ADC Noise Figure Calculation

The noise figure of the selected ADC (AD7665) was calculated using its full scale power and SNR using the equation:

$$NF_{ADC} = P_{FS}(dBm) + 174dBm - SNR - 10\log\left(\frac{\frac{f_s}{2}}{B}\right) - 10\log B$$

where P_{FS} is the full scale power of the ADC, f_s is the signal sampling frequency and B is the noise bandwidth (which is equal to the signal bandwidth).

Given the bit rate, R of 20kbps, and with 8PSK employing 3 bits, the symbol rate, sr is calculated to be:

$$sr = \frac{R}{no.ofbits} = \frac{20 \times 10^3}{3} = 6.7ksps$$

To meet transmission requirements, the Nyquist sampling frequency, f_n is used and found to be:

$$f_n = 2 \times sr = 2 \times 6.7 = 13.34KHz$$

However, for improved modulation and demodulation, the signal is oversampled by a factor of 8 to give a new sampling rate, f_s of:

$$f_s = 8 \times f_n = 8 \times 13.34KHz = 106.72KSPS$$

The ADC bandwidth, B is equal to the Nyquist frequency, f_n while the a full scale peak-to-peak voltage, $Vp-p$ of 2.5V is chosen based on the selected ADC. The full power, P_{FS} is calculated from the full scale voltage thus:

$$P_{FS} = \frac{V_o^2}{2R} = \frac{1.25^2}{100} = 1.562 \times 10^{-2}W$$

and in dBm:

$$P_{FS}(dBm) = 10\log\left(1000 \times 1.562 \times 10^{-4}\right)$$

$$= -11.94dBm$$

where $V_o = \frac{V_{p-p}}{2}$ and R is the input impedance of the ADC taken to be 50Ω. Taking the SNR value of 90dB given in the ADC datasheet and the other calculated values above, the ADC noise figure is found to be:

$$NF_{ADC} = -11.94 + 174 - 90 - 10\log\left(\frac{\frac{106.72\times10^3}{2}}{13.34 \times 10^3}\right) - 10\log(13.34 \times 10^3)$$

$$= -11.94 + 174 - 90 - 6 - 41.25$$

$$= 48.69dB$$