Note VCC & Temperature tests

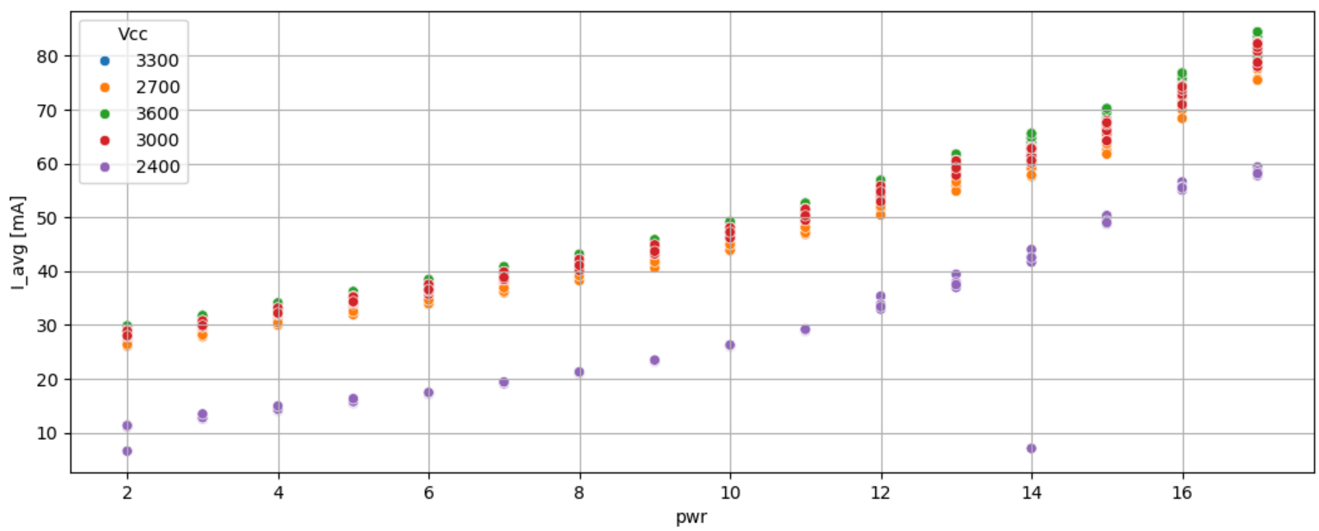
Reasoning

The documentation suggested along with a paper that a gain in efficiency could be obtained for by decreasing the supply voltage. What we have noticed is the supply current draw remains somewhat constant for different Tx states. in [Power consumption measurements for RFM96.](), the output power was unaltered by selection of VCC. Likewise the datasheet [Page 16] states:

Symbol	Describtion	Condition	Typ	unit
ΔRF_T	RF output power stability versus supply voltage	VDD = 2.4V to 3.7V	+/- 1	dB
VDDop	Supply voltage	upto 17dBm output	1.8V-3.7V	V
VDDop_20dBm	Supply voltage at 20 dBm	20 dBm	2.4-3.7	V

Level shifter reasoning.

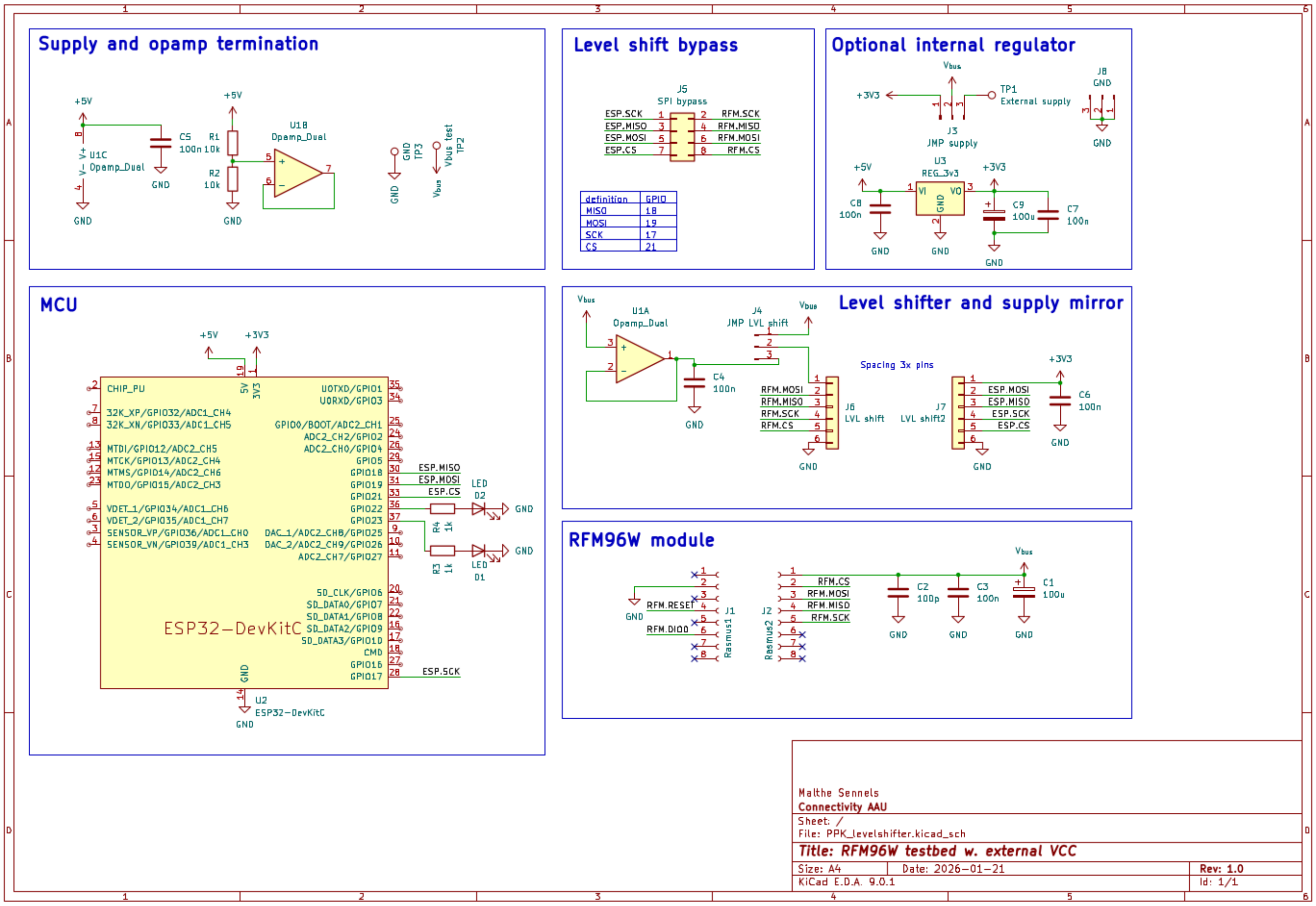
The following were used: BSS138 on breakout: https://www.adafruit.com/product/757?gQT=1. What is interesting is the level shifter will potentially result in a measurment error upto $4 \cdot 0.33mA = 1.32mA$. Initially the following where found:



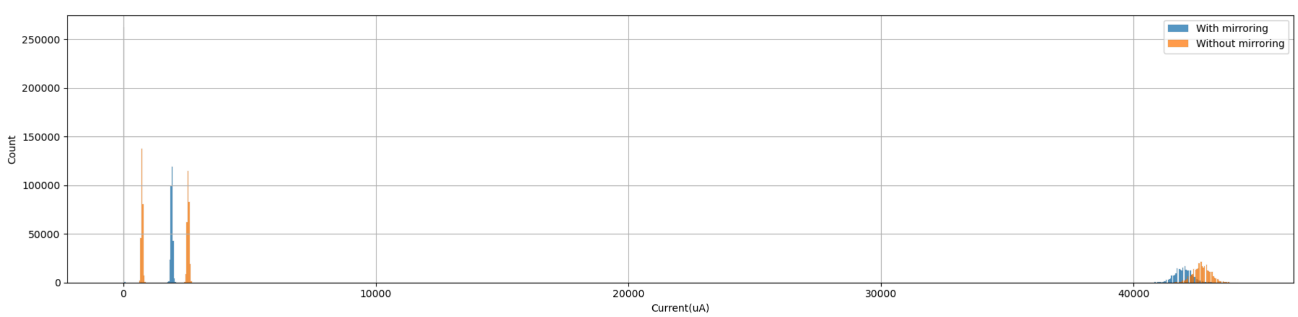
This test was done without level shifters (that is not recommended), what is weird is the 'sudden' drop at 2.4V, it is suspected that it comes from SPI line beginning to power the chip via the ESD diodes.

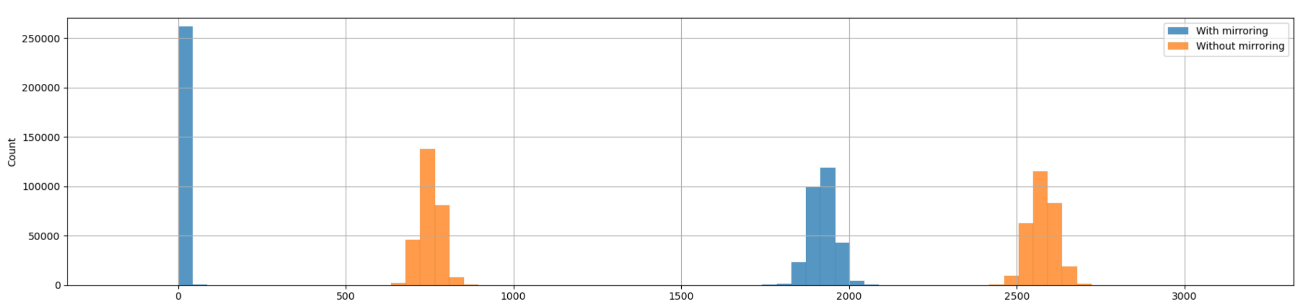
Testbed for VCC tests

To accomodate tests with varying vcc the following design have been derived:



The opamp is supplied to mirror the voltage for the testbench to a void a measurement error at $1.2mA$ depending on chosen vcc

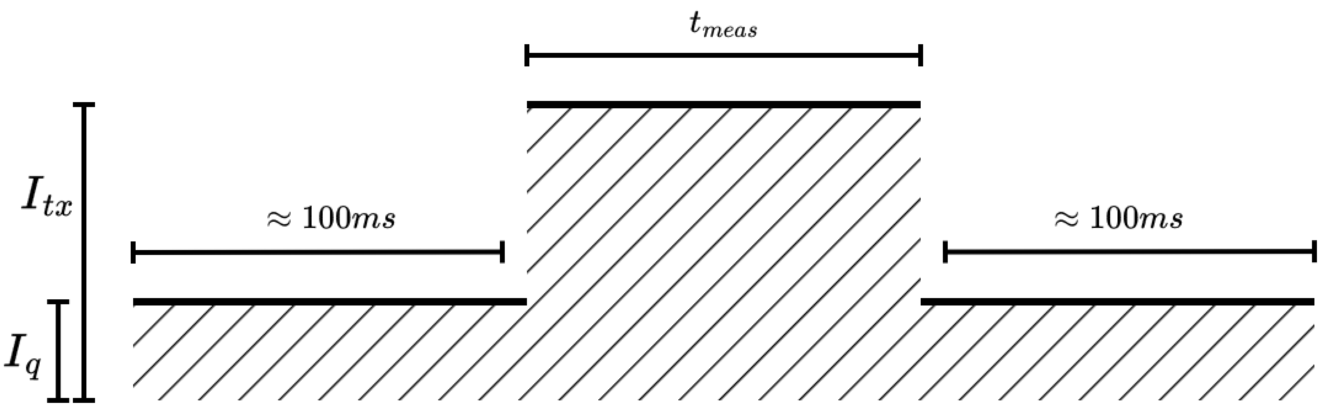




In the figures above, the RFM have been cycled through, `sleep`, `standby` and `tx states`. The blue illustrates the opamp as the supply for the level shift hardware. orange is without this equipment, where the PPK2 supplies the level shifter. The distributions appear to be shifted at approx the 0.7mA.

Testplan

Interesting is the current consumption standby and transmission modes, to accommodate this the new test-bench script splits the measured current into groups of the transceiver in tx state and in standby state.
All test have been conducted with 50 ohm as termination ("MCL ANNE-50 1 334").



data is supplied as the following pandas dataframes:

```
results = {
"vcc": [],     #supply voltage at test time expected to vary +-50mV [mV]
"sf": [],      #spreading factor
"bw": [],      #bandwidh [kHz]
"pwr": [],     #tx power in [dBm]
"cr": [],      #code rate 4/x
"t_est": [],   #estimated time on air [ms]
"t_meas": [], #measured time in high draw state [ms]
"i_q": [],     #current draw outside tx [mA]
"i_tx": []     #current draw in [mA]
}
```

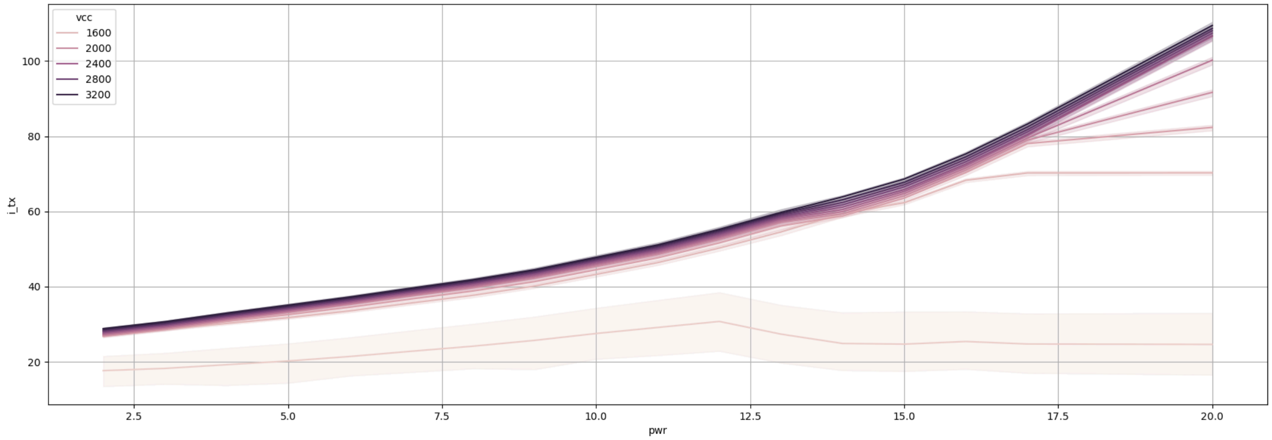
And the following paramters are tested:

```
spreading_factor = [6, 7, 8, 9, 10, 11, 12]
bandwidth = [125, 250, 500]
tx_power = [2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,20]
code_rate = [5]
```

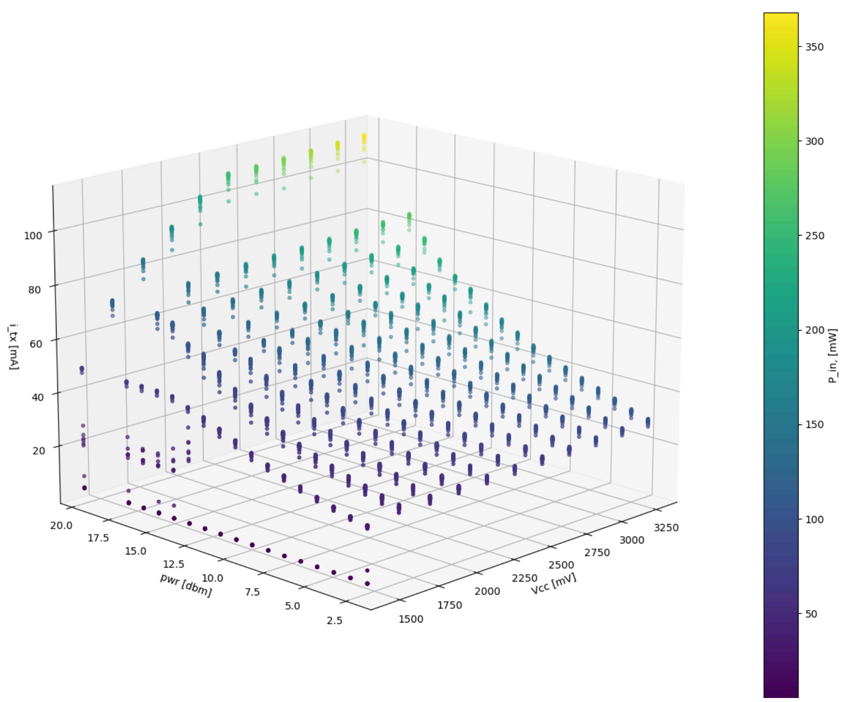
Results:

Vcc results

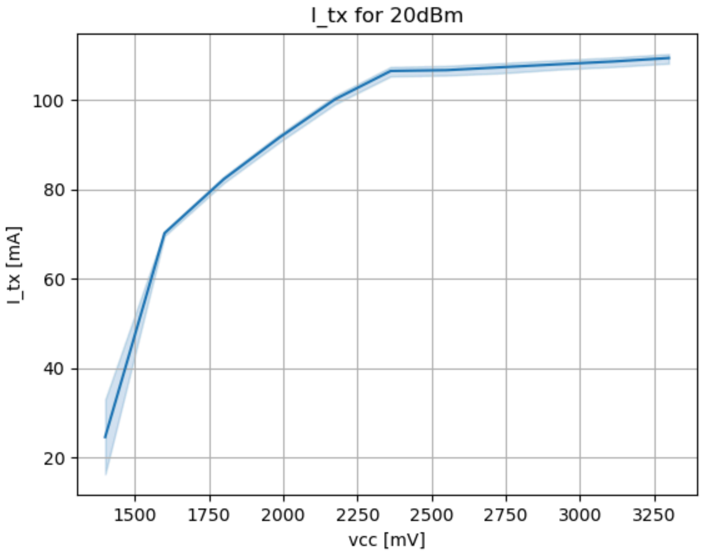
Not all lines have been plotted, but this is is the tendency illustrated.



And same data but in a 3D plot, the color is ($P_{tx} = I_{tx} \cdot V_{cc}$).



The 20dBm line plotted against supply voltage.



And we see the drop as expected around 2.4V

Raw measurements can be found here: https://github.com/Maltheren/CNT_antenna_meas_pt2

Temperature variance

The temperature was evaluated.

Discussion

As seen by the 3D-graph, is that some variance for I_{tx} happens within each *power* and *vcc* setting... wether or not this variance is sourced from individual parameters (SF,BW,CR) is further discussion. The purpose of this discussion is to investigate if a difference in vcc really can determine the I_{tx}. [TBC]