5G DAC Requirements

5G Standards will be based on scalable platform which supports various radio air interfaces. The scalability will be in multiple dimensions, such as bandwidth, power consumptions, latency, efficiency, and etc.

This implies scalable requirements mixed signal converters in terms of sampling frequency, oversampling ratio, effective number of bits, image rejection, bandwidth, and etc.

This document walks through single scenario and shows detail in how to scale the requirement for a different radio air interface. Readers are encouraged to send their questions to the author, Shafie@ieee.org, and I will be more than happy to address them.

• 5G DAC output signal

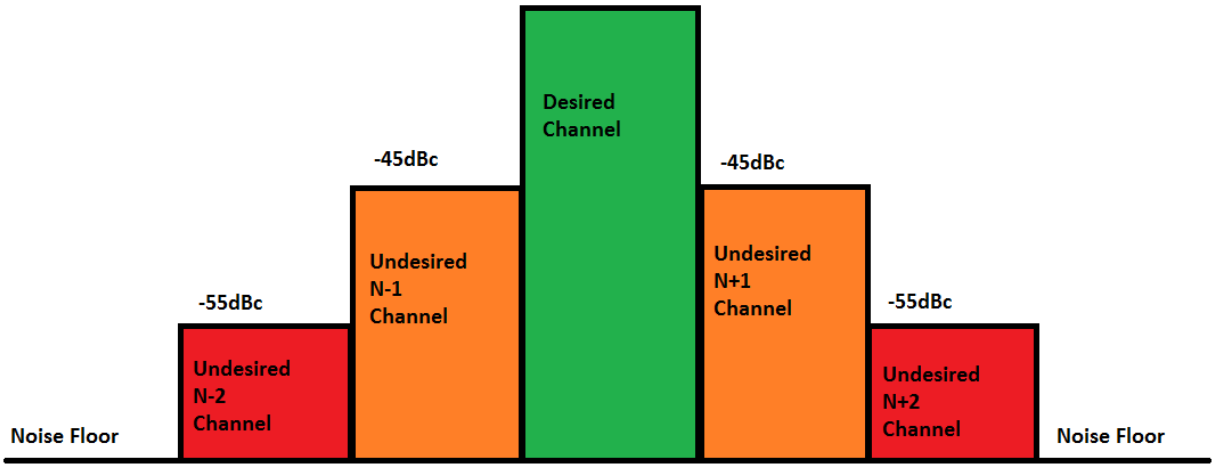

Figure 1: 5G DAC output signal spectrum mask

- dBc is referred to U/D
- The spectrum is noise like – power density is uniform over the channel
- Channel bandwidth is the same for both D and U
- Required $E_b/n_o \geq 25$dB for a Gaussian noise 64-QAM with 7/8 code rate

Where, D and U stands for desired and undesired, respectively.

5G DAC Requirements

The DAC has to provide sufficient dynamic range to account for required SNR, adjacent channels, and PAR.

$$1) \quad DR_{dB} \geq SNR_{req} + \left(\frac{U}{D}\right)_{N\pm 2} + PAR$$

$$2) \quad DR_{dB} \geq 25dB + 55dB + 13dB = 93dB$$

As a result, the required DAC can be calculated as,

$$3) \quad ENOB \geq \frac{DR_{dB} - OSR_{dB}}{6.02}$$

Where, OSR stands for over-sampling-ratio.

Assuming 400MHz clock/sampling frequency (sampling) for the DAC, the OSR can be calculated as;

$$4) \quad OSR_{5G} = 10 \cdot \log_{10}\left(\frac{\frac{f_s}{2}}{CHBW}\right) = 10 \cdot \log_{10}\left(\frac{\frac{400}{2}}{10}\right) = 13dB$$

$$5) \quad ENOB_{5G} \geq \frac{93dB - 13}{6.02} = 13.28$$

For the above assumptions, the required number of DAC bits would be 14bit.

Observations:

1. Parameters that impact the above computation are PAR, SNR, U/D, CHBW, OSR, and Margin. Matlab or spreadsheet can be created to do similar calculations for various input parameters of interest.
2. The DAC MSB can be turned off to scale back the required power consumptions.
3. By turning of DAC LSB and/or MSB the dynamic range of DAC can be controlled, depending on the required noise floor and/or maximum power handling.