Investigation of changes in receiver S11 with back-end cable length

Tom Mozdzen and Nivedita Mahesh
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ASU

This report outlines the results of the receiver S11 measurements that were carried out using two sets of back-end cables . These measurements were performed for the power sensitivity test. On observing a difference in the measured S11 for the same power level due to the different cables, tests were done to find out the reason for it. Also shown here are the results of the second round of S11 measurements done with the two cables after understanding the cause of the discrepancy. In the second measurements, the S11 between the two cases are seen to be in agreement.

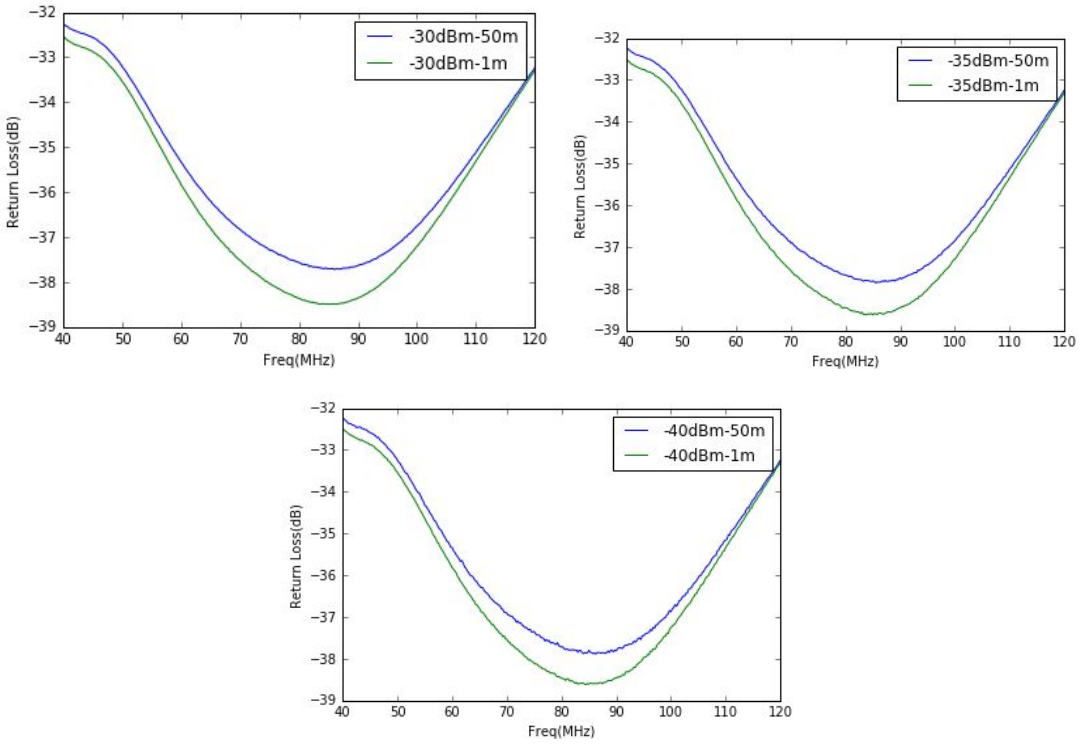
In the measurements of the low-band-1 receiver conducted on 2017/05/04[1], it was noted that the S11 of the receiver changed by ~1 dB when a 50 meter cable was used to connect the receiver the back-end, compared to a 1 meter cable. This behavior was unexpected. The 1 dB difference was observed regardless of VNA power level used to measure the receiver's S11 (show in figure1) or which iteration of measurement was performed(also shown in figure1)

The measurements with the 1m and 50m cable were performed on 2 different days by me and Tom respectively. The procedure followed to perform these measurements were the same, i.e, For each power level,

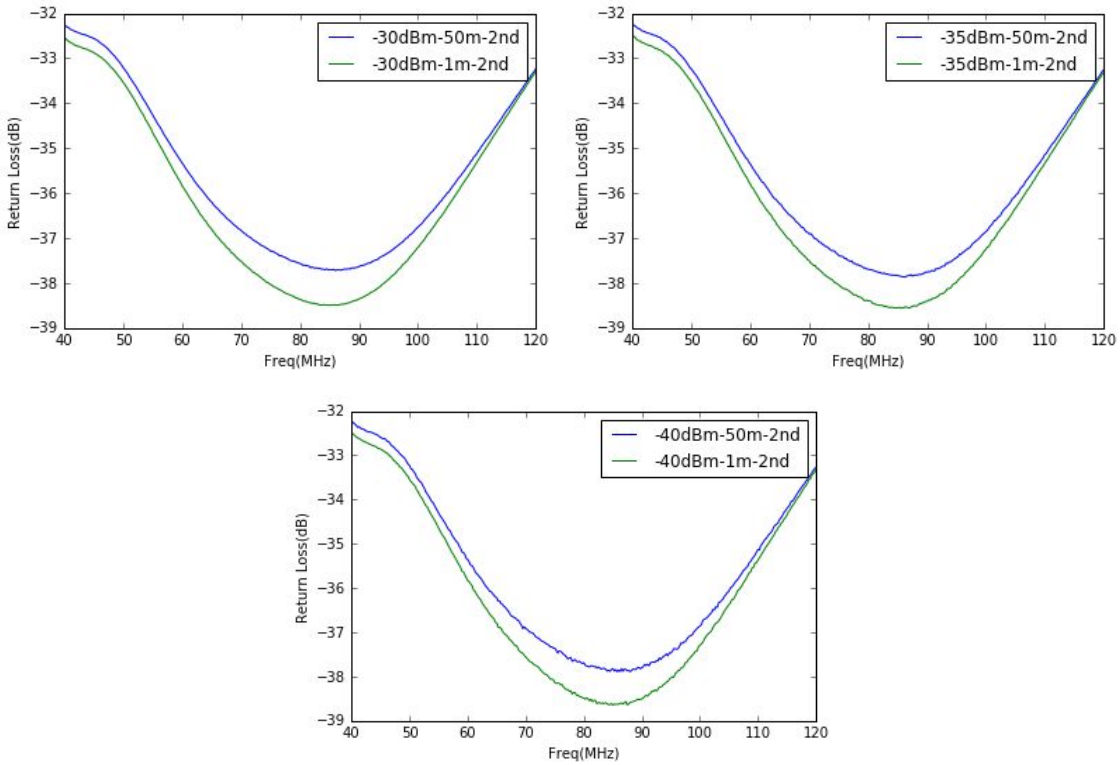
A. S11 of the OSL standards & 6dB attenuator were measured (~6 mins)
B. Receiver was stopped switching
C. Receiver S11 was measured at the VNA
D. Receiver was set to switching
E. S11 of the OSL standards & 6dB attenuator were measured at the VNA again(~6 mins)
F. Receiver stopped switching and its S11 measured.

The calibrated return loss of the receiver measured with the 1m cable/50 m cable connected between the back end and receiver are overplotted in figure1 for comparison.

[1] Data is on enterprise: /data5/edges/data/Lowband1_May2017_recalibration/Power_sensitivity1m|Power_sensitivity1m(or)Power_sensitivity50m



(a)



(b)

Figure1: (a) Comparison of the calibrated return loss of the receiver for the two cases of the receiver-backend cable lengths individually plotted for power levels of -30dBm,

-35dBm&-40dBm. b.) this figure is similar to that in a) except that this uses the second set of measurements as in steps D-F outlined in the procedure

Since no ripples are seen in the return loss curve that would correspond to the cable length, cable itself was eliminated as one of the possible reasons for the discrepancy. One major possibility discussed was that the longer cable may be emitting enough radiation that could be picked up at the VNA. Hence we did a couple of tests using the ferrite cores to understand if RFI was the reason causing the difference.

With the 1m cable connected between the receiver and the backend, we connected the receiver to the VNA and recorded the S11 (without averaging) at the VNA power level of -30dBm. Saving this to the screen and leaving the VNA settings the same, we switched the cable to the 50m one. The same difference as in figure1 was observed. We added a ferrite core on the connector between the VNA and the receiver. The difference still remained. Next we added ferrite cores on the back-end cable itself. Still no improvement. But on waiting for sufficient amount of time, the current S11 curve matched that of the saved one from the measurement using the 1m cable. We switched the cable back to the 1m case. Again, we had to wait for a certain amount of time for the curves to overlap. Thus, it was concluded that the discrepancies are due to thermal issues.

So for the second round of measurements we decided to monitor the temperature of the receiver by connecting the Fluke meter to the other thermistor on the receiver. This resistance was continuously monitored while the S11 measurements were being made as shown in figure2.

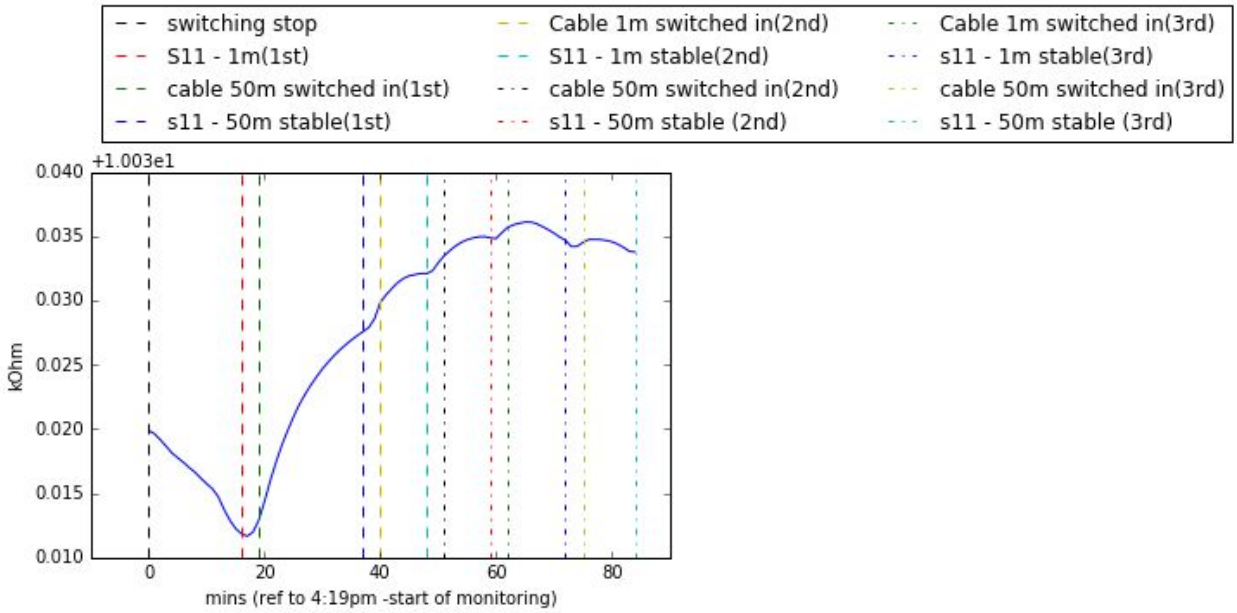


Figure2: Resistance of the second thermistor on the receiver as recorded by the fluke meter while the tests of the cable switching was performed. The y axis time elapsed in minutes from 4:19pm when the receiver was stopped switching. The times at which the cable swaps were performed are noted on the graph by the vertical lines.

These measurements were made after the receiver was left switching for a day. The measurements were performed only at a power level of -30dBm. Only one power level was chosen because from figure1 we noted that the discrepancy was the same for all concerned power levels. The order of the measurements (which are indicated by the vertical lines in figure2) were as follows:

- Receiver stopped switching
- OSL standards measured
- With the 1 meter back-end cable, S11 was measured
- 50 meter cable was swapped in
- The S11 stabilized[2] in 9 mins but I waited longer to see if the resistance stops increasing.
- 1 meter cable swapped in (2nd)
- S11 of the 1 meter cable stabilized after 8-9 mins
- 50 m cable swapped in (2nd)
- S11 of the 50 meter cable stabilized after 8-9 mins
- 1 meter cable swapped in (3rd)
- S11 of the 1 meter cable stabilized after 8-9 mins

[2] Stablized as in, the S11 matched the previously saved measurement. Also S11 stopped changing any further

- 50 m cable swapped in (3rd)
- S11 of the 50 meter cable stabilized after 8-9 mins

The obtained S11 on 05/12/2017 for the above three trials are shown in figure3. The two cases of 1m and 50m cables are overplotted for each trial.
In conclusion, there is a resistance drop at every cable swap for a brief amount of time. And it takes ~8 mins for the S11 values to stabilize.

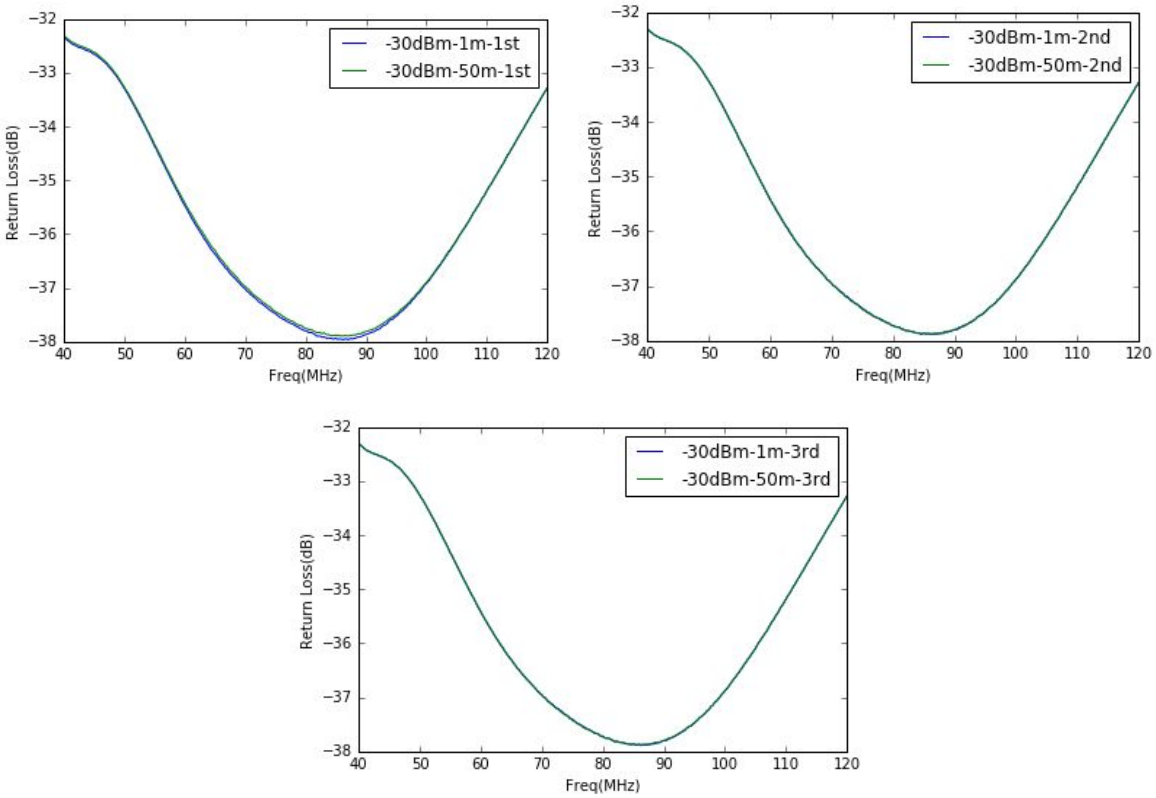


Figure3: (a) Comparison of the calibrated return loss of the receiver for the two cases of the receiver-backend cable lengths individually plotted for power levels of -30dBm, -35dBm&-40dBm.