LOW-PROFILE PLANAR PATCH ANTENNA ARRAY For 10 GHz with Gain > +30 dBi

To: “50 MHz & UP” CLUB, North California

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“MP Antennas and Arrays R&D”

About the author

- Received Graduate Diploma Degree in Electrical Engineering from University of Belgrade, Serbia; and the evaluation to MSEE in USA, 1994.

- Professionally active in Silicon Valley for 20+ years. Used to work for Sanmina and Nortel Networks Corps. as Sr. EMI/RF Engineer; for Cisco Systems as a Technical EMI Leader; and for Enegrous Corp. as Sr. Principal Antenna Engineer.

- Currently Antenna Design and EMI Consulting Engineer.

Some IEEE Publications and USA Patents in R&D

- IEEE Conference paper: “Dual-band metamaterial-structured antenna with coplanar waveguide and radial feed stub”, M. Pajovic with team, et al., *IEEE Symposium on Antennas and Propagation*, *Vancouver, Canada, 2015*
- Common-Mode Filter for 10-Gb/s Differential Microstrip Lines, M. Pajovic with team, *USA patent 8,907,748 B2*, *2014.*
- IEEE Conference paper: “The Gigahertz common-mode filter for differential signal lines”,
- M. Pajovic with team, et al., *IEEE EMC Symposium*, *Denver, Colorado, 2013, and*
- “Improved Common-Mode Filter for 10-Gb/s Straplines”, M. Pajovic with team, USA *Patent pending.*
- “Gigahertz-range Analysis of Impedance Profiles and Cavity Resonances in Multilayered planar structures”, M. Pajovic with team, et al., *IEEE Transactions on Electromagnetic Compatibility*, 2010.
- “The Closed-form Equation for Estimating Capacitance of Signal Vias in Arbitrarily Multilayered PCBs”, M. Pajovic with team, *IEEE Transactions on Electromagnetic Compatibility*, *2008.*

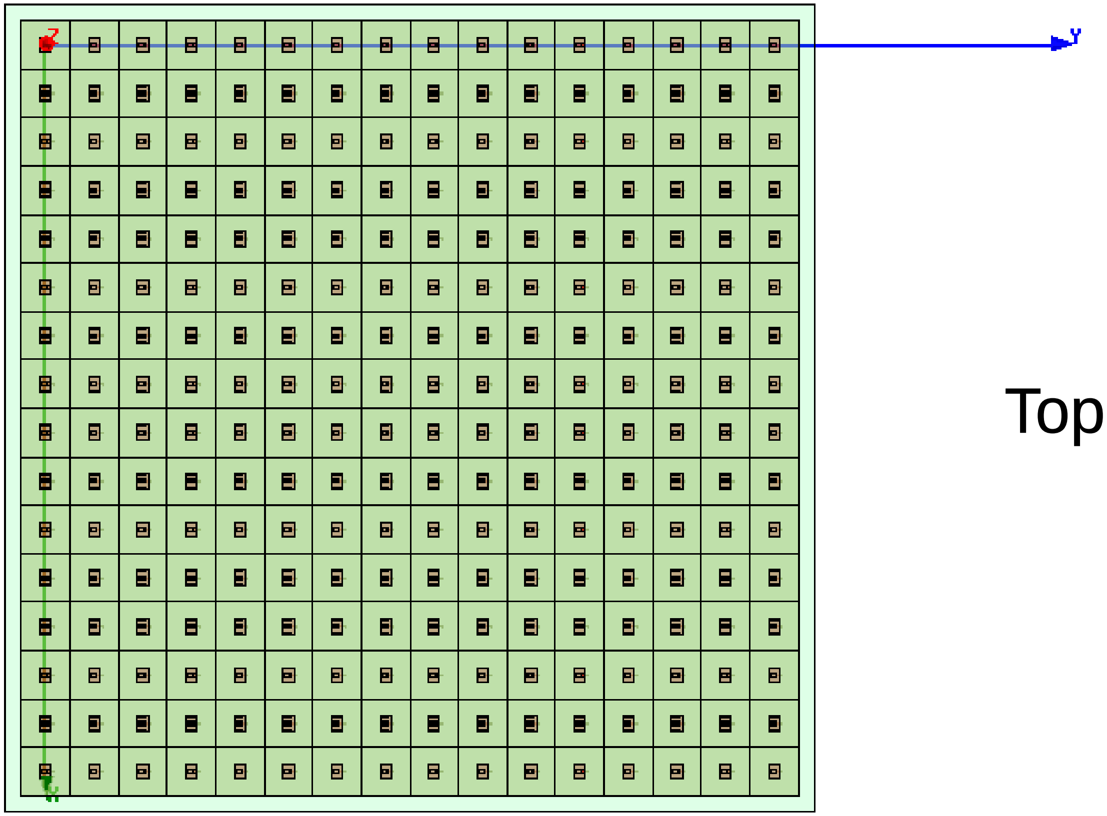
HAM Radio Life

- Received the first Ham Radio license in 1967, former Yugoslavia, in a high school (50 years ago!) Later, got a personal call sign YU1WK.
- Used to be a long time member of Academic HAM Radio Club **YU1EXY** from Belgrade University (well known European Club on Ham-radio bands and in worldwide contests)
- Currently (over a decade) the call sign is WA6MP (extra FCC class)

LOW-PROFILE PANEL PATCH ANTENNA ARRAY
For 10 GHz with Gain > +30 dBi

Design concept and HFSS simulation results

16x16 Patch array (256 patches), (16x16) inch



Top view

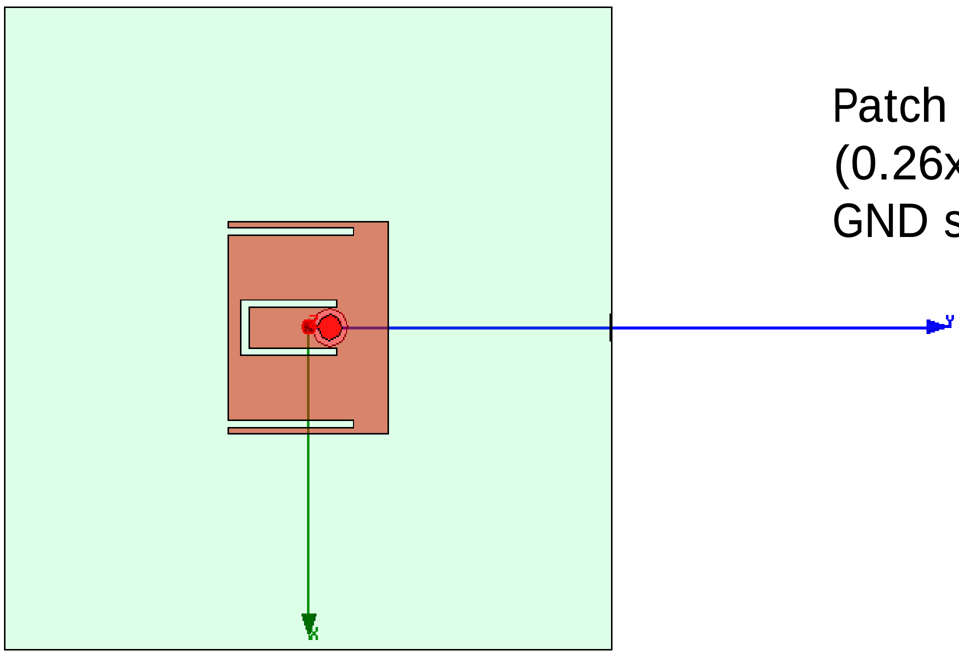
Stackup for 16x16 patch Array

Array PCB> 1st layer; 16x16 patches, Cu
Dielectric Ro3035, thick 60 mil
2nd layer; GND plane, Cu
Feed PCB> 1st layer; GND plane
Dielectric Ro3035, thick 60 mil
2nd layer; feed network, Cu
Air; thick 10mm
Electronic PCB> 1st layer; GND plane, Cu
Dielectrics (?)
Electronic components layer

PCB panels and the array assembling

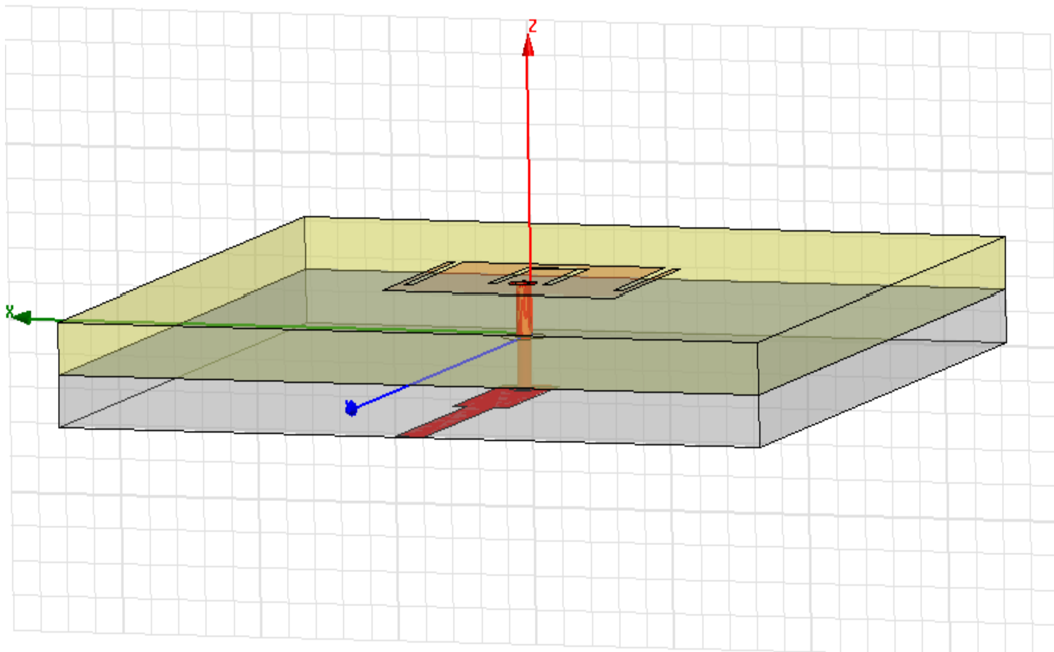
- Ro3035 or Ro3003 are commercially graded materials (DK=3.6 or 3.0; TD=0.0015 or 0.001)
- May be used one panel for two PCBs
- The Array assembling is putting together the two PCBs (face-to-face ground planes)

The array element: a wideband patch above GND plane with embedded slots



Patch X-Y size:
(0.26x0.33) inch
GND size: (1x1) inch

Patch Stackup and dielectric material



1st layer: Patch

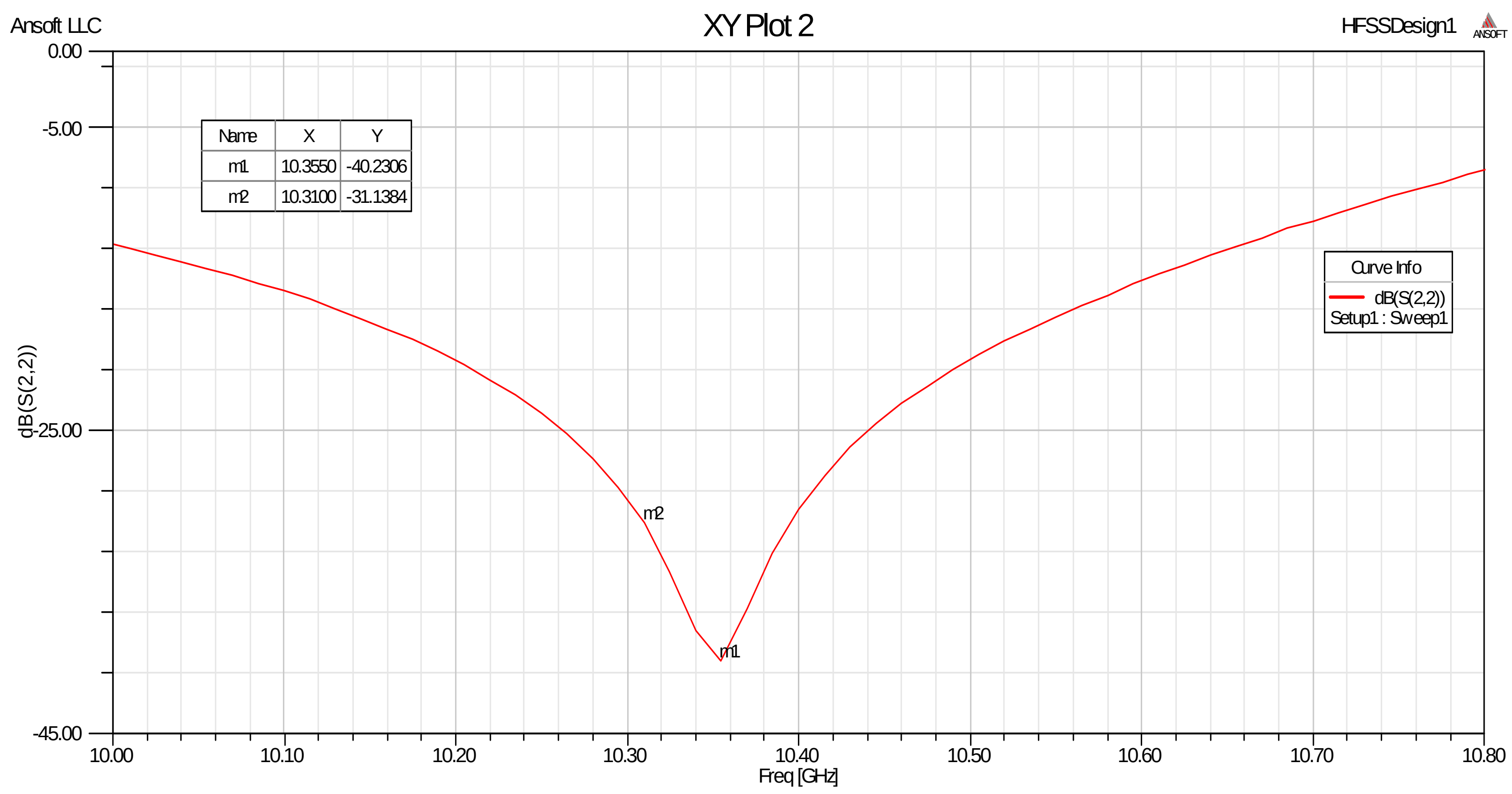
RO3035, thick 60-mil

2nd layer: solid GND

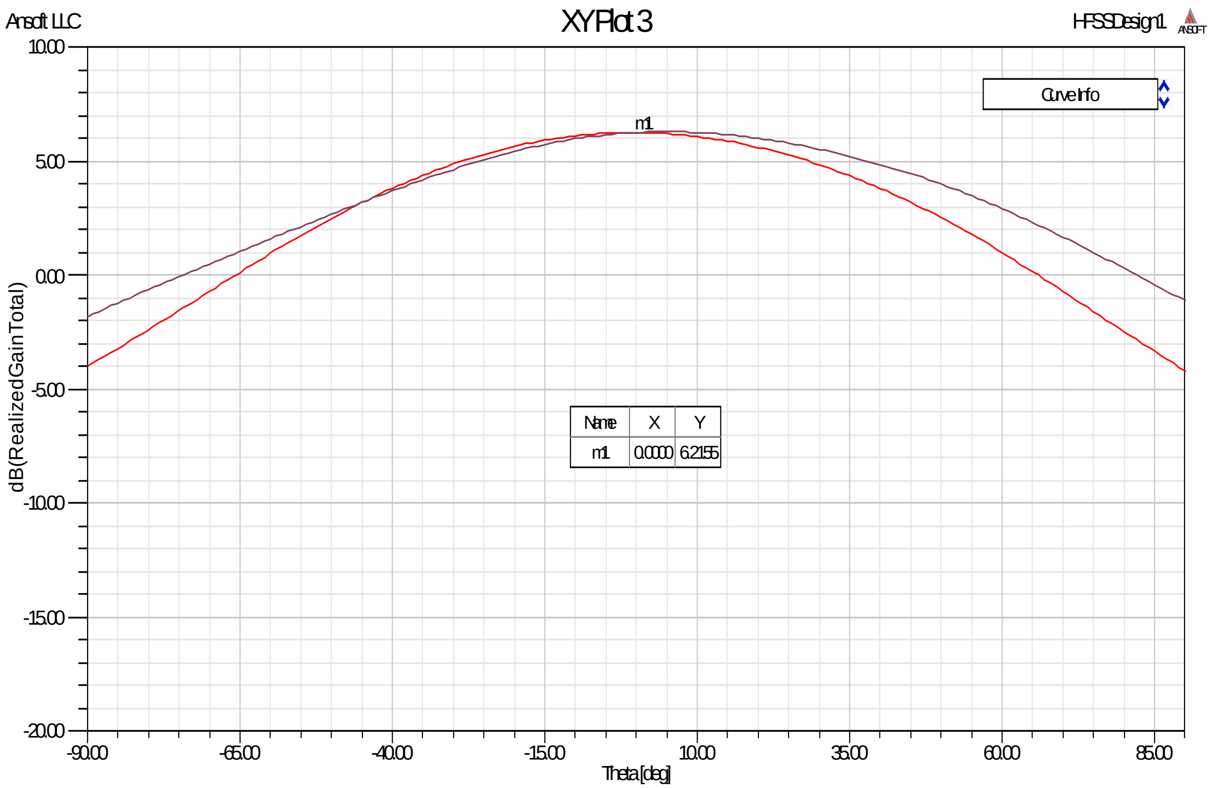
RO3035, thick 60-mil

3rd layer: Microstrip feed

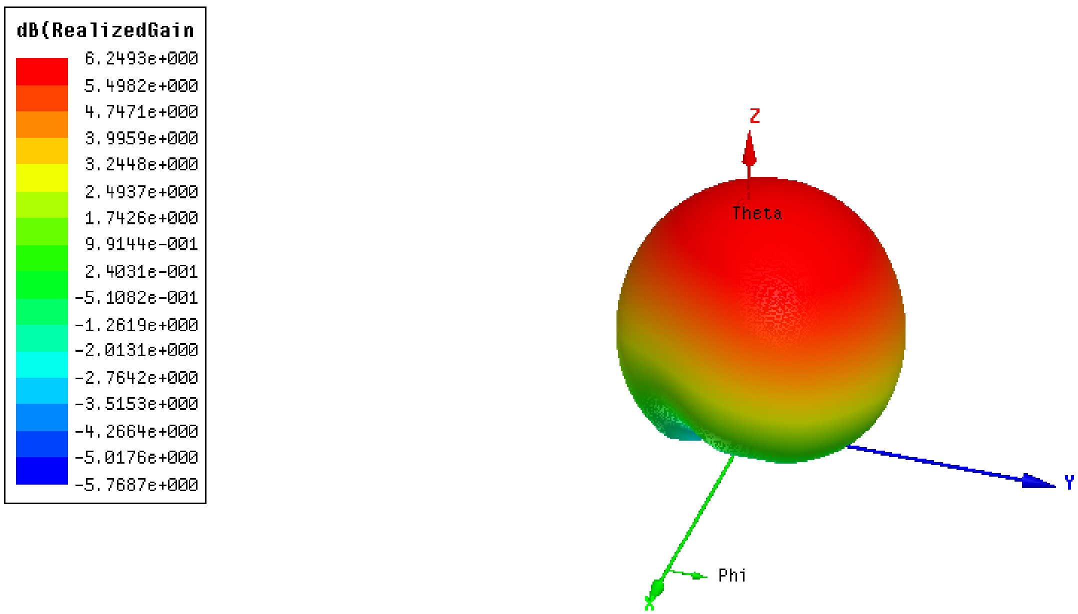
S11=-31 dB @10.3 GHz



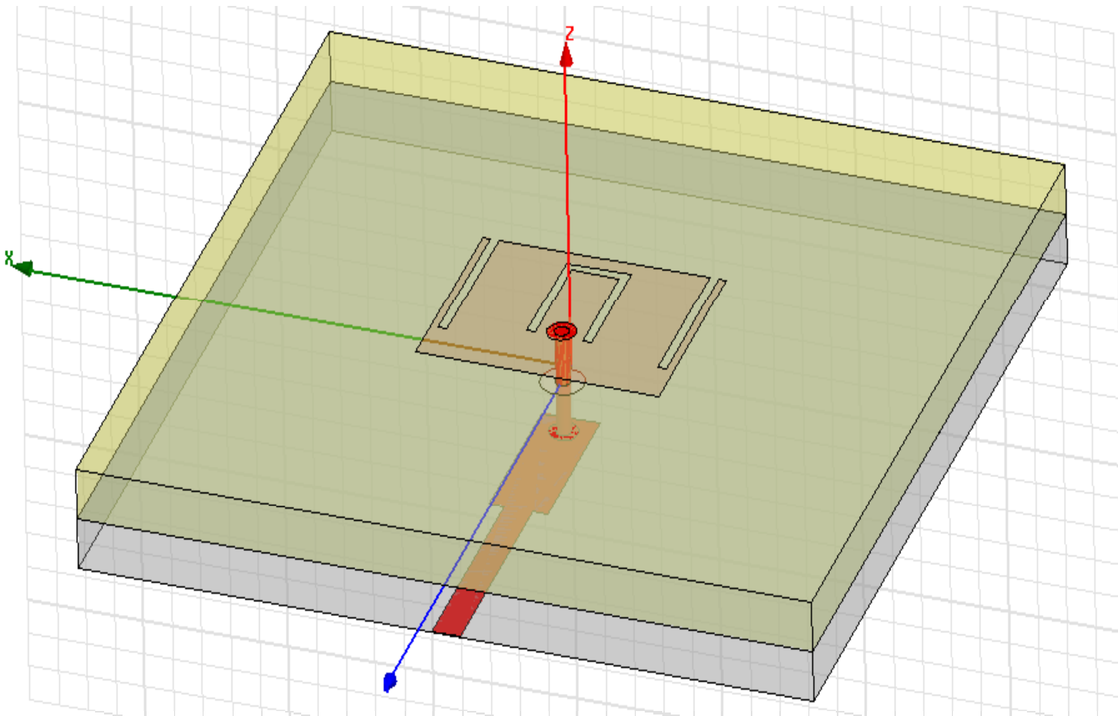
Rad. Pattern with max. Realized Gain=+6.2 dBi in E- and H-plane



3-D Rad. Pattern of the patch; Realized G=6.2dBi

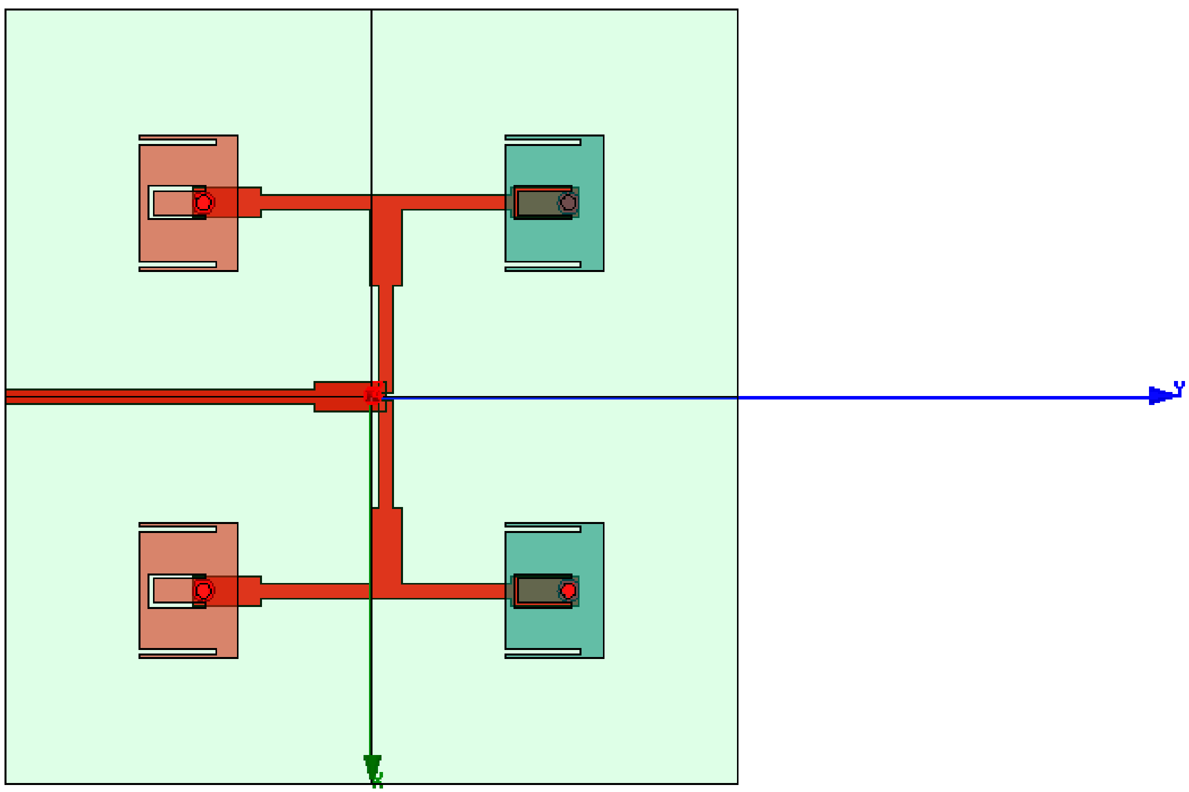


Feed and Impedance Matching for 1 patch

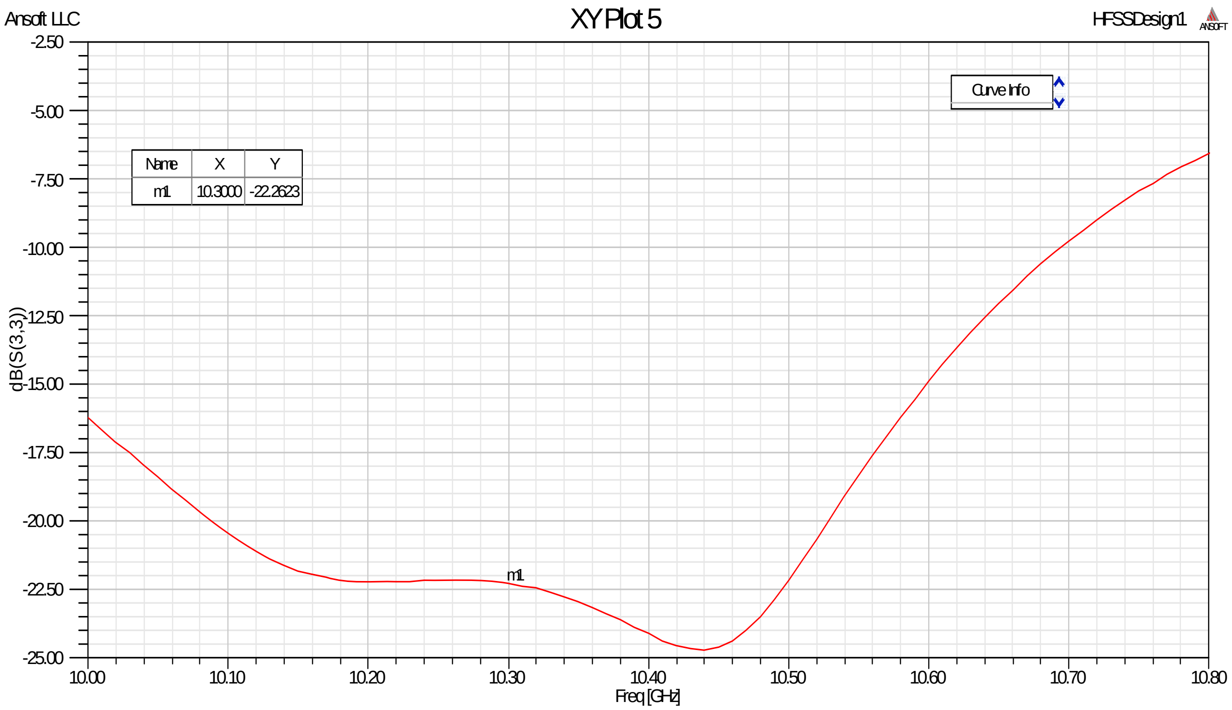


The patch impedance transform from 50 to 100 Ohm by ¼ lambda microstrip transformer

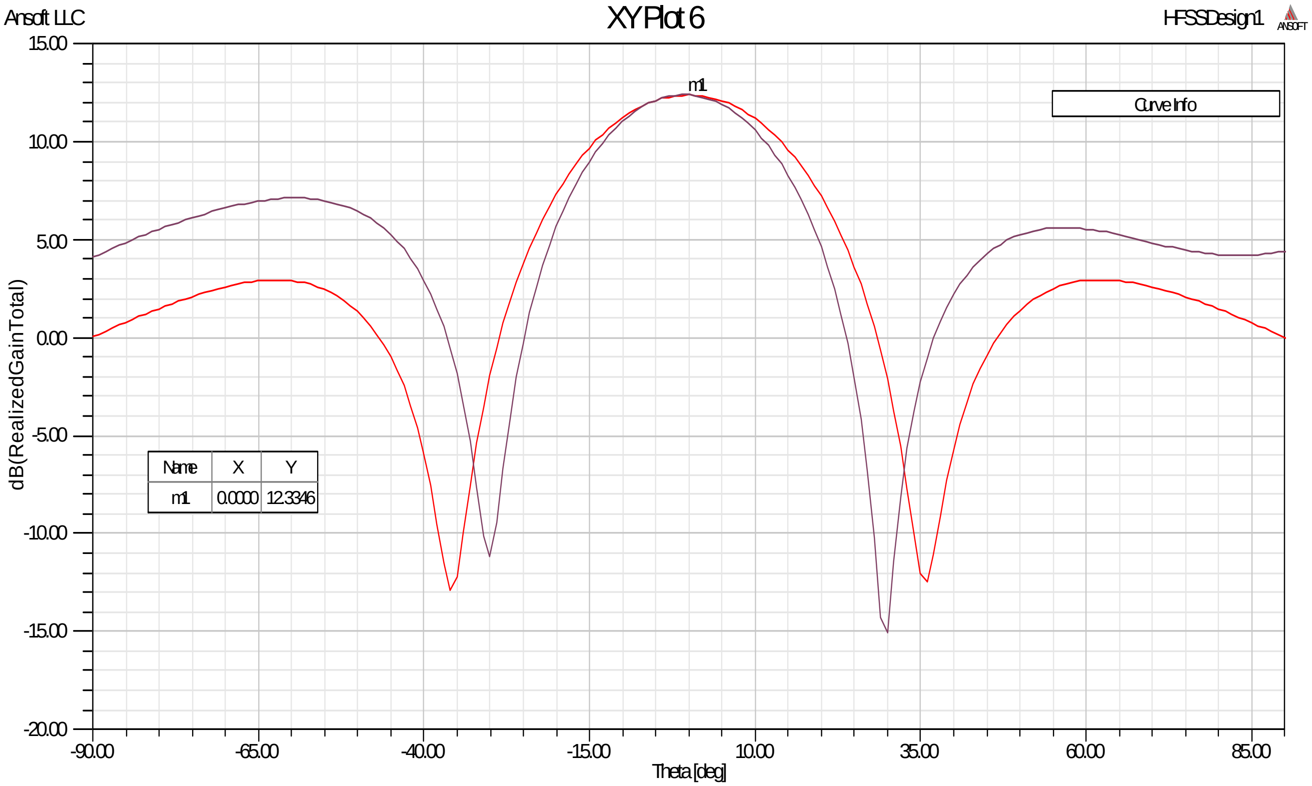
2x2 Patch array with a corporate (parallel) feed network and 50-to-100-Ohm transforms



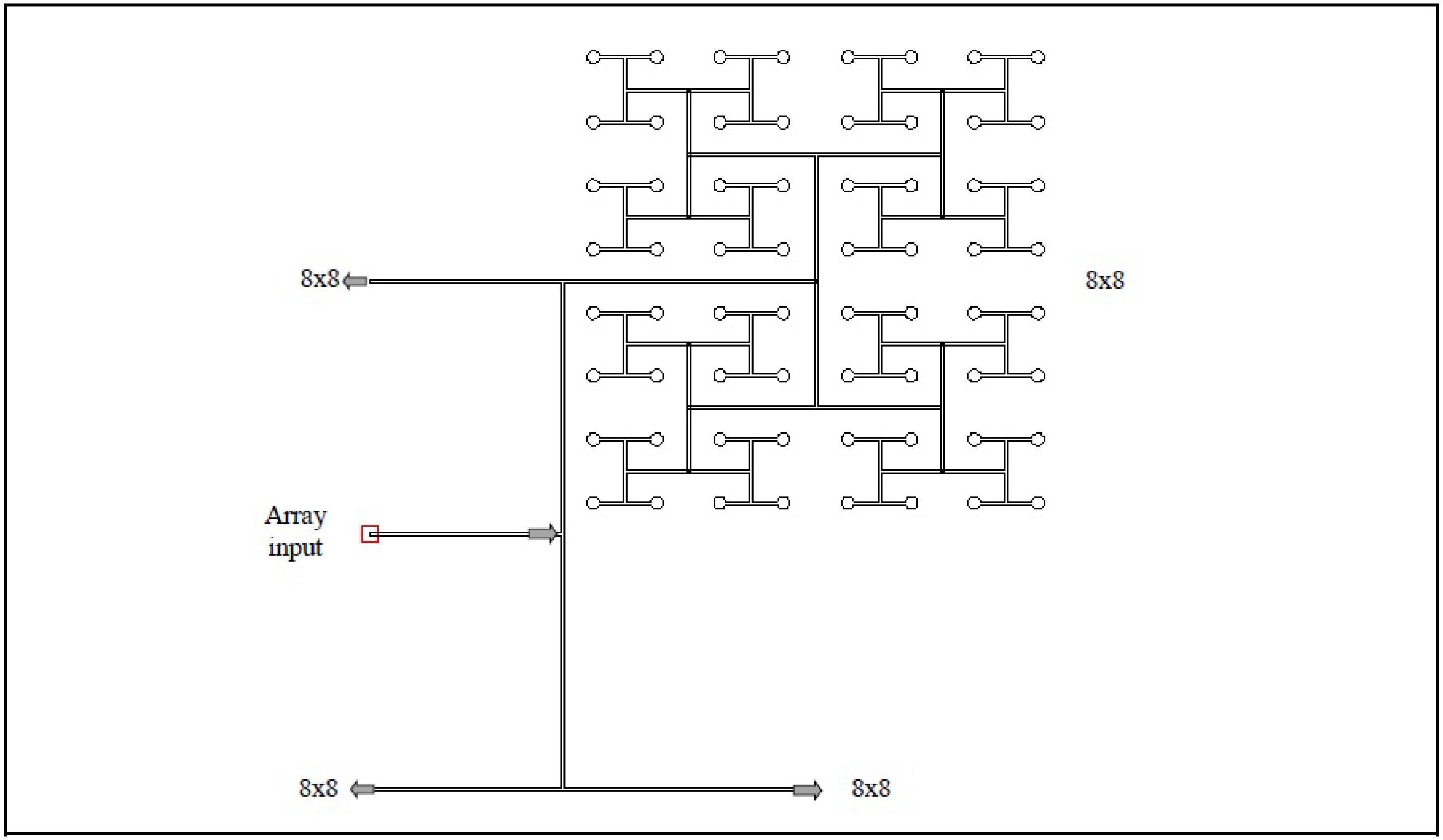
2x2 Patch: S11=-22 dB @ 10.3 GHz at Array input



2x2 Patch; Rad. Pattern with realized G=+12.3 dBi in E and H plane



The corporate network for the 16x16 Array

- 

Gain calculation for existing and operating a **8x8 dipole** array

The example of 8x8 Dipole Array above a solid ground plane:

$f_c := 10.3 \cdot 10^9$ $\quad \lambda_0 := \frac{3 \cdot 10^8}{f_c}$ $\quad$ λo=29 mm

$N_x := 8$ $\quad N_y := 8$ $\quad d := 0.9 \cdot \lambda_0$ $\quad G_{el} := 2.14 + 3$ $\quad$ dBi

$$G_{array} := G_{el} + 10 \cdot \log\left(2 \cdot N_x \cdot N_y \cdot \frac{d}{\lambda_0}\right)$$

$G_{array} = 25.75$ dBi

(The declaring max. gain of an operating 8x8 dipole array is 25 dBi)

Estimated Array Gain calculation for the current **16x16 patch** array

$f_c := 10.3 \cdot 10^9$ $\qquad \lambda_0 := \dfrac{3 \cdot 10^8}{f_c}$ $\qquad$ λo=29mm

$N_x := 16$ $\qquad N_y := 16$ $\qquad d := 0.9 \cdot \lambda_0$ $\qquad G_{el} := 6.2$ dBi

$$G_{array} := G_{el} + 10 \cdot \log\left(2 \cdot N_x \cdot N_y \cdot \frac{d}{\lambda_0}\right)$$

$G_{array} = 32.8$ dBi

Business card