G0MRF Pre-Amplifier
NF + VNA measurements

Measurement report
Wouter Weggelaar
PA3WEG

Wouter Weggelaar
PA3WEG
FUNcube technical team
21st of October 2011
# Table of Contents

Noise Figure and in-band gain ................................................................. 3  
Equipment used: .................................................................................... 3 
Calibration ............................................................................................... 3 
Setup ....................................................................................................... 3 
Results .................................................................................................... 4 

VNA measurements .............................................................................. 5  
Equipment used: .................................................................................... 5 
Calibration ............................................................................................... 5 
Setup ....................................................................................................... 5 
Results .................................................................................................... 5
Noise Figure and in-band gain

The first measurement performed was the NF and in-band gain measurement. The results of the analyzer could not be saved to disk due to a disk drive failure.

Equipment used:

- Agilent N8973A noise analyzer
- Hewlett Packard 346A noise source
- Bias tee
- Delta elektronica power supply set to 5V

Calibration

Measurements were done with the correct ENR table loaded into the analyzer, and by performing a calibration first with the bias-T in circuit. The reference plane is at the noise head N-female connector and at the Bias-T N-female connector.

Setup

The setup consist of the noise analyzer, connected to the noise head by means of a BNC cable. The output of the noise head is connected to the Pre-Amp input by using an N-N male adaptor. The Pre-Amp has a BNC connection to the transceiver. This is connected to the bias-T by means of a BNC-BNC male coupler + BNC-female to N-male adaptor. The Bias-T is in turn connected to the analyzer with an N-male cable. The setup is shown in figure 1.
Results

The following results were obtained:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>NF (dB)</th>
<th>Gain (dB)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>138</td>
<td>5.033</td>
<td>-2.581</td>
<td>-2.51dB on VNA</td>
</tr>
<tr>
<td>144</td>
<td>1.024</td>
<td>10.420</td>
<td>10.54 on VNA</td>
</tr>
<tr>
<td>146</td>
<td>1.016</td>
<td>12.531</td>
<td>12.63 on VNA</td>
</tr>
<tr>
<td>153</td>
<td>3.512</td>
<td>1.783</td>
<td>1.45 on VNA</td>
</tr>
</tbody>
</table>

Figure 2: Noise Figure (yellow, top) and Gain (blue, bottom)
VNA measurements

The VNA measurements were done after NF measurements. Two frequency ranges were swept.

Equipment used:

- Anritsu MS2034A Vector Network Analyzer
- Phase stable Anritsu measurement cable
- Calibration kit Anritsu OSLN-50-1 S/N 0801062
- Load: Anritsu SM / PL-1 sn 0748110
- Through: Anritsu 34NN50A
- Bias-T
- Delta elektronica power supply set to 5V

Calibration

Calibration was performed with the bias-T in circuit. The reference plane is at the VNA measurement cable RF out N-female connector and at the Bias-T N-female connector.

Setup

The setup consist of the VNA + cables, RF out connected to the Pre-Amp input by using an N-N male adaptor. The Pre-Amp has a BNC connection to the transceiver. This is connected to the bias-T by means of a BNC-BNC male coupler + BNC-female to N-male adaptor. The Bias-T is in turn connected to the analyzer with an N-N male coupler to the N-female RF IN cable. Refer to figure 3 for the measurement setup. The reference plane is where the N-female connectors are shown.

Unfortunately, the averaging was not saved in the DATA files, giving somewhat noisy readings.

Figure 3: Measurement setup
Results

The Pre-Amp was swept over two frequency ranges. No attempts were made to record S11, as the noise figure is the important number here. The sweep ranges were as follows:

- Start 45 MHz, stop 600 MHz, Reference level 20 dB, 10 dB/div (figure 4 and 5)
- Start 125 MHz, stop 165 MHz, Reference level 20 dB, 6 dB/div (figure 6)

The VNA power for both measurements was -20 dBm. Markers were placed at interesting frequencies.

Figure 4: 45 to 600 Mhz, marker set 1
Figure 5: 45 to 600 MHz, marker set 2

Figure 6: 125 - 165MHz
A couple of key markers have been placed. The results are as follows:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Gain (dB)</th>
<th>Relative gain (dB)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>-47.97</td>
<td>-60.60</td>
<td>FM broadcast stations</td>
</tr>
<tr>
<td>108</td>
<td>-47.03</td>
<td>-59.66</td>
<td>FM broadcast stations</td>
</tr>
<tr>
<td>138</td>
<td>-2.51</td>
<td>-15.14</td>
<td>Pagers</td>
</tr>
<tr>
<td>144</td>
<td>10.54</td>
<td>-2.09</td>
<td>Low band edge 2m</td>
</tr>
<tr>
<td>146</td>
<td>12.63</td>
<td>0</td>
<td>High band edge 2m</td>
</tr>
<tr>
<td>153</td>
<td>1.45</td>
<td>-11.18</td>
<td>Pagers</td>
</tr>
<tr>
<td>160</td>
<td>-31.15</td>
<td>-43.78</td>
<td>Nautic band (top)</td>
</tr>
<tr>
<td>220</td>
<td>-73.67</td>
<td>-86.30</td>
<td>DVB-T</td>
</tr>
<tr>
<td>435</td>
<td>-50.06</td>
<td>-62.69</td>
<td>70cm satellite uplink</td>
</tr>
</tbody>
</table>

Figure 7: VNA setup