FSK - ENVELOPE DEMODULATION

modules

basic: UTILITIES, TUNEABLE LPF

basic: **generation**: ADDER, AUDIO OSCILLATOR, DUAL ANALOG SWITCH, SEQUENCE GENERATOR, VCO.

advanced: BIT CLOCK REGEN

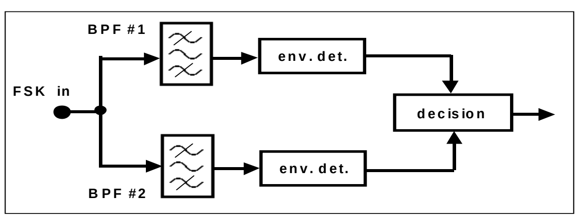
optional extra: TUNEABLE LPF, UTILITIES, VCO

preparation

In this experiment an asynchronous demodulator will be examined. This is based on the observation that the FSK signal looks like the sum of two amplitude shift (ASK - or strictly on-off keying - OOK) signals. These can be separated by bandpass filters, and then each filter output envelope demodulated.

The Lab Sheet entitled ***FSK - PLL demodulation*** describes demodulation with a phase locked loop (PLL). That is a synchronous method.

A block diagram for an asynchronous demodulator is shown in Figure 1.



Two tuneable bandpass filters, suitable for modelling this demodulator, are available in the BIT CLOCK REGEN module (from the TIMS set of advanced modules).

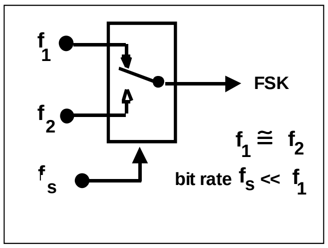
Figure 1: demodulation by conversion-to-ASK

Note that the *space* output is an inverted version of the *mark* output. Thus the output of either envelope detector alone would be sufficient to recover the message sequence. Being a bandlimited signal each would need to be regenerated to a clean TTL waveform. This will be done with a comparator. TIMS has a much more sophisticated module for this purpose - the DECISION MAKER - which is used in other experiments.

Having both space and mark signals allows some logic to be performed in order to improve the bit error rate (BER) compared with using either *space* or *mark* outputs alone. This will not be investigated in the current experiment. Sufficient to demonstrate that the message sequence has been recovered by visual comparison. This is especially easy, since there has been no added noise.

experiment

To generate the incoming FSK a suitable transmitter is described in the Lab Sheet entitled ***FSK - generation***. Figure 2 shows a block diagram, and the TIMS model.



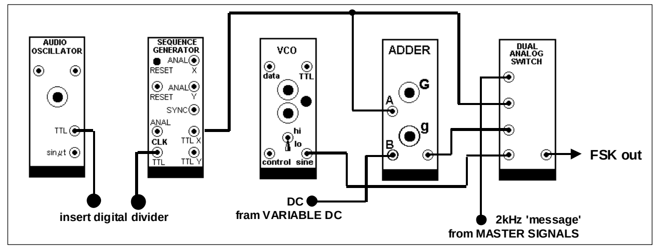
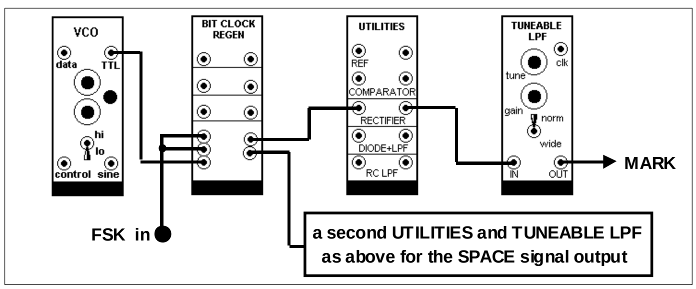


Figure 2: source of the FSK signal for this experiment

The signal f_s represents the message, a binary data stream, realized with a SEQUENCE GENERATOR. Consider the restrictions placed upon this rate.



The demodulator of Figure 1 is shown modelled in Figure 3.

Refer to the ***TIMS User Manual*** for details of the BIT CLOCK REGEN module. Two of its sub-systems are to be used.

Figure 3: the asynchronous demodulator model.

The BIT CLOCK REGEN module has a pair of bandpass filters (BPF1 & 2). Specifically, for this experiment, the onboard switch SW1-1 is switched ON (toggle UP), and SW1-2 OFF (toggle DOWN). This tunes BPF1 to 2.083 kHz, while BPF2 is controlled by a TTL clock into the EXT CLK socket (from the VCO). The centre of BPF2 will be tuned to $1/50^{th}$ of the external clock frequency.

The BIT CLOCK REGEN module also has a DIGITAL DIVIDER. This is used to lower the rate of the bit clock (AUDIO OSCILLATOR).

If you do not have two UTILITIES and TUNEABLE LPF modules the second envelope detector could be omitted. The *principles* of the model can be demonstrated without these.

The bandlimited signal from the TUNEABLE LPF can be ‘squared up’ by using the COMPARATOR in the UTILITIES module.

With one of f_1 and f_2 (at the transmitter) being pre-determined (2.083 kHz) by the available BPF (in the receiver), the other will be close by. The bandwidths of BPF1 and BPF2 place an upper limit on the data rate; hence the DIGITAL DIVIDER in the bit clock path to the SEQUENCE GENERATOR. Once these are determined then the bandwidth of the envelope detector LPF can be chosen. These limits can be calculated, or determined by experiment.

A slow clock rate does make conventional oscilloscope viewing somewhat tedious.

optional modules: to *demonstrate* the demodulation process it is not necessary to model both envelope detectors. In practice both would be required, since, under noisy conditions, their complementary outputs are combined to determine the optimum result.