

Staircase Wave Generation using Mixed Signals

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Sep 28, 2022

Abstract

A staircase waveform is an important form of output from a Digital-to-Analog conversion. The staircase wave is generated using mixed signals. Mixed signal designs combine both analog and digital signals within a single design. A digital circuit is constructed which can provide logic level output for a staircase generation. An analog signal is applied for a summing amplifier, that adds all the digital outputs and produce staircase output. The staircase waveform is used to test a television display to ensure proper operation of the display throughout the gray scale range from white to black.

1. Reference circuit Details

Staircase waveform, a waveform that is generally constrained to lie between maximum and minimum voltage values. Between these extremes the waveform can only take on discrete and constant values of voltage for fixed periods of time. The waveform thus consists of a number of small step changes in voltage level, hence the term staircase. The height of each step will normally be made constant but may be variable, as the period of time over which the waveform resides at a given voltage level.

Staircase Waveform circuit is built using a digital logic block with output 0001, 0011, 0111, 1111, for a 4 level stairs circuit. The digital output is mapped to an Analog voltage pulse to make it work with the analog circuit. Using positive logic, 1 is mapped to 1Volt and 0 is mapped to 0Volts. The pulse signal which is given as clock to the digital block is analog in nature which is converted to logic bits before the digital realization is made.

The next circuit is a summing amplifier (Inverting Negative Feedback) realized using Operational Amplifier. There are four output pins from the digital block, we the summing amplifier adds four different voltages. The four outputs from the digital logic block is applied to the inverting terminal of the opamp using equal resistances.

2. Implemented Circuit

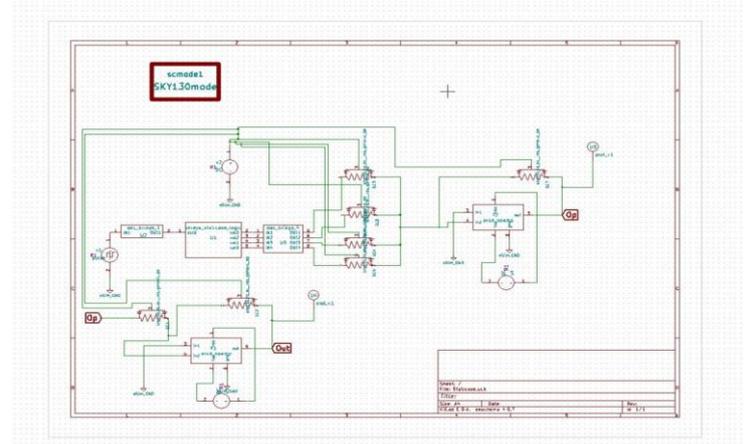


Fig-1: Staircase wave generation using Mixed Signals

3. Circuit Waveforms

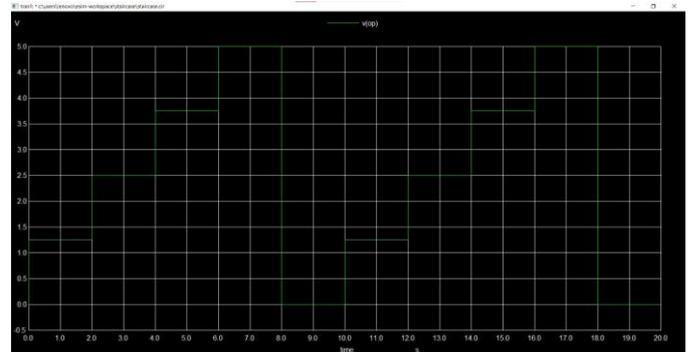


Fig-2: Staircase Waveforms

```
Shreya_Umarani Staircase Logic
// Shreya_Umarani Staircase Logic
module Shreya_staircase_logic(input clk,
output reg[3:0] num);
31
32 always # (posedge clk) begin
33   if(num[3] == 1)
34     num += 8;
35   else
36     num += num* num!;
37   end
38 endmodule
39
40 //Top Module Code Starts here:
41 module top(input logic clk, input logic reset, input logic [3:0]
42   logic [3:0] num;//output
43 //The brackets() can be replaced if user wants to assign values
44   Shreya_staircase_logic Shreya_staircase_logic(clk, num
45
46 $TVL
47 //Add $TVL here if desired
48 $SW
49 endmodule
50
51
52
```

References

- [1] https://en.wikipedia.org/wiki/Mixed-signal_integrated_circuit
- [2] <https://www.encyclopedia.com/computing/dictionaries-thesauruses-pictures-and-press-releases/staircase-waveform>
- [3] [Multilevel converters-a new breed of power converters](#)