Polarization Losses Arising Through EsHail 2 Transponder

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Introduction

I performed some polarization measurements during my antenna installation in Doha. In this paper I would like to share my results and discuss some problems concerning antenna polarization losses.

Definition

To better quantify the problem, the Cross-Polarization Discrimination Term, *XPD*, is introduced and defined as:

$$XPD = 20\log|E_{cross}/E_{co}|$$

Where:

Ecross is the Electric Field Cross-Polarization Component Phasor

Eco is the Electric Field Co-Polarization Component Phasor

XPD is expressed in positive decibels

For circular polarization, using the axial ratio:

$$XPD = 20\log\frac{r+1}{r-1}$$

Where: axial ratio, *r*, is the ratio of the polarization ellipse's major to minor axis of polarization of the electric field vector, $r \in \langle 1, \infty,)$ and Axial Ratio [dB] = 20 log *r*

Additional published information is available [1]. A diagram showing dependence of *XPD* on axial ratio expressed in dB appears in Fig. 1.

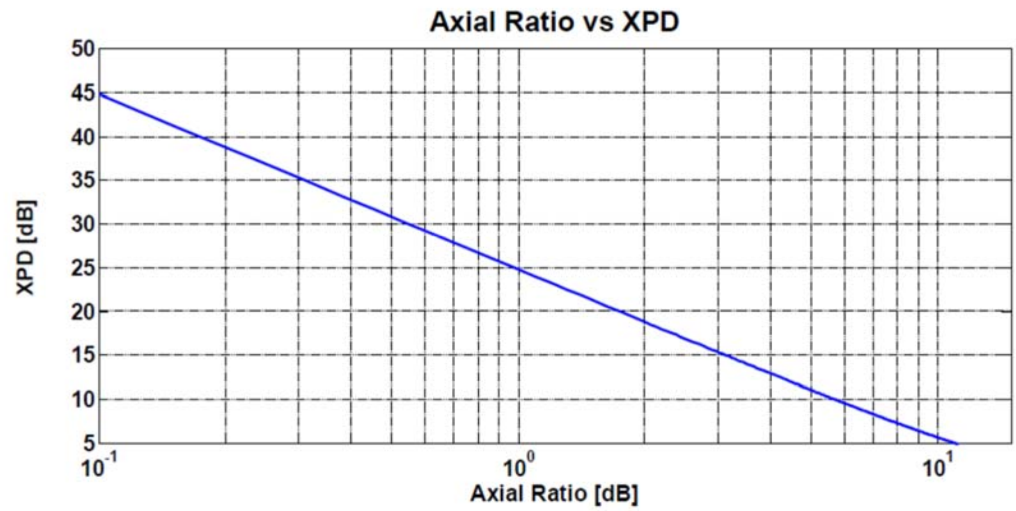

Fig 1 - Dependance of *XPD* on axial ratio expressed in dB

Measurement

With my antenna with *AR* = 1 dB, see Fig. 2, I measured the difference between my LHCP and RHCP signals [2]. The measured value was 18 dB (3S).

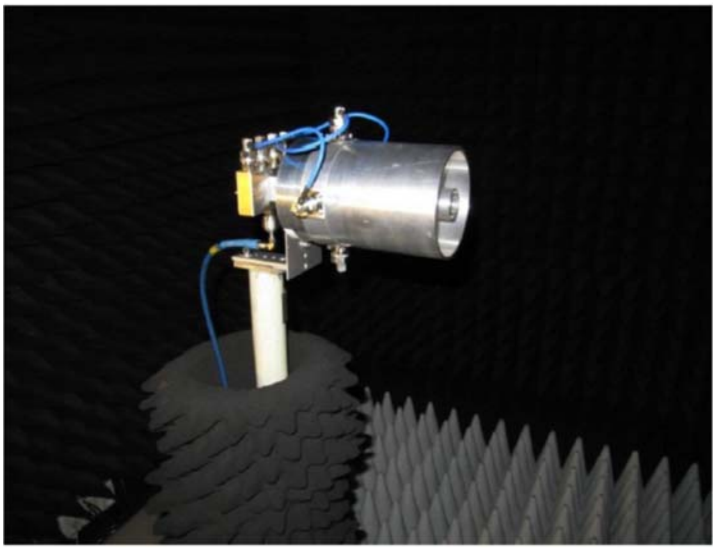

Fig. 2 Feed under test in anechoic chamber

Lets eliminate the *XPD* deterioration caused by my antenna:

$XPD_{Sat} = XPD_{Rx} - XPD_{Ant}$ (ratio)

Where

XPD_{Sat} is a satellite antenna *XPD*

XPD_{Rx} is measured *XPD* (0.01585)

XPD_{Ant} is dish antenna *XPD* (0.0031623)

$XPD_{Sat} = 0.01585 - 0.0031623 = 0.0126877$ (ratio) = -18.97 dB

According to Fig 1, this *XPD* corresponds to *AR* = 1.9 dB

So the estimated *AR* of the satellite antenna is better than 1.9 dB

Example 1

Determine the maximum and minimum polarization losses for a satellite antenna with *AR* = 1.9 dB and almost an ideal linear polarized antenna with *AR* = 40 dB

Since the actual calculation is somewhat complicated and impractical, various nomographs have been published. A nomograph showing the maximum and minimum losses was published in [3] and reprinted in our article [4]. See Fig. 3.

From nomograph we can read that the polarization mismatch loss is in the interval between **2.1 and 4 dB** depending on the angle between major axes.

Example 2

Determine the maximum and minimum polarization losses for a satellite antenna with *AR* = 1.9 dB and an RHCP antenna with *AR* = 3.6 dB (POTY)

From the nomograph shown in Fig. 3, we can read maximum polarization losses **0.45 dB and minimum 0.06 dB**

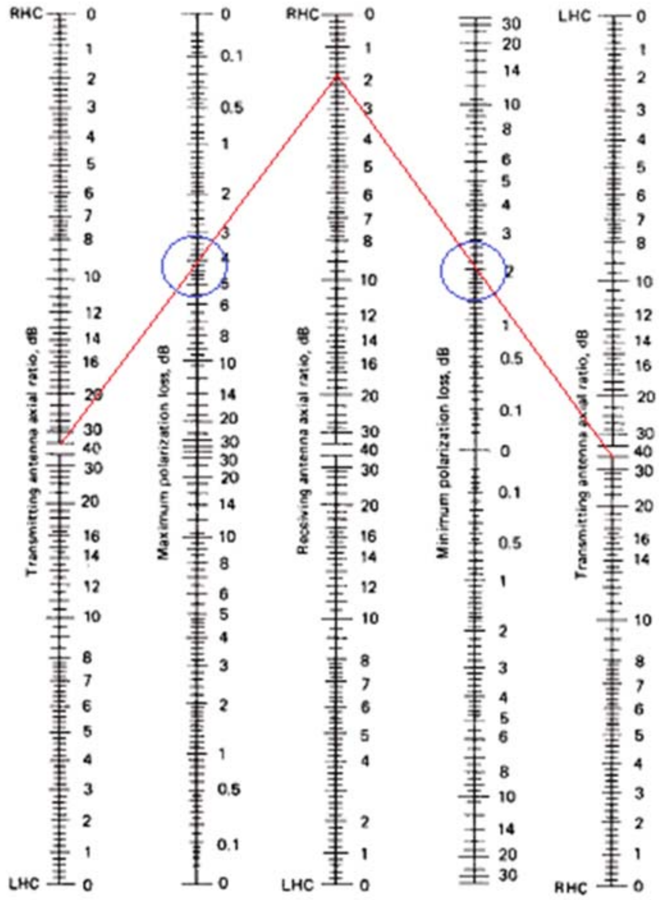

Fig.3 Maximum and minimum polarization loss (Reprinted from [2], with John Wiley & Sons, Ltd., permission)

Summary

I performed the simple test with the equipment available at the time. The accuracy was not very high, however, the test shows that the circularity of EsHail 2 Rx S-band antenna is good. Using a linear polarization antenna with an EsHail 2 transponder, we can expect polarization losses between 2.1 and 4 dB.

If you measure larger differences in your experiments, these are caused by changing other parameters of your antenna than polarization properties. (Illumination, impedance match etc)

References

[1] Allnut J.E. „Satellite-to-ground radiowave propagation" 2d ed. IET publication 2011, London, United Kingdom, ISBN 978-1-84919-150-0

[2] Galuscak Rastislav, Hazdra Pavel, Mazanek Milos, „A Simple S/X Dual-Band Coaxial Feed for Satellite Communication" DUBUS 03/2016, ISSN 1438-3705, available on line at: http://www.om6aa.eu/A_Simple_S_X_Dual_Band_Coaxial_Feed_for_Satellite_Communication_FV.pdf

[3] Milligan, T. A. „Modern Antenna Design" Wiley-IEEE Press, 2nd edition, July 11, 2005.

[4] Galuscak Rastislav, Hazdra Pavel, „Circular Polarization and Polarization Losses", DUBUS, 4/2006, ISSN 1438-3705 available on line at:
http://www.om6aa.eu/Circular_Polarization_and_Polarization_Losses.pdf