

Patch array antenna for Es'Hail-2 satellite

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Introduction

While for the 10 GHz band it seems to be the easiest to use a standard LNB with PLL for HD TV broadcasting, the handling of uplink feed in the 2.4 GHz is very different - from two separate antennas through feeds with several turns helix [1] or single patch [2] to a precise, but mechanically very much challenging quadrupole system [3]. If only one antenna with a small offset dish is entered, there is a problem with the dimensions of the helix or the patch against the LNB with an integrated horn. In this paper, we describe a system with four patches surrounding the LNB and phased for left-hand circular polarization so that the resulting polarization after reflection from the dish is RHCP.

Patches

The antenna consists of four rectangular spots which are mutually rotated on a substrate of CuClad 217 with a thickness of 62 mil (1.57 mm) and relative permittivity of 2.17., Fig. 1. There is a Cu foil on the back side forming a reflector where four SMA connectors are soldered exactly at the point of the driving points indicated in Figure 1. The external diameter of the antenna is 195 mm and the picture is on scale.

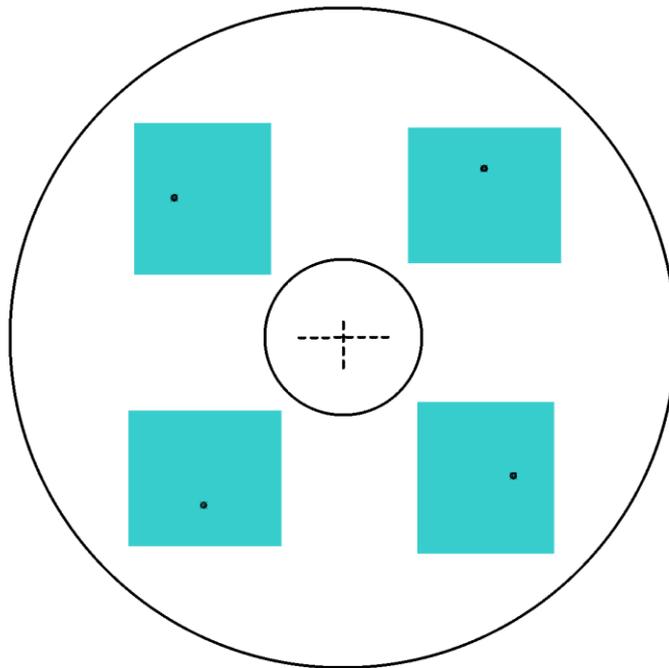


Fig. 1. Four patches on CuClad 217 substrate.

Individual patches are being excited with a delay of 90 deg to result in LHCP. The transmitter signal is firstly divided into four branches by Wilkinson dividers and then phased by $\lambda/4$ shorter cable lengths relative to the previous one. The whole simulated antenna radiation pattern is shown in Figure 2. More radiation to the side of the transmitting antenna does not matter that much. However, the width of the main lobe corresponds to $f / d = 0.6$ of the standard offset dish for TVB. Typical measured impedance matching of the individual patches is in Figure 3.

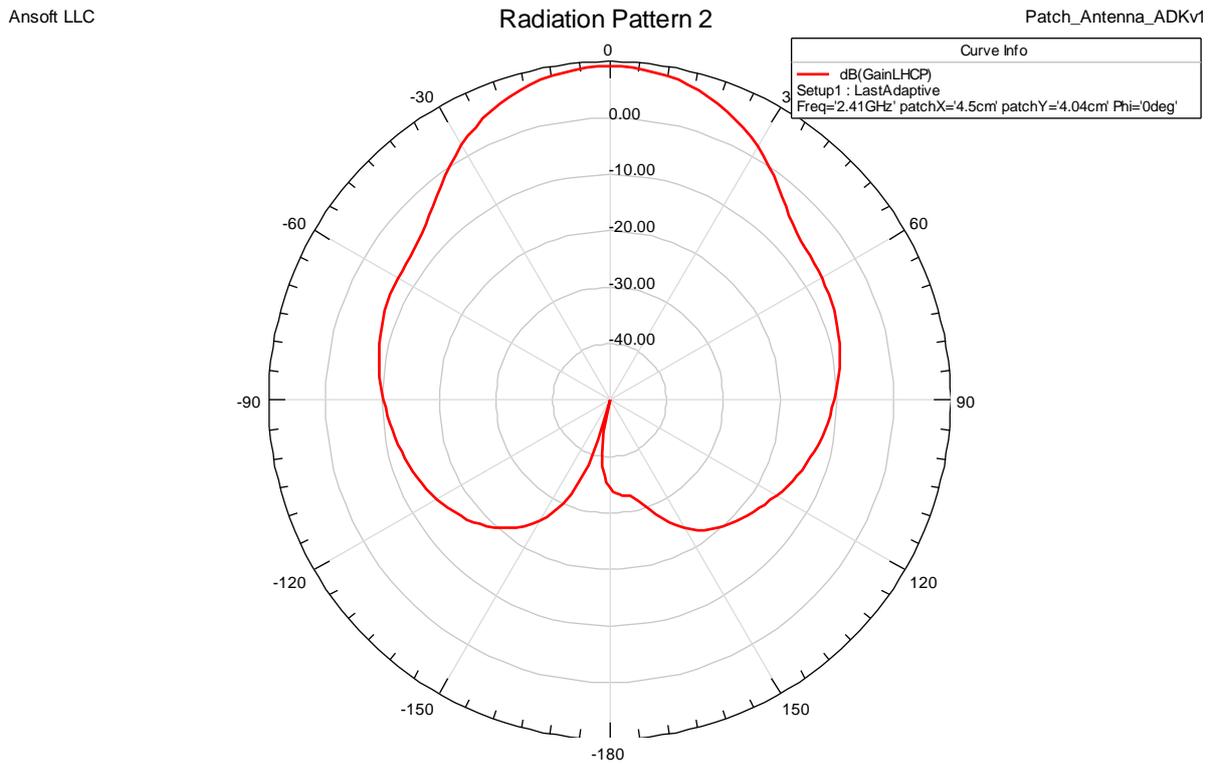


Fig. 2. Radiation pattern of the four patches phased for LHCP.

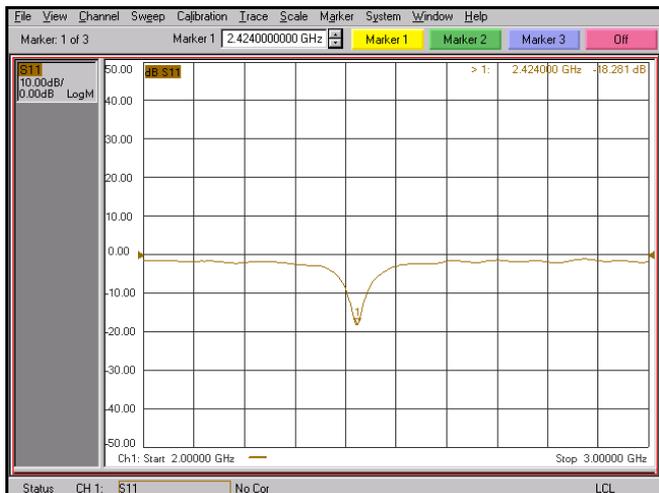


Fig. 3. Individual patches matching.

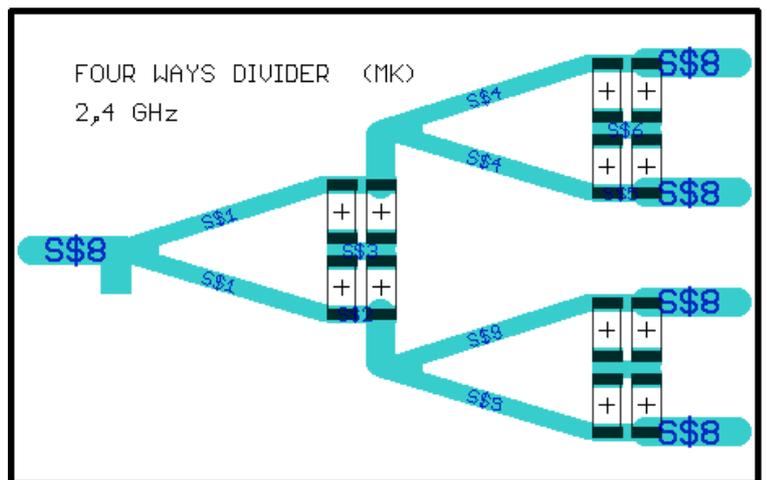


Fig. 4. Wilkinson dividers. The resistors are 100 Ω , size R2512. Substrate is also CuClad 217, 62 mil.

Power dividers and phasing cables

Three Wilkinson dividers are made on the same CuClad 217 substrate, Figure 4. Balancing resistors consist of four $100\ \Omega$ smd resistors R2512. All four ports at the output have the same phase. A thin cable with PTFE dielectric with a shortening factor of 0.66 is used for phasing. The lengths of individual cables in our case are $L1 = 264.0\ \text{mm}$, $L2 = 243.5\ \text{mm}$, $L3 = 223.0\ \text{mm}$ and $L4 = 202.5\ \text{mm}$. The overall assembly is shown in Figure 5. The front view of the feed arrangement including the LNB in the middle is shown in Figure 6. The dual band feed of the 70 cm offset dish is shown in Figure 7.

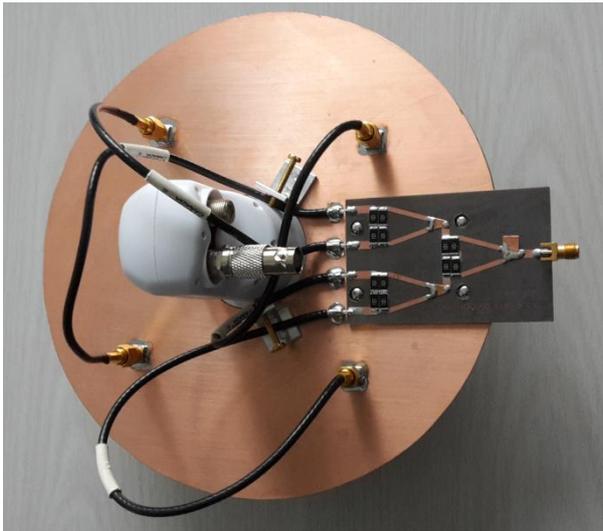


Fig. 5. The back view of the power dividers and phasing cables.



Fig. 6. The front view of the dual band feed.

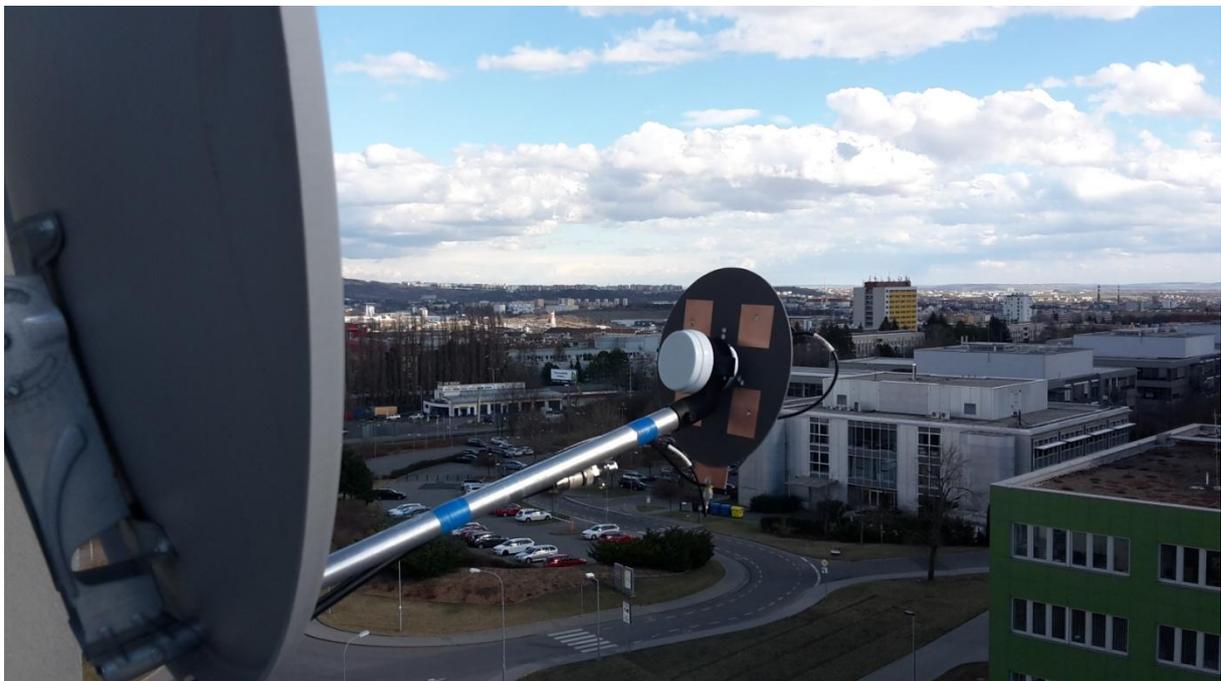


Fig. 7. Dual band feed in the focus point of the 70 cm offset dish with f/d ratio 0.6.

Conclusion

When designing this antenna, we tested the variant with FR4 substrate as well. In this case the result was not as satisfactory. The reflector would have to be separated so that air is at least part of the dielectric. We also tried to simulate the collar to suppress side radiation, but the improvement was marginal. The four patches template as well as power dividers designed in Eagle environment are available at:

http://www.urel.feec.vutbr.cz/esl/files/EsHail-2/2_4%20GHz%20feed/2_4%20GHz%20feed.html

References:

- [1] Miller, J., G3RUH: A 60 cm S-Band Dish Antenna.
<https://www.amsat.org/amsat/articles/g3ruh/116.html>
- [2] Gödecke, P.,J., DJ7GP: Duoband – Antenne für 13 und 3 cm. *AMSAT-DL Journal*, No. 2, 2015
- [3] Galuscak, R., OM6AA, Hazdra, P., Mazanek, M.: A Simple S/X Dual-Band Coaxial Feed for Satellite Communication. *DUBUS*, No. 3, 2016