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Near-ground path loss

To test the near-ground path loss, the loss from the transmitting antenna (Tx) to the receiving antenna (Rx) will be measured, where the antennas are placed at different heights and with different distances between them. From worksheet link budget it is known that by measuring the power received from a reference signal, the path loss(PL) can be found if the gains of the antennas and system loss are known.

Equipment

Antennas

- 2x Patch antennas 2.58 GHz
- 2x Patch antennas 858 MHz
- 2x Monopole antennas 2.58 GHz
- 2x Monopole antennas 858 MHz

Measurement equipment

- Signal generator (AAU nr: 33376)
- Spectrum analyser (AAU nr: 56915)

Setup equipment

- 2x High stands 2.5 m
- 2x Low stands (Bags) 0.14 m

Extra

- Computer to note down measurements
- Wagon

- 2x Clamps
- Extension cord +35 m
- SMA male/male connector
- SMA cables (2.5 m SUCOFLEX_104, 1.5 m SUCOFLEX_104 and 1 m rg223_U

Measurement points

Heights of antennas The Tx and Rx are set in one of these heights for each measurement.

- 0.04 m
- 0.14 m
- 0.36 m
- 2.02 m

All combinations of different heights of the two antenna are measured, except those combination where the Rx is place higher than the Tx, as these will give the same measurement, as if the two height where switched. This is done because it is assumed the PL is the same independently of which antenna is the receiver and transmitter.

Distance between antennas The distance between the antennas 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 combination of heights, each distance is measured. With 10 height combinations 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 The measurements are performed in two locations an outdoor empty parking lot and and indoor empty school gym. Furthermore, as horizontal and vertical polarization do not act the same, each antenna set will be tested at both polarizations, given 16 setups in total.

Setup

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

Stationary station At the stationary station the signal generator is placed and tuned to the frequency of the antenna set used and a amplitude on 0 dBm. A high stand and a low stand are placed beside the signal generator. The Tx is set a the highest measurement point on the high stand and is connected to the signal generator. The antenna is set to face the Rx and have the same polarization as the Rx.

Moveable station At the moveable station the spectrum analyser is placed and tuned to the antenna set's frequency. The spectrum analyser needs power but is moved with the moveable station, therefore an extension cord is needed, to power it. A high stand and a low stand are placed beside the signal analyser. The Rx is set a the highest measurement point on the high stand and is connected to the spectrum analyser. The antenna on the high stand is placed, so it is facing the Tx and has the same polarization. The distance between the two stands is set to the smallest of the measurement distances.

Procedure

The procedure for a single setup is:

1. Tx is placed at 2.02 m
    - Rx is placed at 2.02 m, all distances are measured
    - Rx is placed at 0.36 m, all distances are measured
    - Rx shifting between 0.14 m and 0.04 m, all distances are measured
2. Tx is placed at 0.36 m
    - Rx is placed at 0.36 m, all distances are measured
    - Rx shifting between 0.14 m and 0.04 m, all distances are measured
3. Tx/Rx shifting between 0.14/0.14 m, 0.14/0.04 m and 0.04/0.04 m , all distances are measured

At each measurement point, there is taken 10 measurements, which is read from the spectrum analyser and written down into an excel file.

All this is done for each polarization (vertical and horizontal) on all 4 sets of antennas at both locations.

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 Tx.
- Antenna gain, in the Tx.
- Path loss, form the Tx to the Rx.
- Alignment loss, from the polarization of the Tx and Rx.
- Antenna gain, in the Rx.
- Cable loss, from the Rx to the spectrum analyser.

As can be seen in worksheet link budget.