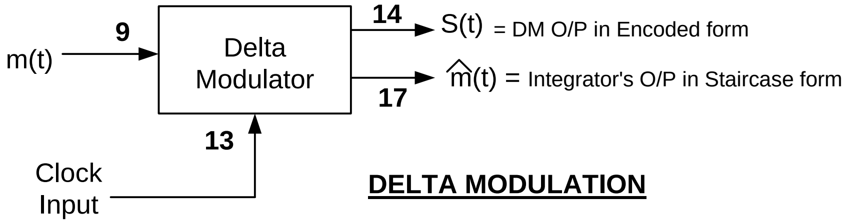
Delta Modulation

Object:- a) **Generate Delta modulated signal using the given Scientech kit model ST-2105.**
b) **Determine the conditions for slope-overloading.**
c) **Study the elimination of the slope-overloading by adjusting various parameters**.

APPARATUS USED:-

1. Scientech Delta Modulation Trainer kit Model ST-2105
2. 20 MHz Dual Channel Oscilloscope

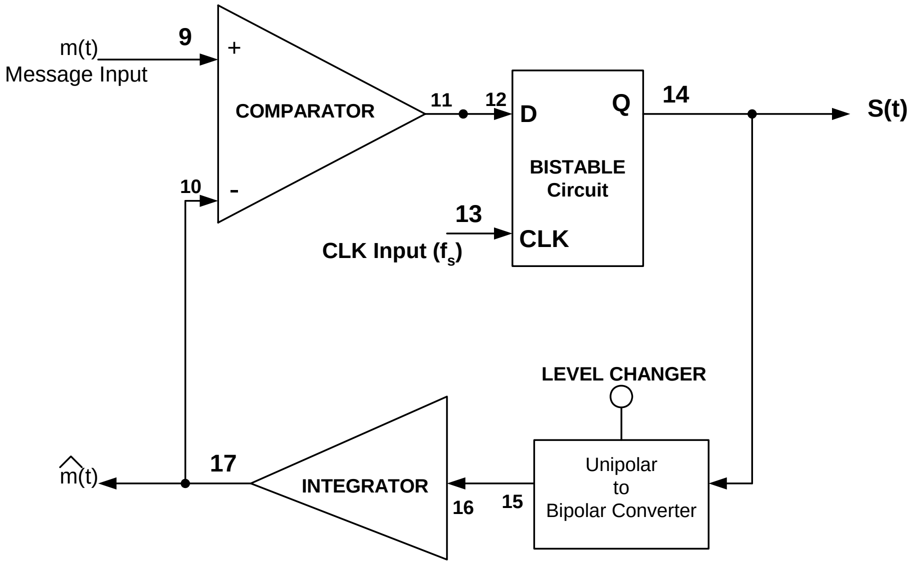


Schematic Diagram for Delta modulation:-

The following sections of the given kit are to be used for this experiment on Delta Modulation:-

1. Function Generator section providing sinusoidal signals (to be used as modulating signals) of adjustable amplitudes and of 250 Hz, 500 Hz, 1 KHz and 2 KHz frequencies.
2. CLOCK Generator section providing clocks of adjustable frequencies of 32 KHz, 64 KHz, 128 KHz and 256 KHz (to be used as a carrier of given sampling rates).
3. A COMPARATOR Circuit (in the Transmitter Part of the kit).
4. A BISTABLE Circuit (in the Transmitter Part of the kit) with "LEVEL CHANGER" control.
5. An INTEGRATOR Circuit (in the Transmitter Part of the kit) with adjustable gain control.
6. A Unipolar to Bipolar Converter section (in the Transmitter Part of the kit).

The above sections of the kit are to be inter-connected according to the following Schematic diagram:-



<u>PROCEDURE</u>:-

1. Adjust the Clock frequency (sampling rate) to 32 KHz (by setting the switches A = 0, B = 0).and connect it to socket number (13) in the "BISTABLE Circuit (in the Transmitter Part of the kit)".

2. Adjust the "Step size", by connecting 0-volt to the positive-input (9) of the COMPARATOR Circuit and monitor on an Oscilloscope, the output of Integrator 1 (t.p.17) and the output of the transmitter's LEVEL CHANGER (t.p15).

3. Ensure that integrator 1 block's switches are in following position:

(A) Gain control switch in left-hand position (towards switch A & B).

(B) Switches A & B in A=0 and B=0 positions, corresponding to the minimum gain.

4. Adjust the transmitter's LEVEL CHANGER preset until the output of INTEGRATOR 1 (t.p. 17) is a triangle wave centered around 0 Volts. The peak-to-peak amplitude of the triangle wave at the integrator's output should be 0.5V (approx), this amplitude is known as the **integrator STEP SIZE Δ**. The output from the Transmitter's BISTABLE Circuit (t.p. 14) will now be a stream of alternate '1' and '0', this is also the output of the delta modulator itself. The Delta Modulator is now said to be 'balanced' for correct operation.

5. Now remove the 0-volt from the positive-input (9) of the COMPARATOR Circuit and connect a Sine-wave (as a message signal) of 500 Hz (obtained from the Function Generator section) to the positive-input terminal (9) of the COMPARATOR Circuit.

6. Observe the **"Integrator's output" m(t)** at (17) on one channel of the CRO.

7. Adjust the "TRANSMITTER LEVEL ADJ Preset" (provided in the BISTABLE Circuit) in order to obtain a stable trace of "Integrator's output" m(t) at (17).

8. Now observe the sinusoidal message signal of 500 Hz connected at (9) of the Comparator on the other channel of the CRO, and after adjusting the CRO controls, observe that the "Integrator's output" m(t) at (17), is following the message signal m(t) on the CRO screen. This ensures the correct operation of Delta modulation; and the "**encoded Delta modulated signal S(t)**" is now available at the output of the BISTABLE Circuit at socket (14). View it on the CRO and observe that it is a stream of '1s' and '0s'.

9. Record all the parameters adjusted for this setting in your observations. This completes the first part (a) of this experiment.

Now proceed for taking **observations for slope-overloading** as required for **part (b)** of the experiment in the following way:-

1. Increase the frequency of the message signal m(t) by connecting a 1 KHz and then a 2 KHz sine-wave to the Comparator's input (one by one), and record the maximum frequency of the m(t) in your observations, at which the "Integrator's output" m(t) ceases to follow the message signal m(t)

on the CRO. The condition in which the "Integrator's output" is no longer following the message is called **"slope over-loading"**. This gives the first condition of slope over-loading.

2. Now restore the message frequency and start increasing the message amplitude, until you again observe the slope-overloading. Record the maximum message amplitude in your observations at which the slope-overloading is occurring, which is the **second condition** of slope-overloading.

Next, **for part (c)** of the experiment, proceed as follows:-

1. First observe the slope-overloading at the maximum message frequency (as already done in part b), then, increase the step-size Δ, by increasing the integrator's gain by setting the integrator switches A & B accordingly, and observe that, at what setting of integrator's gain switches, the slope-overloading is eliminated and the "Integrator's output" m(t) again starts to follow the message signal m(t). Record the value of the step-size Δ (in volt) in your observations, at which the slope-overloading is eliminated.
2. Similarly, get the slope-overloading at the maximum message amplitude (as already done in part b) and eliminate it by again increasing the step-size Δ (as done in the above step) and record it in your observations.
3. Also, try to eliminate the slope-overloading by increasing the sampling frequency.

OBSERVATIONS:-

(a) For the proper occurrence of Delta Modulation (no slope-overloading) :-

Amplitude of the sinusoidal (message) signal, A_m = …………. Volts $_{p-p}$
Frequency of the sinusoidal (message) signal, f_m = …………. KHz
Sampling frequency, f_s = ………….. KHz,
Step-size. Δ = …………….. volts, $_{p-p}$

(b) Conditions for slope-overloading :-

Maximum frequency of the message, causing slope-overloading = …………… KHz
Maximum amplitude of the message, causing slope-overloading = …………… Volts $_{p-p}$

(c) For elimination of slope-overloading:-

(i) Step-size (for eliminating slope-overloading at maximum message freq. of …. KHz) = …. Volt
(ii) Step-size (for eliminating slope-overloading at max. message amplitude of …. volts $_{p-p}$) = …. Volt
(iii) Sampling frequency (for eliminating slope-overloading at max. message freq. of . KHz) = … KHz

References:- 1. For understanding the operations of the various sections of the kit, refer to the "**Manual of the Scientech Delta modulation Trainer kit, model ST-2105**".
2. For theory of the Delta Modulation, refer to the Textbooks prescribed on Digital Communication.

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Experimental kit model ST-2105 Layout