

Digital to Analog Converter

Last updated 1/11/24

DAC Basics

- Digital to Analog Converter
 - Converts a digital word to a fixed analog voltage level
 - Many applications
 - Electronic music
 - Audio conversion – heart monitor
 - Video conversion – ultrasound
 - Mechanical conversion – valve opening %

DAC Basics

- Digital to Analog Converter Performance
 - Resolution
 - n-bit digital word can represent 2^n levels
 - 8-bit DAC \rightarrow 256 levels
 - Frequency
 - Outputs are provided at a fixed rate – sampling rate
 - Accuracy
 - Linearity
 - Noise
 - Many others

DAC Basics

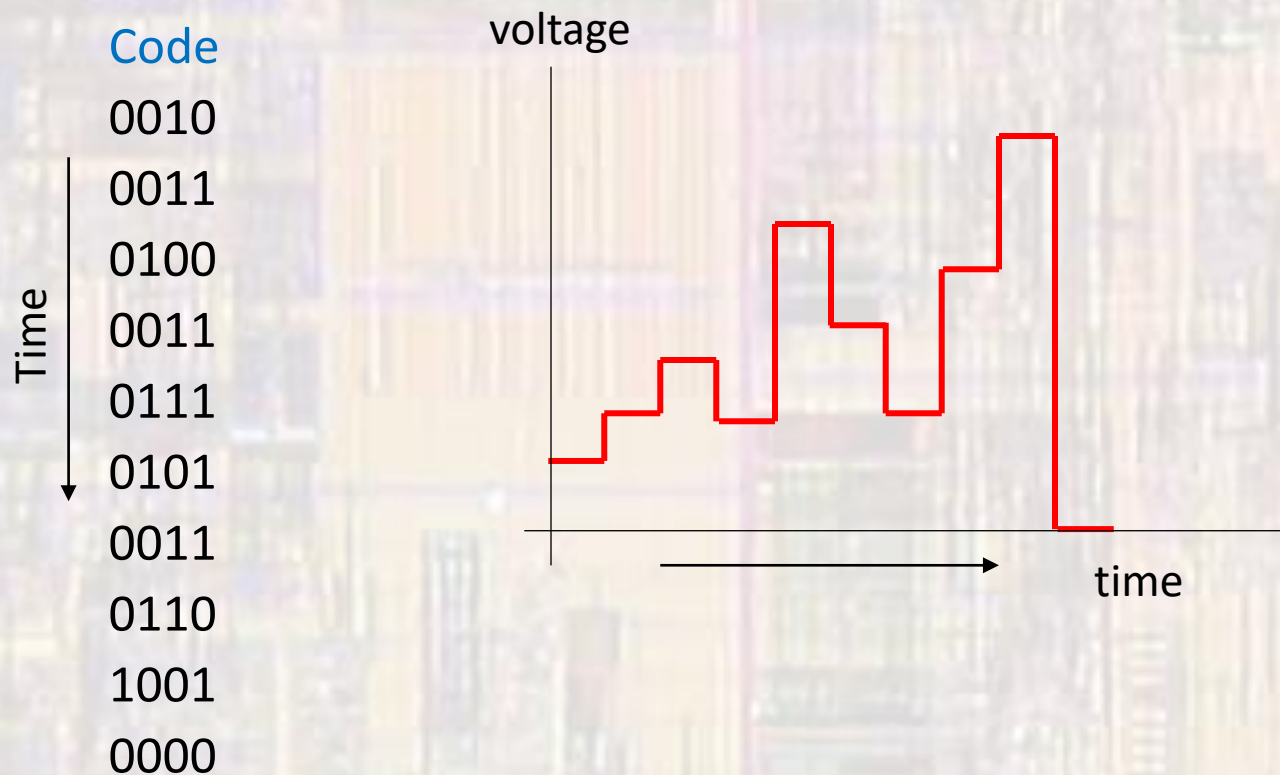
- Digital to Analog Converter Performance
 - 4 bit DAC, 5v range
 - $5\text{v} / 2^4 \rightarrow 0.3125\text{v/step}$

Code	Output
0000	0.0v
0001	0.3125v
0010	0.625v
0011	0.9375v
...	
1101	4.0625v
1110	4.375v
1111	4.6875v

Note – the output cannot reach the maximum value

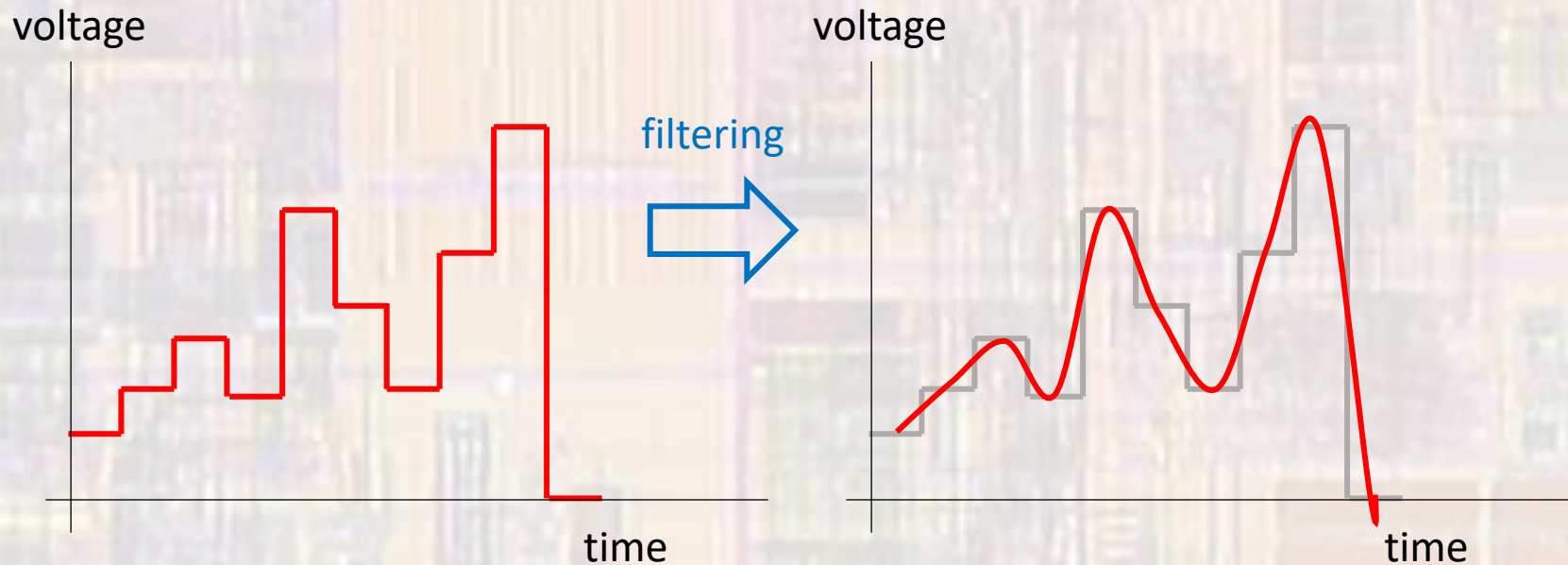
DAC Basics

- Digital to Analog Converter Performance
 - 4 bit DAC, 5v range



DAC Basics

- Digital to Analog Converter Performance
 - Typically, additional signal conditioning is required to 'clean up' the output
 - Low pass filter



DAC Basics

- DAC Conversion Example

3.3V Vref
8 bit converter

Code	Steps	Volts
0000 0000	0	0
0000 0001	1	0.013
0001 0000	16	0.206
0111 1111	127	1.637
1000 0000	128	1.650
1100 0000	192	2.475
1111 1111	255	3.287

$$3.3\text{v} / 2^8 \text{ steps} \\ = 12.89\text{mv/step}$$

DAC Basics

- Digital to Analog Converter
 - Many types of D/A converters
 - Resistor DAC
 - Current DAC
 - Switched Capacitor DAC
 - Delta-sigma DAC
 - Pulse width modulator