Report: HMC-C200 stability problems

1. Background

Two DRO modules HMC-C200-8100 (8.1 GHz) were received from the supplier in November 2015. One of them was left in company stores and the other was taken out and used for mechanical fitting. It was not yet switched on and tested.

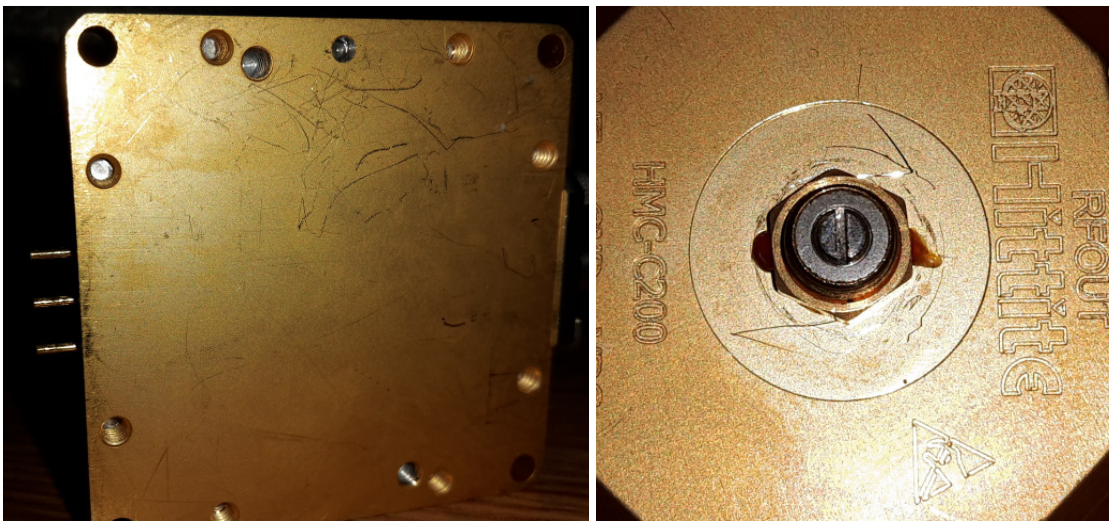
Four DRO modules HMC-C200-8300 (8.3 GHz) were received from the supplier in February 2016. One of these was subsequently tested on the bench to verify performance. When problems were detected with this unit, the other three were also tested, together with one of the 8.1 GHz modules. All modules had the same problems, described below.

2. Physical appearance

It was observed that, when received, some of the screws on the two 8.1 GHz modules were not fully fastened. The modules also showed some scratch marks.

The modules were initially tested without adjusting the screws, but later they were fastened. It did not make a difference to the results.

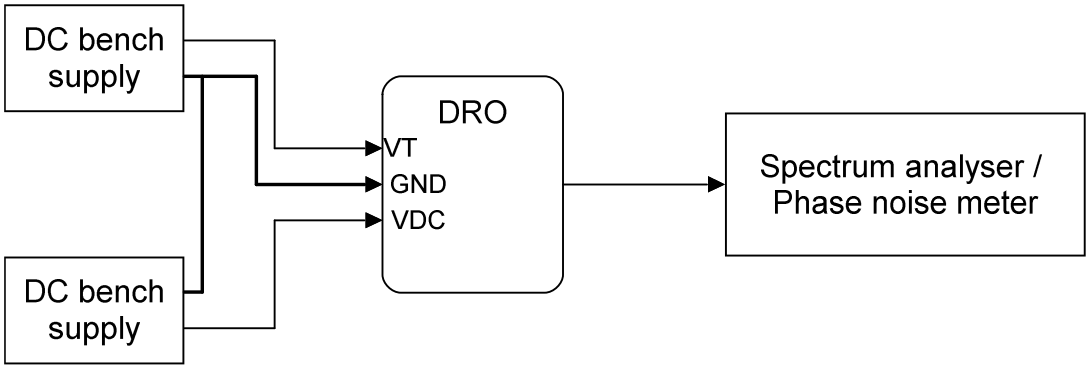
Screws not properly fastened when received - SN 1541-0002 on the left, SN 1541-0001 centre and right



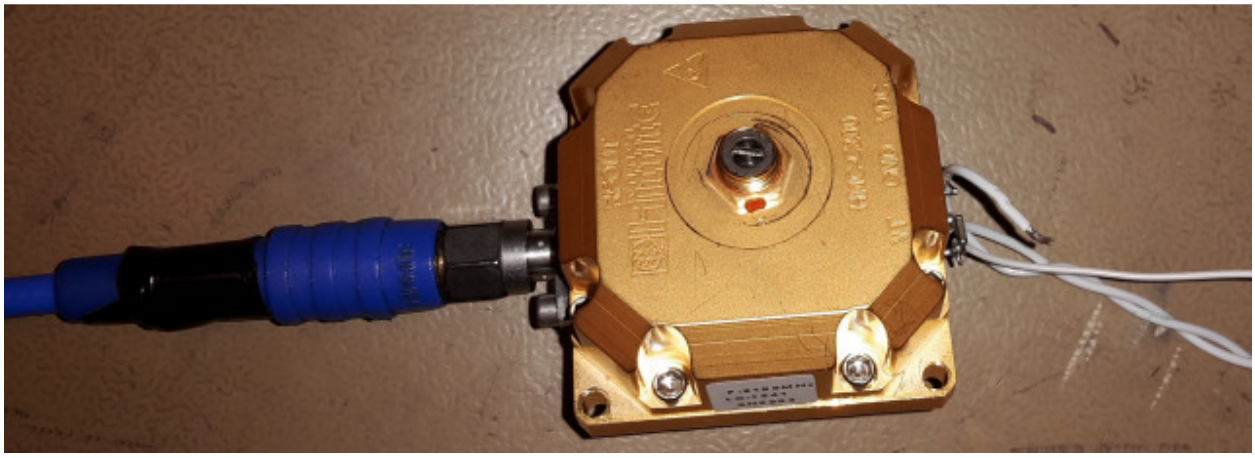
Scratch marks visible on SN 1541-0001 when taken out of the box.

3. Test setup

Measurements were done with a Rohde & Schwarz FSUP signal source analyser (26.5 GHz), last calibration September 2015. The test setup is shown below.

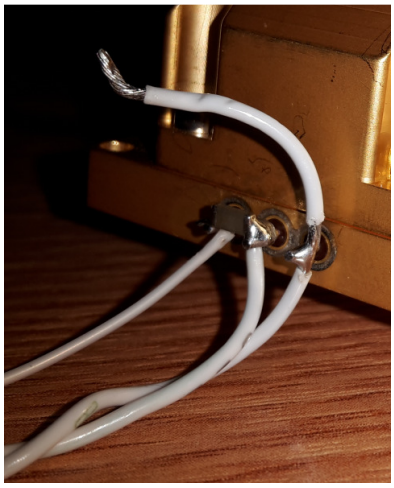


Test setup block diagram



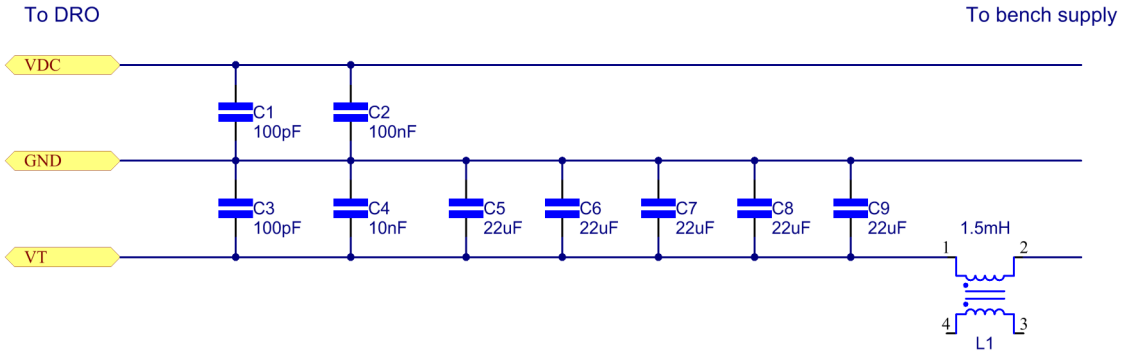
Connections during testing

Initially, VT and VDC were connected together, and a 100nF capacitor was soldered between the GND and VT pins. Later, these two voltages were driven separately. The picture below shows the capacitor, and the separate wires. The lose wire standing up is the previously used connection between VT and VDC.

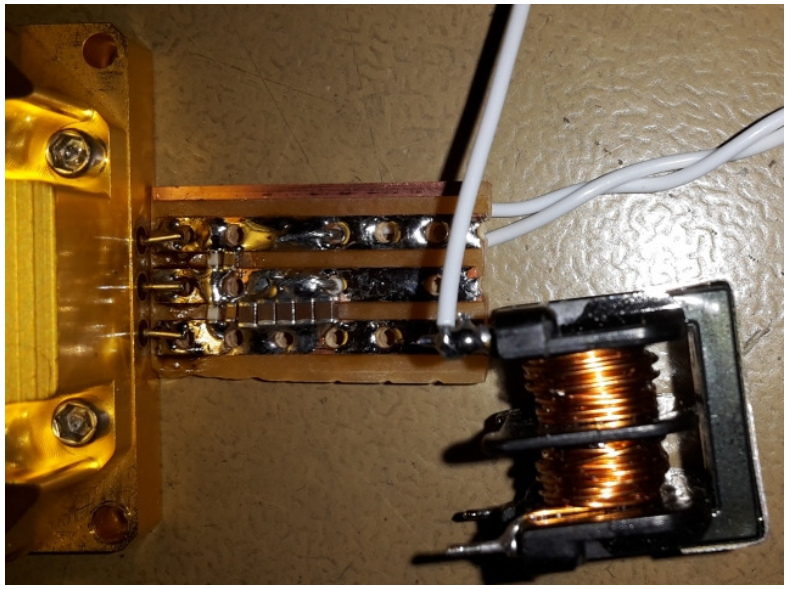


DC voltage connections

Finally, a small PCB was built to implement the decoupling capacitors and inductors as suggested in the datasheet, using available components. This small PCB was soldered directly to the three pins of the DRO.



Decoupling PCB circuit diagram



Decoupling PCB soldered to DRO pins

4. Tuning voltage

The 8.1 GHz unit that was measured (SN 1541-0002) had a very small tuning voltage range. The output signal dropped away completely at a VT higher than 9.4V. The other units came closer to 12V (as specified) before dropping off.

5. Output spectrum

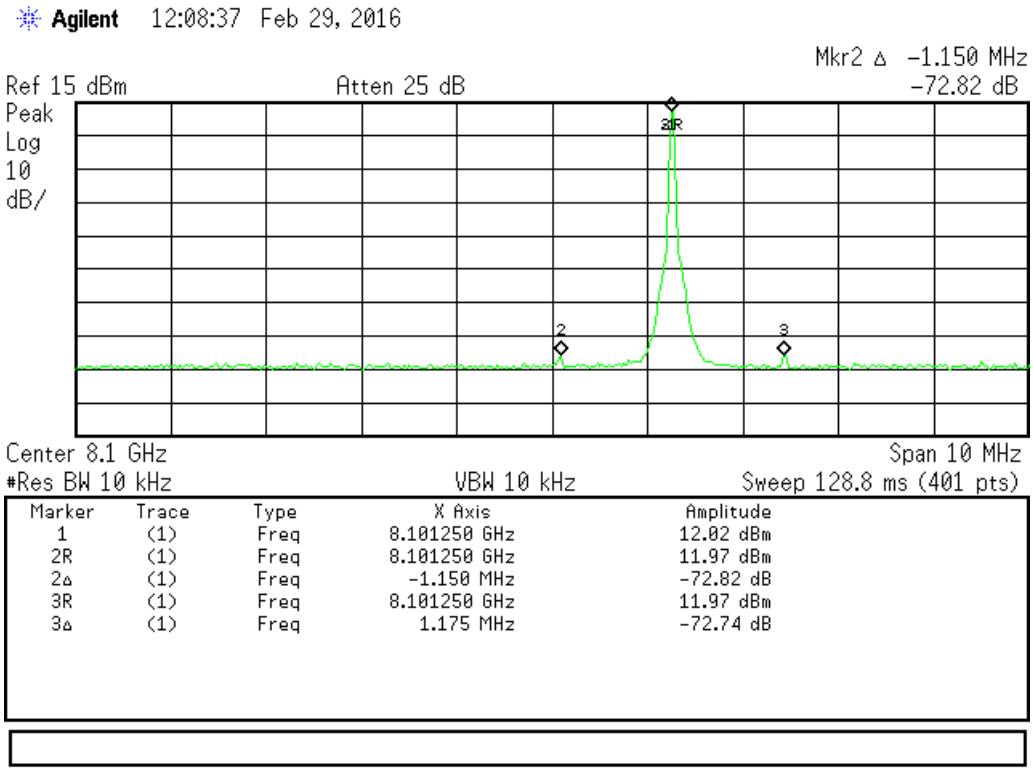
Instruments used for this test:

Agilent E4407B spectrum analyser, last calibration date April 2015

Rohde&Schwarz power meter NRP-Z85, last calibration date March 2015

The 8.1 GHz unit was measured on the spectrum analyser and it was found that the max output power was achieved with a VT of 6.5V. Some spurs were observed close to the carrier (see figure below). Harmonics were measured to be -24.9 dBm (higher than specified) and -35.0 dBm for second and third harmonics respectively. The power meter confirmed the output power level to be 13.5 dBm.

In general, the modules displayed adequate output power level. For the 8.3 GHz modules, the best VT was about 8V.



Output power spectrum showing close-in spurs

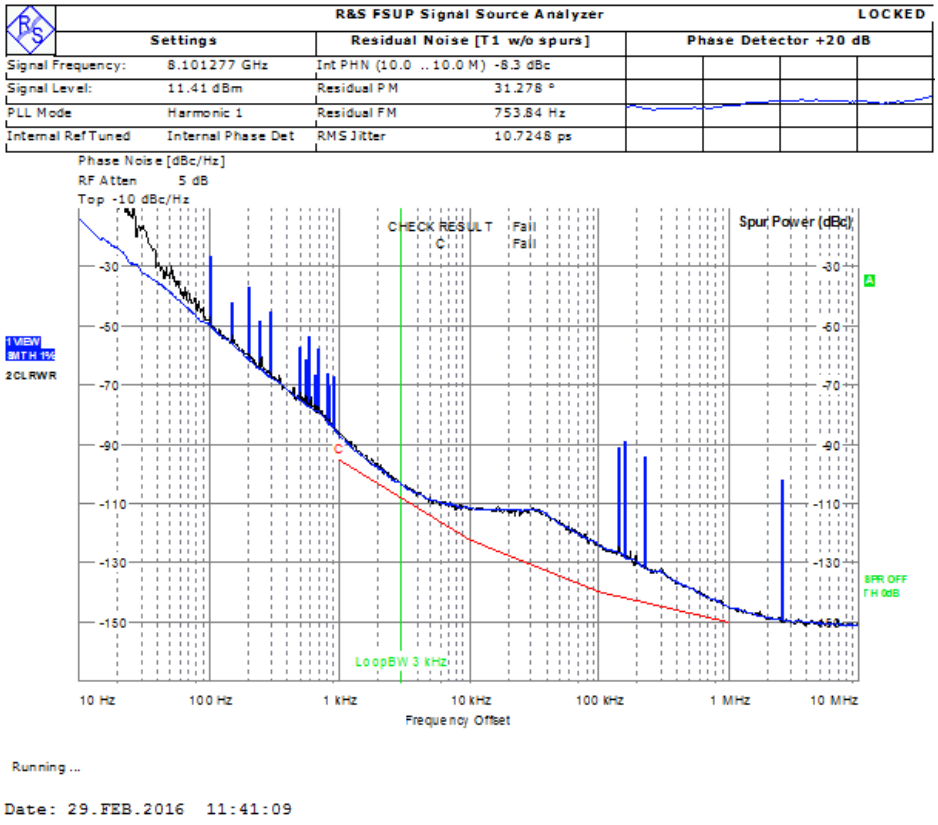
6. Phase noise

Phase noise could not be accurately measured at higher offset frequencies due to noise floor limitations of the instrument used.

7. Sensitivity

The test setup was extremely sensitive to any disturbance or movement. It was easily demonstrated that touching the RF cable between the DRO and signal analyser caused a disturbance in the output signal. Touching the DRO casing caused a shift in frequency. Waving one's hand close to the DC pins caused disturbances in the phase noise. These responses are hard to quantify or capture in a photo, but they were *not* subtle. In the screen shot below, a disturbance can be seen in the low-frequency phase noise (black trace) and the detector trace (top right of the image). This disturbance was caused by waving a hand close to the unit, and is *very small* compared to other disturbances witnessed.

Is it possible that there is RF leakage present outside the unit, which couples back into the module and which can be easily disturbed in the ways described above?



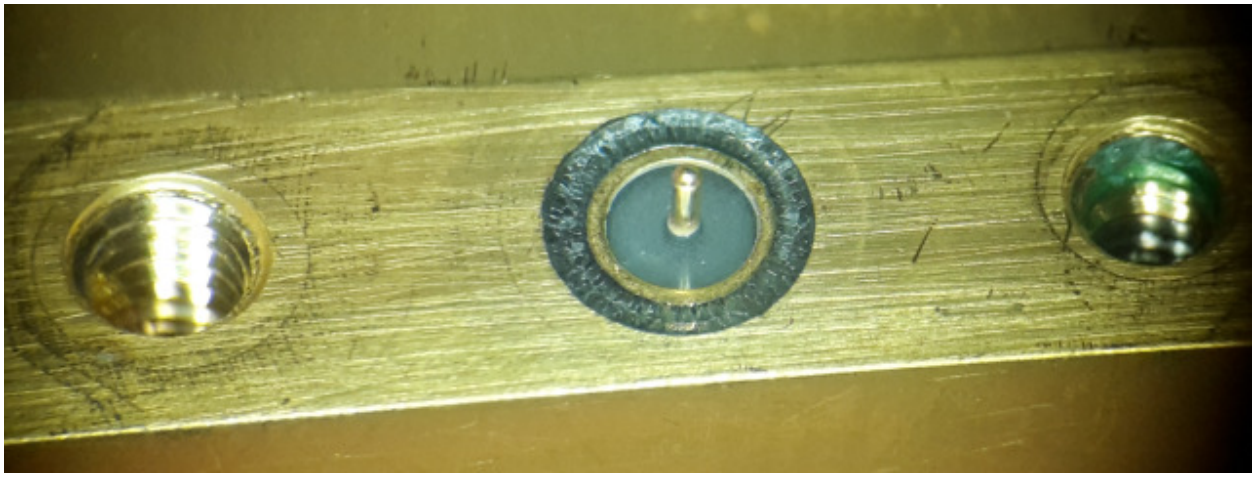
Measured phase noise of 8.1 GHz module (SN 1541-0002), with 100nF decoupling capacitor on VT pin, VDC = 6.4V, VT = 6.5V. A hand is moving close to the DC pins, causing a disturbance.

8. RF connector

The field-replaceable SMA connector of one of the modules was removed. It was observed that the ground ring of the coaxial transition is not positioned flush with the surface of the module (see picture below). Instead, it is slightly recessed. This will cause an air gap between the ground surface of the field-replaceable SMA connector and the ground ring on the DRO module, when they are mated. This is a cause of concern and possibly the reason that the RF signal is leaking out of the module.

Experiments using shim to provide a more continuous ground ring did lead to an improvement in the sensitivity.

It is also unusual that the GND pin is not grounded directly on the chassis where the pin enters the body, but instead leads to a feedthrough component. Does this not create a path for disturbances on the line to enter the cavity?



RF pin on DRO module, with SMA connector removed

9. Conclusion

All units received from Analog Devices are extremely sensitive to any form of handling while operational, which would currently make them unsuitable for use in a real system, where vibration can be present.

The grounding at the GND pin and the field-replaceable SMA connector may be responsible for some of the problems.