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Receiver Design Report

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I certify that ALL of the following are true:

i. I have read the UCD Plagiarism Policy and the College of Engineering and Architecture Plagiarism Protocol. (These documents are available on Brightspace.)

ii. I understand fully the definition of plagiarism and the consequences of plagiarism as discussed in the documents above.

iii. I recognise that any work that has been plagiarised (in whole or in part) may be subject to penalties, as outlined in the documents above.

iv. I have not previously submitted this work, or any version of it, for assessment in any other module in this University, or any other institution.

v. I have not plagiarised any part of this report. The work described was done by me, and this report is all my own original work, except where otherwise acknowledged in the report.

Signed By: Tiarnach Ó Riada **Lab Date:** 12th November 2020

Simulation Parameters

Sampling rate:
Symbol transmission rate:

Signal Bandwith

I estimated the signal bandwidth as XXX, by measuring at XXX dB below the peak of the signal.

EEEN40050 Wireless Systems

Date submitted : 19th November 2020

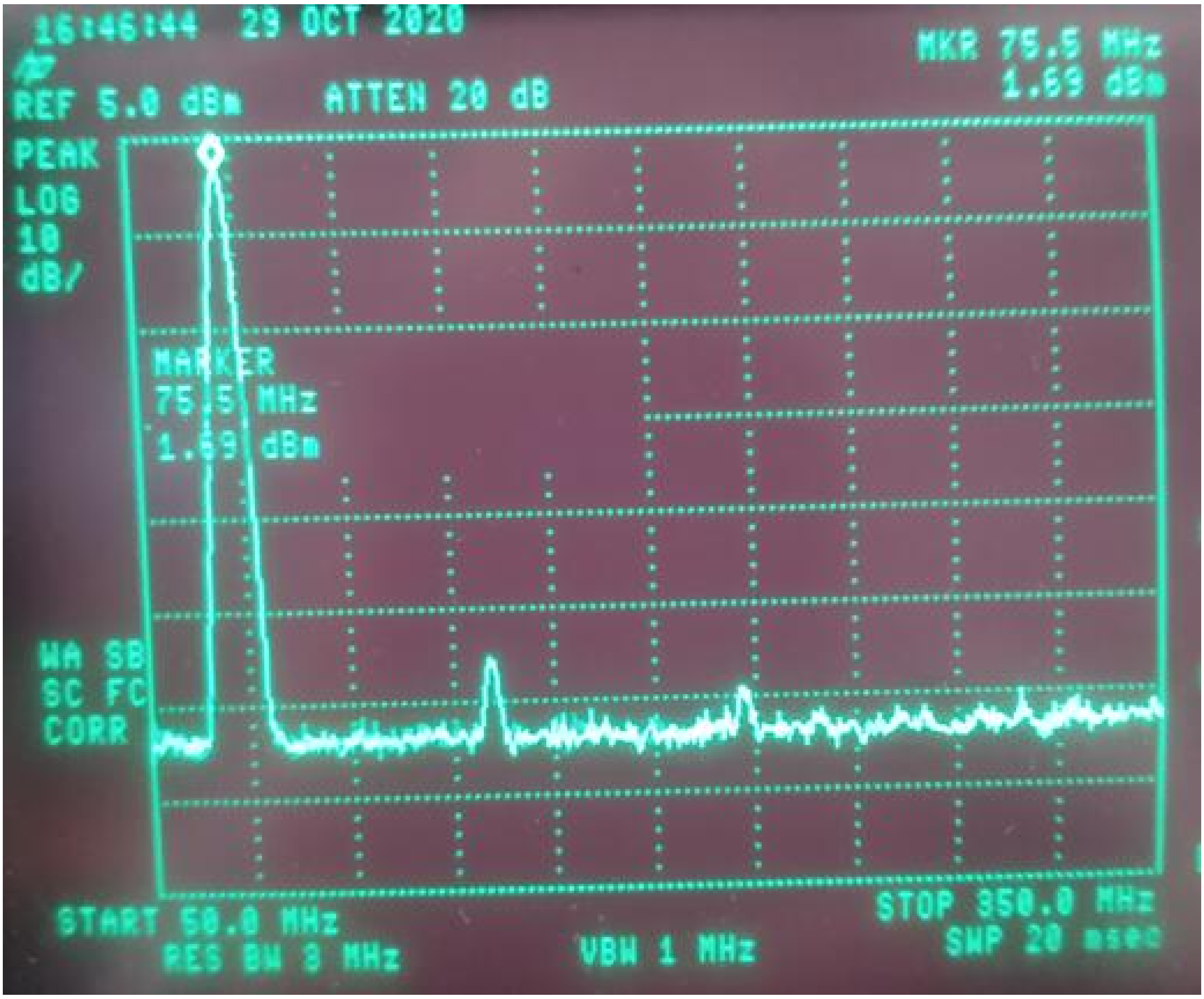

Figure 1: Signal generator output showing 1st harmonic at 150 MHz and −50.37 dBm and 2nd harmonic at 225.5 MHz and −56.87 dBm

1 Small Signal Gain

As fig. 2 shows, the harmonics visible in the signal generator output (fig. 1) have increased considerably.

The measurement of the small signal gain was made for the following values:

Attenuation	P_{in}	P_{out}	Gain
35 dB	−33.31 dBm	−10.98 dBm	22.33 dB
33 dB	−31.31 dBm	−8.95 dBm	22.36 dB

The gain measurement, 22.35 dB on average, is quite close to the manufacturer's value of 22.76 dB; the difference could be due to measurement error and deviations in the manufacturing process. The gain increase was quite constant—a variation of only 0.03 dB for 2 dB change in the input power—proof that the amplifier was in its linear region.

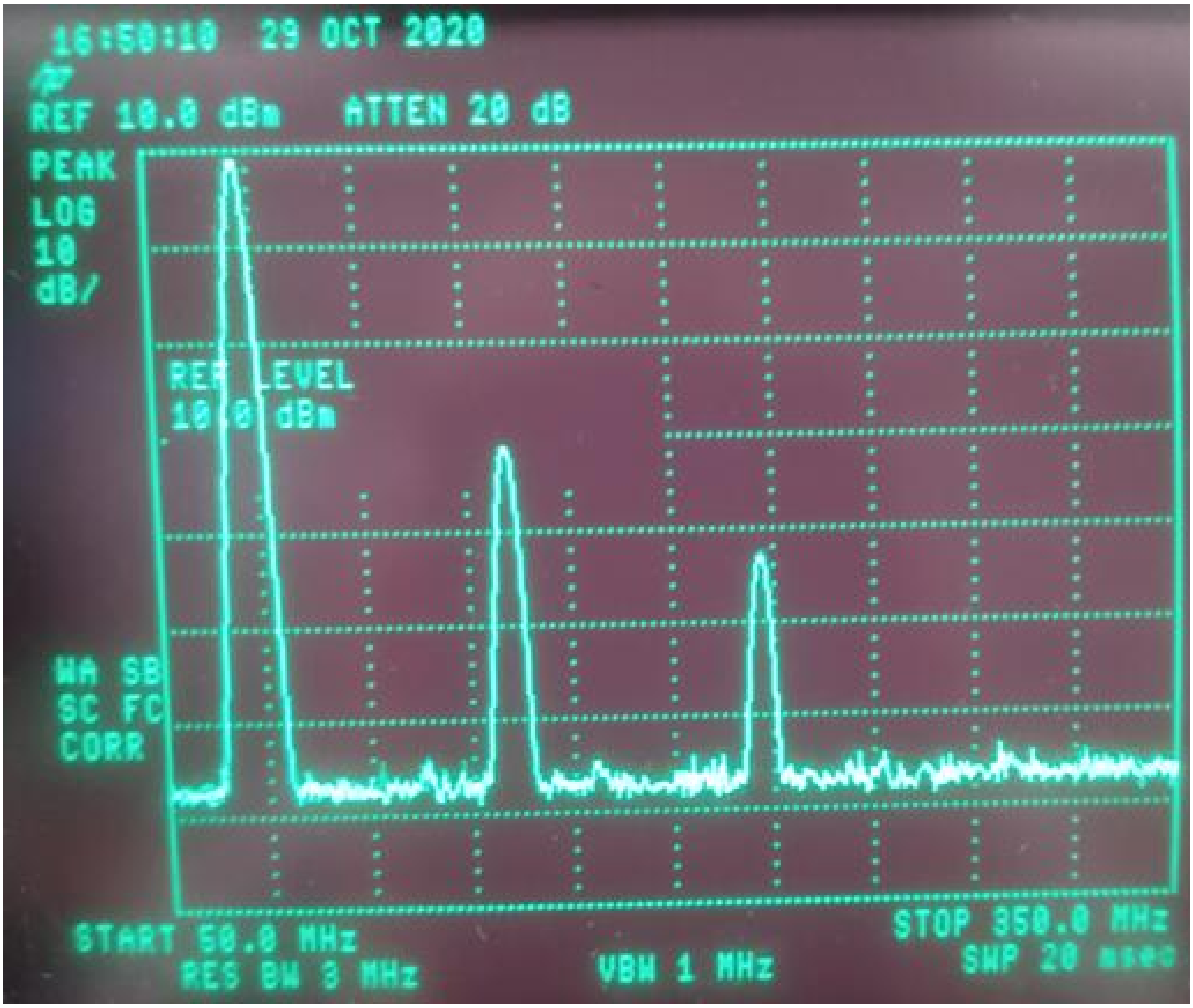

Figure 2: Amplifier output showing significant harmonics

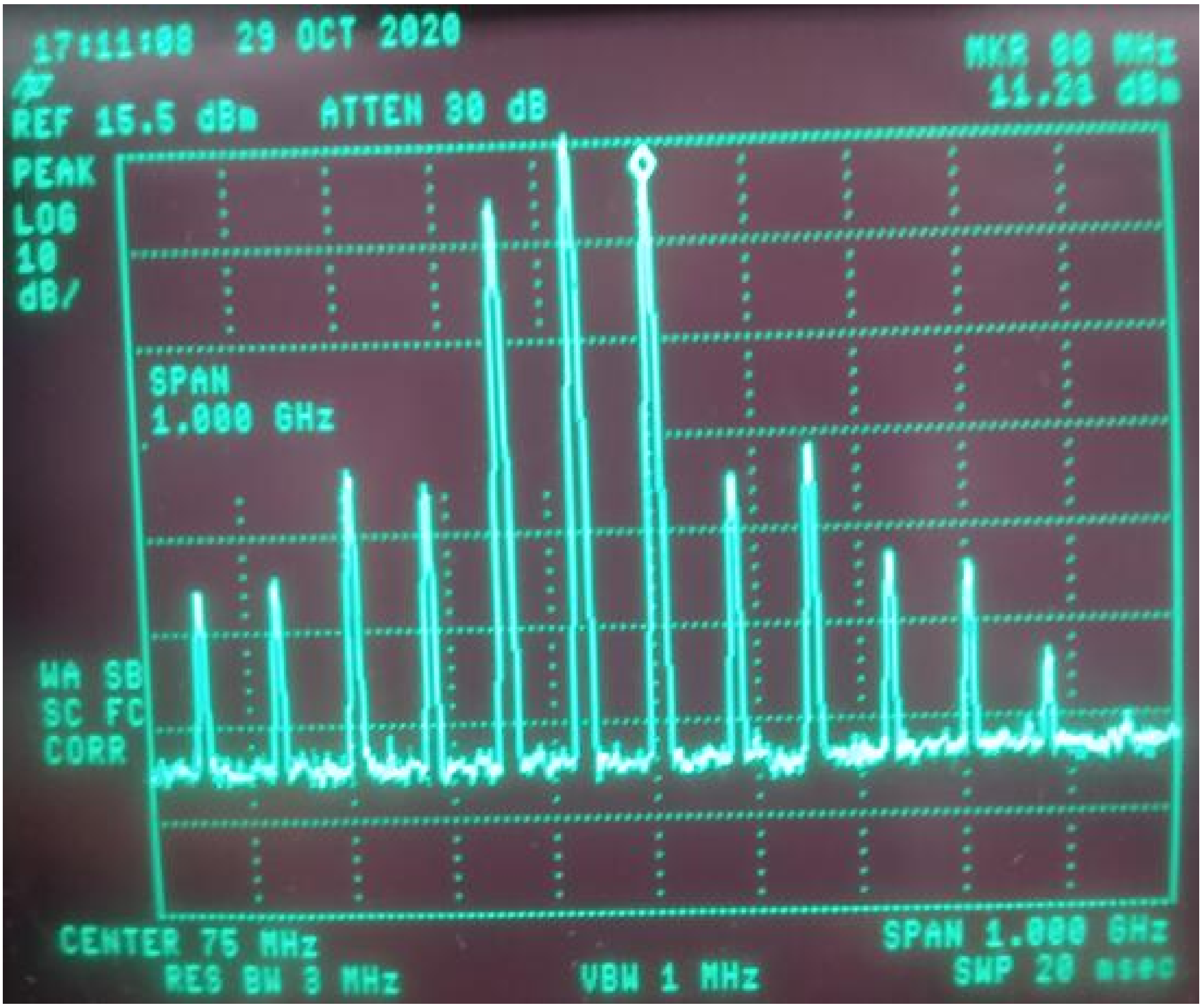

Figure 3: Harmonics at 1 dB gain compression point

2 Gain Compression Point

I found the 1 dB gain compression point by decreasing the attenuation in steps of 1 dB until the gain had fallen by 1 dB from the previously calculated value of 22.35 dB. Below are the final two points of measurement.

Attenuation	P_{in}	P_{out}	Gain
12 dB	−10.31 dBm	11.24 dBm	21.55 dB
11 dB	−9.31 dBm	11.97 dBm	21.28 dB

The data sheet value for the output power at the 1 dB compression point is 13.00 dBm. The point measured here is a little less than 11.97 dBm. The result is somewhat different, about 1.03 dBm lower than the manufacturer specified. This could be due to variation in manufacture as well as errors in measurement.

At the 1dB gain compression point (see fig. 3), the harmonics were significantly greater in both amplitude and number than when the amplifier was operating in its linear region (see fig. 2). The greater number of visible harmonics is due to the amplifier in its nonlinear region adding new frequency components at these harmonic frequencies.

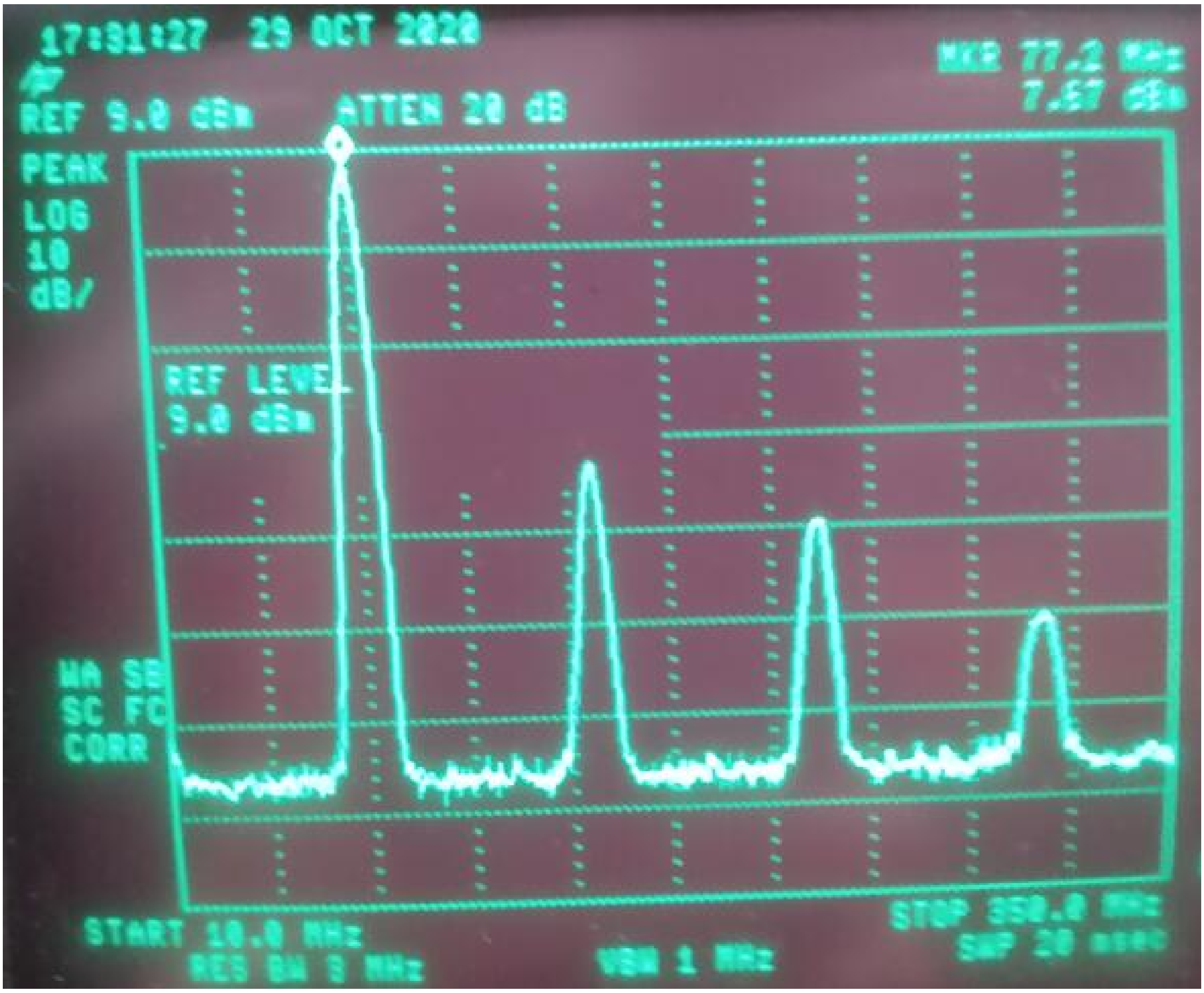

Figure 4: Intermodulations products with powers as measured in table 1

3 Intermodulation

The second channel of the signal generator was set to 77 MHz. The power of each signal as measured at the spectrum analyser was 0 dBm.

At an attenuation of 18 dBm ($P_{in} = -18$ dBm), the intermodulation products visible in fig. 4 were measured. The powers in the IMPs were as follows:

Frequency MHz	Power MHz	IMP Order
77	7.67	-
81	-23.9	3
85	-30.4	5
89	-41.3	7

Table 1: Frequencies and powers of signals and intermodulation products.

4 Third Order Intercept Point

The third order intercept point was calculated using the below data. The procedure followed was to increase the input power in steps of 1 dB until the change in power in the third order intermodulation products was recorded as 3 dB. As is shown in the table, I went beyond this point to make sure it had been reached; in other words, I wanted to make sure that at the point where I measured that the slope $\frac{P_{out}}{P_{in}}$ was 1 and the slope $\frac{P_d}{P_{in}}$ was 3.

With regard to precautions, I performed the measurements with the amplifier in its linear region in order that the output not be distorted by harmonics.

P_{in} dBm	P_{out} dBm	P_d dBm	ΔP_d dBm
-23	-0.02	-51.9	-
-22	0.95	-48.9	3
-21	1.95	-45.5	3.4
-20	2.90	-42.1	3.4

$$
\begin{aligned}
P_{IIP3} &= P_{in} + \frac{1}{2}\left(P_{out} - P_d\right) \\
&= -22 + \frac{1}{2}\left(0.95 - (-48.9)\right) \\
&\cong 26.93\,\mathrm{dBm} \\
P_{OIP3} &= P_{IIP3} + 22.35 \\
&= 49.28\,\mathrm{dBm}
\end{aligned}
$$

The measured value of 49.28 dBm and the data sheet value of 48.64 dBm differ by 0.64 dB. The difference here could be due to variations in manufacturing and inaccuracy in measurement.