Integration & Radio Qualification

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WiFi / Cobalt 88

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ARTURIA

DATE	VERSION	AUTHOR	MODIFICATION
23/03/2023	Has	P Champaney	Creation

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1 Project context

ARTURIA is currently working on the release of an 88-key variant of the Cobalt music synthesizer, featuring 2G45-5G2 WiFi and Bluetooth connectivity. The product therefore has integrated antennas but remote in a very metal housing and therefore very restrictive.

Arturia therefore requested AW's support for the selection and integration of the two 2G45-5G2 WiFi radiating elements.

2 SUMMARY OF BOM'S DEVELOPMENTS

Nothingness

3 Conception

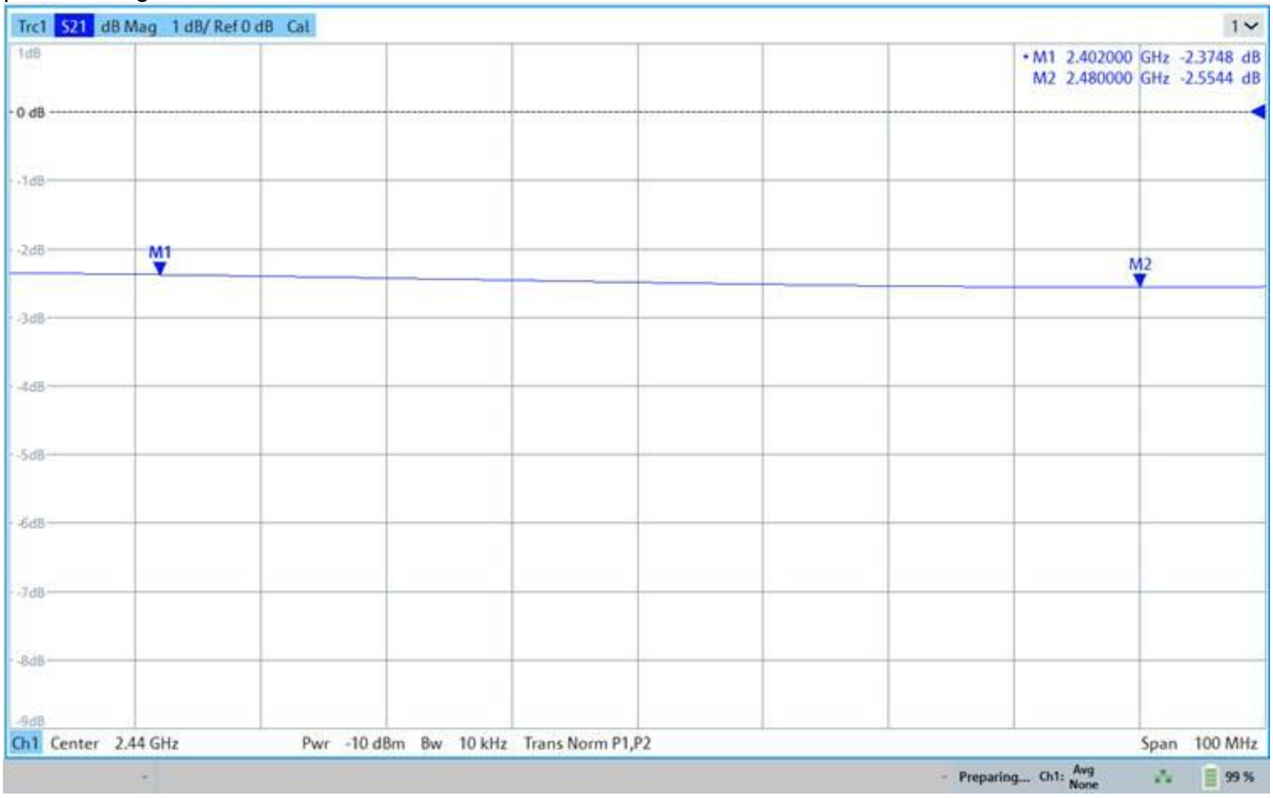
3.1 Integration of the two WiFi antennas

The two WiFi antennas selected are 2.45 GHz/5.3 GHz M.Gear.

3.1.1 Increased the length of M.Gear antenna coaxial cable from 80 to 100 cm

This possibility is only used if one of the M.Gear antennas is located on the right side of the keyboard, due to the lack of a favourable location in the left "cheek". This test is to ensure the effect of a long coaxial cable on the efficiency of the 2G45 antenna.

The 80 cm coaxial is placed between the two ports of an R&S ZNL network analyzer to get its attenuation per unit length:



The average attenuation is 2.45 dB for 80 cm, i.e. 0.3 dB / 10 cm. A 1 m coaxial cable therefore "costs" -3 dB, i.e. a transmission power divided by 2, but an "indoor" range only reduced by 15 to 20%.

This is a loss of performance that does not seem to be negative to the use of the Cobalt 88 keyboard, especially given the M.Gear / coax 80 cm antenna already used on Cobalt 61.

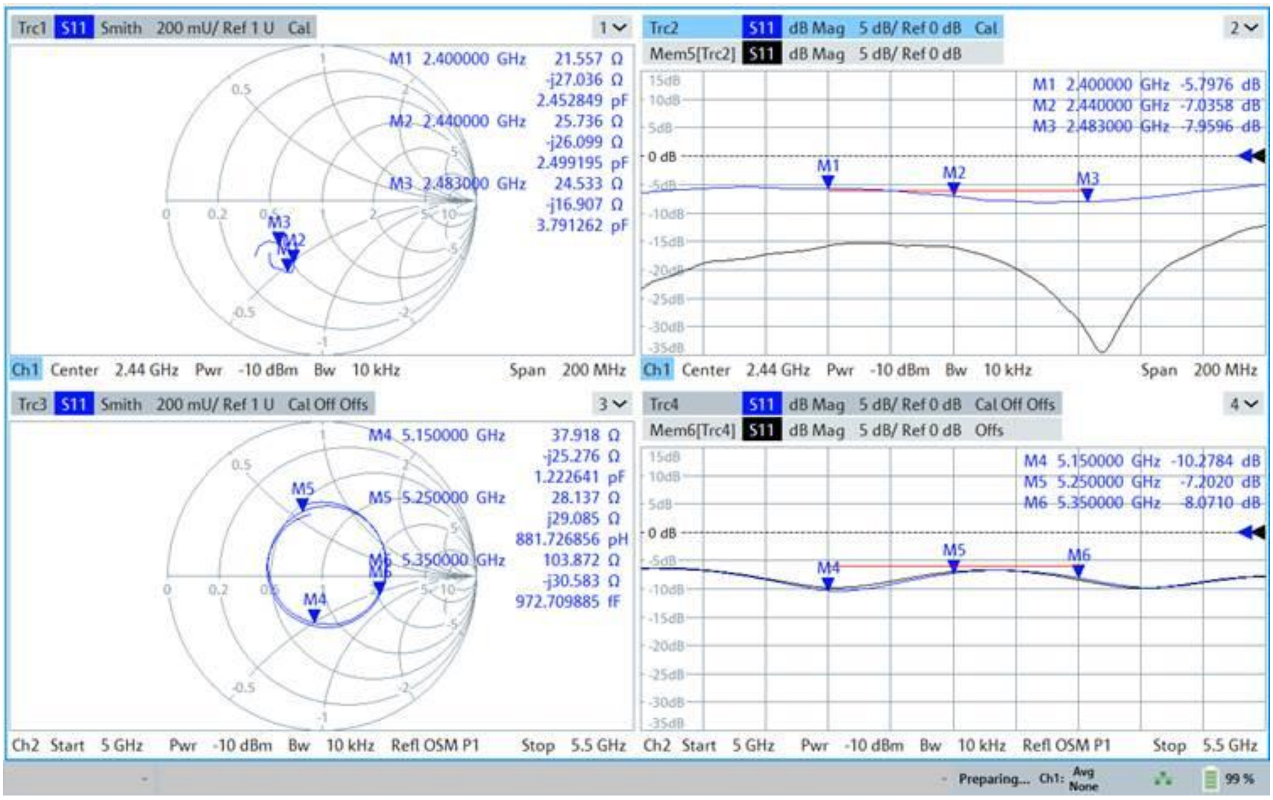
3.1.2 Distance to metal / S11 impedance matching

Since the environment is very metallic, it is worth looking at the minimum distance between the side metal plate / Cobalt 88 and the M.Gear antenna used, in terms of S11 adaptation.

The S11 adaptation is the ratio "Reflected power / Developed power" which reflects compliance with the 50Ω impedance. It is essential for a good power transfer of Antenna <> Electronics and it must be checked before any radiated consideration. On a wideband antenna such as WiFi, the S11 should be as low as possible (typ < -6 dB).

The M.Gear WiFi antenna is mounted on a plastic support and then it is brought close to the side metal plate until it observes an S11 @ 2.45 GHz > -6 dB. If the 5.2 GHz is not affected much (which is not reassuring... but excluding services), the limit of -6 dB is reached for a distance to the metal of 10 mm.

In black, the S11 adaptation of the antenna alone.
In blue, the one observed when 10 mm from a metal plate



The M.Gear antenna can be placed 10 mm away from the metal, but the impact on the 5GHz becomes noticeable. It is therefore preferable to remove the metal immediately under the antenna.

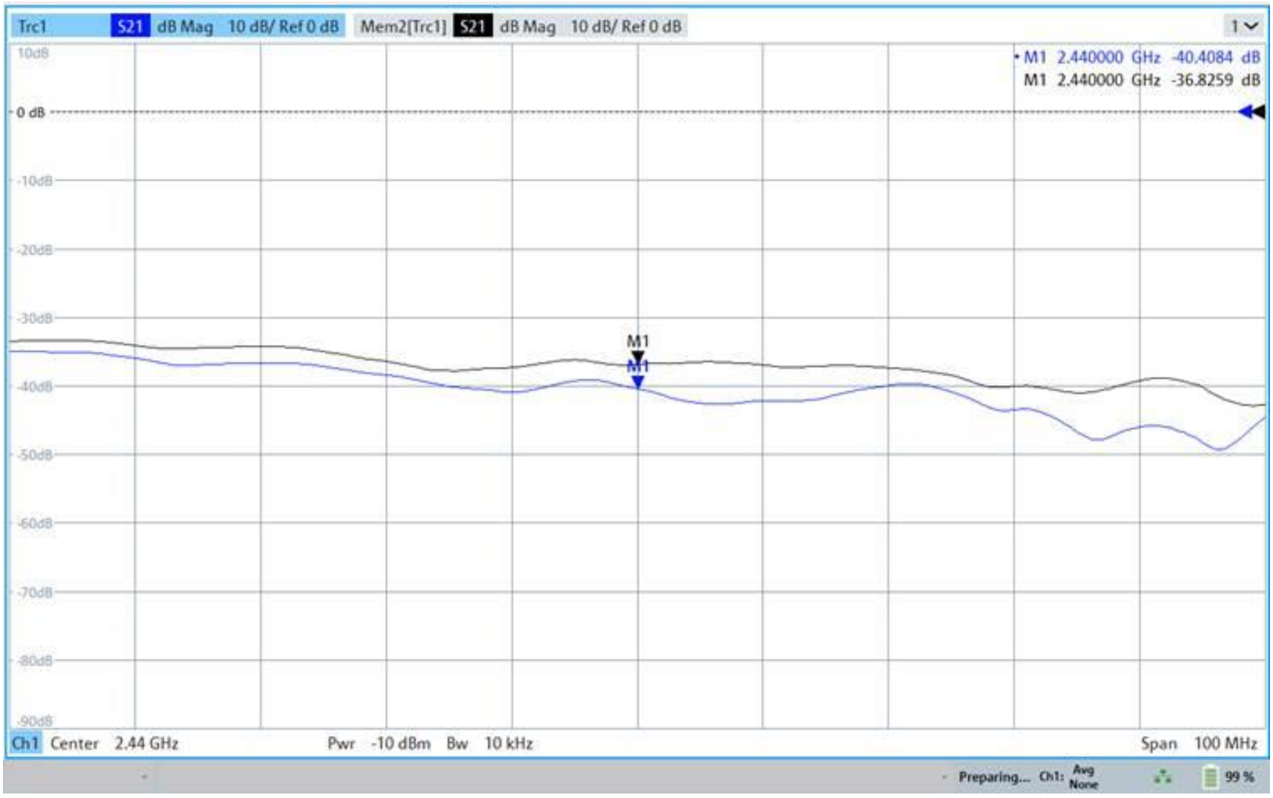
3.1.3 Distance to Metal / Radiated Power

It is then necessary to measure the impact of the distance between the side metal plate / Cobalt 88 and the M.Gear antenna used, in terms of radiated power. Indeed, the plate has the effect of "short-circuiting" the developed E-field, which reduces the antenna radiation efficiency.

The M.Gear WiFi antenna / plastic bracket is placed at a distance of one meter from a ETS3115 reference horn antenna. The attenuation between the WiFi antenna and the horn is then taken as a reference. The side metal plate is then approached from the back of the WiFi antenna until a power drop of 3 dB is observed, i.e. 15 to 20% less range.

Below is the reading of the attenuation introduced by the solid side metal plate, located 12 mm behind the antenna. Below this gap, the radiated power drops drastically!

In black, the S21 transmission, M.Gear antenna / Plastic only.
In blue, the one observed M.Gear antenna / Plastic only & metal plate at 12 mm

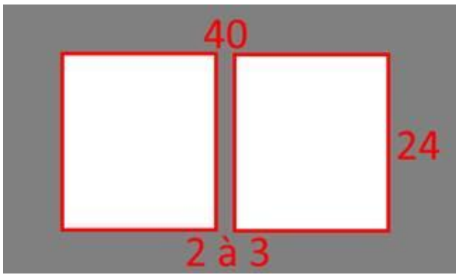


However, in Cobalt 88, the distance between the plastic keyboard edge cover and the side plate is only 9 mm. It should be noted that this 12 mm can therefore be the distance to the edge of a metal plate that would be at the edge of the antenna. In fact, and applied to Cobalt 88 to respect this minimum distance of 12 mm, it would be desirable for each antenna to be placed in front of an air window in the metal side plate.

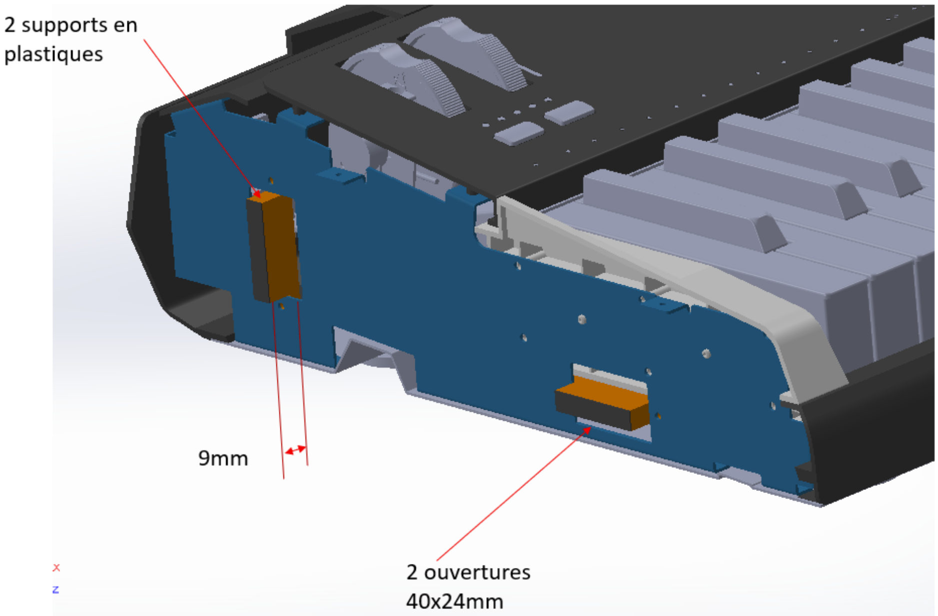
3.1.4 Position and metal recess

Faced with this 40 x 8 mm M.Gear antenna, the window in the side plate would then be 40 x "8 + 8 + 8", or 40 x 24 mm. Given the 9 mm distance from the plastic hubcap, the long edges of the antenna will then be 12 mm from the edge of the side metal plate. The same constraint applies to the vertical antenna mounted on a dedicated plastic support.

Important: To avoid losing too much rigidity and if necessary, the center of the window can keep a "rigidity bar" 2 to 3 mm wide, without impact on the antenna (only both ends of these dipole antennas work to develop the E-field):



Or the final implementation, on a plastic support with complete recess:



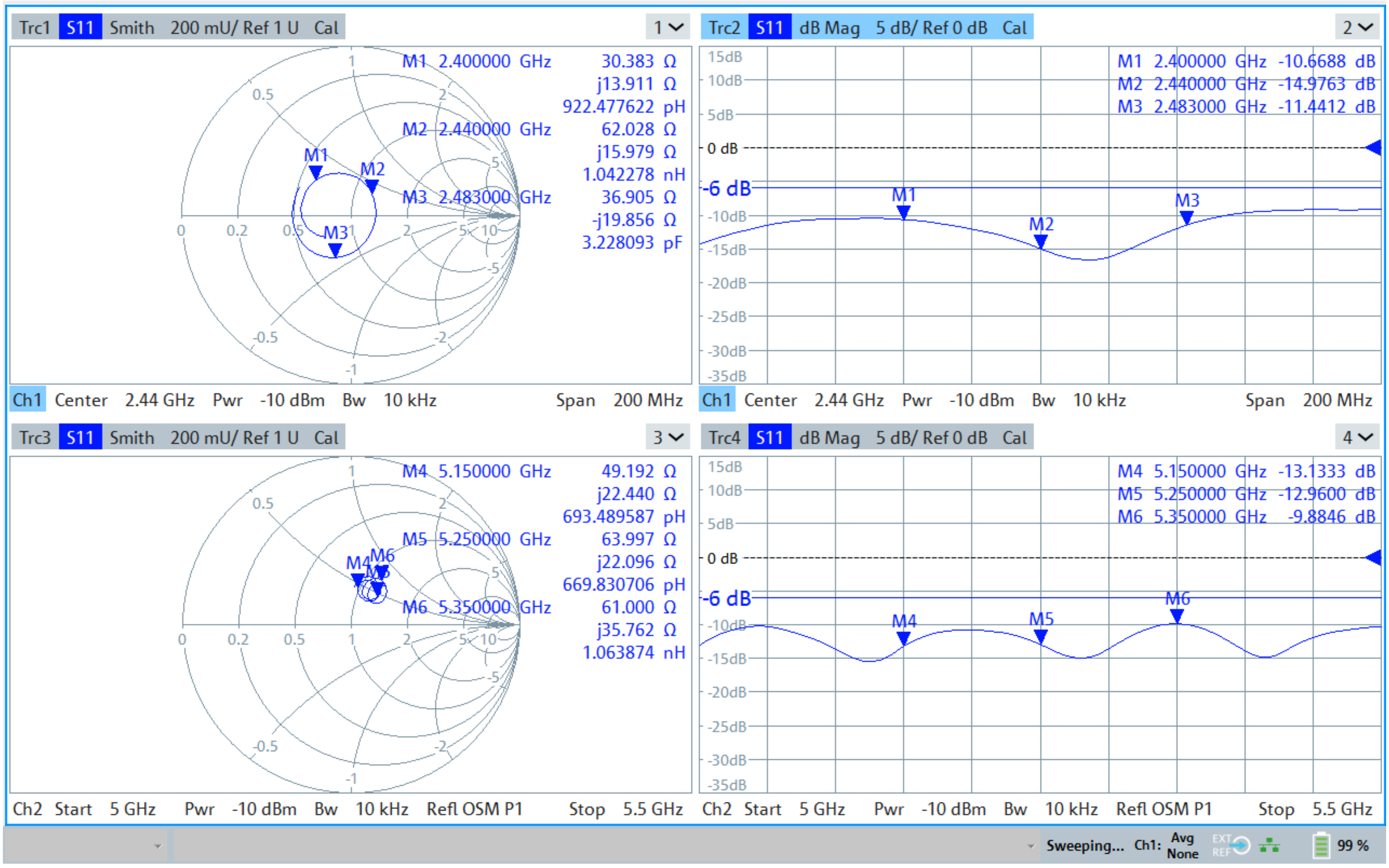
4 Qualification

4.1 S11 antenna adaptations

The two antennas are directly connected to the R&S ZNL network analyzer for the reading of their S11 matching and impedances.
The S11 adaptation is the ratio "Reflected Power / Developed Power" which reflects the respect of the 50R impedance and maximizes the RF transfer from Antenna to Receiver. It must be minimal and a wideband antenna is considered usable for S11 < -6 dB.

<u>S11 / Vertical antenna adaptation:</u>

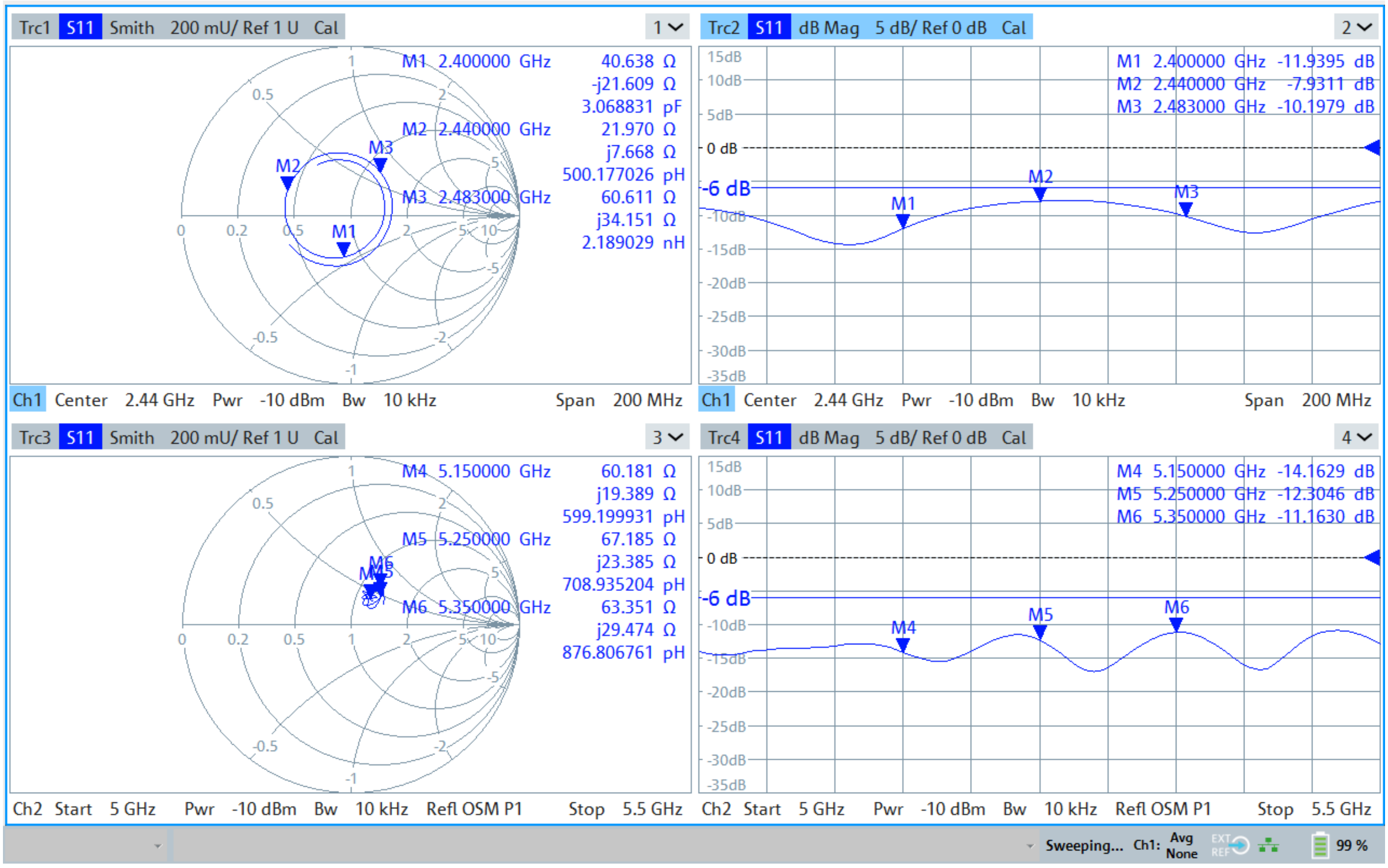
On the left in blue, the -6 dB limit
Top left, 2.45 GHz band
Left bottom, 5.3 GHz band



The S11 adaptations are very good, <u>better than during the initial mock-up</u>.

S11 / Horizontal antenna adaptation:

On the left in blue, the -6 dB limit
Top left, 2.45 GHz band
Left bottom, 5.3 GHz band



The S11 adaptations are also very good.

Remark:

The quality of these S11 adaptations shows that the antennas seem to be little influenced by the various surrounding cables.

4.2 Gains of both WiFi antennas

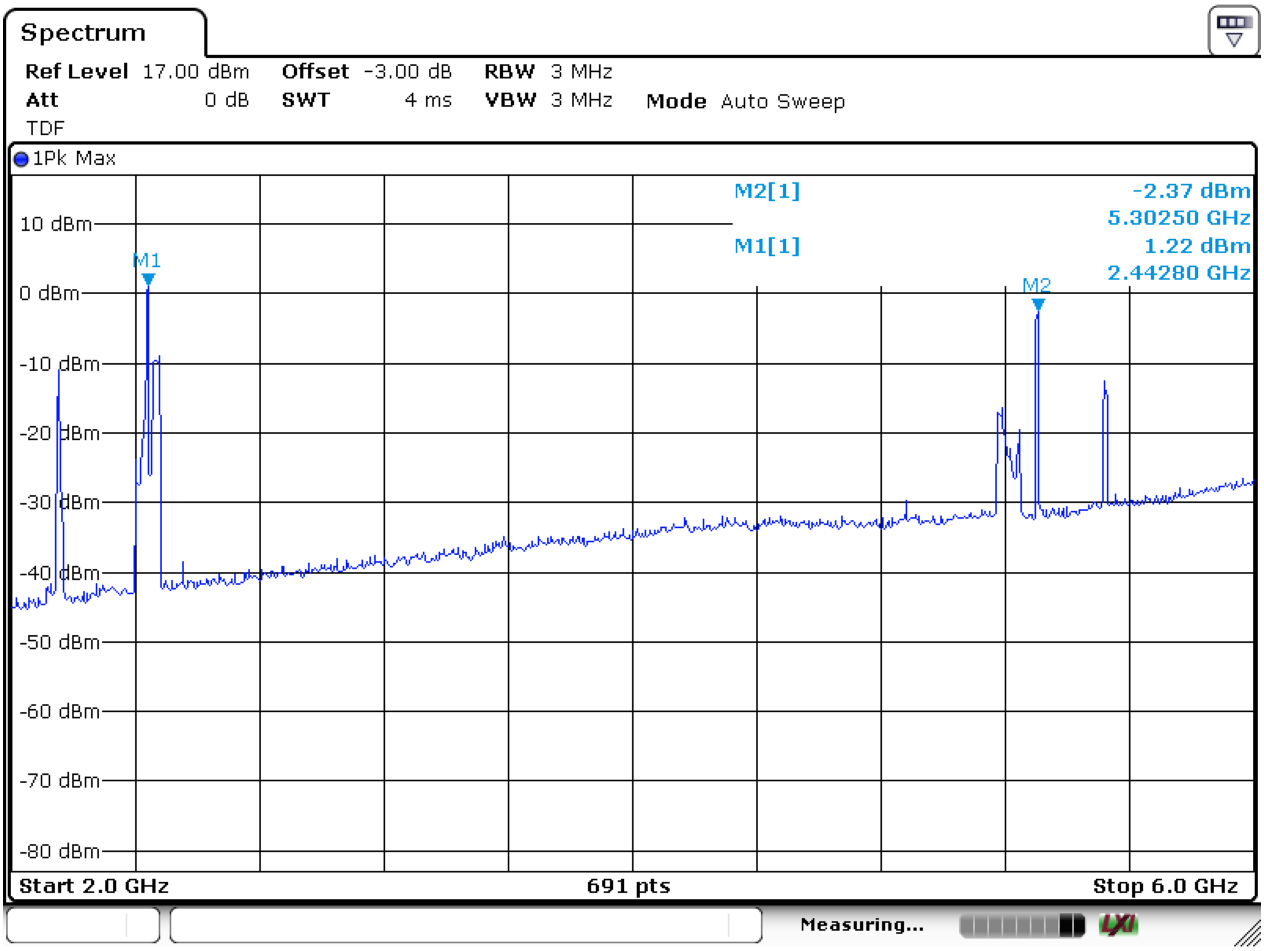
The two antennas are excited successively by an autonomous BPSG-6 micro-generator which develops two carriers 2440 and 5300 MHz / 0 dBm.

The EIRP radiated power is measured to 2440 and 5300 MHz for both WiFi bands. The product is 2 m from an ETS-3115 reference horn antenna connected to an FSV-14 R&S ANALYZER. The E field is thus measured to deduce the EIRP power by simple calculation, which corresponds to the gain, given the 0 dBm attack.

The product is explored by rotating 180° along 2 axes, to search for maximum radiation, and by raising the reference antenna.

Vertical Antenna Gain

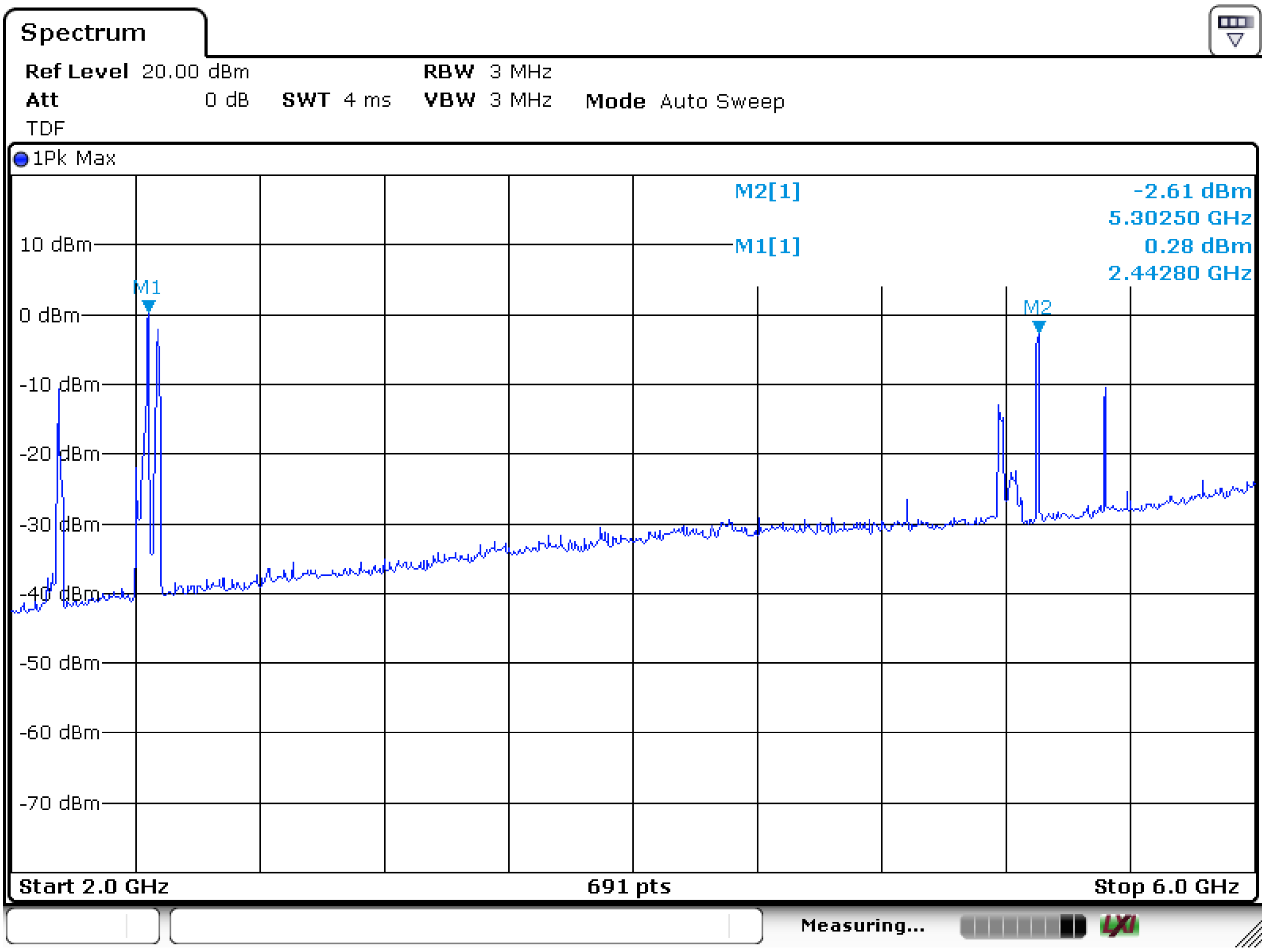
Fq	Gain	Theoretical
Mhz	Dbi	Dbi
2440	**+1.2**	+2
5300	**-2.3**	+1



These gains are very good, given the integration. The 5300 MHz one is a little lower, as it is an additional element to this multiband antenna.

Horizontal antenna gain

Fq	Gain	Theoretical
Mhz	Dbi	Dbi
2440	**+0.3**	+2
5300	**-2.6**	+1



These gains are also good, and like the other antenna (although a little weaker, probably due to the aftertouch ribbon of the keyboard being a little too close). Same remark about the 5300 MHz necessarily a little disadvantaged.

All these results confirm that this solution of integrating two 90° WiFi antennas into the side of a keyboard can be perfectly generalized on your future instruments.