Current layout

We introduce the requirement for accurate PA characterisation for efficient design and first pass design success for 5G and beyond. We explain the necessity for nonlinear PAs and the unwanted side effects we need to mitigate using the accurate models.

Basic RF and microwave measurements are introduced, with considerations of the effects seen at RF and above such as reflections and mixing. Power meters are introduced. VNAs are explained along with their requirement for systematic error correction due to each measurement setup having a large impact on uncorrected results. The different error models are mentioned, along with compatible calibration routines. The ripple method for measuring residual systematic error is explained along with results from an author paper on applying it to waveguide VNA calibrations. Nonlinear VNAs are introduced, including the power and phase calibrations required for absolute measurements of electromagnetic waves.

Measurement uncertainty is now explained in detail along with the role of NMIs and traceability. The GUM is discussed and parts of an author paper reviewing the effects of the latest supplements on evaluating scattering parameter measurements are presented.

The application of measurement uncertainty evaluation to VNAs is now analysed. We itemise different input quantities to the scattering parameter measurements and study the nature of their systematic and/or random uncertainty contributions. We reference much existing work on VNA calibration uncertainty and software frameworks used by NMIs and labs for this evaluation. We then move on to uncertainty evaluations for NVNAs and again reference a lot of recent international work in this area. The power meter and phase reference uncertainties are studied and results from a traceable characterisation of the phase reference is shown. Finally, results from a recent paper co-authored by the author concerning a round-robin study of NVNA measurements of verification devices are presented.

Nonlinear behavioural models are studied in this chapter, in particular the X-parameter model. We discuss the reason for the model and its place in the design process, and how measurement uncertainty can be included in the model to incorporate confidence in device characterisations. The meat of this chapter is an expanded version of the author’s IEEE transactions paper presenting the first incorporation of measurement uncertainty into a nonlinear behavioural model. We then show that the model can be used within a circuit simulator.

Finally, we review the work which has been completed throughout the project and its value to the both knowledge and the communications industry. We suggest future work and useful immediate applications of the software framework.