Electronic System Design 3003
Lecture: Figure of Merit
Static Errors

Dr Sajjad Hussain

Thanks to Prof. Duncan Bremner

Sajjad.Hussain.2@glasgow.ac.uk

Design example: Figures of merit

Often many numbers contribute:

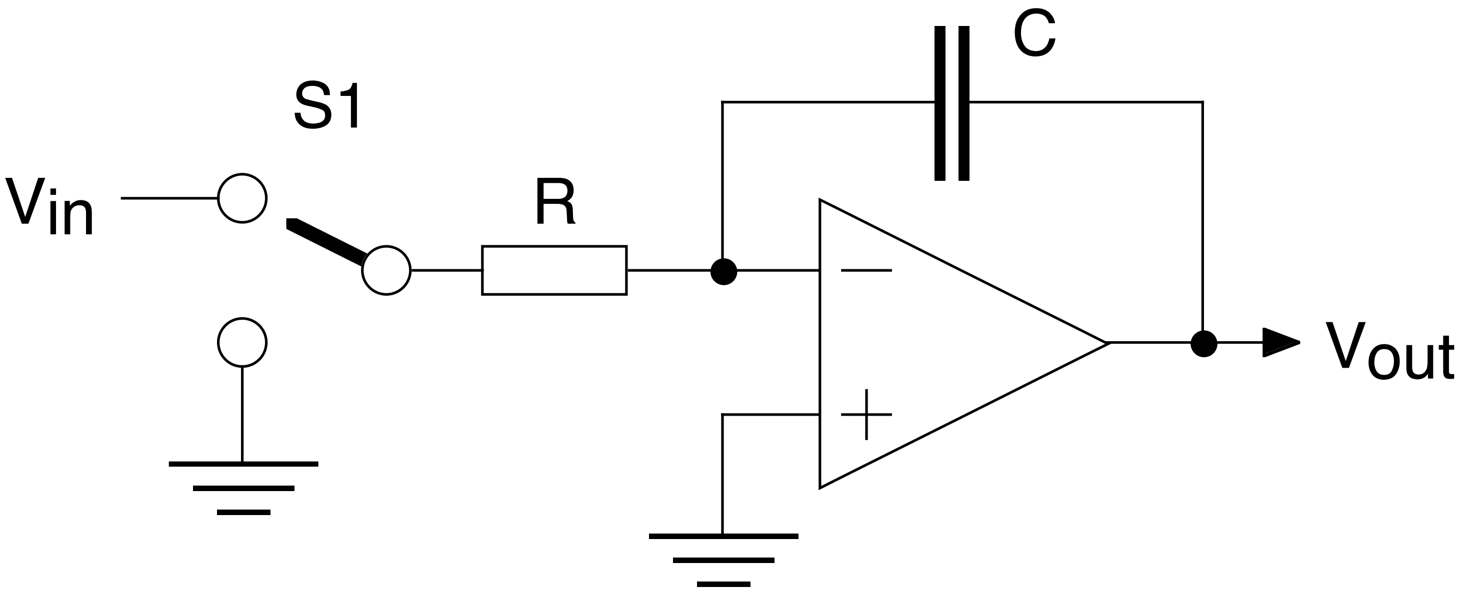
Define a Figure of merit for the component

Figure of merit is a function of all significant contributions of the component to the total system error.

Figure of merit changes **monotonically** with the overall error due to the component

The total error contributed by the component is clearly a good choice

Example: Integrate-and-Hold

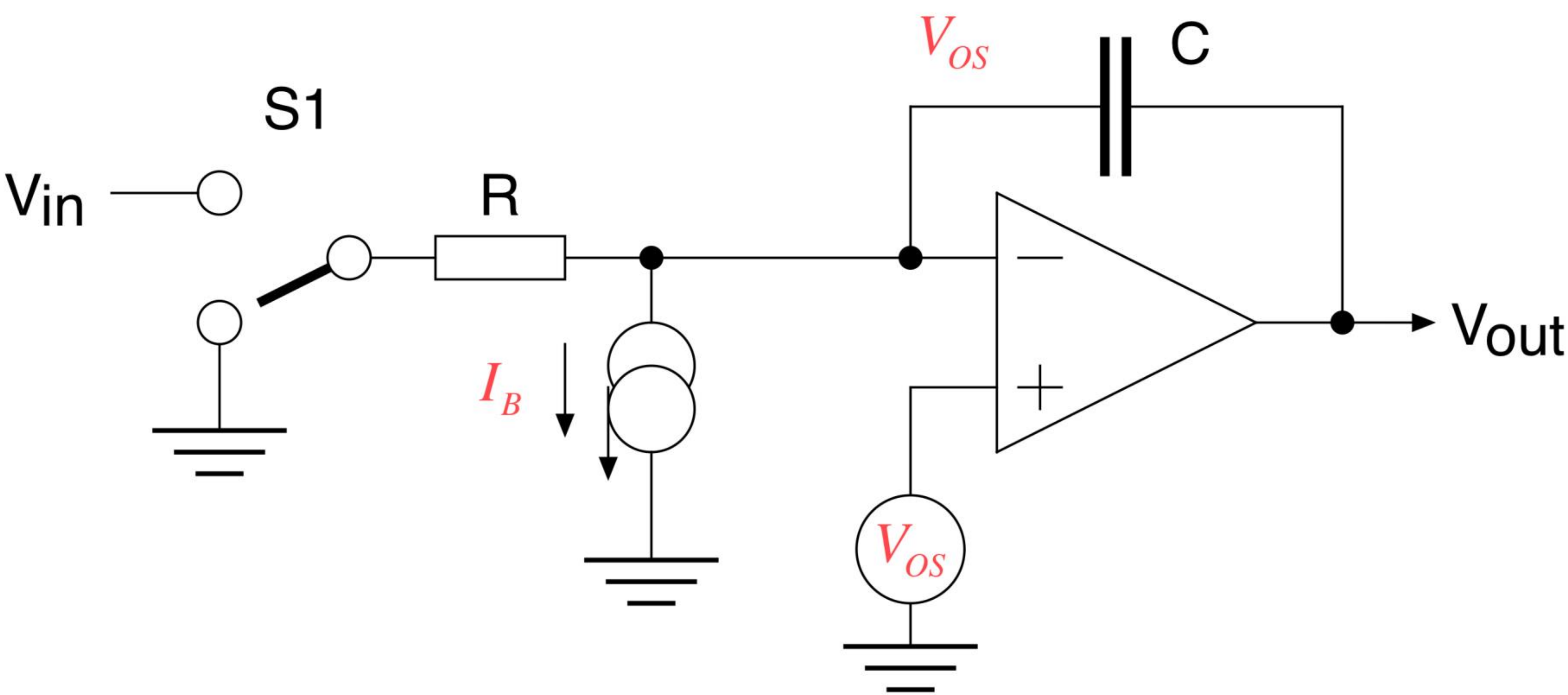


If S1 connects to V_{in} circuit is an integrator $V_{out} = -\int \frac{V_{in}}{RC}\, dt$

If S1 connects to 0V circuit is a memory $V_{out} = \text{constant}$

Error Analysis

Important parameter is drift during "Memory"



$$\left|\frac{dV_{\text{out}}}{dt}\right| = \frac{1}{C}\frac{dQ}{dt} = \frac{1}{C}\left(I_B + \frac{V_{OS}}{R}\right)$$

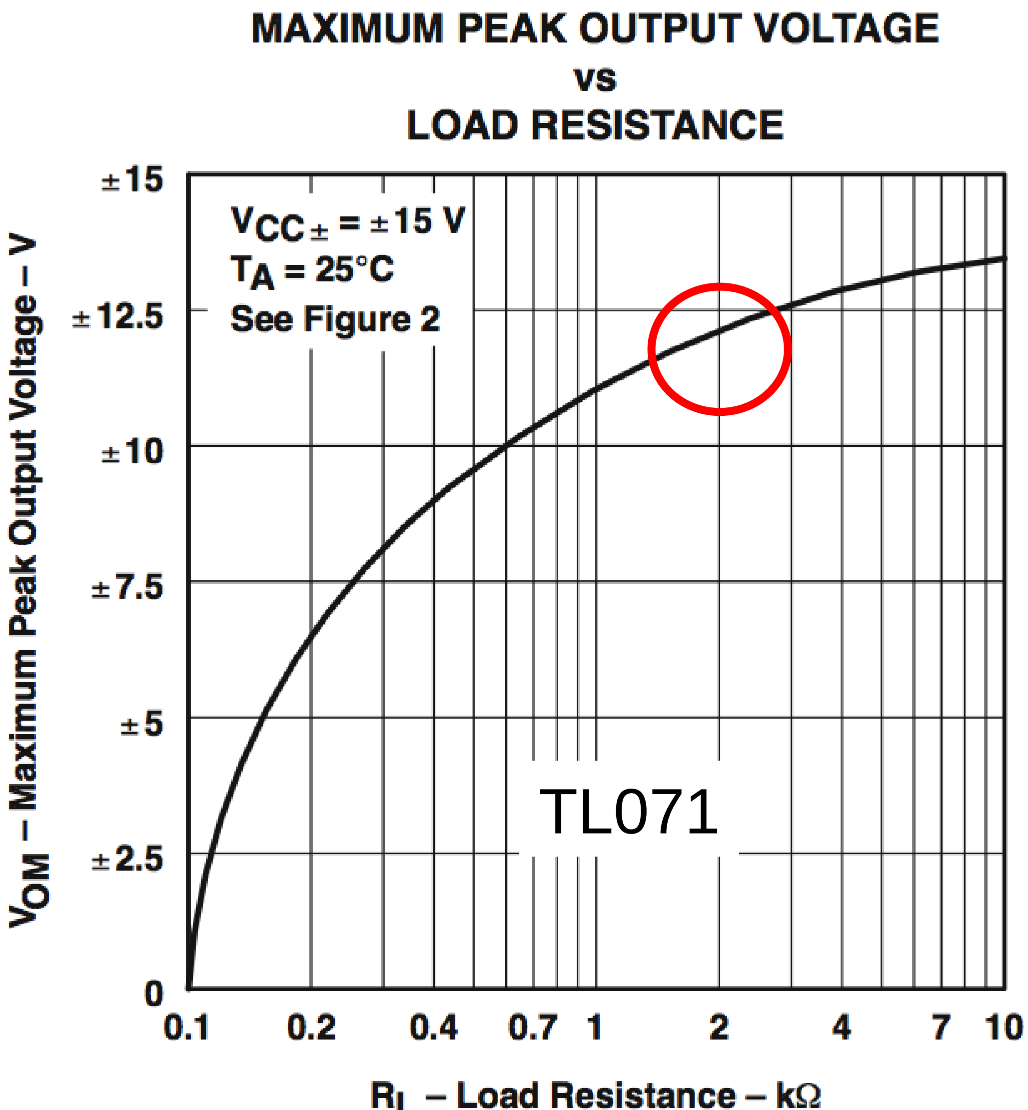
Error Analysis (2)

Time constant is fixed: $\tau = RC$ $\therefore$ one free parameter (R)

$$\left|\frac{d\mathrm{V}_{\mathrm{out}}}{dt}\right| = \frac{1}{C}\left(I_B + \frac{V_{OS}}{R}\right) = \frac{1}{\tau}\left(I_B\mathrm{R} + V_{OS}\right)$$

Optimisation: make R as small as possible

Practical limits on R:



If R too small,
Input Voltage range
is too small

Also:

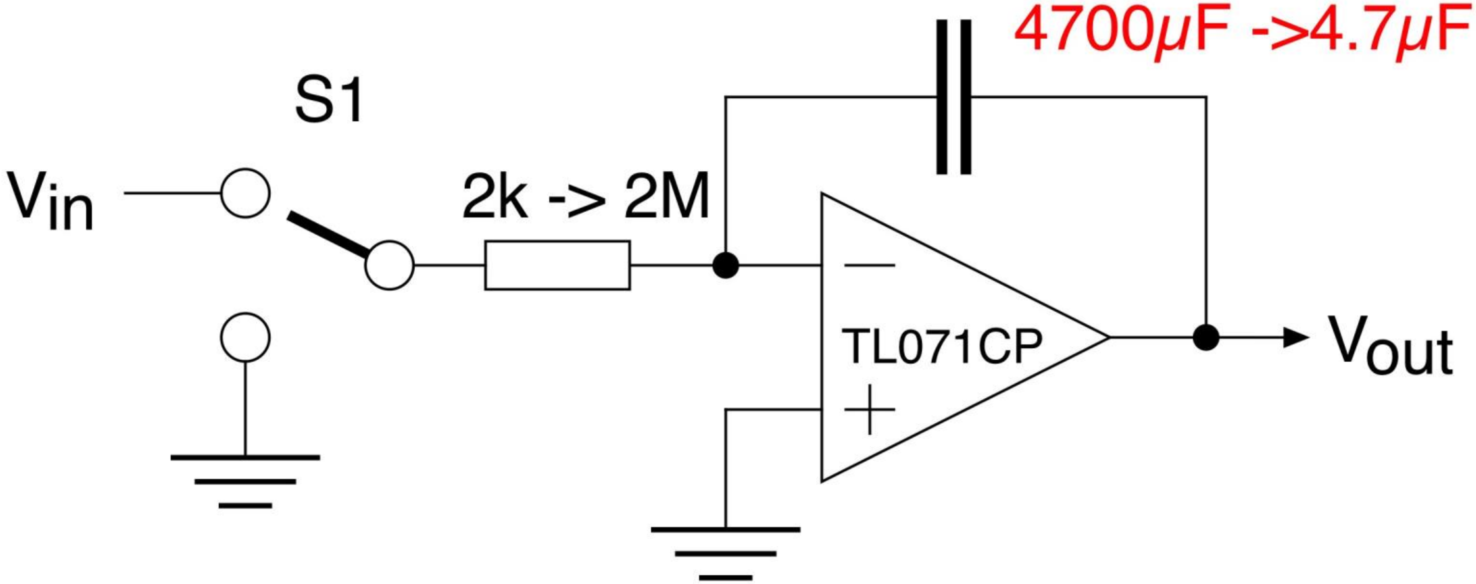
- Supply current
- Power dissipation
- Thermal drift
- V across PCB
- Available C values

R≥2kΩ

Error Analysis (4)

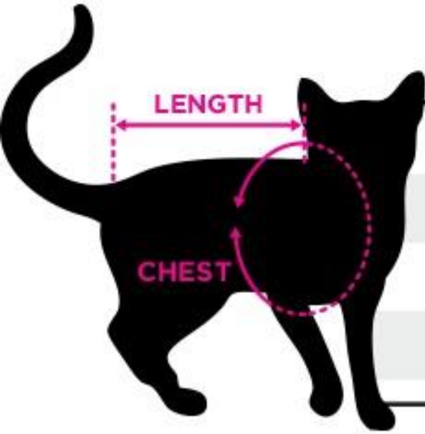
Naïve circuit (τ=10s)

No good 4700μF capacitors



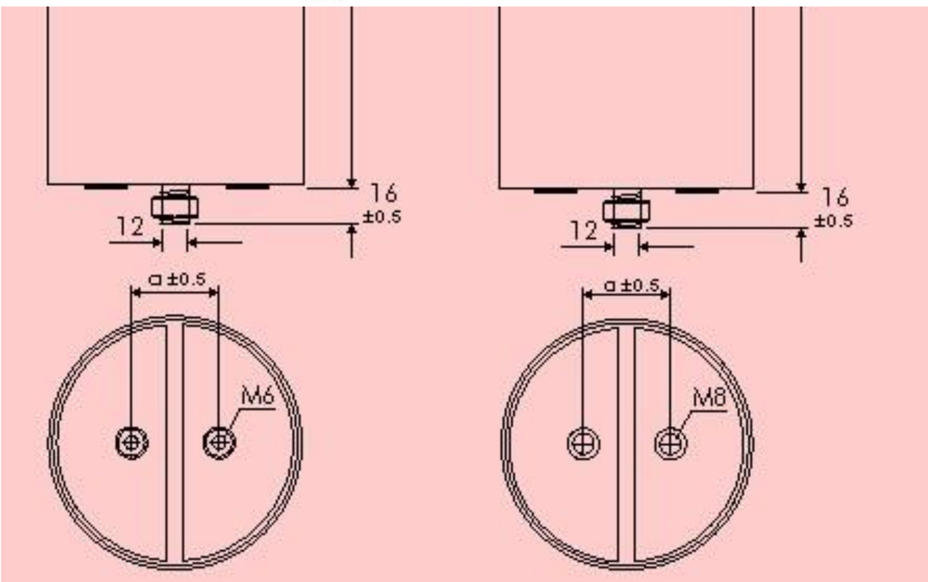
$$\left|\frac{dV_{out}}{dt}\right| = \frac{1}{\tau}\left(I_B R + V_{OS}\right) = \frac{1}{10s}\cdot\left(200\,pA\cdot 2M\Omega + 10mV\right) = 1.04mV\cdot s^{-1}$$

How large is a 4700µF Polypropylene Capacitor?



	INCHES/POUNDS			CENTIMETERS/KILOGRAMS		
	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
CHEST	11-14 in	14-17 in	17-20 in	28-36 cm	36-43 cm	43-51 cm
LENGTH	10-13 in	13-16 in	13-16 in	26-33 cm	33-41 cm	33-41 cm
APPROX. WEIGHT	4-8 lbs	8-12 lbs	12-16 lbs	2-4 kg	4-6 kg	6-8 kg

This one



85	260	32	12	6
85	345	32	12	6
116	110	50	14	5
116	140	50	14	5
116	158	50	14	5
116	185	50	14	5
116	215	50	14	5
116	230	50	14	5
116	255	50	14	5
116	295	50	14	5
116	342	50	14	5

Dims. in mm.

This one

Electrolytic Capacitors No!!!
Relatively small
Low quality
Poor tolerance
Temperature sensitive
Not ideal for precision circuits!

(Wima DC-LINK MKP 6 HP 4920µF 600V)

University of Glasgow

Thank you
谢谢

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