

DELTA-SIGMA MODULATION

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DELTA-SIGMA MODULATION

ACHIEVEMENTS: introduction to an important variation of the basic delta modulator (as used in compact disc players).

PREREQUISITES: completion of the experiments entitled *Delta modulation* and *Delta demodulation* in this Volume.

ADVANCED MODULES: DELTA MODULATION UTILITIES, DELTA DEMOD UTILITIES

PREPARATION

It is assumed that you have been introduced to the principles of delta-sigma modulation in your course work, and have completed the experiment entitled *Delta modulation*.

Delta-sigma modulation¹ is an apparently simple variation of the basic delta modulation arrangement. Whilst it is easy to describe the variation (by way of the block diagram, for example), the implications of the change are not necessarily transparently obvious. You should refer to your course work, which presumably will have treated the theory at an appropriate level. Suffice to say that the delta-sigma modulator and demodulator combination finds application in the compact disk digital record player, where its properties are exploited to the full.

The nature of the variation can be seen by first reminding yourself of the configuration of the basic delta modulator, shown in block diagram form in Figure 1.

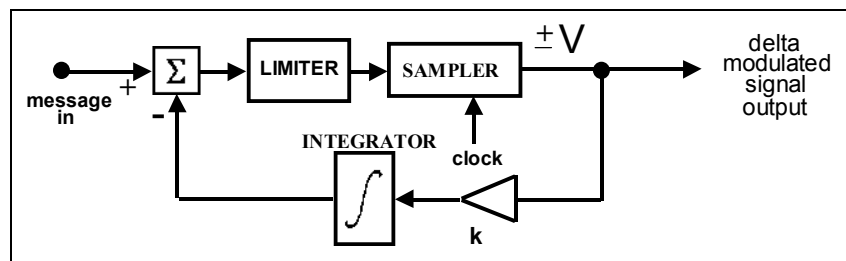


Figure 1: basic delta modulator

¹ also called sigma-delta modulation

The delta-sigma modulator places an integrator between the message source and the summer of the basic delta modulator.

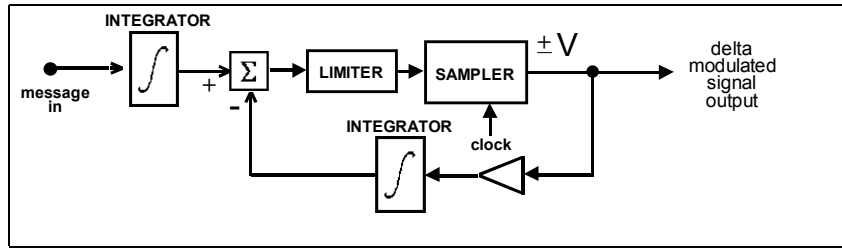


Figure 2: the delta-sigma modulator

The two integrators at each *input* to the linear summer can be replaced by a single integrator at the summer *output*. This simplified arrangement is shown in Figure 3.

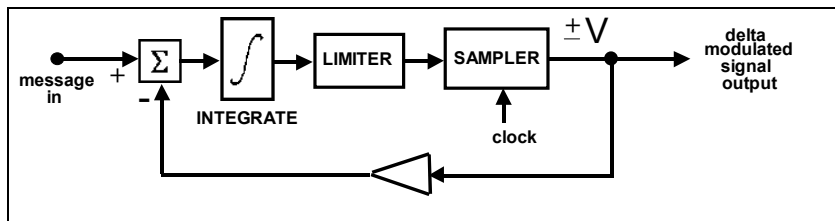


Figure 3: the delta-sigma modulator simplified

The integrator introduced at the input to the summer obviates the need for an integrator in the demodulator. Thus the demodulator can be a simple lowpass filter.

EXPERIMENT

A model of the delta-sigma modulator block diagram of Figure 3 is shown in Figure 4.

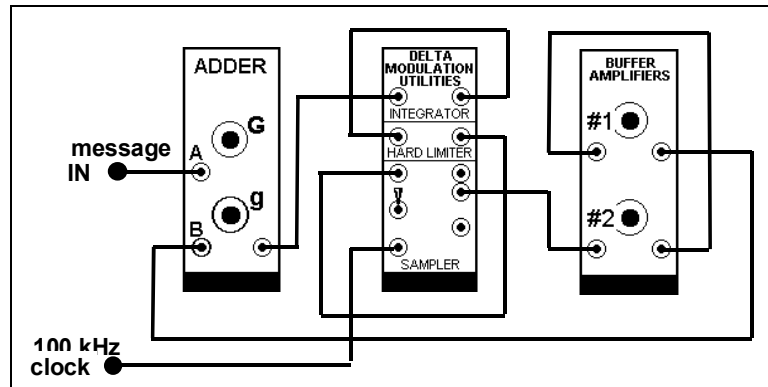


Figure 4: the delta-sigma modulator model

- T1* before plugging in the DELTA MODULATOR UTILITIES module decide upon the integrator time constant, then set it with switches SW2A and SW2B. See Appendix A of this experiment.
- T2* adjust both ADDER gains to unity, and both BUFFER AMPLIFIER gains to unity. Throughout the experiment the gain g of the ADDER (acting as the SUMMER) will not be changed.
- T3* patch together the complete delta-sigma modulator according to Figure 4.

The familiar sawtooth waveform may be observed at the INTEGRATOR output.

You can now examine the behaviour of the modulator under various conditions, and with different messages, as was done for the basic delta modulator in an earlier experiment.

An important message to examine is one with a DC component.

- T4* use a lowpass filter as a demodulator.

Examine the demodulator performance as was done in the previous delta modulation experiments.

TUTORIAL QUESTIONS

Q1 describe how the delta-sigma modulator-demodulator arrangement is used to advantage in a compact disk (CD) player. This has not been explained in the introduction to the experiment, so you will need to refer to your course work or other sources.

APPENDIX A

The integrator time constant in the DELTA MODULATION UTILITIES module is controlled by the on-board switch SW.

Full details of this integrator may be found in the *Advanced Modules User Guide*. In summary it is composed of an R and C network.

The component subscripts refer to their circuit board designations. Thus the single, fixed capacitor is C2.

The resistor R of the network is made up of R11, R12, and R13.

Resistor R11 is permanently in place, but R12 and R13 can be added in parallel with the switches SW2-A and SW2-B respectively (when ON).

Component values are:

C2	47 nF
R11	5k6 ohms
R12	5k6 ohms
R13	1k5 ohms