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# WR15 Six-port Interferometric Set-up for Millimeter-wave Characterization in Harsh Environments

N. Alsaleh, D. Pomorski, M. Sebbache, C. Lenoir and K. Haddadi

**Abstract**— Continuous wave (CW) millimeter-wave radars have gained the interest from industry for accurate distance measurement. In particular, six-port radar (SPR) architecture presents advantages such as high resolution combined with low-power consumption and low-cost implementation. A WR15 waveguide six-port interferometer is designed and realized for accurate phase measurement in the millimeter-wave regime for harsh environment conditions. This latter is combined with dedicated calibration algorithms to provide measurements performance in terms of sensitivity and accuracy. Experimental results are exemplary shown with mean phase error 2.2 degrees at the test frequency 60 GHz.

**Keywords**—Six-Port, millimeter-waves, free-space, radar, demodulator IQ.

## I SUMMARY

The six-port is a passive linear component, first developed in the 1970s for accurate automated measurements of the complex reflection. Since then, a variety of six-port systems have been demonstrated. Each technology presents own advantages and drawbacks in terms of circuit size, power consumption, fabrication facility, system integration, measurement performance and cost. Therefore, the choice of the technology is mainly driven by the requirements of the targeted application [1]-[4].

This work presents a fully WR15 metallic waveguide six-port interferometer acting as an IQ demodulator operating in the frequency range 55-75 GHz for near-field sensing applications, i.e. near-field high precision distance measurement. The circuit is fully calibrated with reference waveguide phase shifter followed by an attenuator as shown in figure 1. The source power is set to 0dbm.

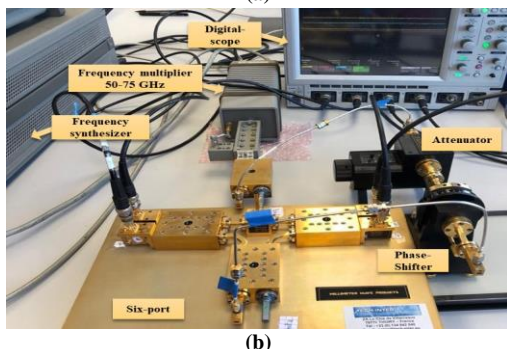
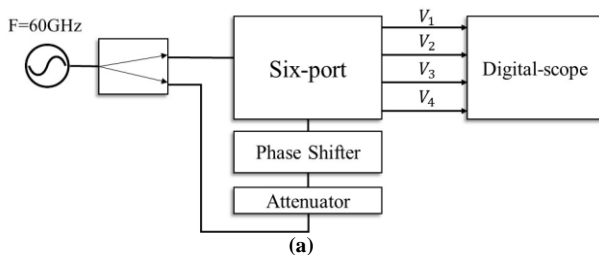


Figure 1 (a) Schematic of the test platform; (b) Photograph of the test platform

As a demonstration, the steps consists in (i) in-situ linearization of the six-port detectors, (ii) interferometric measurements using waveguide phase-shifter.

The first step concerns in the linearization of the detectors of the SPR in order to eliminate the distortion of theirs electrical response (figure 2 (a)). The linearization procedure consists to interpolate the measured data using a polynomial function.

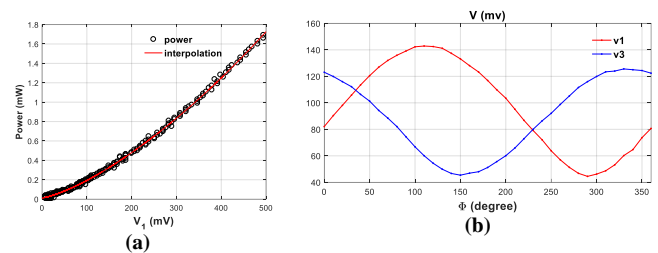


Figure 2 (a) Power in the detector 1 as a function of the voltage; (b) Detected voltage as a function of the phase

The next step is to calculate the calibration coefficients by fitting the measured voltage curve shown in Figure (2(b)). The calculated phase is presented in Figure 3 as a function of the measured phase. To validate our approach, this step is first performed without linearizing the detectors and then with. The average error on the calculated phase decreases significantly from 6.01 degrees to 2.2 degrees after the detector linearization step.

These procedures can lead to high accuracy measurements and take into account the imperfections of the system. An extended method for total calibration and system modelling will be presented in the extended version of the paper.

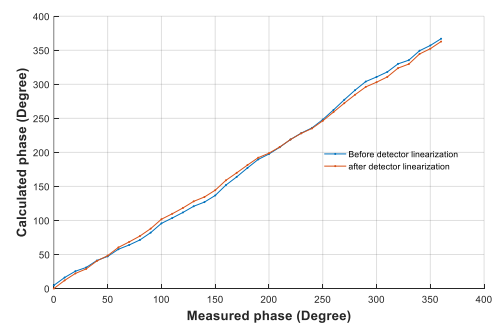


Figure 3 The calculated phases as a function of the measured phases with and without the detector linearization.

## II References

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