An Ultra Low-Cross-Polarization S-band Active Array Antenna for a Fully Digital Polarimetric Phased Radar System

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***Abstract*—This paper presents the progress of the 2D scanning active array design for ultra-low, dual-polarized S-band fully digital, multibeam and multifunction phased array radar system.**

***Index Terms*—radar, digital array, MIMO, digital beamforming, polarimetric, active array, low-cross polarization.**

I. Introduction

THE University of Oklahoma (OU) has a long history of severe local storms research and field program activities using mobile radars. During the last decade, the Advanced Radar Research Center (ARRC) at the University of Oklahoma (OU) has pushed the boundaries with the development of emerging e-scanning radar for multifunction radar system [1]–[3]. Phased array antenna technology with agile multi-beam enable unprecedented radar flexibility and high data rate capacity. A fully-digital PAR offers many attractive features which will allow the next-generation of radars to supersede the performance of conventional single 2D beam scanned PAR's or partially digital architectures. The design of a high performance radiating antenna an array for wide scanning and ultra-low cross-polarization isolation is considered. This contribution presents updated results of a dual polarized radiating element designed to achieve low cross polarization (lower than -40 dB) and large fractional bandwidth (18%) over wide scanning angles 60°. The design includes multiple features that enable high isolation between ports, reduction of spurious radiation, highly symmetrical radiated fields, and suppression of diffracted fields between contiguous sub-array gaps [4], [5]. Fig.1 represents the mobile platform demonstrator with 16 panels (32x32 elements) in a 4x4 panel configuration

II. HORUS antenna concept and preliminary results

The antenna element and array antenna in this work presents combined several techniques including the cross-stacked parasitic patch with electromagnetic coupling as show in Fig. 2(a-b). This approach enabled 18% impedance bandwidth for the presented antenna element with cross-polarization levels below -40 dB for the principal planes. Non-contacting feeds,

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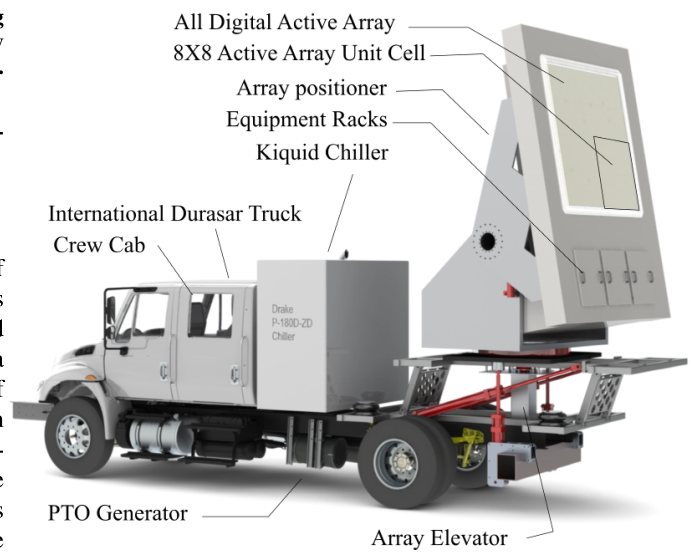

Fig. 1: Mobile platform demonstrator with 16 panels (32x32 elements) in a 4x4 panel configuration.

aperture-coupled microstrip antennas offer a more robust design because their construction lacks soldered feed pins. An aperture is located on a ground plane that separates both vertical and horizontal polarization. Each feeding network couples to the aperture, while the aperture then couples the energy to the driven patch. A cross-sectional view of this mechanism using stacked patches is show in Fig.2(a) and 2(b). This technique allows for high isolation between ports which is inherently related to the cross-polarization level. On the downside, the construction of this configuration is difficult and the back-lobe radiation is higher than the traditional probe-fed patch due to the energy coming from the slot. In order to reduce the radiation that comes from the slot, a feeding network based on striplines with a backing ground plane could be used for one of the polarizations as shown in Fig. 2(b). In terms of cross-polarization, this technique shows better performance than other feeding methods when the apertures are designed to keep cross-polarized radiation away from broadside.

Figure 2(e) shows the active array antenna setup at the near-field chamber, T/R module board, control board an the

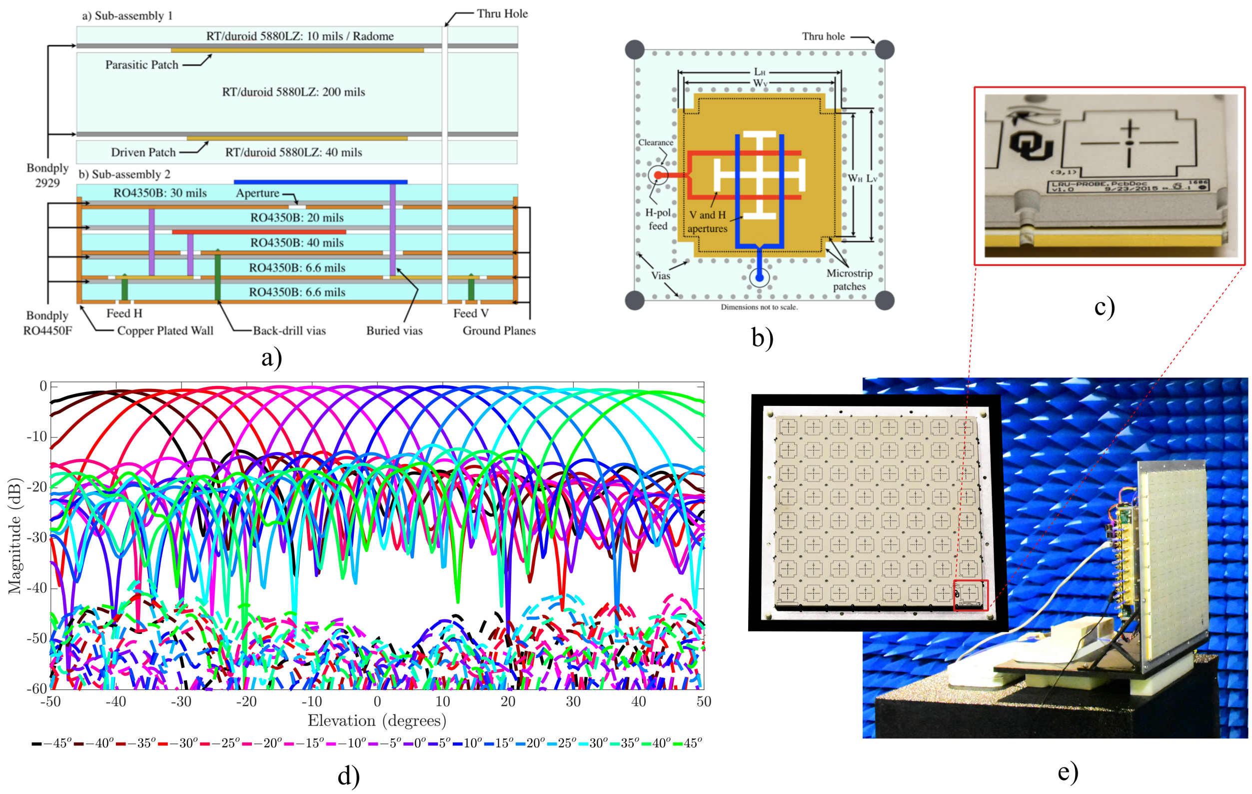

Fig. 2: a) Antenna stack-up, b) Antenna geometry, c) Picture of antenna element d) Scanned antenna patterns (H-pol) in the E-plane and e) NF measurement setup .

overall scanned measured performance of the antenna array of 2x8 elements for H- and V-polarizations. Measurements were obtained every 5° in a scanning range of ± 45° for both polarizations in azimuth and elevation planes. To control the phase of the antennas, 6-bit serial control phase shifter and attenuator cards were made with a resolution of 5.625° and 0.5 dB for each element. A calibration algorithm was performed to remove amplitude and phase inaccuracies between channels. Fig.2(d) shows the co- and cross-polarization of 2 rows and 2 columns in the 8x8 array scanned every 5°.

III. Conclusion

The design and implementation of an active dual-polarized S-band active array for a digital and multi-beam phased array is developed by the Advanced Radar Research Center (ARRC) at the University of Oklahoma is presented. Scanned patterns with cross-polarization of -40 dB across the scanning range was obtained.

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