/IEE EMC Professional Network joint meeting, NPL, Teddington
http://www.npl.co.uk/electromagnetic/clubs/freemet/

30th November 2005, Signal Processing Awareness Seminar,
http://www.npl.co.uk/ssfm/training/sig_proc_awareness.html

7 December 2005, Direct Current and Low Frequency Metrology Club, NPL, Teddington
www.npl.co.uk/electromagnetic/clubs/dclfclub/

8th December 2005, EMMA Club meeting, "A Celebration of Dielectrics - EMMA's 21st meeting",
http://www.npl.co.uk/electromagnetic/clubs/emma/

12th January 2006, FOToN Club meeting, "Practical Implementations of Fibre Optic Sensor Systems",
http://www.npl.co.uk/photonics/clubs/

For further information, event details and contacts visit the website: www.npl.co.uk/electromagnetic/

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