Focus on CSIR

C-Band Active Element Phased Transmit Array Panel

An affordable yet capable step into phased array radar technology

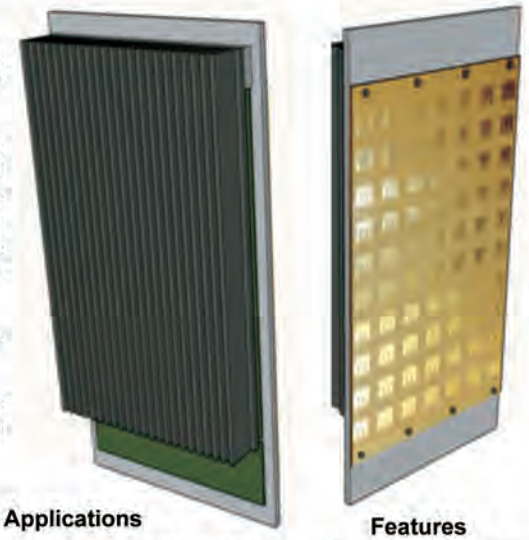
Introduction

The C-Band active element transmit panel is a compact phased array building block that enables scalable radar antenna solutions from 1 to 16 panels to be realised.

Each panel consists of 70 individual antenna elements each fed by a dedicated 1W power amplifier located directly behind the patch antenna element. The antenna elements are arranged in 7 columns of 10 elements each. The phase shift and power level of each column are controlled to realise electronic scanning of the transmission beam with good side-lobe level control.

For wide beam widths a single panel can be used. Multiple panels can be used together to yield a narrow transmit beam.

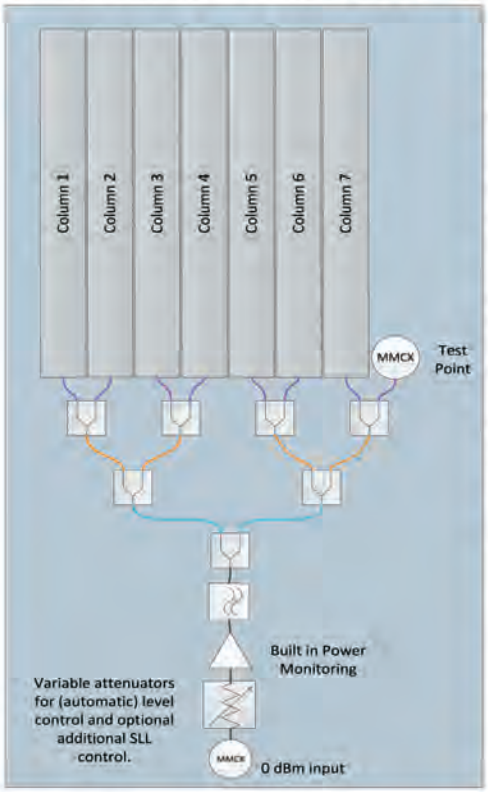
Airborne operation is possible with the array panel as it has been designed to be rugged and lightweight for use onboard manned and unmanned aircraft.



Front (right) and rear view of the compact C-Band phased array Tx panel

Block diagram

The RF block diagram below illustrates the high level panel architecture. Control and system monitoring details not shown for clarity.



Origins and Applications

The C-Band transmit array panel was developed to meet the needs of various demonstrator radar systems by being low cost, easy to use, modular and scalable.

The panel was also developed as a first, affordable, step for CSIR DPSS to enter into the world of phased array technology. Low cost RF components operating from 5.25 – 5.85 GHz now enables various narrow and wide band systems to use phased array technology where previously expensive T/R modules were required.

Additionally by utilising this panel, system designers can focus on exploiting the benefits of phased array technology without getting bogged down with low level detailed implementation issues. To enable this, the panel offers easy interfaces for control and timing.

Product Planning / Roadmap

Based on this first panel, a family of future phased array products is currently being planned:

- A matching size receiver panel, (available: 2016 Q3)
- X-Band Tx Panel
- X-Band Rx Panel
- C-band high power TX panel
- C-Band dual polarisation upgrade

Features

- Small size, lightweight.
- Scalable up to 16 panels.
- Azimuth beamwidth of 20° for a single panel.
- Azimuth beamwidth as narrow as 1.25° for a maximum of 16 panels.
- Elevation pattern optimised for 70° back angle for extended coverage.
- Phased array transmit beam steering at a fraction of the cost.
- Fully programmable with automatic status monitoring and reporting.
- Adjustable side lobe levels.
- Automatic Thermal and RF protection.
- Monitors delivered RF power to antenna elements.
- Rugged modules are suitable for airborne operation.
- Built in ESD protection.
- Optional automatic gain control.

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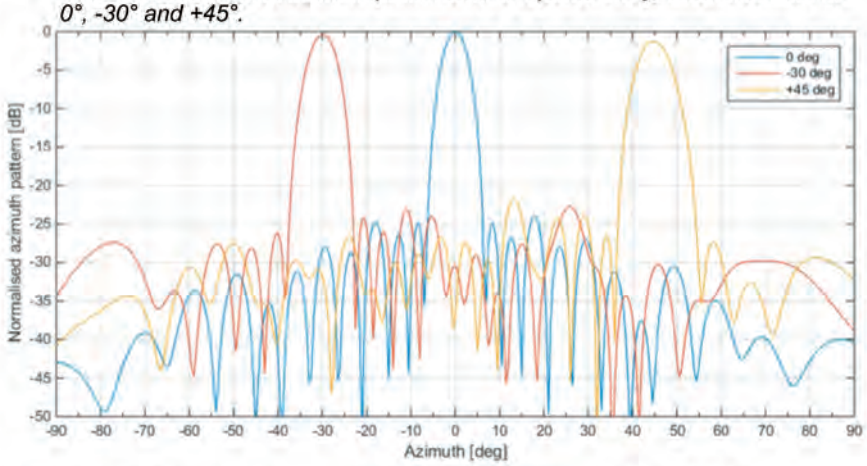
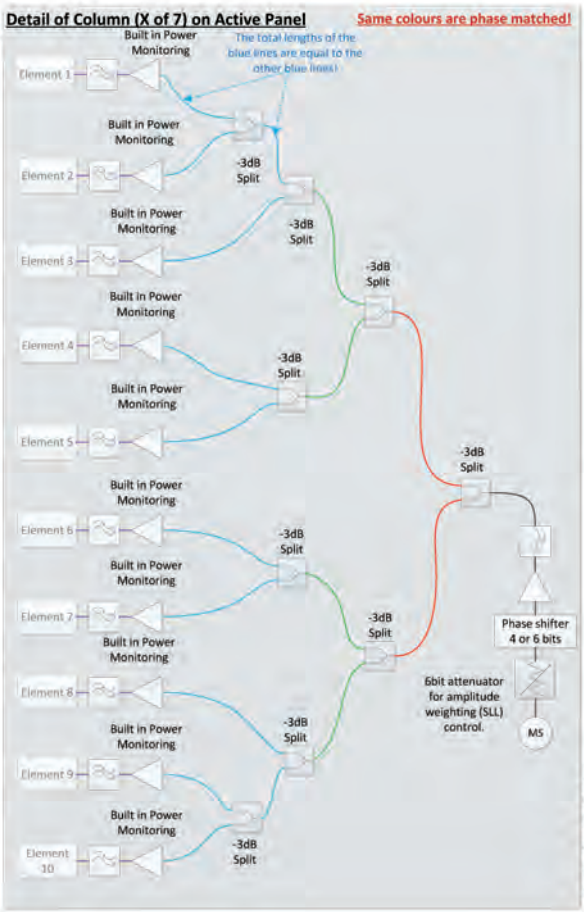
Simulated normalised azimuth patterns for a 4 panel array, when scanned to 0°, -30° and +45°.



Four panel patch array on display at the IEEE Radar Conference in 2015.

The simulated performance of such an array in terms of azimuth pattern is shown in the figure on the left.



Detail RF block diagram of the feed network and amplifiers that drive each patch array element

Specifications

Physical:

- Dimensions (single panel) 161x400x50mm (WxHxD).
- Weight: ~3.5 kg (depends on options)

Scanning / Control

- Scan angle: -45° to +45° (full power) -50° to +50° (reduced power)
- Scanning update rate: 1kHz

Waveform constraints

- Maximum PRF: 50 kHz.
- Minimum PRF: 1kHz (5% duty cycle), 2kHz (10% duty cycle), 4kHz (20% duty cycle).

RF Performance:

- Frequency coverage: 5.25 – 5.85 GHz
- RF Output power: 70W peak, maximum 20% duty cycle (1W CW test mode).
- RF Input power: nominal 0dBm, acceptable input power levels -10 to + 10 dBm..
- Adjustable RF Output power level control: 20dB in 0.5dB steps.

Interfaces

RF interface:

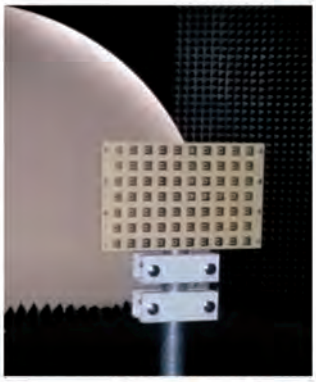
- MMCX:

Control interfaces:

- 10/100 Ethernet or RS232.
- RS-422 Trigger inputs.

Electrical interface:

- DC +5V @ 20A (Max) and -5V 0.2A
- Optional AC power supply (adds 0.6kg): 85 - 264VAC 47-63Hz (1.5A to 0.5A respectively).



Antenna patch array panel being measured at the Compact Range Facility at the University of Pretoria

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