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## **Title: Metrology for high-speed microelectronics**

### **Abstract**

The topic aims to greatly improve the measurement and test mechanisms available to the electronics and microelectronics industries for next-generation Printed Circuit Board (PCB) and on-chip environments for high speed (i.e. high frequency) digital applications in computing, communications, automotive and consumer electronics. Likely priority areas will be typical time and frequency domain instrumentation such as vector network analysers and high-speed sampling oscilloscopes in coaxial, waveguide, free space, printed circuit boards and on-wafer, up to 110 GHz. In addition to the main industrial users other beneficiaries will include organisations involved in the test and instrumentation industries underpinning these areas of technology.

### **Conformity with the Work Programme**

This topic conforms to the EMRP Outline 2008 and, in particular, the scope of the Call for TP Industry and underpins the areas identified on Page 10 under Electricity and Magnetism. The topic is in the area of electrical and magnetic metrology (including time and frequency metrology).

### **Keywords**

High Frequency Electronic Testing; Printed Circuit Boards (PCBs); Linear Circuit Analysis, Coaxial and Planar Interconnects; On-wafer, MICs and MMICs; Measurement Traceability and Assurance; Signal Integrity, Vector network analysis, S-parameter measurement, online uncertainty determination, verification standards, dielectric substrates, material characterisation, on-wafer microwave measurements

### **Background to the Metrological Challenges**

Technology roadmaps foresee the further development of electronics and nanoelectronics as the key enabling technology for the whole of European industry. The ability to perform accurate vector network analyser (VNA) measurements is a key competence to reach the goals of these roadmaps. Such measurements are required to

- characterise materials used as substrates for high-speed electronic circuits on printed circuit boards,
- develop and test transmission lines that serve as RF connections between electronic devices,
- perform on-wafer characterisation of active devices

Existing European NMI capabilities provide only partial coverage of the required device architectures and response. The gaps in this coverage create barriers to reliable, efficient and fit-for-purpose testing, leading to problems in acceptance testing involving suppliers and customers. In order for the electronics and microelectronics industries in Europe to remain competitive, global drivers - being established by ITRS, IPC (the association connecting electronics industries, [www.ipc.org](http://www.ipc.org)), etc – also need to be responded to in a timely manner.

The primary need is to improve the competitiveness of the European semiconductor and related industries involved in electronics and microelectronics by establishing reliable testing techniques in high-speed digital electronics by introducing methods based on novel applications of existing 'high frequency' techniques. Methods suitable for implementation by industrial test facilities are required

that will be inherently multi-disciplinary in nature – i.e. they will include both electromagnetic and dimensional measurement capabilities, along with materials characterisation capabilities

## **Scientific and Technological Objectives**

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them, in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the JRP-protocol.

The focus of this topic is to provide the metrological tools and methods needed by the microelectronics industry for typical time and frequency domain instrumentation like vector network analysers and high-speed sampling oscilloscopes in coaxial, waveguide, free space, printed circuit boards and on-wafer, up to 110 GHz. The aim is to meet end-user requirements for reliable measurements in both transmission lines and planar circuit geometries, in both unbalanced and balanced configurations. The specific objectives are:

1. To develop automated calibration and uncertainty determination for vector network analysers
2. To develop advanced calibration and verification schemes for vector network analysers taking into account non-ideal calibration and verification standards especially at higher frequencies and considering materials issues for on-wafer devices
3. To develop traceable measurement techniques using state-of-the-art instrumentation, including dual and multi-port network analysers, high speed sampling oscilloscopes, mmwave coaxial interconnects, on-wafer and PCB probing techniques
4. To evaluate signal integrity effects due to fast signals needing to be quantified using commercially available instrumentation like time domain reflectometers and vector network analysers

Proposers shall give priority to work that meets documented industrial needs and that which supports transfer into industry e.g. by cooperation and/or by standardisation.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

## **Potential Impact**

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

Where a European Directive is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

You should also detail other Impacts of your proposed JRP as detailed in the document “Guidance for writing a JRP”

You should detail how your JRP results are going to:

- feed into the development of urgent standards through appropriate standards bodies
- transfer knowledge to the microelectronics and instrumentation sector.

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased

- outside researchers & research organisations other than NMIs and DIs to be involved in the work

### **Time-scale**

The project should be of 3 years duration.