

## Antennas

#### Characteristic, Mounting and Debugging

FSG Academy – Main Workshop for FSG 2024 on 21<sup>st</sup> of October 2023 at Schaeffler in Herzogenaurach

#### Disclaimer

- There are "rules" don't mess with the authorities
- Regulations shown herein are valid in Germany (2023-10-20)
- They should also apply to EU (as well as ITU Region 1)
- Anyway, everyone is responsible for their own compliance with the applicable regulations



## About the RES

- 88 mW ERP transmit power
- 12 fixed frequencies within 433.05 MHz to 434.79 MHz range
- All frequencies inside the ISM 70 cm band of ITU Region 1
  - Industral, Scientific and Medical (ISM)
- ISM does not include/allow data transmission
- SRD is the right application
  - Short Range Devices (SRD)

## About the RES

- SRD 70 cm band generic assignment (Allgemeinzuteilung) has same frequencies range as the 70 cm ISM band but is limited to 10 mW ERP transmit power
- Operating the RES (with 88 mW ERP) requires a valid Frequency Assignment (*Frequenzzuteilung*) for the used frequency (channel), area and time
- FSG applies for the Frequency Assignment of all 12 channels during competition (only)
- Make sure to have a valid Frequency Assignment while testing, ...

## Wireless Data Transfer

- Transmitter (TX)
- Receiver (RX)
- Antenna
- Transmission line in between
  - Usually coax cable



### **RES System**





### Wire & HF

- Every transmission line has its specific impedance
  - Usually 50 Ω
- Every change in impedance causes reflections
  - Like visible light
- Open end reflects the full energy back
- Full system should have the same impedance



#### Antenna

- Radiates power
- $\frac{1}{2} \lambda$  to get a stading wave
- Voltage max. at the ends
  - Same as open wire
- Current max. at center



## Coax Cable & Antenna

- 50 Ω Coax cable
- Impedance of antenna must be 50 Ω as well
- Will cause reflections otherwise
- Standing Wave Ration (SWR)





- Ratio of reflected to forward wave
- Key measurement to check if cable and antenna are properly matched at the frequency band
- Small values 2 down to 1 are good



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## Types – Dipole

- The reference antenna (ERP)
- Symmetric antenna
- $I = \frac{1}{2} \lambda$ ,  $\frac{1}{4} \lambda$  each element
- Requires symmetric feed
- Coax cable is asymmetric
- Impedance must be matched



## Types – $\frac{1}{4}\lambda$ or Ground Plane

- Asymmetric antenna
- $I = \frac{1}{4} \lambda$ , radials a bit longer
- Requires asymmetric feed
- Angle of radials to match impedance



## Types – 5/8 $\lambda$

- Asymmetric antenna
- I = 5/8 λ
- Groundplane below
- Requires asymmetric feed
- Inductance to match impedance



## Types – Yagi

- Directional antenna
- Symmetric dipole feed
- Reflectors for beamforming





## $\frac{1}{4} \lambda$ without Radials



## $\frac{1}{4} \lambda$ with Radials



## Mounting – commercial antenna on FS vehicle

- Vehicle antennas expect a ground plane
- Main hoop is not a (good) ground plane





## Mounting – commercial antenna on FS vehicle

#### Do's

- Antenna should must be vertical
- Put a proper ground plane below
- Proper ground plane: about 10 cm x 10 cm
- No obstackels around
  - Wings
  - Main hoop
  - Driver ('s head)



#### Rules – what to mount where

- Comply with T11.11
- Antennas < 100 mm might protrude surface envelope
- Mounting must be in anyway





## Troubleshooting

- Measure SWR in mounted
  - Include the cable
- Ensure that there is a ground plane
  - Also check connection
- There should be no reflector around
  - Main hoop, wings, ...
- Check connectors



# Thank you for your attention

