Building a National Measurement Capability for the Millimetre- and Submillimetre-Wave Frequency Ranges

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SUMMARY

Summary—The National Physical Laboratory (NPL) is the UK’s National Metrology Institute (NMI). As such, NPL is tasked with developing, maintaining and disseminating the UK’s primary national standards of measurement. These standards represent the ultimate in measurement accuracy and are used to provide measurement traceability to the international system of units (SI) [1], as maintained by the International Bureau of Weights and Measures (BIPM).

NPL develops measurement standards and associated measurement capability in areas of relevance to science and technology. As new science and technology is developed, new measurement standards and new measurement capability are required to underpin and validate the new science and technology.

In recent years, much use has been made of the millimetre- and submillimetre-wave (also known as terahertz) parts of the electromagnetic spectrum. This corresponds to frequencies ranging from 30 GHz to 3 THz. This part of the spectrum is becoming useful for applications in electronics and telecommunications, defense and security, radio astronomy and atmospheric science, and, healthcare and pharmaceuticals. All these applications have driven the need for accurate and reliable measurement capabilities at these frequencies.

This paper will review some recent developments made at NPL to establish such measurement capabilities. Some examples of research and development activities will be given that have recently been undertaken as part of the ‘TEMMT’ European Joint Research Project. (‘TEMMT’ stands for Traceability for electrical measurements at millimetre-wave and terahertz frequencies for communications and electronics technologies’.) This project involves 19 organizations from around the world and is running from 2019 to 2022.

The paper will also describe how new rectangular metallic waveguide standards, as shown in Fig. 1, are being used to establish measurement traceability at these frequencies [2]. A new strategy has been developed, using these standards, to achieve accurate and reliable reference calibrations for vector network analysers (VNAs) operating at millimetre- and submillimetre-wave frequencies [3]. The paper will also describe how state-of-the-art on-wafer probing techniques (Figs. 2 and 3) are being developed to enable this traceability to be transferred to planar substrates used for TMICs (Terahertz Monolithic Integrated Circuits) [4] and other applications relating to terahertz electronics.

1 Metrology is the science of measurement.

REFERENCES