Adjustment of an Active Phased Array Antenna on a Near-Field Range and Determination of it's characteristic Performance Parameter in an Anechoic Far-Field Chamber

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ABSTRACT :

Active Phased Array Antennas especially for use in radar systems (e.g. Airborne Radars) have to be adjusted and tested before they can be operated in the radar system. This adjustment process shall guarantee the antenna performance under all operating conditions.
Therefore, the Active Phased Array Antenna is measured on a Near-Field Test Range to determine the adjustment corrections to improve the pattern quality.
Operating the antenna with the adjustment corrections, it is ready to determine the antenna performance. This will be performed in two steps; on the Near-Field Test Range and within an anechoic chamber.

This paper describes the adjustment process and how to determine the performance parameter of the Active Phased Array Antenna. Performance parameter are

- **Sum and Difference Antenna Patterns (measured on a Near-Field and Far-Field Range)**
- **Directivity**
- **Average Far SLL**
- **Difference Null Depth**
- **Noise Figure (described by G/T)**
- **EIRP**
- **Electrical Gain**
- **Beam Pointing Resolution**
- **Beam Pointing Accuracy**
- **Pulse Shape**
- **and the Antenna Signature.**

TOPIC :

An Active Phased Array Antenna will be a standard equipment of a fighter aircraft in the near future. There it will be used as a front radar antenna with a planar aperture containing a large number of radiating elements , e.g. 1000.
Each radiating element (RE) is directly connected to an **active** Transmit / Receive Module (TRM), which provides the necessary output power in transmit operation (TX) and vice versa amplifies the incoming signal in receive operation (RX). TX output power and RX amplificiation can be individually controlled on each TRM over a range of 20 dB below the nominal values and further, the insertion phase of each RF path to the RE can be changed between 0° and 360° in TX and RX mode using a phase shifter within each TRM.
Because the TRMs have an insertion transmission varying between different TRMs, all other RF components have transmission variations as well, there is a strong need to adjust the Active Phased Array Antenna on a Near-Field Test Range to ensure a good antenna performance (e.g. pattern quality).
Only one TRM is switched on, all others are switched off (S**ingle Element Adjustment**). A defined digital control state is set at the TRM and the insertion amplitude and phase are measured for TX and RX in the considered frequency band for several frequency points. This procedure is repeated for all other TRMs in the antenna.
Adjustment corrections will be derived and entered in the antenna control process.

Now the Active Phased Array Antenna can be mounted in the Anechoic Far-Field Range on a turntable and the described performance parameter can be determined.

CONCLUSION :

The Near-Field Range is a fundamental tool for the adjustment of an Active Phased Array Antenna and a valuable tool to evaluate the antenna, especially when full 3D antenna patterns are needed.
The measurement equipment architectures, described in this paper, were proofed during the evaluation of an Active Phased Array Antenna. They fulfil all needs for RX and TX measurements. The wideband detector in the Network Analyser used for pulsed TX measurements has an acceptable dynamic range of 45 dB, this is not a big limiting factor when the power budget of the measurement equipment setup is considered and carefully adjusted.
Pulse Shape measurements are performed with a Peak Power Meter, the Noise Figure is measured with an Average Power Meter.