XWRx EVM Antennas Review

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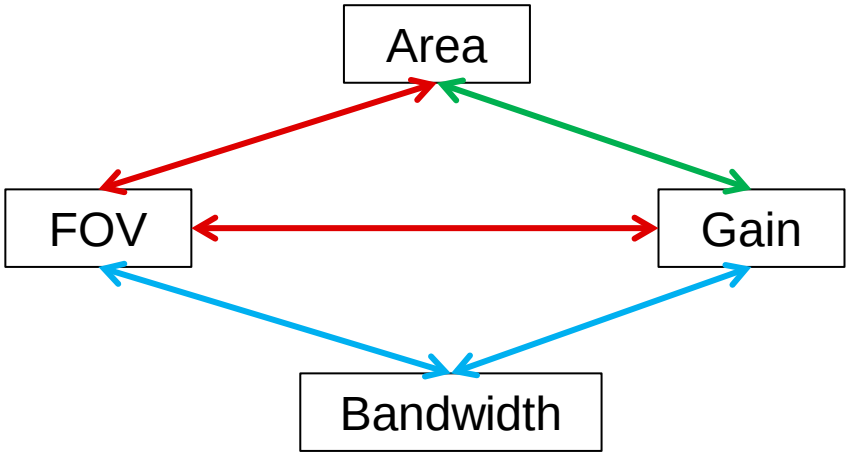
Antenna Parameters – Fundamental Tradeoffs

- Parameters of interest for an antenna design are correlated:
  - Gain & Beamwidth (FOV):
    - Gain and beam area of an antenna are related: $G = \frac{4\pi}{\Omega_A}$
    - Hence, antenna with higher gain has lower beamwidth (/FOV) and vice versa
  - Gain & Area:
    - Gain and effective aperture of an antenna are related: $G = \frac{4\pi}{\lambda^2} A_e$
    - Antenna with larger aperture (/area) has higher gain
  - Gain & Bandwidth:
    - Gain and bandwidth of an antenna are related and depends on the particular design



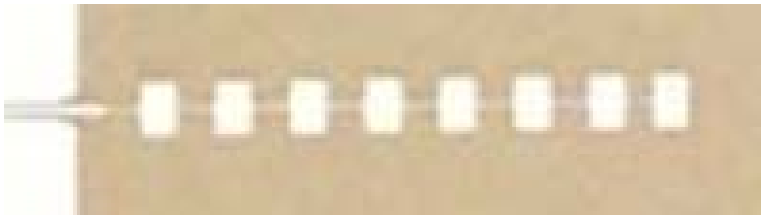
Patch Antenna Performance vs. Substrate

- Patch antenna parameters are dependent on the substrate specifications:
  - Thicker substrate → Wider BW
  - Lower dielectric constant (Dk) → Wider BW
  - Lower loss tangent (Df) → Higher efficiency → Higher gain

Series-Fed Patch Array

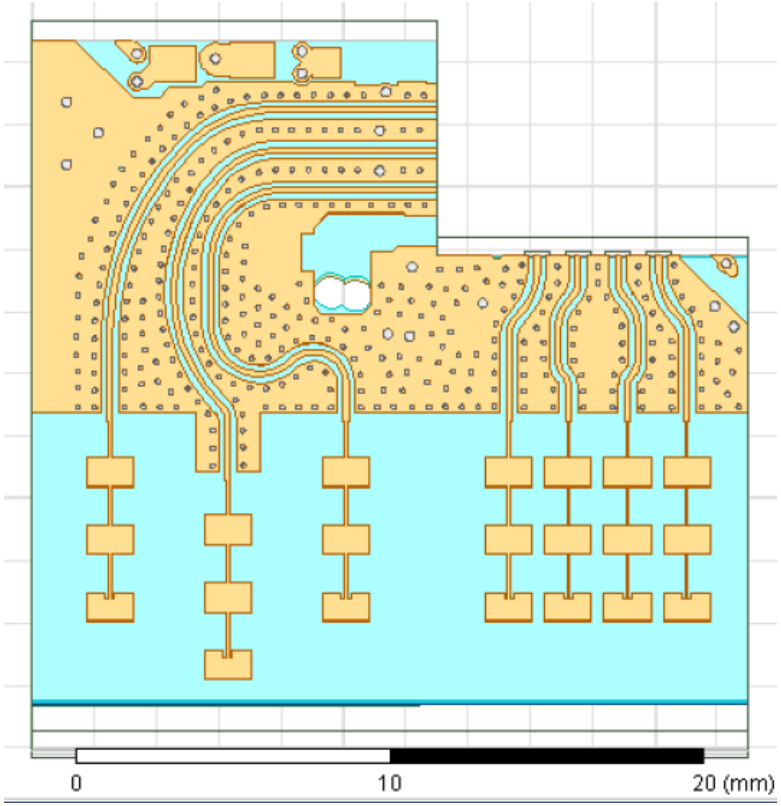
- Patch elements can be connected with microstrip line sections in series to form an array
- Radiated field from each element is added in the far-field increasing the total gain and reducing the beamwidth in E-plane
- BW is typically narrower than single patch, however, by properly designing the inter-element spacing BW can be made wider at the expense of reduced gain.

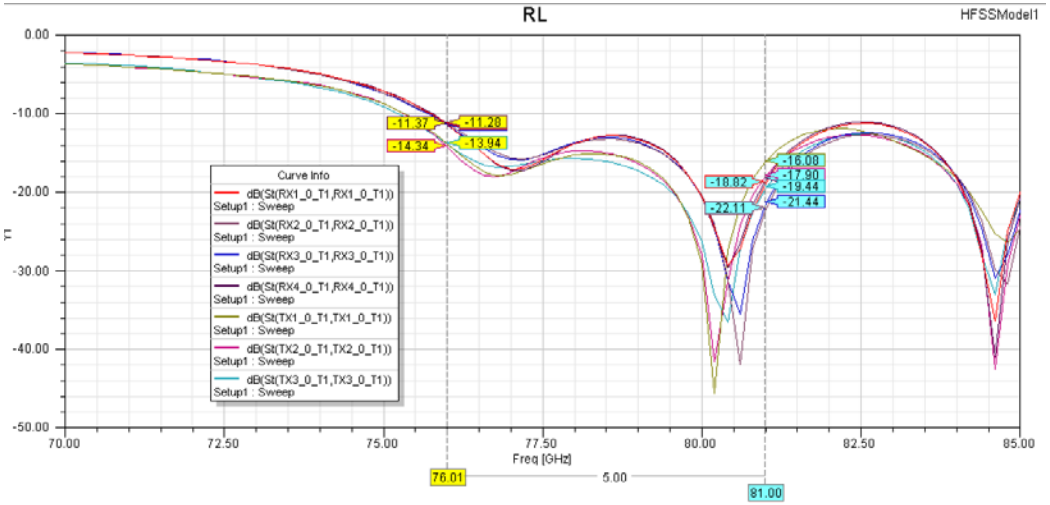
High Gain
Narrow beam in E-plane
Potential side-lobes

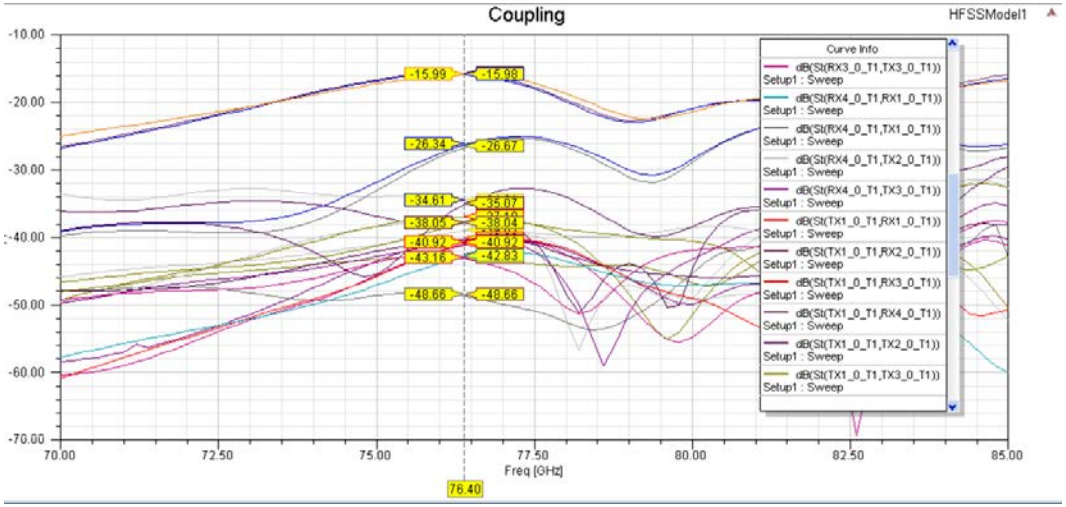


XWR1443 EVM antennas

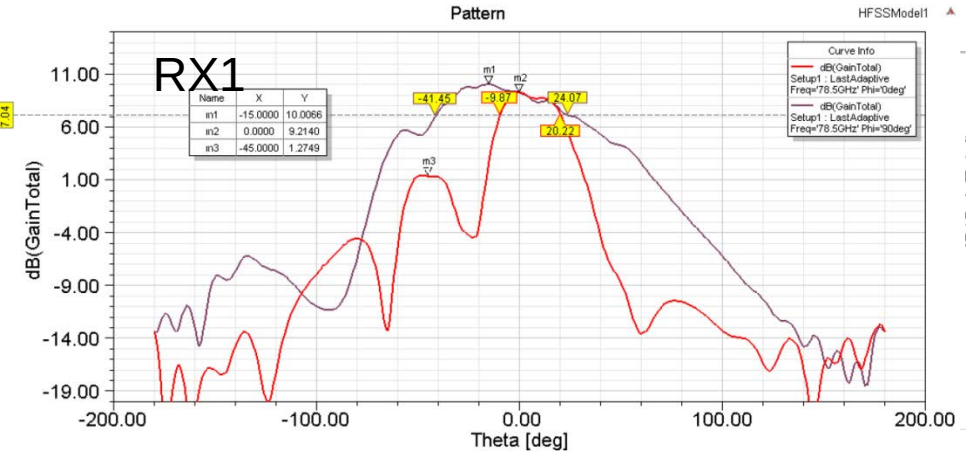
- Simulation includes the traces to the edge of the package
- RX-RX coupling < 16 dB
- TX-RX coupling < 36 dB

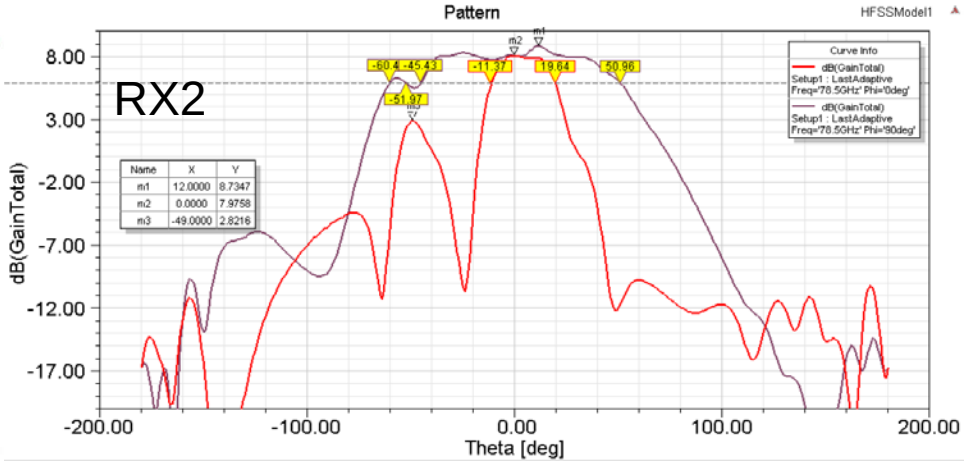


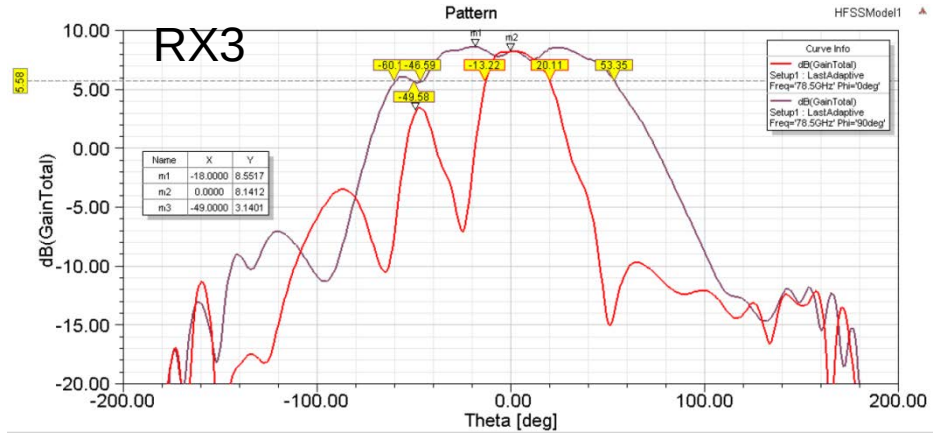


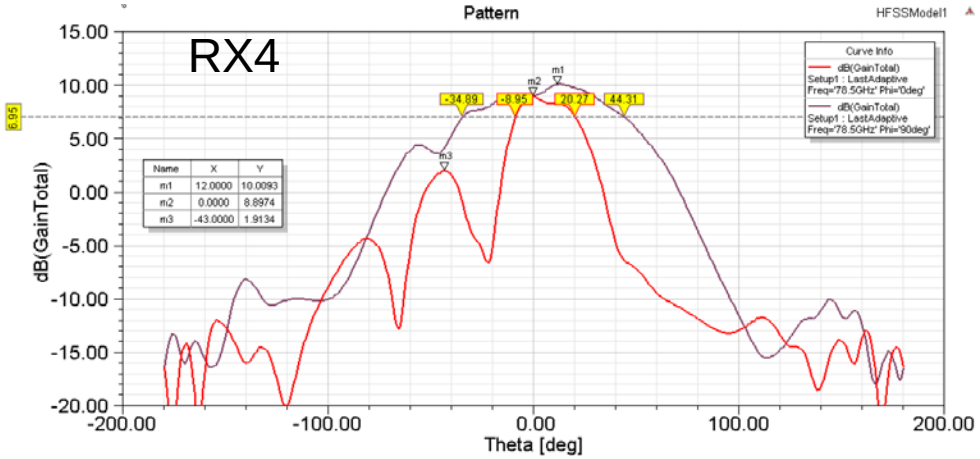


Antenna pattern @ 78.5GHz: RX

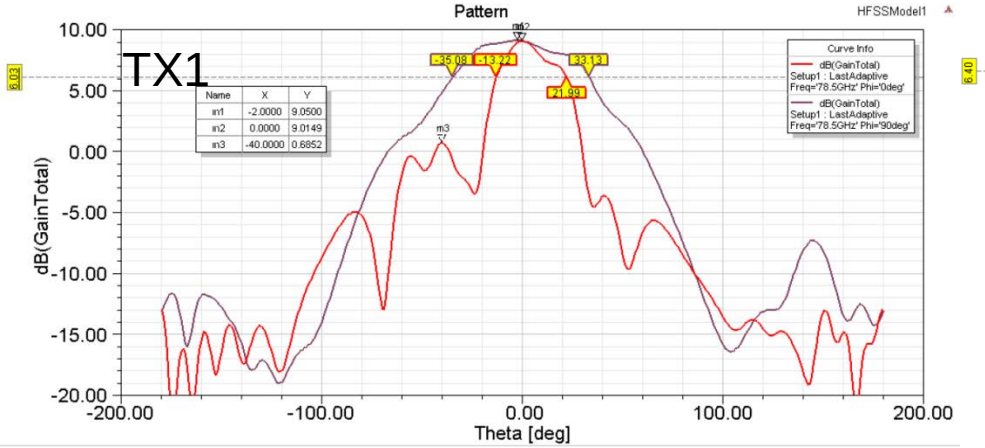


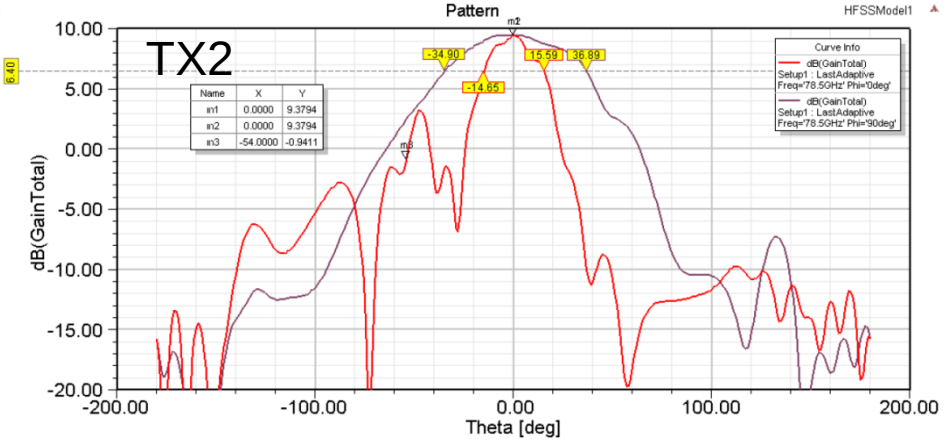


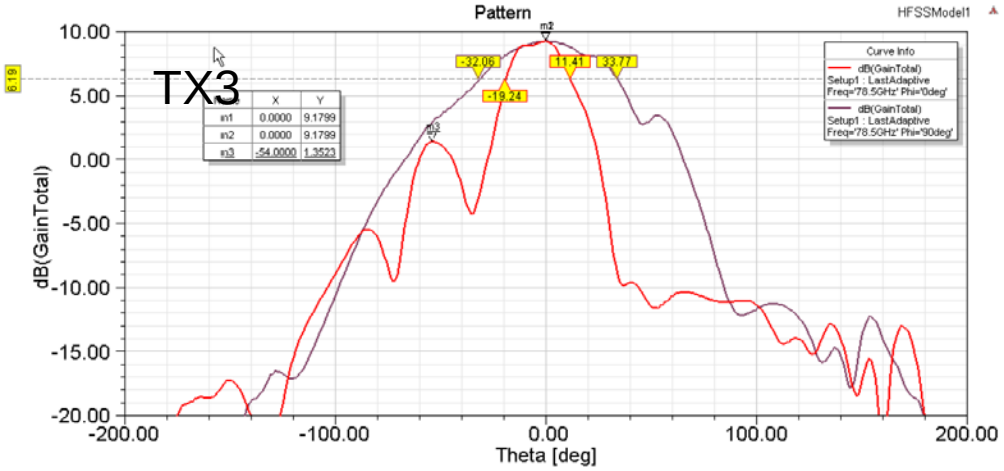




Antenna pattern @ 78.5GHz: TX





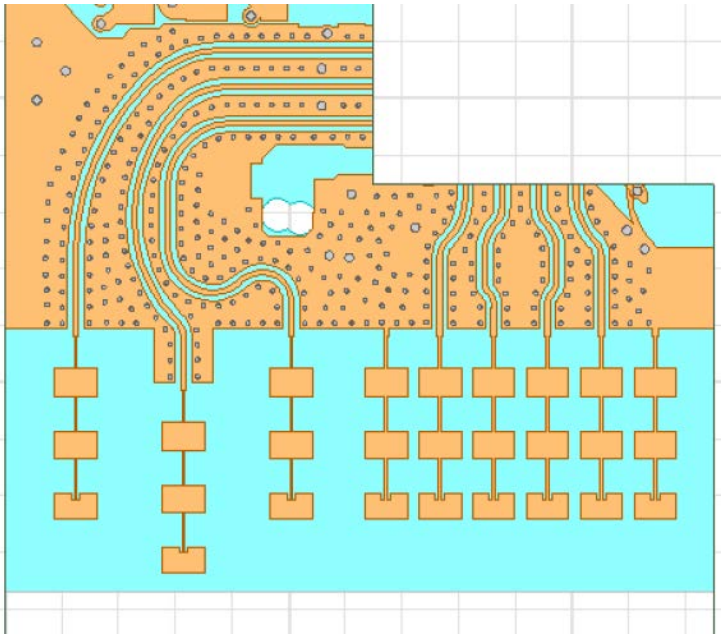


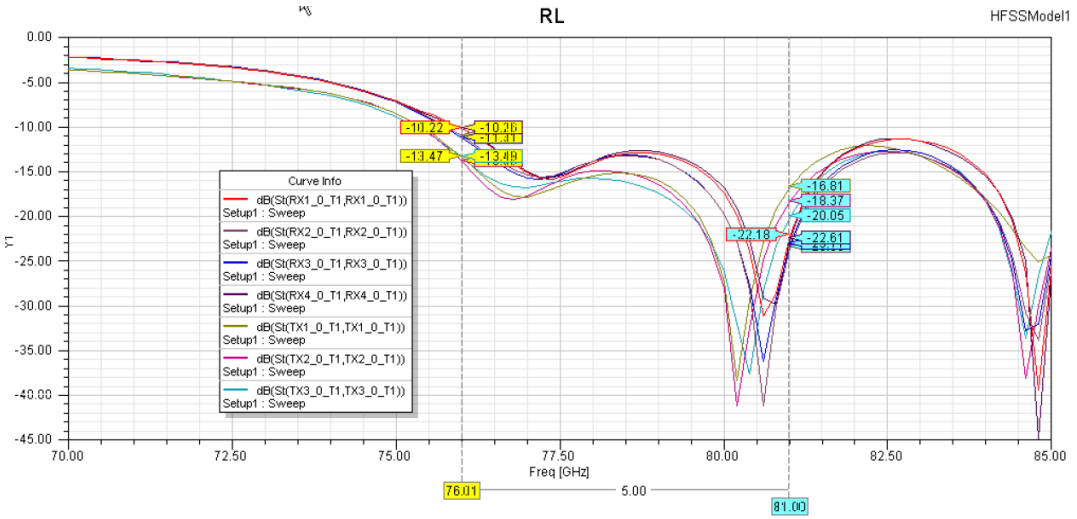
Performance Summary (78.5GHz)

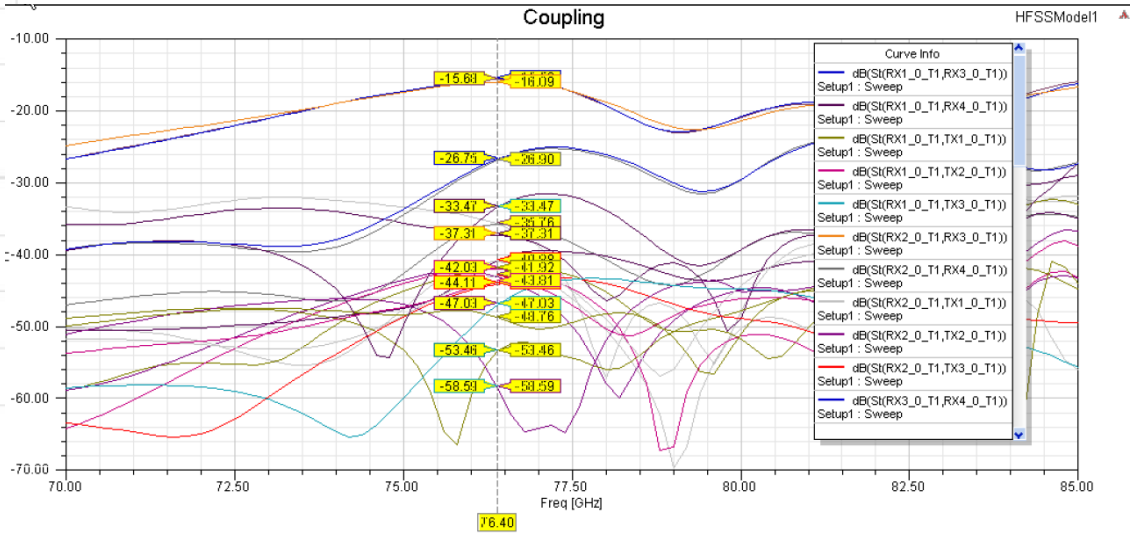
Antenna	RX1	RX2	RX3	RX4	TX1	TX2	TX3
Peak Angle (deg)	Az:-15, El:7	Az:-12, El:12	Az:-18, El:12	Az:13, El:7	Az:-2, El:8	Az:-5, El:10	Az:0, El:15
Peak Directivity (dBi)	11.5	10.4	10.2	11.5	11.3	11.7	11.5
Peak Gain (dBi)	10	8.7	8.6	10	9.1	9.4	9.2
Radiation Efficiency (%)	70	69	69	70	57	58	58
Side lobe Level (dB)	8.7	5.9	5.2	8.1	8.4	6.3	7.8
H-plane Beamwidth (deg)	65	95	100	78	68	72	66
E-plane Beamwidth (deg)	30	30	33	30	35	30.5	31

XWR1443 EVM antennas with dummies

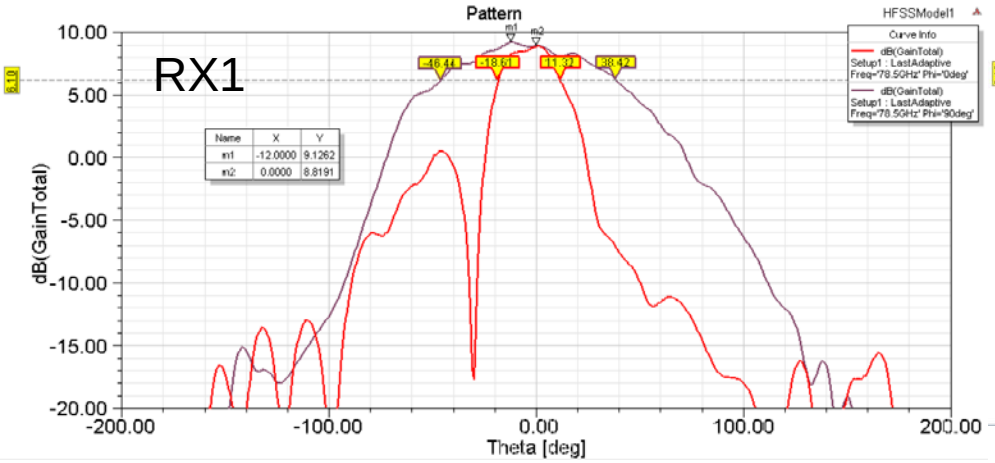
- Simulation includes the traces to the edge of the package
- RX-RX coupling < 15 dB
- TX-RX coupling < 35 dB

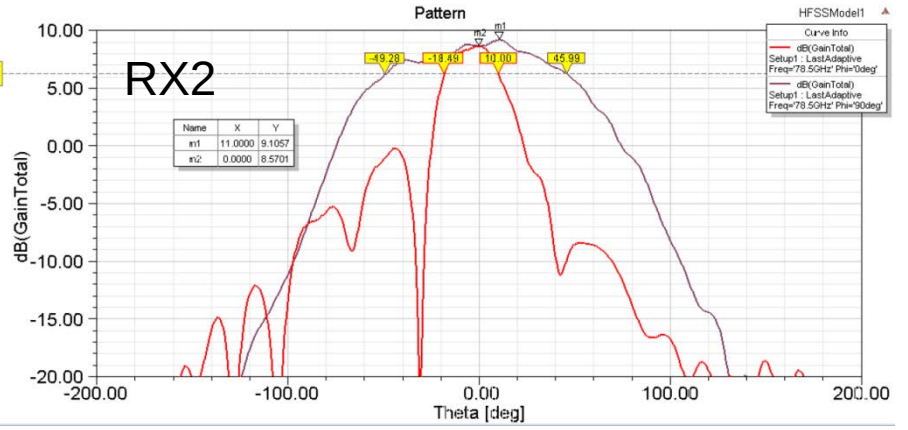


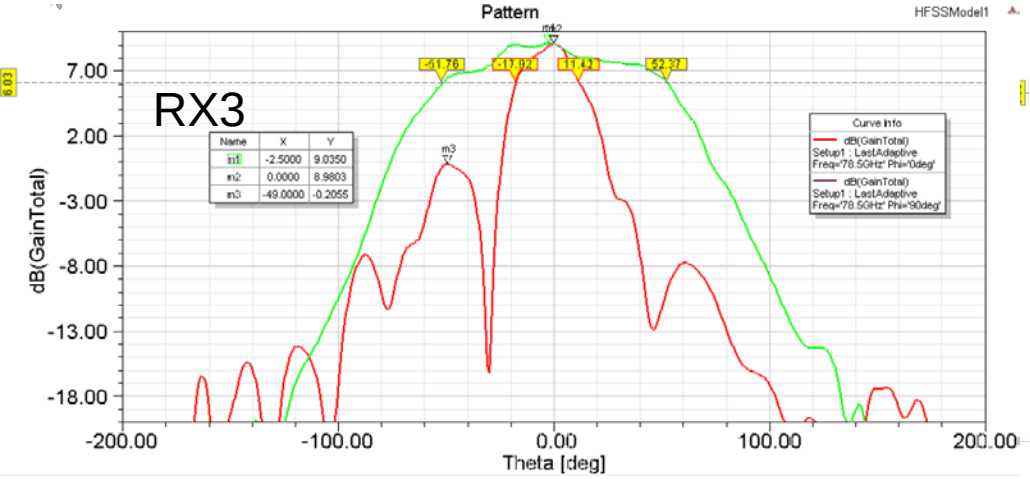


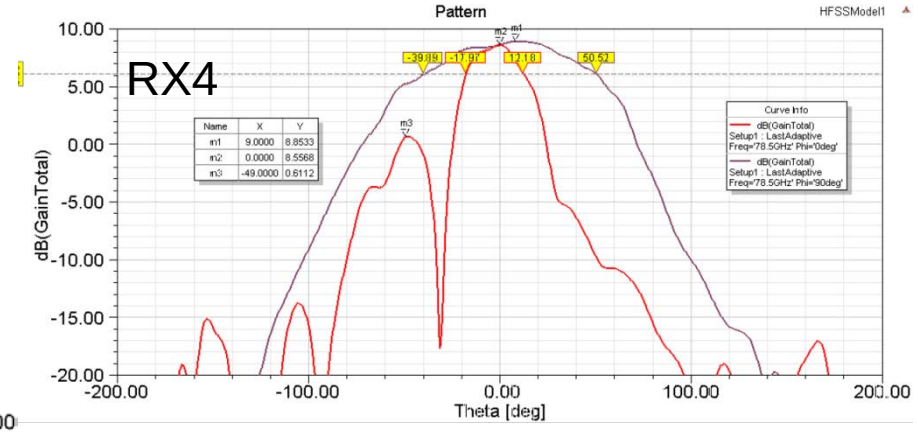


Antenna pattern @ 78.5GHz: RX







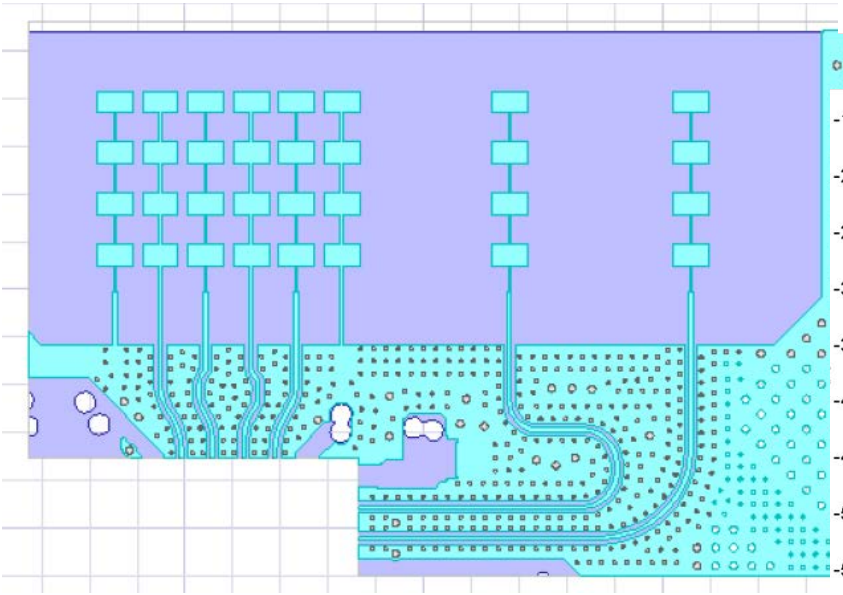


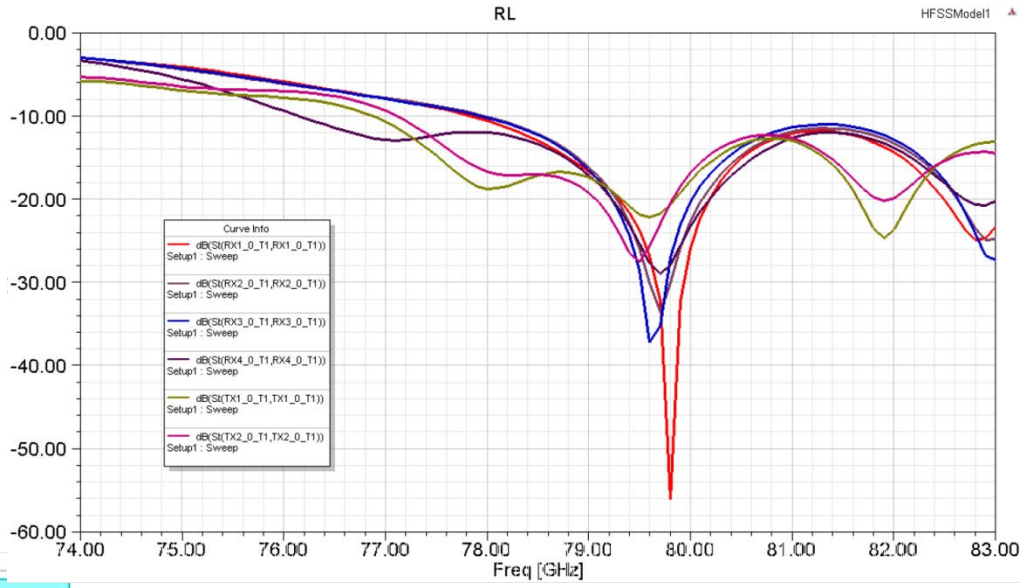
Performance Summary (78.5GHz)

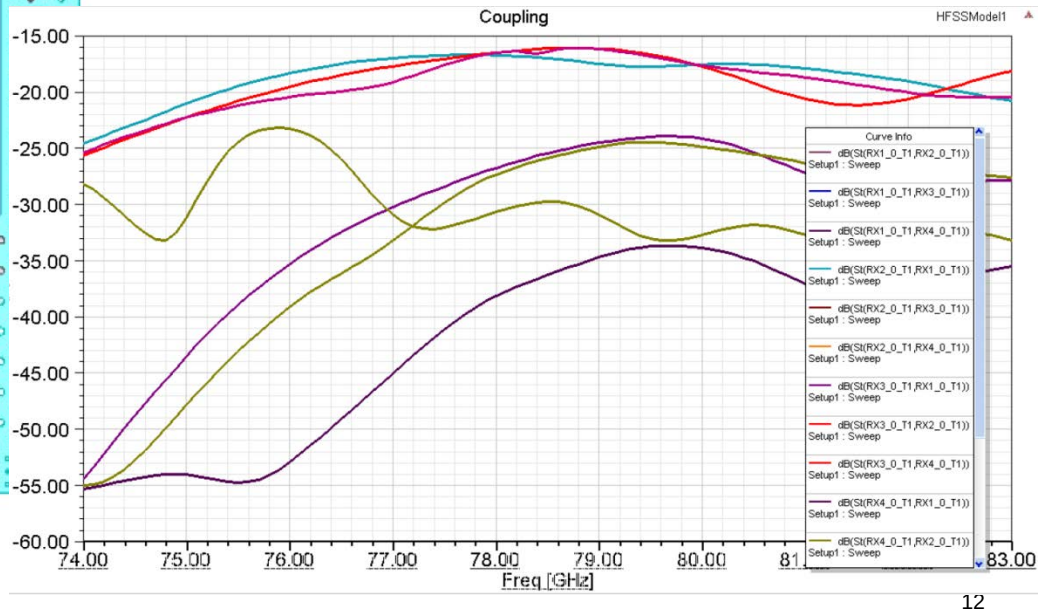
Antenna	RX1	RX2	RX3	RX4
Peak Angle (deg)	Az:-12, El:18	Az:11, El:18	Az:-2, El:17	Az:9, El:18
Peak Directivity (dBi)	10.8	10.8	10.8	10.5
Peak Gain (dBi)	9.1	9.1	9	8.9
Radiation Efficiency (%)	67	67	67	68
Side lobe Level (dB)	9	9	9	8.5
H-plane Beamwidth (deg)	85	95	100	92
E-plane Beamwidth (deg)	30	29	29	31

S11 & Coupling

- S11<-6dB @76GHz,
- S11<-10dB 78-81GHz
- Coupling<-16dB for adjacent RX antennas







Performance Summary (78.5GHz)

Antenna	RX1	RX2	RX3	RX4	TX1	TX2
Peak Angle (deg)	Az:0, El:6	Az:15, El:4	Az:0, El:4	Az:6, El:6	Az:5, El:4	Az:-5, El:4
Peak Directivity (dBi)	12.2	11.6	11.5	12.7	13.2	12.9
Peak Gain (dBi)*	10.6	9.9	9.8	11	10.8	10.4
Radiation Efficiency (%)*	70	68	67	68	57	56
Side lobe Level (dB)	-8.5	-9	-8.5	-9	-10	-9.5
H-plane Beamwidth (deg)	70	85	90	71	63	62
E-plane Beamwidth (deg)	28	25	28	20	23	25

* Gain and efficiency numbers include transmission line loss