Notes for ELEC4402 Project

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1 Noise PSD

$$N_0 = \frac{(V_{av})^2}{R} \tag{1}$$

Where N_0 is the power spectral density (PSD) of the noise signal in W/Hz and V_{av} is the average voltage of the *noise* signal in the frequency domain (use FFT). Note that V_{av} is measured using the `Wideband True RMS module`, it is not calculated.

2 Clock Signal

Display the clock signal to measure R_b. Do not rely on "eyeballing" 1 bit on the modulated signal. The clock signal may be weak, so if this is the case, use the `ADDER` module to amplify the signal.

The master clock is 8.333kHz, however, the bit clock is 2kHz, since

$$R_b = \frac{MCLK}{4} \tag{2}$$

3 BER Calculations

$$BER = \frac{N_e}{N_t} \tag{3}$$

Where BER is the bit error rate, N_e is the number of erroneous bits and N_b is the total number of bits transmitted.

$$\frac{E_b}{N_0} = \left(\frac{V_{av,s}}{V_{av,n,f}}\right)^2 T_b \tag{4}$$

Where $\frac{E_b}{N_0}$ is the signal to noise ratio (SNR), $V_{av,s}$ is the average voltage of the signal, $V_{av,n,f}$ is the average voltage of the noise signal in the frequency domain and T_b is the time period for each bit.

Note that the graph used is log-normal. Example calculation:

$$BER = \log_{10}\left(\frac{538}{2000}\right) \tag{5}$$

$$\frac{E_n}{N_0}\ \text{dB} = 10\log_{10} \tag{6}$$

4 Signal Constellation

The signal constellation gives information on the symbol distance d which in turn gives information on the bit error rate.

$$BER = Q\left(\sqrt{\frac{d}{\cdots}}\right) \tag{7}$$

As d decreases in eqn. (7), BER will increase.

5 Troubleshooting

- Reset the `Line Decoder` each time a new clock is given.
- Use a local signal generator to avoid propagation delay.
- Use the `Phase Shifter` module $\phi = \pm 180°$ if the signal is out of sync.
- Use the output of the `Error Counting Utilities` to reset the signal generator if message signal and demodulated signal are not in sync.

6 Common Lab Test Questions

1. Sketch the (provided) modulated signal
2. Demodulate the signal and sketch its spectra and temporal waveform
3. Theory question on performance
4. Identify which line encoding method was used
5. Sketch block diagram of demodulator

7 Miscellaneous Notes for Future Labs

- Know which input/output of which module corresponds to the message, modulating, carrier and modulated signals.
- Know the demodulator circuit well since this will be the one used in the test (you will not be modulating your own signal).