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Path loss near ground

To test the path loss near ground, the loss from the transmitting antenna to the receiving antenna will be measured, where the antennas is place at different heights and different distance between them. By knowing the rest of the parameters through the system, as the gains of the antennas and the transmission and received power, the path loss can be found, for the different setups.

Equipment

Antennas

- 2x Patch antennas 2.44 GHz
- 2x Patch antennas 870 MHz
- 2x Monopole antennas 2.44 GHz
- 2x Monopole antennas 870 MHz
- 2x Mini demo boards (PIC18F46J50 with MRF89XAM8A) 868 MHz

Measurement equipment

- Signal generator (AAU nr:)
- Spectrum analyser (AAU nr:)

Setup equipment

- 2x Measurements stand 2.5 m
- 2x Bags or low stands X.X m

Extra

- Computer to note down measurements

- Wagon
- 2x Clamps
- Extension cord +30 m
- 2x SMA cables and connectors
- Lots of coffee, coca cola and energy drink
- A lot of free time

Measurement points

Heights of antennas The transmitting and receiving antenna are set in one of these heights for each measurement.

- 1 cm
- 8 cm
- 34 cm
- 200 cm

All combinations of different heights of the two antenna is measured, except those combination where the receiving antenna is place higher than the transmitting antenna, as these will give the same measurement, as if the two height where switched.

Distance between antenna The distance between the antenna are set to one of these distances for each measurement.

- 1 m
- 2 m
- 4 m
- 8 m
- 15 m
- 30 m

Total measurement points per setup

For each combinations of height, there will be measured at each distance. With 10 height combination and 6 distances, this gives 60 measurement points. In each point there will measured 10 times, which gives a total of 600 measurements per setup.

Different setups As horizontal and vertical polarization do not act the same, each antenna set will be tested at both polarizations, given 10 setups in total.

Setup

The setup is made of a stationary station and a moveable station. The moveable station is placed, so the setup have the right distance between the antennas.

Stationary station At the stationary station the signal generator is placed and set to the frequency of the antenna set used and a amplitude on 0 dB. A measurement stand and a low stand is placed beside the signal generator. The transmitting antenna is set a the highest measure point on the measurement stand and is connected to the signal generator. The antenna is set to face the receiving antenna and have the same polarization directions as the receiving antenna.

Moveable station At the moveable station the spectrum analyser is placed and set up to measure at the antenna sets frequency. As the spectrum analyser needs power and shall be moved with the moveable station, a extension cord is needed, to power it, and as the moveable station is moved back and forth with 30 m, this extension cord, shall have a length of over 30 m. A measurement stand and a low stand is placed beside the signal generator. The receiving antenna is set a the highest measure point on the measurement stand and is connected to the spectrum analyser. The moveable station is placed, so the antenna on the measurement stand is placed, so the antenna is facing the transmitting antenna and have the same polarization directions as the transmitting antenna. The distance between the two antennas is set to the smallest of the measurement distances, by placing the moveable station at the right spot.

Measurements with demo boards When testing with the demo boards, the signal generator and spectrum analyser is not needed, as the demo boards it self provide the transmitted signal and measurement at the receiving end. The rest of the setup is still used the way as with the other antennas.

Procedure

To minimize the time to make the measurement, a procedure is chosen, so that the time used on changing the position of the antennas between each measurement point is lowered. As changing the heights from 200 or 34 cm take longer than moving the moveable station,

all measurements at these heights will be taken subsequently of each other, if possible. The order of measurements, that is used is:

1. Transmitter on 200 cm
    - Receiver on 200 cm, all length
    - Receiver on 34 cm, all length
    - Receiver shifting between 8 cm and 1 cm, all length
2. Transmitter on 34
    - Receiver on 34 cm, all length
    - Receiver shifting between 8 cm and 1 cm, all length
3. Transmitter/Receiver shifting between 8/8 cm, 8/1 cm and 1/1 cm , all length

At each measurement point, there is taken 10 measurements, which is read from the spectrum analyser (on demo boards, when they are used) and writing down into the excel file. In the file, the mean and variance is found for the measurement point.

All this is done for each polarization (vertical and horizontal) on all 5 sets of antennas.

Results

The results will be the total system loss, from the signal generator to the spectrum analyser. The total system loss is a combination of:

- Cable loss, from the signal generator to the transmitter antenna.
- Antenna gain, in the transmitter antenna.
- Path loss, form the transmitter antenna to the receiver antenna.
- Alignment loss, from the polarization of the transmitter and receiver antenna.
- Antenna gain, in the receiver antenna.
- Cable loss, from the receiver antenna to the spectrum analyser.

[Poole, 2016]

Bibliography

Poole, I. (2016). What is GMSK Modulation - Gaussian Minimum Shift Keying. http://www.radio-electronics.com/info/rf-technology-design/pm-phase-modulation/what-is-gmsk-gaussian-minimum-shift-keying-tutorial.php. Downloaded 7. March 2016.

Appendix