1 QubeCL Noise Measurement Setup

1.1 introduction

The QubeCL current noise is so low that it needs a specific setup to be measured. The goal is to be able to measure noise spectral densities on the order of $100pA/\sqrt{Hz}$, to do this we must use an amplification stage that does not degrade the quality of the input signal, for this purpose the following measurement setup was used.

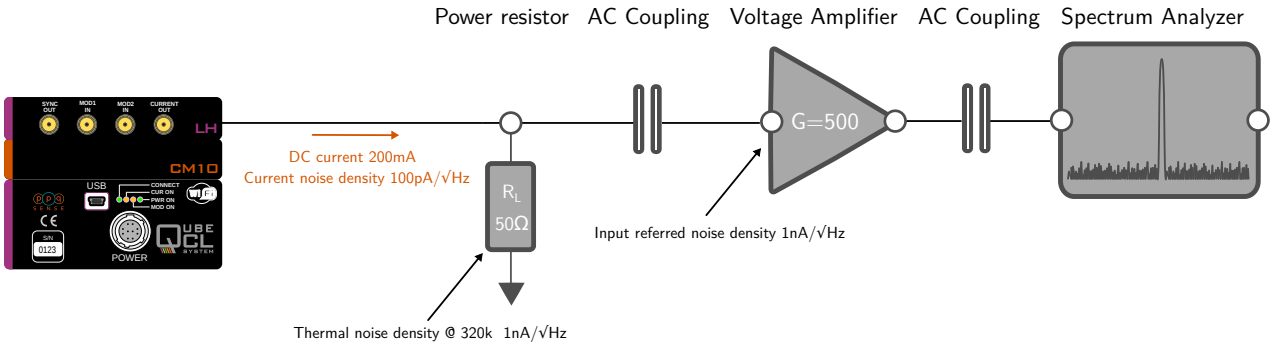

Figure 1: Current noise measurement setup

A current of $200mA$ is supplied to a 50 Ω resistor, and noise is AC-coupled to a voltage amplifier with gain $G = 500$. The thermal noise of the resistor and the input noise of the amplifier stage do not substantially degrade the measurement. The current noise is amplified for a total transimpedance gain of 25000 given by $G \cdot R_L$ without appreciable alteration, so it can be easily measured with a common spectrum analyzer.

1.2 Current Noise Power Spectral Density (CNPSD) calculation

Typically the measurement taken on a spectrum analyzer is given in dBm units, to switch to $nA/\sqrt{Hz}$ representation the following relationships are used:

The noise power expressed in dBm is defined as:

$$Pnoise[dBm] = 10 \cdot \log(\frac{Vnoise^2}{50\Omega} \cdot 1000 \cdot RBW)$$

$Vnoise$ is the noise level at the input of the spectrum analyzer expressed in Volts, RBW is the resolution bandwidth of the measurement expressed in Hz.
The expression of $Vnoise$ is:

$$Vnoise = \frac{Inoise}{10^9} \cdot G \cdot R_L$$

$Inoise$ is the current noise expressed in nA, G is the gain of the voltage amplifier, R_L the value of the load resistor expressed in Ω.

Using these relationships, we obtain the expression of current noise spectral density expressed in $nA/\sqrt{Hz}$ as:

$$Inoise[\frac{nA}{\sqrt{Hz}}] = (10^{\frac{Pnoise}{10}} \cdot \frac{1}{RBW} \cdot \frac{50}{1000})^{\frac{1}{2}} \cdot \frac{1}{G \cdot R_L} \cdot 10^9$$

$Pnoise$ is the Power noise expressed in dBm.
This relationship is used to obtain the spectral noise density plot presented in the QubeCL datasheet from measurements taken with the spectrum analyzer.

1.3 Final consideration

In order to obtain a good noise measurement, it is necessary for all components of the setup to be wired properly. Shielding and good dissipation of load resistance R_L is recommended. The power supply for the entire system must be highly filtered; batteries can also be used as an alternative.