

IDM

Fabless

MSP430

\$70

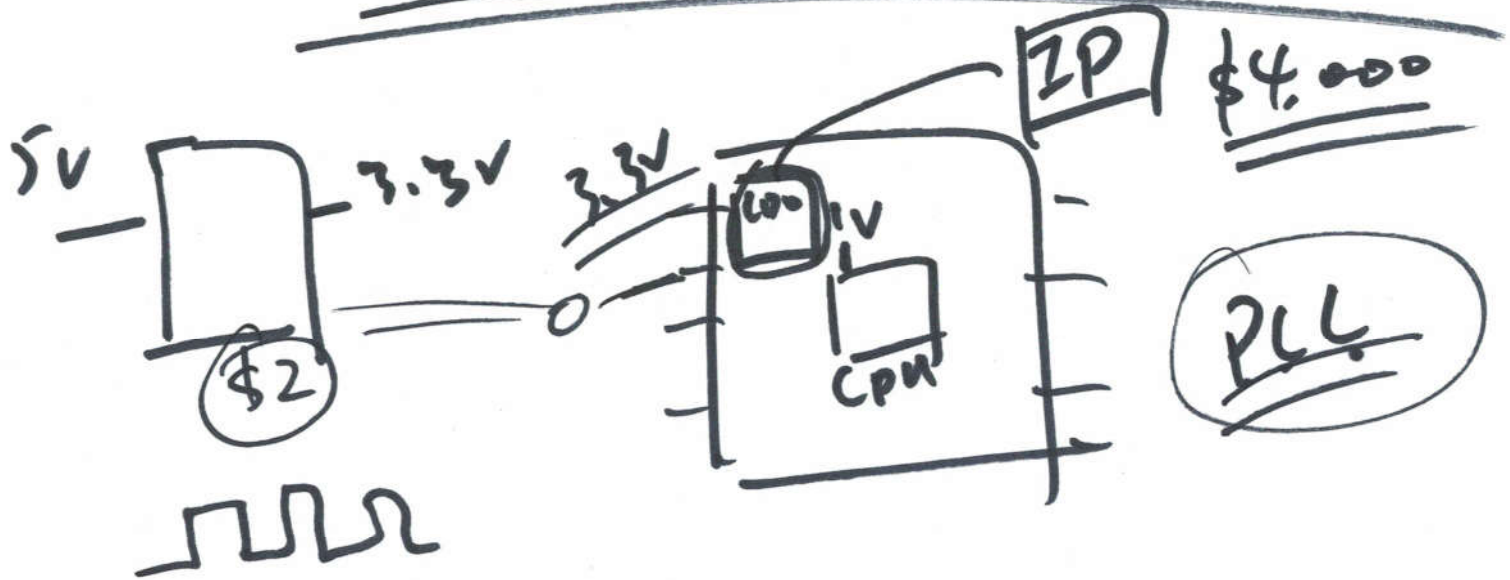
Foundries (pure play)

UMC, TSMC

Service: MUSE, MOSIS

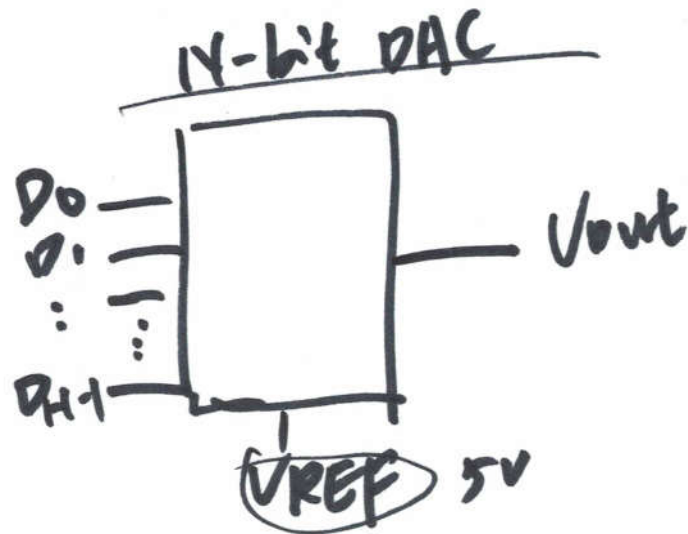
skywater

LDO low-Dropout voltage regulators



(1)

# Digital-to-Analog Converter



$\Delta$  N-bit DAC  $2^N$  input combinations  
 $\Delta F = \frac{D}{2^N} \rightarrow$  Digital input word 101...01

$$V_{out} = F \cdot V_{REF} = \frac{D}{2^N} \cdot 5V = \frac{5V}{2^N} \cdot D$$

$$\rightarrow \frac{101_{(2)}}{8} \cdot 5V$$

$\rightarrow 000 - 111$

A 3 bit DAC, input  $100_{(2)}$ ,  $V_{REF} = 5V$ ,  $V_{out}$ ?

$$F = \frac{100_{(2)}}{2^3} = \frac{100_{(2)}}{8} = \frac{4}{8}$$

$$V_{out} = F \cdot V_{REF} = \frac{4}{8} \cdot 5 = 2.5V$$

Δ what is maximum  $V_{out}$ ?

$$F = \frac{111_{(2)}}{8} = \frac{7}{8}$$

$$V_{out(max)} = \frac{7}{8} \cdot 5 = \underline{\underline{1 \text{ LSB less than } 5V}}$$

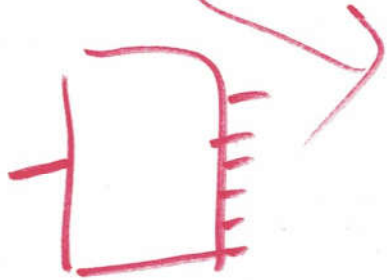
$$1 \text{ LSB is } 5V \cdot \frac{1}{8} V$$

smallest increment or change at the output

③

Example:

Find the resolution for a DAC if the output voltage is desired to change in 1mV increments while using a reference voltage of 5V.



8 14  
2 2

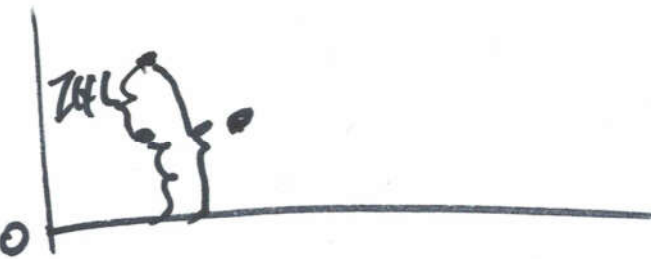
$$\frac{1 \text{ mV}}{5 \text{ V}} = \frac{1}{2^N}$$

$$N = \log_2 \frac{5 \text{ V}}{1 \text{ mV}} = \underline{12.29 \text{ bits}} \approx 13$$

Find the number of input combinations, values for 1 LSB, and Full-scale voltage generated for a 3-bit, 8 bit, and 16-bit DAC.  $V_{REF} = 5 \text{ V}$ .

Resolution	Input Combinations	1 LSB (V)	<del>V</del> VFS
3	8	0.625 V	4.375 V
8	256	$\frac{5V}{256} = 19.5 \text{ mV}$	$5V - 19.5 \text{ mV}$ or $\frac{2^N - 1}{2^N} \cdot 5$
16	65536	76.29 $\mu\text{V}$	4.999 V

PNL 

INL 

(6)

