Experiment 1

ADC tracking

In this experience we built an 8-bit ADC tracking with thw output switching from 0 and 5 volt (TTL logic).

1.1 Materials

- Resistors, capacitors
- Power supply RIGOL DP831A
- 5V power supply NI myDAQ
- Waveform generator RIGOL DG1032
- Multimeter RIGOL DM3068
- Digital counter (from previous experiment)
- DAC08
- 8-bit LED viewer
- Comparator LM311

The resistors used were all with an uncertainty of 5%

1.2 Experimental setup

First of all we tested our DAC08 powering it with ±15V and setting the input current in the $+V_{Ref}$ pin to 2mA: this was acheved by using a 4.4V voltage from the RIGOL power supply and a resistor of 2.2kΩ. In order to clear as much as possible the bias current effects, we used another identical resistor between the $-V_{Ref}$ pin and ground and also added a 10nF capacitor between the COMP pin and -15V to optimize the behavior of the component.
Since we used TTL logic and only one output, we put to ground both the V_{LC} and the $\overline{I_{Out}}$ pins.
At this point we had an output current, but we desired an output voltage: for that reason we added a 2081.7±0.4Ω resistor between the I_{Out} pin and ground.
We than tested the component with various different inputs and measured its resolution.
Once done these measurements we connected the counter circuit from last experiment as the DAC08 input, verifying the output to be a sawtooth signal.
Finally we connected this output to a comparator together with the input voltage to be converted, obtained from the -15V power supply voltage with a 5.6kΩ resistor and a 5kΩ trimmer (therefore freely variable), and used this new output as the $\overline{Up}$/Down counter input, removing the D-FlipFlop being now useless its signal slowing function.
We chose different signals at different frequencies and visualized them with the 8-bit LED viewer. We

verified this way the correct working of the circuit.
0.1μF were added to all the connections with power supply.

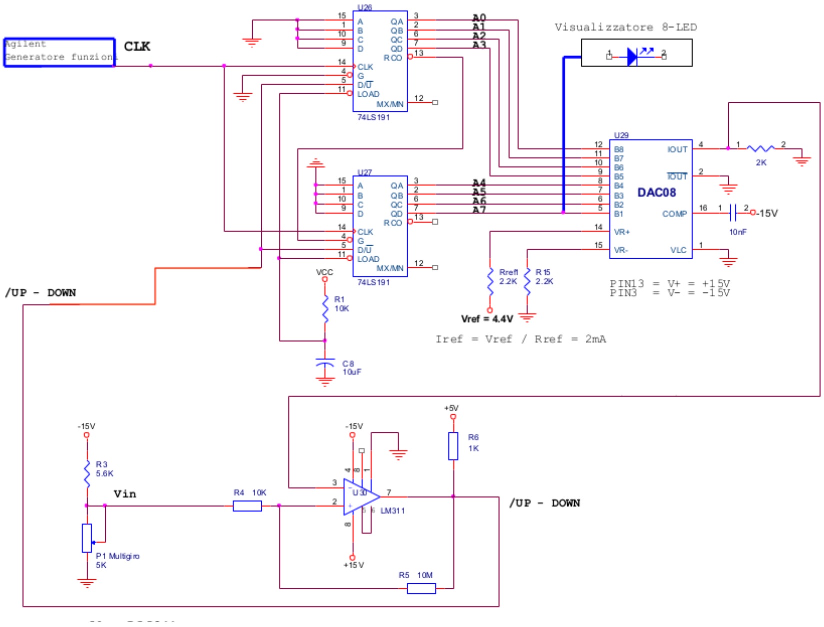

Figure 1.1: Circuit used

1.3 Data Analysis

Once mounted the DAC08, we tested its output with different configurations of the input. The results are shown in table 11.1

Range Fraction	B1	B2	B3	B4	B5	B6	B7	B8	I_{out} (measured)	V_{out} (measured)
FULL RANGE	1	1	1	1	1	1	1	1	1.9870±0.0011 mA	-4.1358±0.0003 V
HALF-SCALE +LSB	1	0	0	0	0	0	0	1	1.0057±0.0006 mA	-2.09378±0.00018 V
HALF-SCALE	1	0	0	0	0	0	0	0	0.9979±0.0006 mA	-2.07775±0.00018 V
HALF-SCALE -LSB	0	1	1	1	1	1	1	1	0.9892±0.0006 mA	-2.05968±0.00018 V
ZERO-SCALE +LSB	0	0	0	0	0	0	0	1	8.08±0.03 μA	-16.807±0.006 mV
ZERO-SCALE	0	0	0	0	0	0	0	0	0.33±0.03 μA	-0.744±0.005 mV

Table 1.1: Test DAC08: measures

Range Fraction	B1	B2	B3	B4	B5	B6	B7	B8	I_{out} (theoretical)	V_{out} (theoretical)
FULL RANGE	1	1	1	1	1	1	1	1	1.992±0.004 mA	-4.147±0.008 V
HALF-SCALE +LSB	1	0	0	0	0	0	0	1	1.008±0.002 mA	-2.098±0.004 V
HALF-SCALE	1	0	0	0	0	0	0	0	1.000±0.002 mA	-2.082±0.004 V
HALF-SCALE -LSB	0	1	1	1	1	1	1	1	0.992±0.002 mA	-2.065±0.004 V
ZERO-SCALE +LSB	0	0	0	0	0	0	0	1	7.8125±0.016 μA	-16.39±0.03 mV
ZERO-SCALE	0	0	0	0	0	0	0	0	0±0 μA	0±0 mV

Table 1.2: Test DAC08: expected values given I_{Ref} = 2.000±0.004 mA, R_{out} = 2081.7±0.4 Ω

Comparing the results in these last 2 tables, we can see that the measurements are sufficiently compatible with the expected values (with the only exeption of the zero-scale that theoretically should be zero with no uncertainty at all).
We can as well measure the resolution of our converter: it is actually the least difference that we can distinguish between two different outputs. Making an average, we come to the result of 1LSB = 16.72 ± 0.12 mV
Then, connected the DAC08 to the counter and verified the signal tracking and "capture" feature of our system, we observed the response to a 0.3V continue input, using a 30Hz clock frequency and setting the oscilloscope time scale to 20ms/div. We obtained the graphic shown in figure 11.2

12/mis2.png

Figure 1.2: signal tracking and "capture" feature of our circuit with a constant input