ENAMS-receiving system

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1. Antenna

Principle: active e-field sensor, k-factor=1 (variable by changing resistor values), power supply via coaxial cable

1.1. Measured Values

effective height by mechanical dimensions, 1m radiator, 1m stand, 8 radials \( h_N = 1.5 \text{ m} \)
electrical gain at 50\( \Omega \) load und 9pF antenna substitute \( v = -3.5 \text{ dB} \)
resulting k-factor \( k = 1.0 \text{ m}^{-1} \)
k-factor logarithmic \( k' = 0 \text{ dB/m} \)
input capacity \( C_i = 8.6 \text{ pF} \)
input resistance \( R_i = 5 \text{ M}\Omega \)
output resistance \( R_A = 50 \text{ \Omega} \)
OPIP2 \( +56 \text{ dBm} \)
OPIP3 \( +43 \text{ dBm} \)
1dB-compression (output) \( +11 \text{ dBm} \)

**note:** gain and k-factor can be changed by replacing resistors
1.2. Sensitivity Diagrams

![Sensitivity Diagrams]
2. Receiver

A Red Pitaya 14bit is being used as receiver supplemented by a diplexer network, a lowpass and 2 preamplifiers forming the frontend. For dynamic improvement purposes the 2 available A/D-channels of the red pitaya are used in 2 frequency ranges with different gains. The diplexer cutoff frequency is 8MHz, thus a range up to 8MHz and another 8MHz to 30MHz is implemented. The frontend also contains a 32MHz lowpass of 5th order. The gain of the 2 preamplifiers can be dimensioned independently to optimize dynamic, 10dB (low band) and 20dB (high band) are used momentary. Furthermore the frontend contains a bias-T and a current limiter for the 15V supply of the active antenna.

**Attention** when measuring the frontend: the antenna input is connected to the 15V DC powersupply for the antenna permanently! Use a DC-Block!

2.1 Red Pitaya

Software: HDSDR, input attenuator of RP deactivated (jumper in middle position), external 50Ω load applied (with T-connector)

2.1.1. Intermodulation, f1=11,05MHz, f2=11,1MHz (RP only)

<table>
<thead>
<tr>
<th>input level</th>
<th>measured</th>
<th>IM</th>
<th>IP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x -30dBm</td>
<td>2 x -42dBm</td>
<td>68dB</td>
<td>+4dBm</td>
</tr>
<tr>
<td>2 x -20dBm</td>
<td>2 x -32dBm</td>
<td>72dB</td>
<td>+16dBm</td>
</tr>
<tr>
<td>2 x -10dBm</td>
<td>2 x -22dBm</td>
<td>71dB</td>
<td>+25,5dBm</td>
</tr>
<tr>
<td>2 x -3dBm</td>
<td>2 x -15dBm</td>
<td>65dB</td>
<td>+29,5dBm</td>
</tr>
</tbody>
</table>

2.1.2. Noisefigure and Dynamic

The noise figure was measured with the noise generator SUF2 (R&S). A noise level of -133.9dBm/Hz caused a noise increase of 3dB. Thus the resulting noise figure is **F=40.1dB**. For comparison: ELAD FDMS2: F=18.1dB, Perseus: F=23.1/25.5dB with and without preamp. Maximum input level (fullscale A/D converter) is +5dBm.
2.2 Red Pitaya + Frontend (complete receiver)

2.2.1. Frequency Response and Gain of Frontend

![Graph showing frequency response and gain](image)

<table>
<thead>
<tr>
<th>Marker</th>
<th>Trace</th>
<th>Type</th>
<th>X Axis</th>
<th>Amp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1D</td>
<td>1</td>
<td>Freq</td>
<td>450.000 MHz</td>
<td>10.34 dB</td>
</tr>
<tr>
<td>2D</td>
<td>1</td>
<td>Freq</td>
<td>7.00000 MHz</td>
<td>6.20 dB</td>
</tr>
<tr>
<td>3D</td>
<td>2</td>
<td>Freq</td>
<td>14.20000 MHz</td>
<td>19.55 dB</td>
</tr>
<tr>
<td>4D</td>
<td>2</td>
<td>Freq</td>
<td>28.50000 MHz</td>
<td>17.99 dB</td>
</tr>
</tbody>
</table>

2.2.2. Noise at Output of Frontend with and without Antenna

- Noise level at output, low band (5 MHz) without antenna: \( P_R = -158.6 \) dBm/Hz
- Noise level at output, low band (5 MHz) with antenna: \( P_R = -142.6 \) dBm/Hz
- Noise level at output, high band (14 MHz) without antenna: \( P_R = -148.6 \) dBm/Hz
- Noise level at output, high band (14 MHz) with antenna: \( P_R = -130.5 \) dBm/Hz

When measuring „with antenna“ the radiator was removed and substituted by an equivalent load (9pF).
2.2.3. Noisefigure with Preamp

noisefigure complete RX:

2.2.4. Input Level Limit (Fullscale) with Preamp

- lowband: -2dBm
- highband: -13dBm

2.2.5. Intercept Point

- lowband (6,0 / 6,5MHz)
  - IP2 @ 2 x -20dBm: +52dBm (summ) / +56dBm (diff.)
  - IP3 @ 2 x -20dBm: +20dBm
- highband (10,0 / 19,0MHz)
  - IP2 @ 2 x -20dBm: +37dBm (summ) / +49dBm (diff.)
  - IP3 @ 2 x -20dBm: +10dBm
### 2.2.6. Spurious

<table>
<thead>
<tr>
<th>Frequency [MHz]</th>
<th>level [dBm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,110</td>
<td>-115</td>
</tr>
<tr>
<td>0,220</td>
<td>-113</td>
</tr>
<tr>
<td>2,148</td>
<td>-115</td>
</tr>
<tr>
<td>2,258</td>
<td>-116</td>
</tr>
<tr>
<td>11,303</td>
<td>-116</td>
</tr>
<tr>
<td>13,566</td>
<td>-117</td>
</tr>
<tr>
<td>18,088</td>
<td>-116</td>
</tr>
<tr>
<td>25,000</td>
<td>-118</td>
</tr>
<tr>
<td>29,395</td>
<td>-116</td>
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