EXPERIMENT 1:
Amplitude Shift Keying (ASK)

1) OBJECTIVE

Generation and demodulation of an amplitude shift keyed (ASK) signal

2) PRELIMINARY DISCUSSION

In ASK, the amplitude of a carrier signal is modified in a discrete manner depending on the value of a modulating symbol. On-Off Keying (OOK) is a particularly simple form of ASK that represents binary data as the presence or absence of a carrier. For example, the presence of a carrier over a bit duration may represent a binary "1" while its absence over a bit duration may represent a binary "0". Figure 1 illustrates a binary ASK signal (lower), together with the modulating binary sequence (upper).

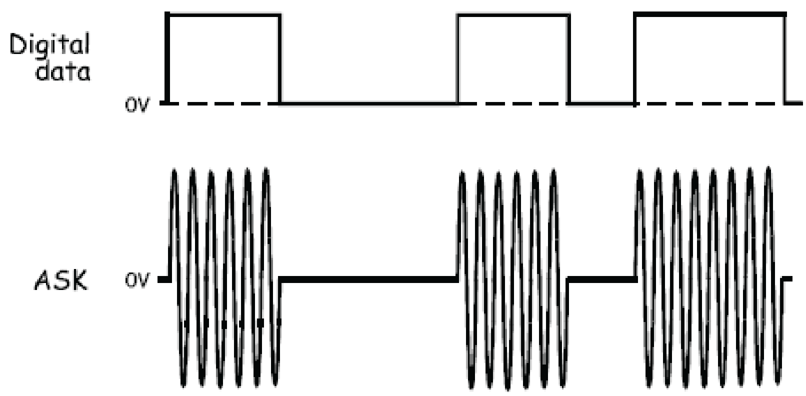

Figure 1: an ASK signal (below) and the message (above)

Notice that the ASK signal's upper and lower limits (the envelopes) are the same shape as the data stream (though the lower envelope is inverted). Thus, recovery of the data stream can be implemented using a simple envelope detector. However, noise on the channel can change the envelopes' shape enough for the receiver to interpret the logic levels incorrectly causing errors.

3) LAB WORK

In this experiment you'll use the Emona Telecoms-Trainer 101 to generate an ASK signal using the switching method. Digital data for the message is modelled by the Sequence Generator module. You'll then recover the data using a simple envelope detector and observe its distortion. Finally, you'll use a comparator to restore the data.

Equipment

- Emona Telecoms-Trainer 101 (plus power-pack)
- Dual channel 20MHz oscilloscope
- Three Emona Telecoms-Trainer 101 oscilloscope leads
- Assorted Emona Telecoms-Trainer 101 patch leads

Procedure

Part A - Generating an ASK signal

1. Set the scope's Channel 1 and Channel 2 *Input Coupling* controls to the DC position.
2. Set the scope's *Timebase* control to the *1ms/div* position.
3. Connect the set-up shown in Figure 2 below.
4. Set the scope's Mode control to the DUAL position to view the Sequence Generator module's output and the ASK signal out of the Dual Analog Switch module.
5. Compare the signals.

Note: Insert the black plugs of the oscilloscope leads into a ground (GND) socket.

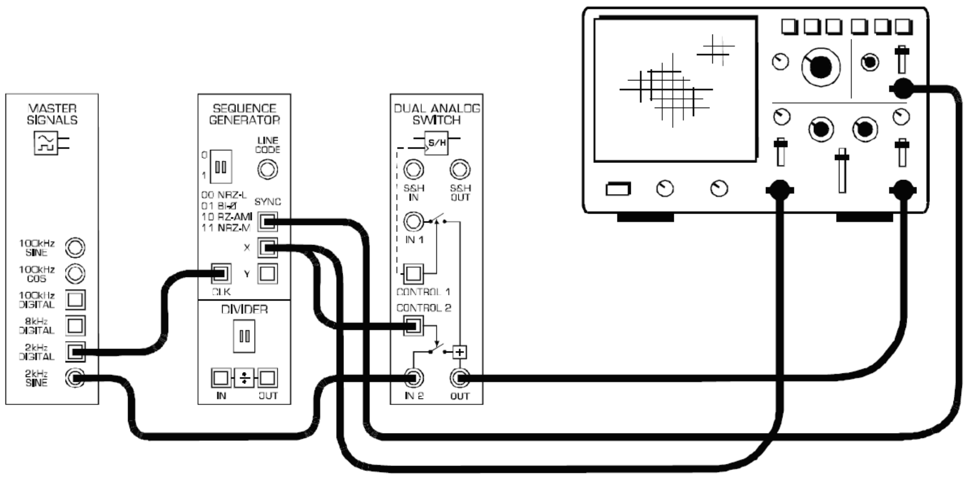

Figure 2: the set-up for an ASK signal generation

The set-up in Figure 2 can be represented by the block diagram in Figure 3 below. The Sequence Generator module is used to model a digital signal and its SYNC output is used to trigger the scope to provide a stable display. The Dual Analog Switch module is used to generate the ASK signal.

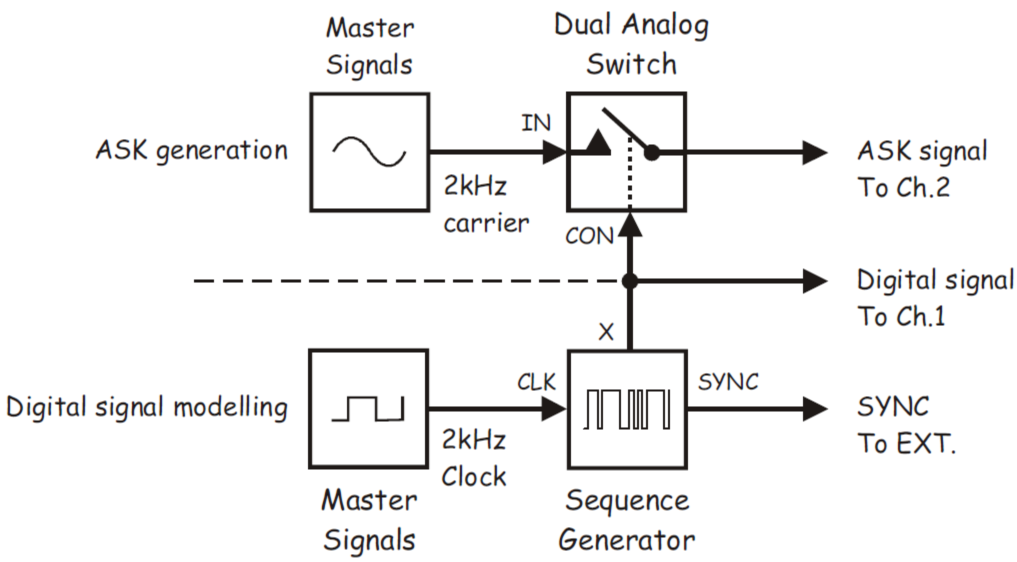

Figure 3: block diagram of Figure 2

Question 1
What is the relationship between the digital signal and the presence of the carrier in the ASK signal?

Question 2
What is the ASK signal's voltage when the digital signal is logic-0? **Tip:** If you're not sure, briefly set the Channel 2 Input Coupling control to the GND position.

Notice that the ASK signal's carrier and the Sequence Generator module's clock are the same frequency (2 kHz). Moreover, notice that they're from the same source - the Master Signals module. This has been done to make the ASK signal easy to look at on the scope. However, it makes the set-up impractical as a real ASK communications system because the carrier and the data signal's fundamental are too close together in frequency. This makes recovering the digital data at the receiver difficult if not impossible.

Ideally, the carrier frequency should be much higher than the bit-rate of the digital signal (which is determined by the Sequence Generator module's clock frequency in this set-up). The next part of the experiment gets you to set the carrier to a more appropriate frequency (about 100 kHz). In the process, the Dual Analog Switch module's output will look more like a conventional ASK signal.

1. Locate the VCO module and set its Frequency Adjust control to about the middle of its travel.
2. Set the VCO module's Range control to the HI position.
3. Modify the set-up as shown in Figure 4 below.

Remember: Dotted lines show leads already in place.

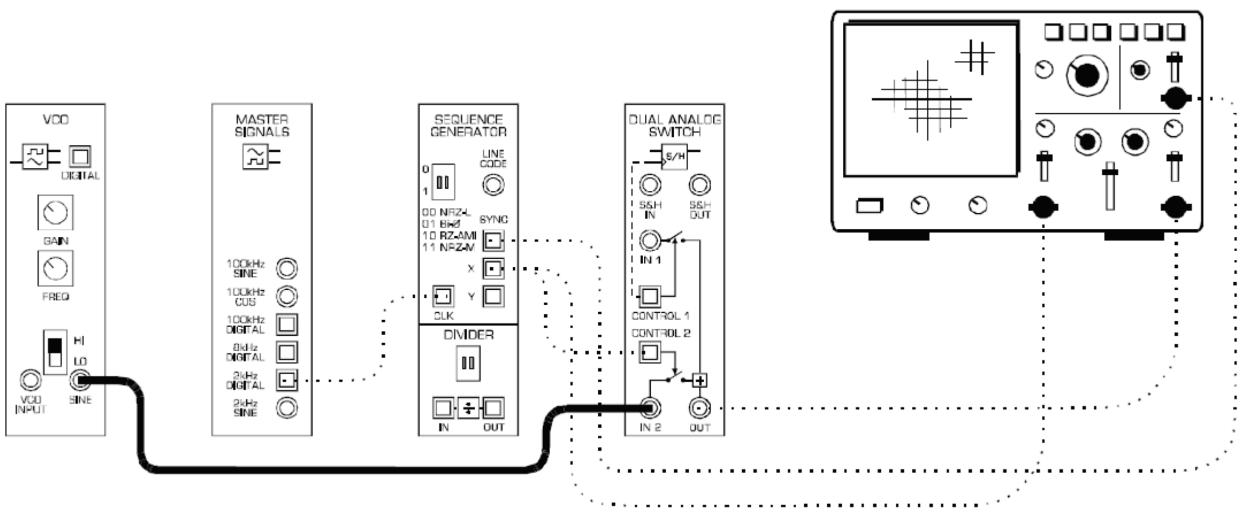

Figure 4: the set-up for a practical ASK signal generation

The set-up in Figure 4 can be represented by the block diagram in Figure 5 below.

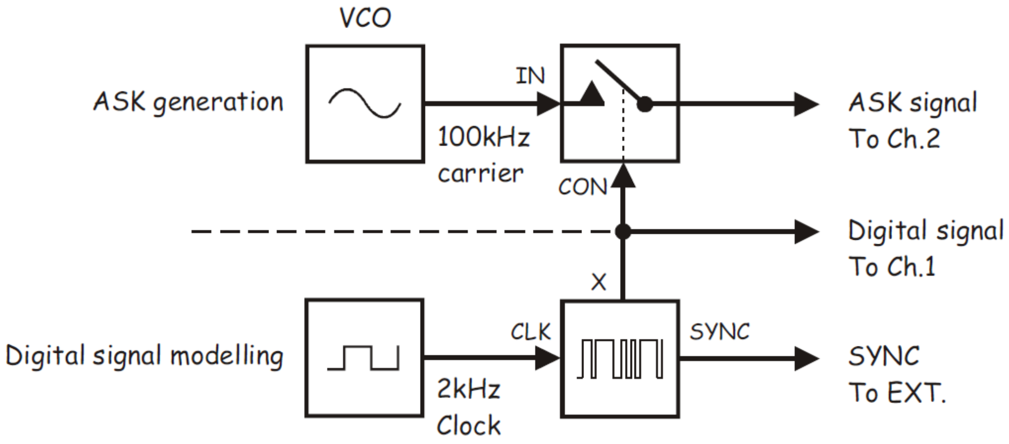

Figure 5: block diagram of Figure 4

1. Compare the signals.
2. Use the scope's Channel 1 Vertical Position control to overlay the digital signal with the ASK signal's envelopes and compare them.

Question 3
What feature of the ASK signal suggests that it's an AM signal?

Part B - Demodulating an ASK signal using an envelope detector
As ASK is really just AM (with a digital message), it can be recovered using any of AM demodulation schemes. The next part of the experiment lets you do so using an envelope detector.

1. Locate the Tunable Low-pass Filter module and turn its Gain control fully clockwise.
2. Turn the Tunable Low-pass Filter module's Cut-off Frequency Adjust control fully clockwise.
3. Modify the set-up as shown in Figure 6 below.

Note: The left most modules have been left off to fit the drawing on the page.

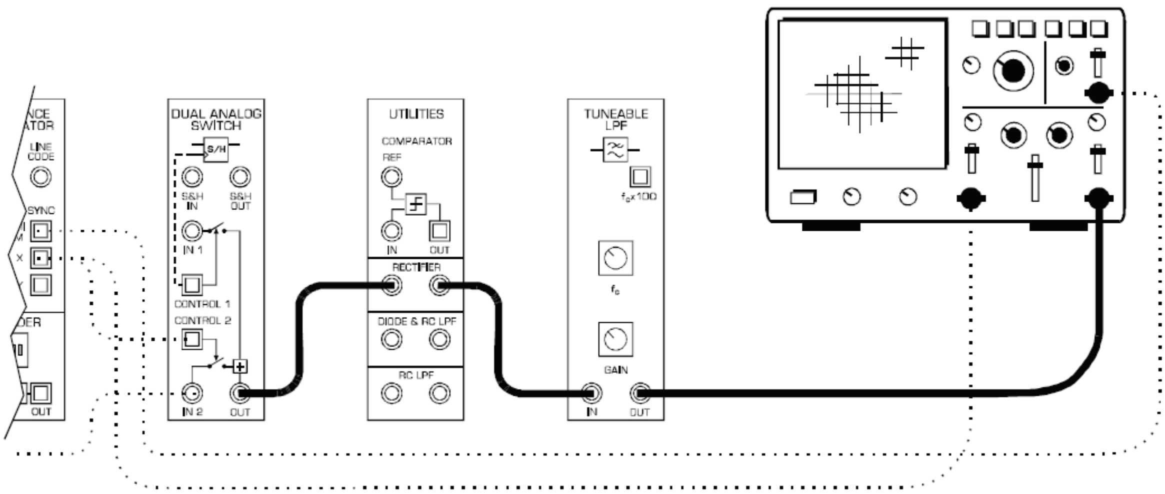

Figure 6: the set-up for an ASK demodulation

The ASK generation and demodulation parts of the set-up can be represented by the block diagram in Figure 7. The rectifier on the Utilities module and the Tunable Low-pass filter module are used to implement an envelope detector to recover the digital data from the ASK signal.

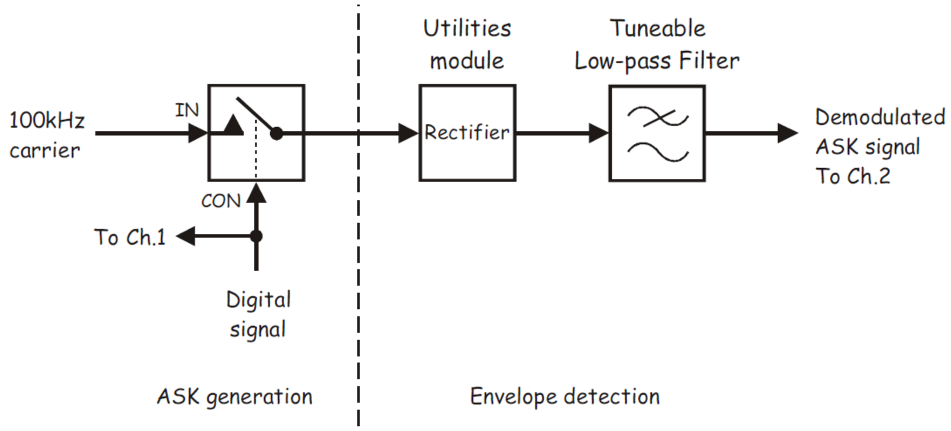

Figure 7: an ASK generation and demodulation

1. Compare the original and recovered digital signals.

Question 4
Why is the recovered digital signal not a perfect copy of the original?

Question 5
What can be used to "clean-up" the recovered digital signal?

Part C - Restoring the recovered digital signal using a comparator

The next part of the experiment lets you use a comparator to clean-up the demodulated ASK signal.

1. Modify the set-up as shown in Figure 8.

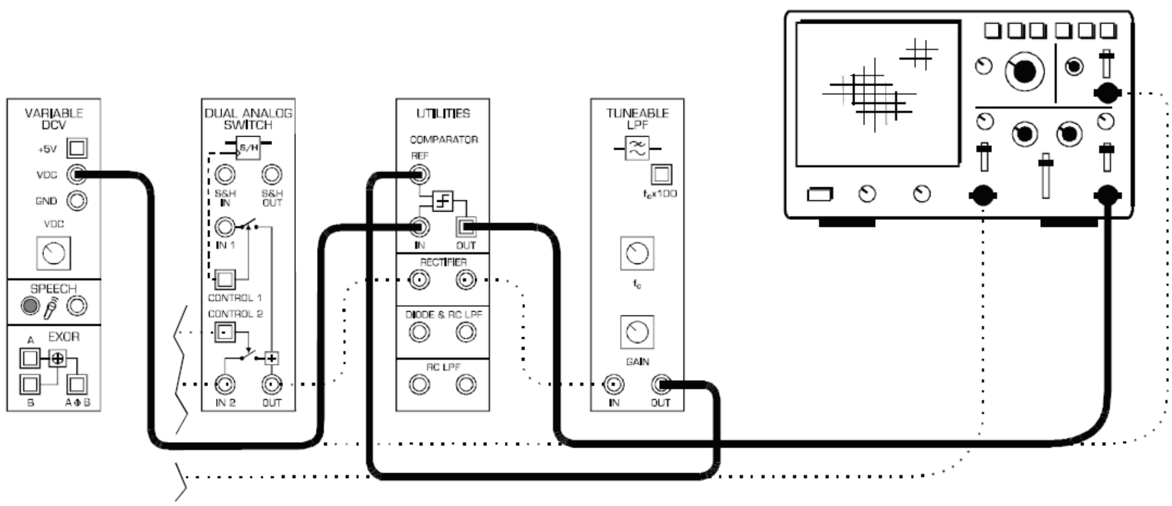

Figure 8: the set-up for a digital signal restoration

The ASK generation, demodulation and digital signal restoration parts of the set-up can be represented by the block diagram in Figure 9 below.

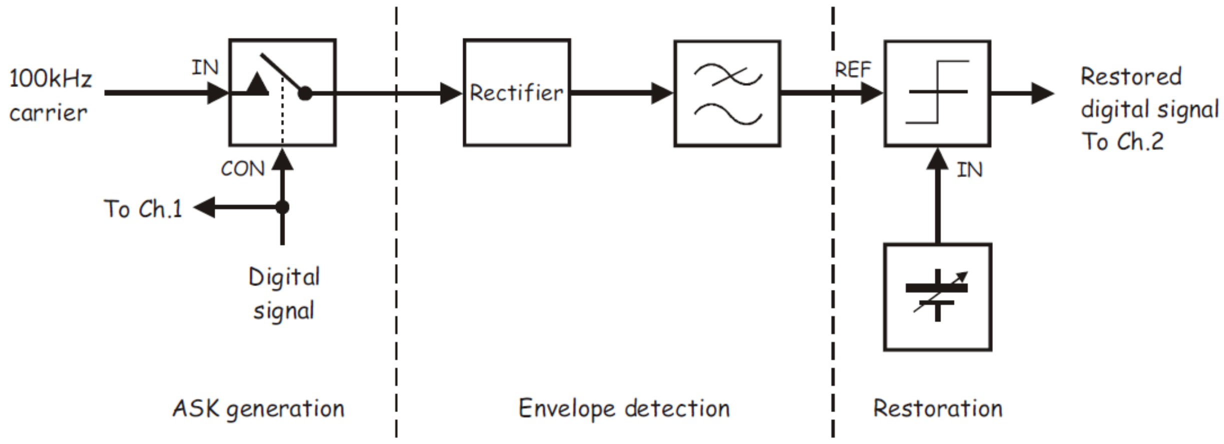

Figure 9: an ASK generation, demodulation, and digital signal restoration

1. Set the Variable DCV module's Variable DC control to about the middle of its travel.
2. Compare the signals. If they're not the same, vary the Variable DCV module's Variable DC control until they are.

Question 6
How does the comparator turn the slow rising voltages of the recovered digital signal into sharp transitions?