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Digital to Analog Conversion Operation with RAMP Waveform by using Dual 4 Bit Binary Counter

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Abstract: In this paper, we propose DAC which produce the ramp output for high-speed applications. A Digital- to -Analog Converter (DAC) is a chip or circuit that converts a number (Digital) into a voltage or current (Analog). The DAC is a useful interface between a computer and an output transducer. For example, DACs are used to control devices that require a continuous range of control voltages or currents such as electro-acoustic transducers (speakers), some types of variable -speed motors, and many other applications where an analog signal output is required.

Keywords: Digital to analog, 74393, clock, DAC0800.

I. INTRODUCTION

Digital-to-Analog (D/A) and Analog-to-Digital (A/D) conversions form two very important aspects of digital data processing. Digital-to-analog conversion involves translation of digital information into equivalent analog information. As an example, the output of a digital system might be changed to analog form for the purpose of driving a pen recorder. Similarly, an analog signal might be required for the servomotors which drive the cursor arms of a plotter. In this respect, a D/A converter is sometimes considered a decoding device. The process of changing an analog signal to an equivalent digital signal is accomplished by the use of an A/D converter. For example, an A/D converter is used to change the analog output signals from transducers (measuring temperature, pressure, vibration, etc.) into equivalent digital signals. These signals would then be in a form suitable for entry into a digital system. A/D converter is often referred to as an encoding device since it is used to encode signals for entry into a digital system. Digital-to-analog conversion is a straightforward process and is considerably easier than A/D conversion.

II. GENERATION OF RAMP OUTPUT

To convert the digital signal to analog signal a Digital-to-Analog Converter (DAC) has to be employed. The DAC will accept a digital (binary) input and convert to analog voltage or current. Every DAC will have "n" input lines and an analog output. The DAC require a reference analog voltage (Vref) or current (Iref) source. The smallest possible analog value that can be represented by the n-bit binary code is called resolution. The resolution of DAC with n-bit binary input is 1/2n of reference analog value. Every analog output will be a multiple of the resolution. The DAC0800 require a positive and a negative supply voltage in the range of ± 5V to ±18V. It can be directly interfaced with TTL, CMOS, PMOS and other logic families. For TTL input, the threshold pin should be tied to ground. The reference voltage and the digital input will decide the analog output current, which can be converted to a voltage by simply connecting a resistor to output terminal.

An inexpensive and very popular D/A converter is the DAC0800, an 8-bit D/A converter is connected to provide a full-scale output voltage of V0 =+12 V dc when all 8 digital inputs are 1’s (high). If the 8 digital inputs are all 0’s (low), the output voltage will be V0 = 0 Vdc. Let's look at this circuit in detail. First of all, two dc power-supply voltages are required for the DAC0800: Vcc= +5 Vdc and VEE= -12 Vdc. pin 15 is referenced to ground through a resistor. The circuit which produce the ramp output and is shown in figure 1

The 74393 contains two separate 4-bit (0 to 15) counters, one on each side of the chip. They are ripple counters so beware that glitches may occur in logic systems connected to their outputs due to the slight delay before the later outputs respond to a clock pulse. The count advances as the clock input becomes low (on the falling-edge), this is indicated by the bar over the clock label. This is the usual clock behaviour of ripple counters and it means a counter output can directly drive the clock input of the next counter in a chain. For normal operation the reset input should be low, making it high resets the counter to zero (0000, QA-QD low). Counting to less than 15 can be achieved by connecting the appropriate output(s) to the reset input, using an AND gate if necessary.

Rig up the circuit as shown in the diagram with proper power supplies in a trainer kit. Keep the MSB bits in a suitable required value using toggle switches (e.g.: 0110 = 9). Feed the LSB bits from the 4 bit counter which counts from 0000 to 1111. (Alternatively we can construct a full 8 bit counter using 74LS393). Supply a 1 KHz clock to the counter and observe the ramp output on CRO. Voltages for individual counts can be measured in a voltmeter by applying mono pulses to the counter.

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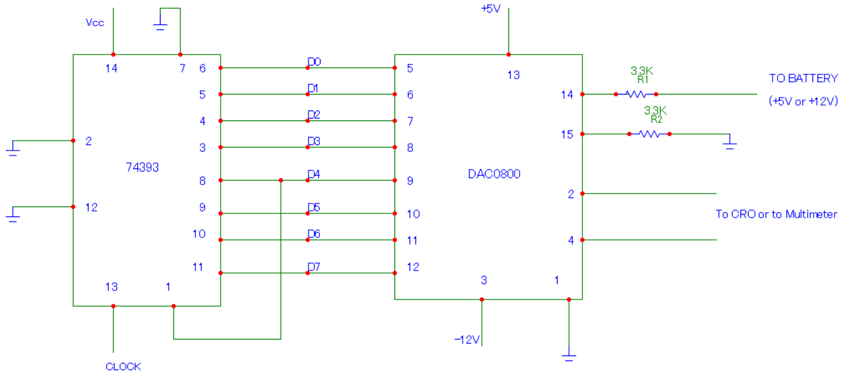

Fig1: RAMP generator circuit using DAC0800

III. CALCULATIONS

An N-bit DAC can output 2^N different levels in 2^N -1 steps so if we have an 8 bit DAC then this gives us $2^N = 2^8 = 256$ different output levels in 255 steps. Output voltages can be theoretically calculated using following formula

$$V_0 = \left(\left(\frac{V_{ref}}{R_{ref}}\right)\left(\frac{D0}{2} + \frac{D1}{4} + \frac{D2}{8} + \frac{D3}{16} + \frac{D4}{32} + \frac{D5}{64} + \frac{D6}{128} + \frac{D7}{256}\right)\right) R$$

IV. OBSERVATION TABLE

The circuit shown in figure 1 which converts digital value to analog values based on clock pulse. So the table 1 which shows the conversion process from binary value to corresponding analog voltage.

Table 1: DAC calculated and observed values

Decimal i/p (digital)	Binary i/p (digital)	Calculated o/p (analog)	Observed o/p (analog)
0	00000000	0	0.08
16	00010000	0.74	0.78
32	00100000	1.49	1.06
48	00110000	2.24	1.33
64	01000000	2.99	2.00
80	01010000	3.74	2.75
96	01100000	4.49	3.51
112	01110000	5.23	4.24
128	10000000	5.99	5.00
144	10010000	6.84	5.7
160	10100000	7.4	6.4
176	10110000	8.2	7.16
192	11000000	8.99	7.93
208	11010000	9.7	8.64
224	11100000	10.4	9.4
240	11110000	11.2	9.84

V. RESULTS & CONCLUSION

The circuit which produce output and it can be seen in multimeter as well as cathode ray oscilloscope. The output seen in multimeter is shown in above table 1 and corresponding output observed in CRO is shown in bellow figure 2. The resulted output is staircase and in generally we can see ramp output in CRO. In this paper, we have presented a ramp generator. Ramp output generate when inputs are passed to DAC0800 through IC74393 and successfully verified.

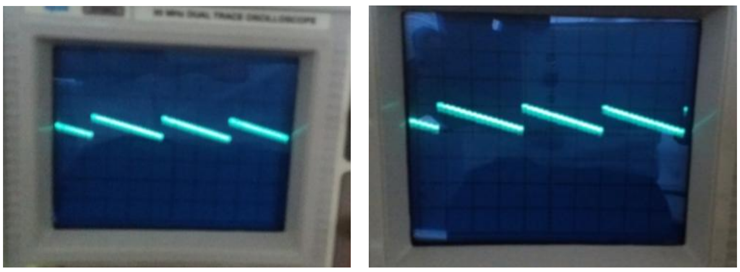

Fig 2: RAMP output

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BIOGRAPHY

Mr. Rakesh M.R received his B.E degree in Electronics and Communication from KVG College of Engineering Sullia and received his M.Tech degree in Electronics from Canara College of Engineering Bantwal. Currently he is working in AJIET Mangaluru. His areas of interest are VLSI and Image Processing.

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