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Active Array Platform (3.5 GHz)

Developed by Jiayu Hou and Yuan Ding

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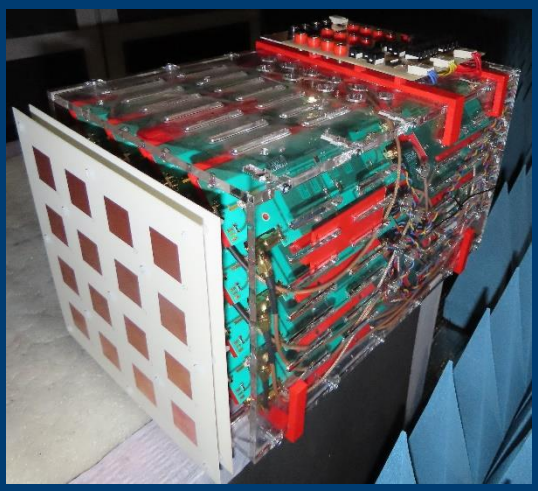


Microwaves and Antenna Engineering Group

https://microwaves.site.hw.ac.uk

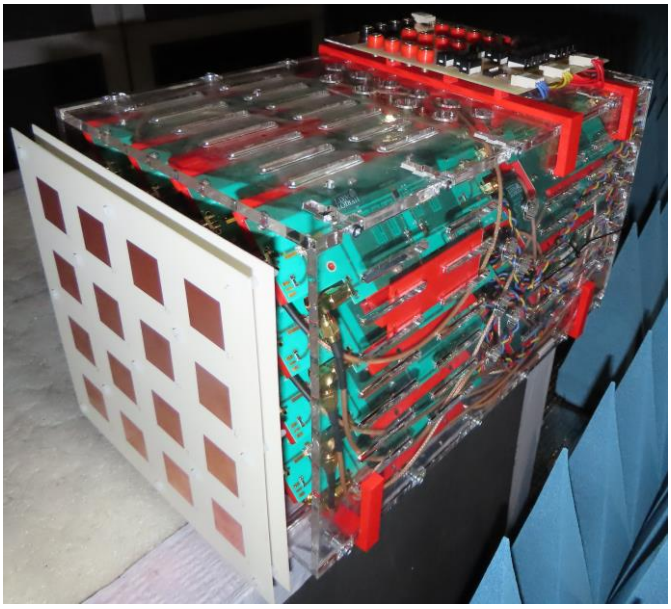
Motivation

Increasing demand for higher wireless link/network capacity inevitably requires transmitters (Tx) and receivers (Rx) equipping more antennas, normally forming different types of arrays. Integration, thus, becomes a trend, and on the other hand a challenge, to reduce the system complexity, power consumption and cost, especially at Tx end.

To enable our physical-layer wireless research in the group, we have developed, and will continue making further improvements, an active array platform that can be used in many fronts of our research, including, but not limited to:

- Power amplifier (PA) non-linearity characterisation/modelling, and its predistortion algorithms;
- PA active loadpulling phenomenon, i.e., non-linear interaction between PAs and coupled antenna arrays;
- Inter-modulation and harmonic distortions in multi-beam or MIMO Tx active arrays;
- Physical-layer wireless security systems, e.g., directional modulation (DM) and radio frequency fingerprinting (RFF).

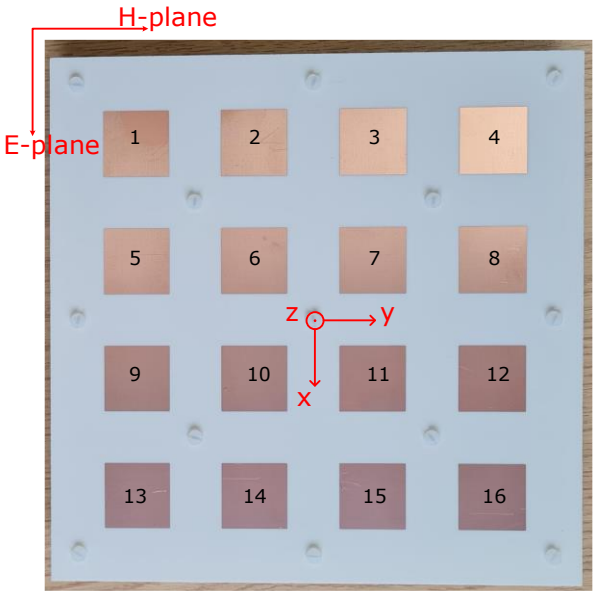
Active Array Platform Specs



Operation Frequency: 3.5 GHz

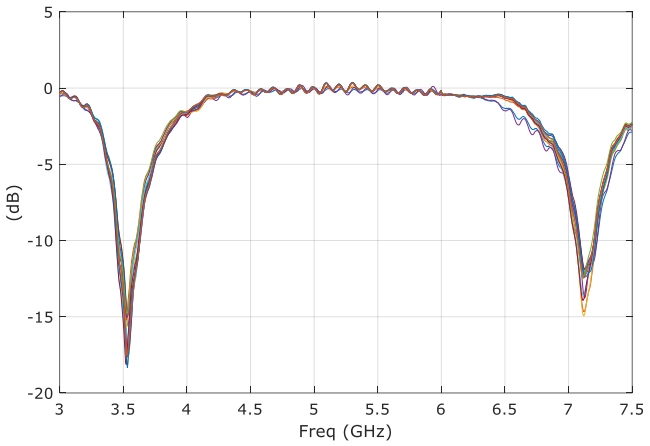
Array Size: 4×4, 16-chain array

Antenna Array: 4×4, 16-element capacitively-fed microstrip patch array with half-wavelength spacing.

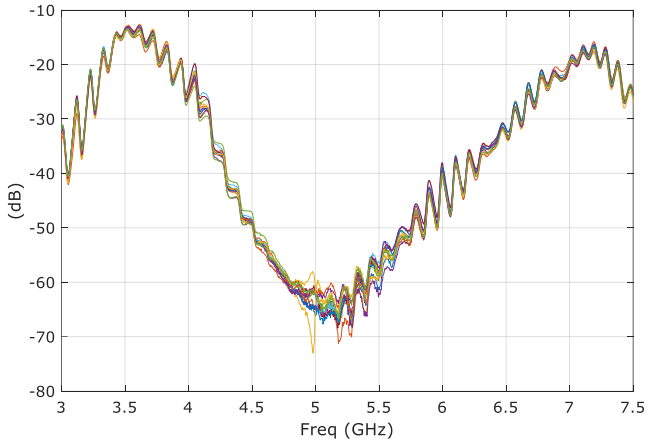


Measured S-parameters

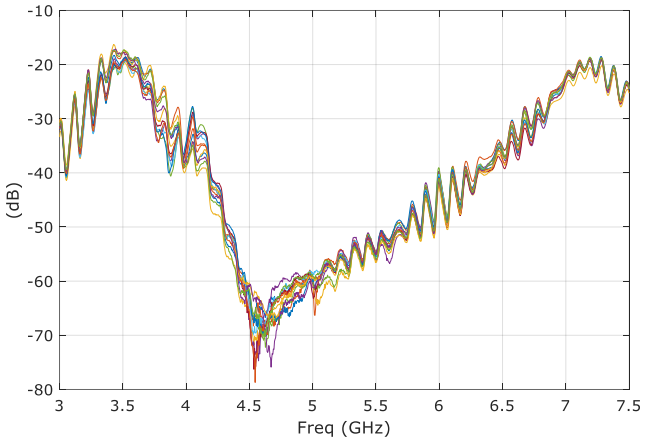
- Reflection Coefficients S_{ii} (i = 1, …, 16)



- Coupling between two adjacent elements in E-plane.

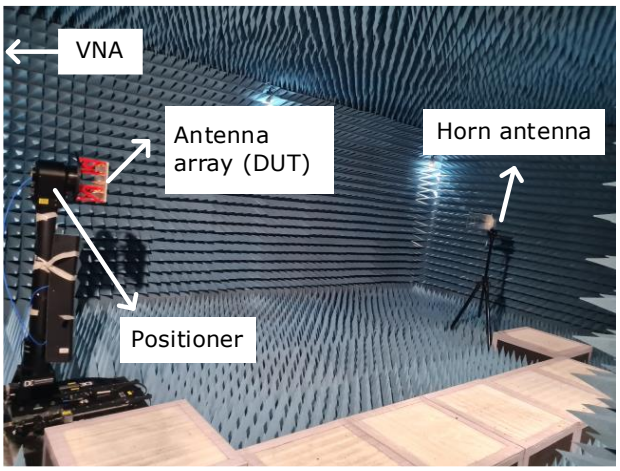


- Coupling between two adjacent elements in H-plane.

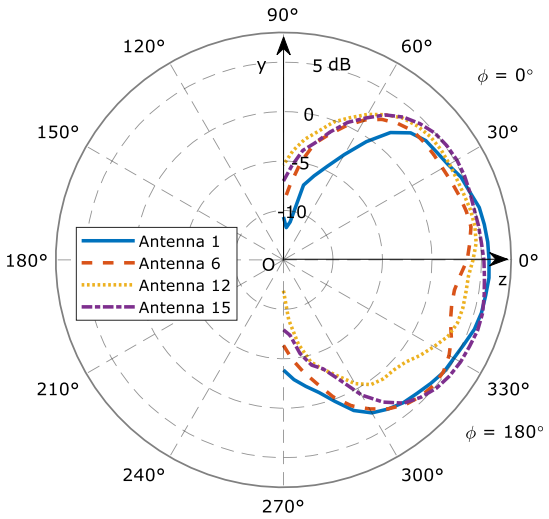


Measured Radiation Patterns

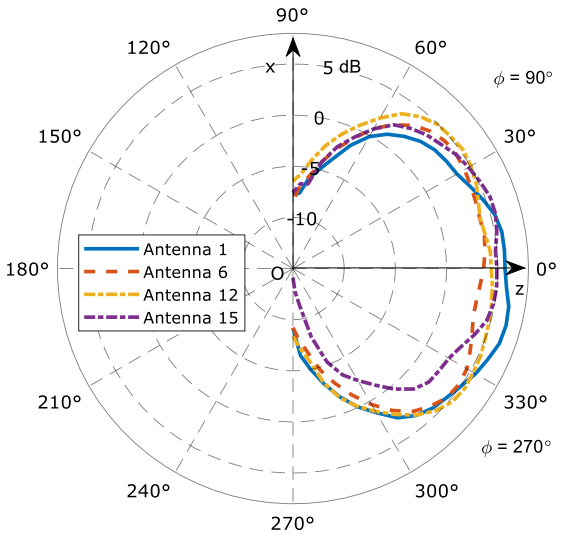
Patterns @3.5 GHz of four selected antenna elements (1, 6, 12, 15) are illustrated as below.



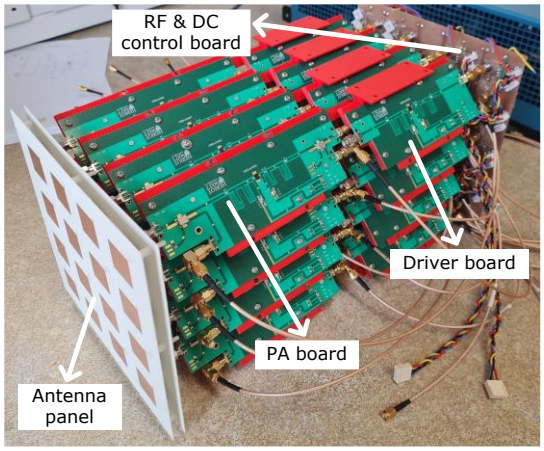
- G_φ in yoz plane



- G_θ in xoz plane



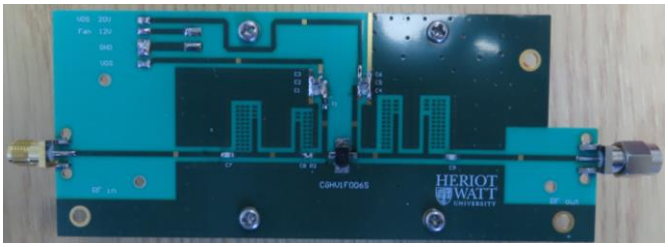
Active array platform assembly without case



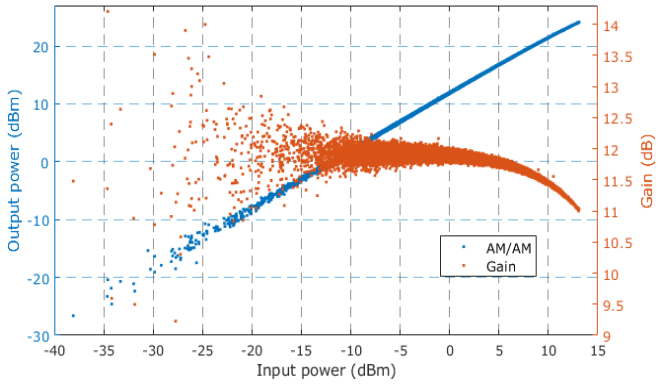
Driver:

Transistor: GaN CGHV1F006S

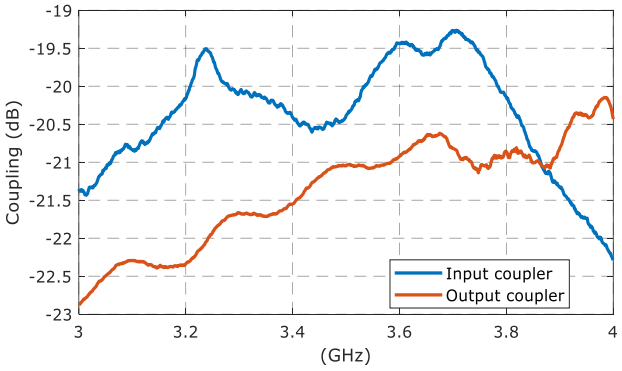
Biasing: 20V Vd; 100mA Iq



- Typical measured AM/AM and Gain compression curves (using LTE signals of 200kHz bandwidth)



- Input and output couplers (cabling and connectors included)

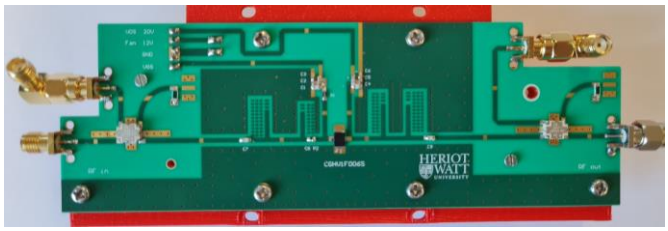


Final Stage PA:

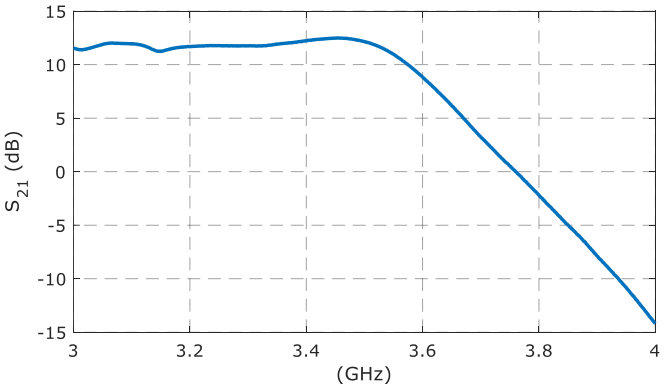
Transistor: GaN CGHV1F006S

Biasing: 20V Vd; 100mA Iq

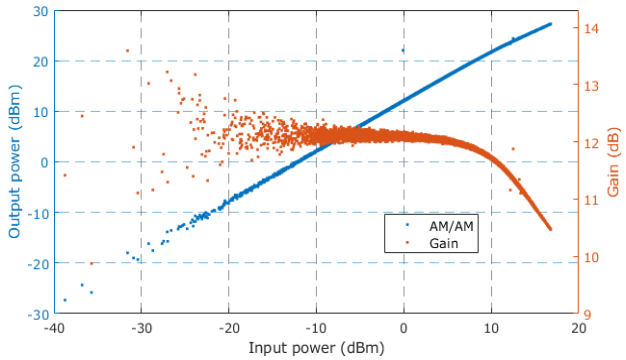
Input & Output coupling: ~–20 dB



- Typical measured small-signal S_{21}

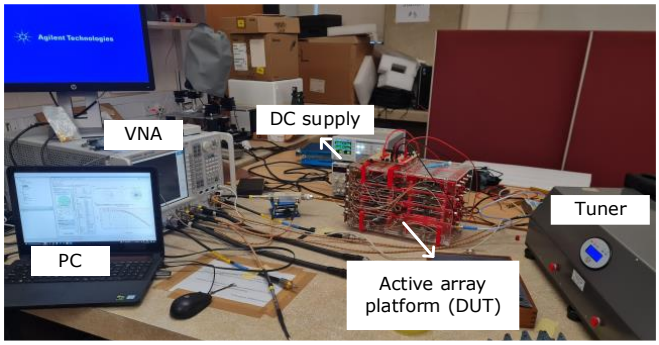


- Typical measured AM/AM and Gain compression curves (using LTE signals of 200kHz bandwidth)

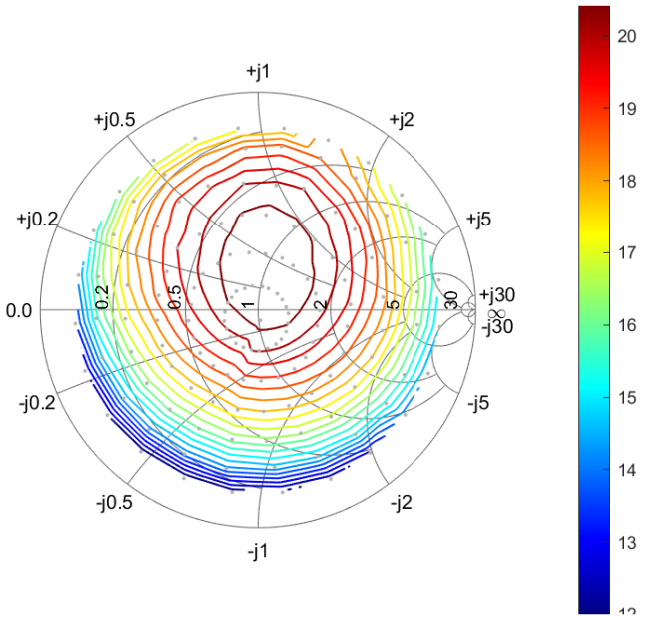


Loadpull Measurement:

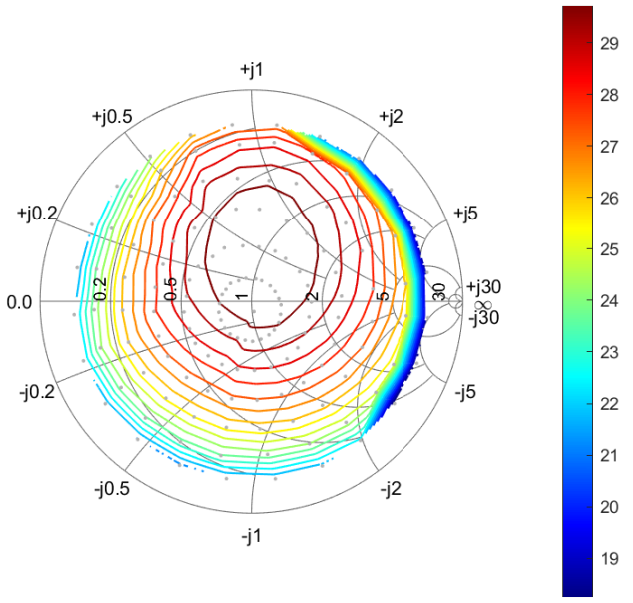
Loadpull measurement was performed with Maury passive tuner XT982ML01, and Keysight PNA N5225A.



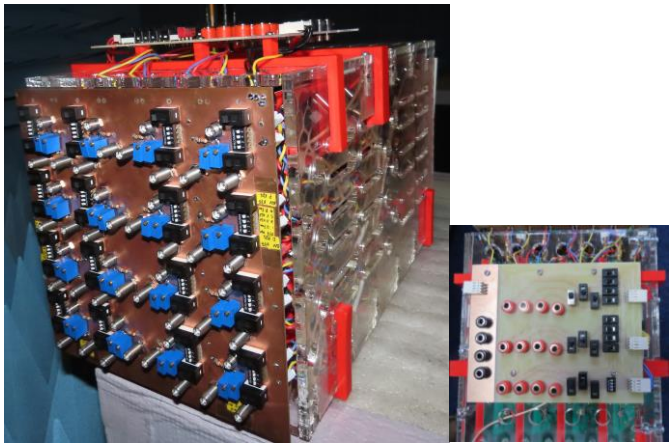
- Gain (dB) @ 2.5dB compression – Chain6



- Pdel (dBm) @ 2.5dB compression – chain6



RF and DC Control Board:



For each chain,

- the drain voltage can be switched on/off;
- the gate voltage for driver and PA can be individually switched on/off;
- the gate voltage for driver and PA can be individually tuned;
- the fans for driver and PA can be individually switched on/off;
- coupled RF signals from PA input and output can be individually monitored.
- The entire drain and gate currents can be monitored.

Data

Please send your requests to Jiayu Hou and Yuan Ding.

Funding Support

EPSRC (EP/V002635/1): 'Boosting Power Efficiency of Physical-layer Secured MIMO Communications'

EPSRC (EP/Y037197/1): 'Securing Spectrum Connectivity Over-the-Air Authentication using Radio Frequency Fingerprinting' in HASC: Future Communications Hub in All-Spectrum Connectivity

Selected Publications

To be added

Researchers

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