

# Protecting Low Voltage ADC - Improved Solution

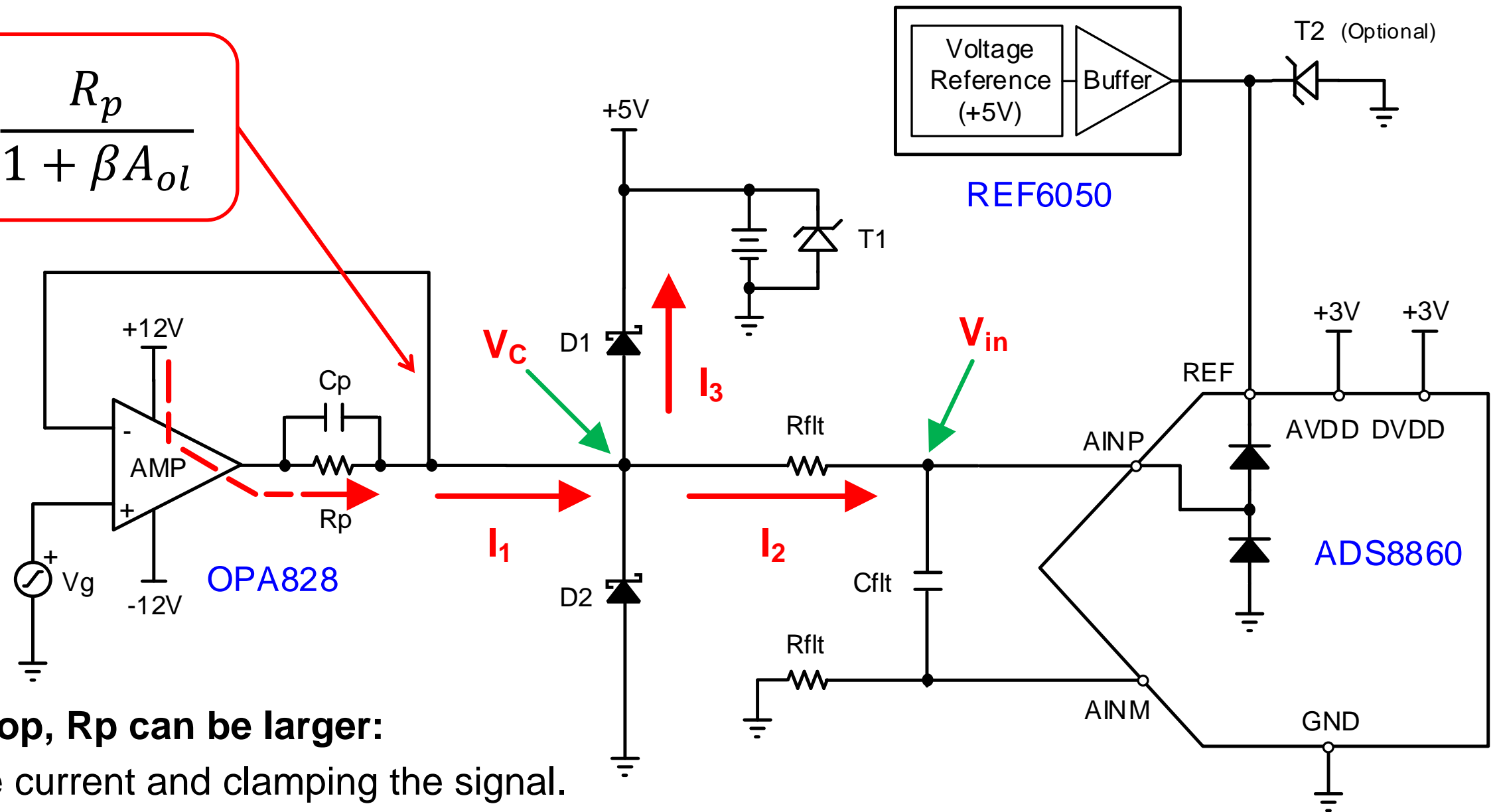
TI Precision Labs – ADCs

Presented by Alex Smith

Prepared by Dale Li

# Solution to Improve Settling

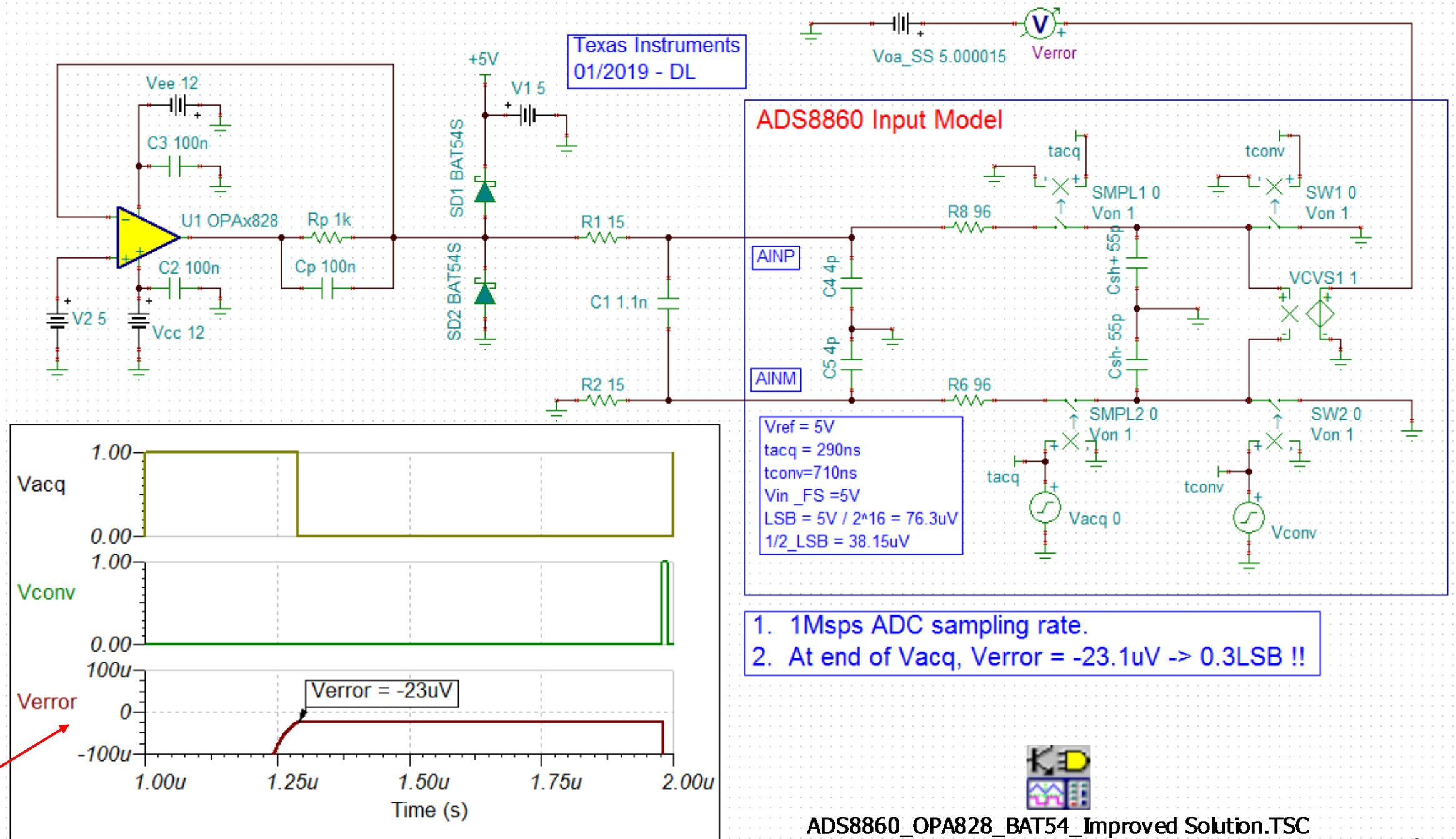
$$Z_{out}(R_p) = \frac{R_p}{1 + \beta A_{ol}}$$



**Within the feedback loop,  $R_p$  can be larger:**

- Better for limiting the current and clamping the signal.
- No impact on settling the signal on the sample-and-hold capacitor of the ADC.
- A small size and low power dissipation resistor can be used.

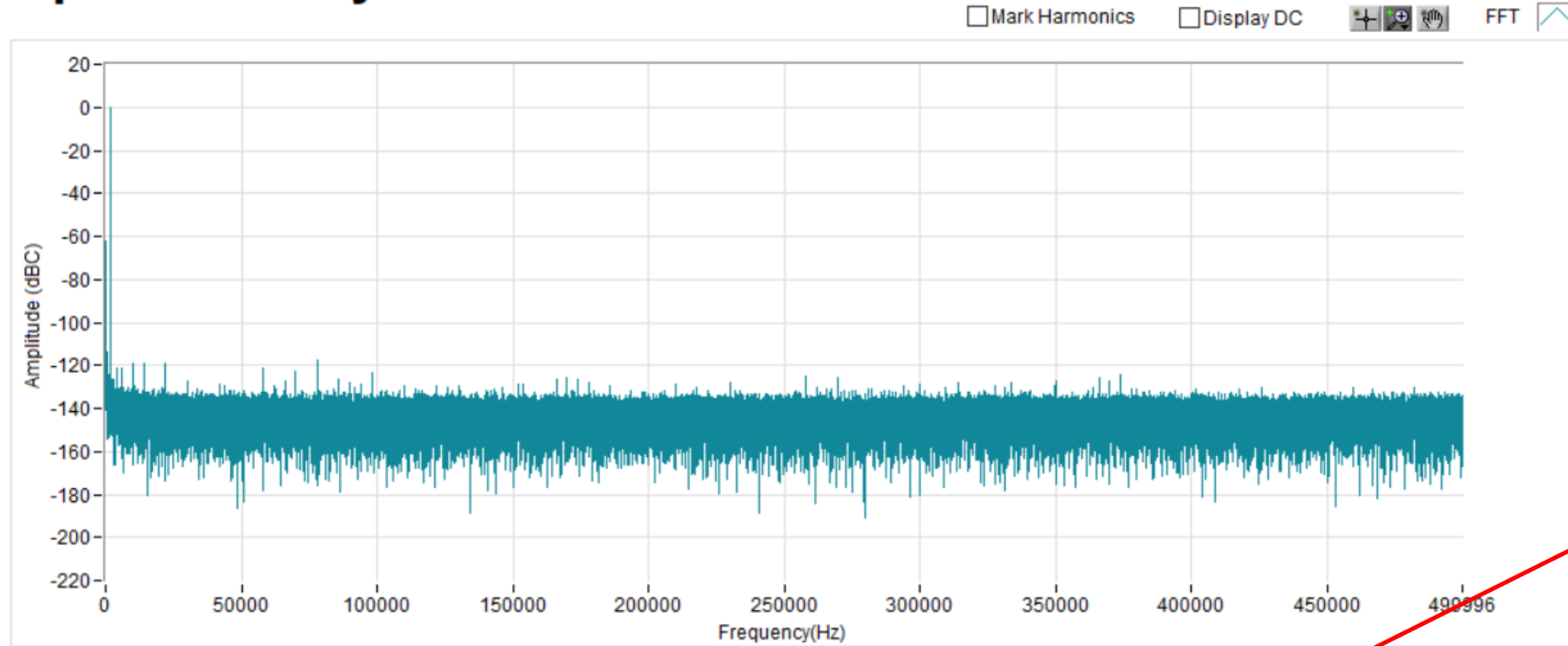
# TINA Simulation for Improved Solution



# Hardware Performance Check for Improved Solution

(BAT54, Riso=1kΩ, C\_comp=100nF, Rflt=15Ω, Cflt=1.1nF, OPA828+ADS8860 at 1Msps sampling rate)

## Spectral Analysis



## ADS8860 Data Sheet (1Msps)

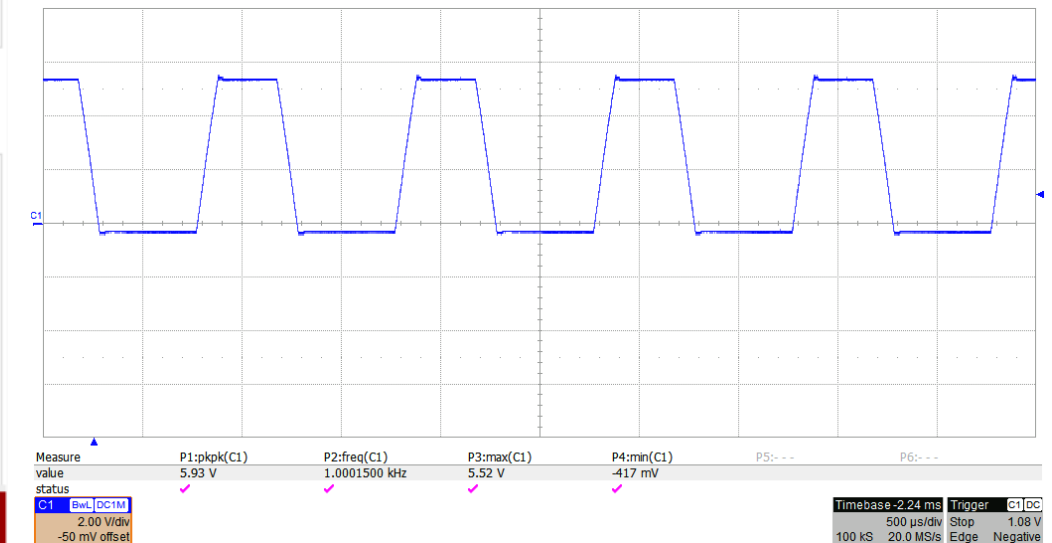
Parameter	Min	Typ	Max	Unit
SNR	92	93		dB
THD		-108		dB

## Measured Performance:

**SNR = 93.3dB**

**THD = - 113.7dB**

## HV Sinewave Input Signal Clamped:



Samples: 262144 Capture

Input Parameters

Device Fs (Hz): 1.00M

# Harmonics: 9

Window: 7 Term B-Harris

**Output Parameters**

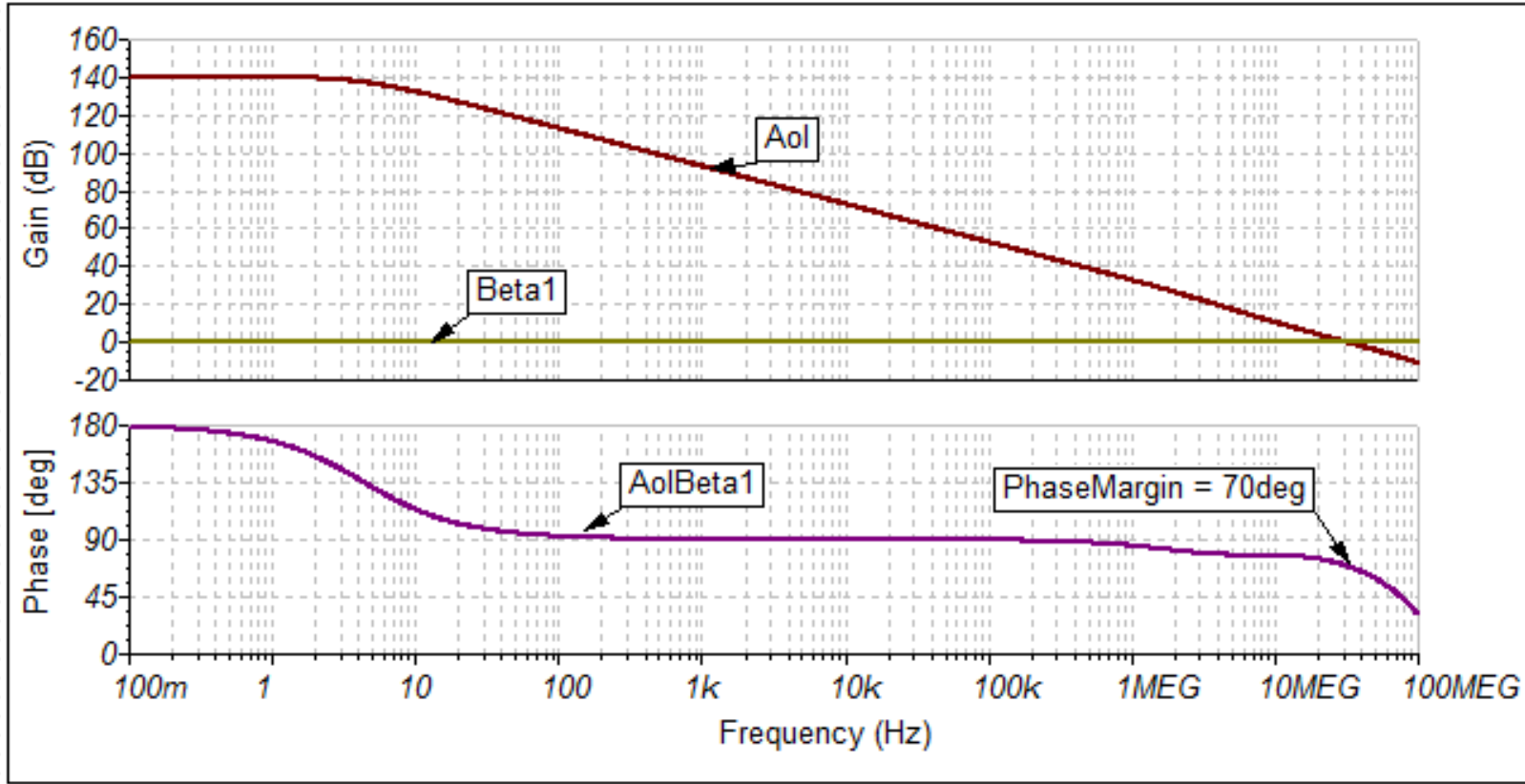
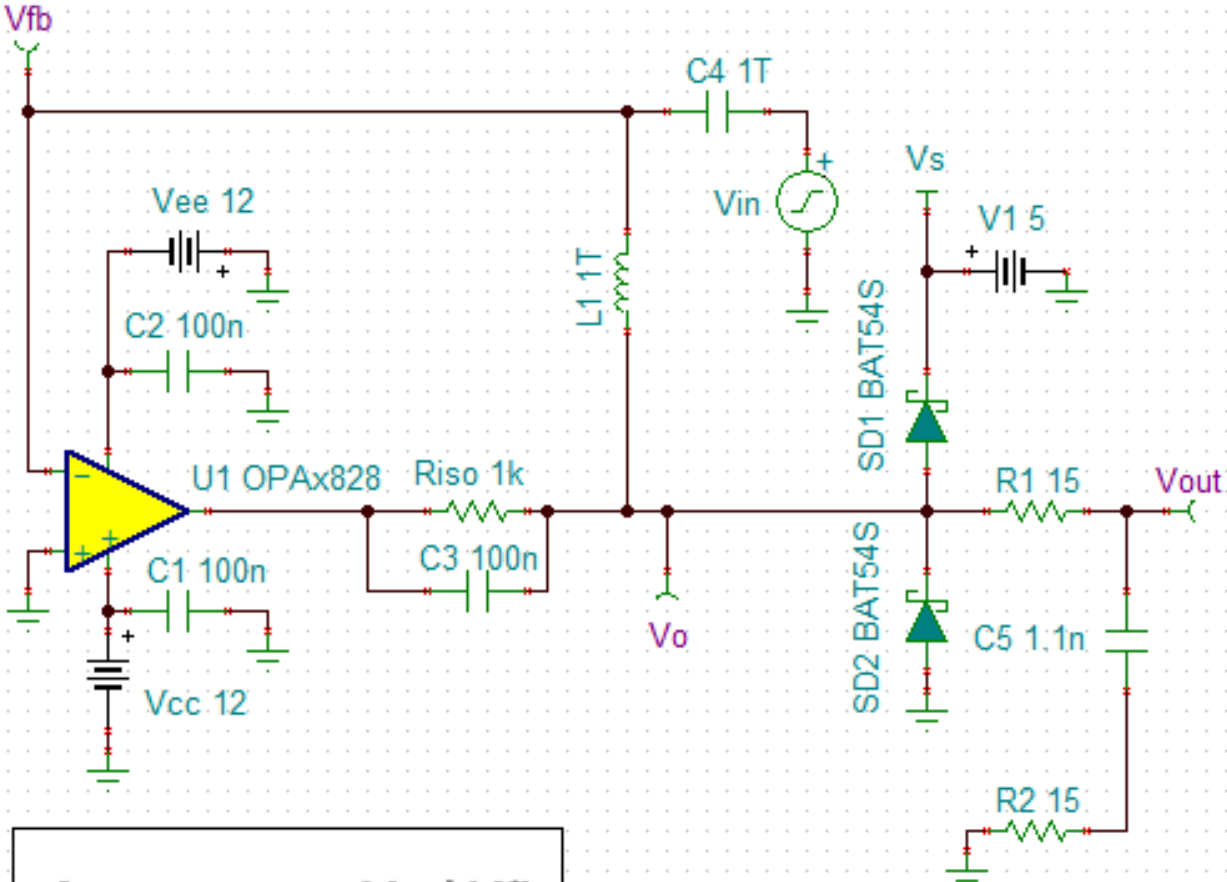
SNR(dB)	THD (dB)	Signal power(dBFS)
93.3221	-113.737	-0.509407
SFDR(dB)	SINAD(dB)	ENOB
117.815	93.2828	15.2031
Fi Calculated (Hz)	Maximum Spur (dBC)	Maximum Spur (Hz)
2.000002k	-117.815	77999.1

**Harmonics(dBC)**

H1	0.00
H2	-121.04
H3	-121.40
H4	-131.01
H5	-118.73
H6	-137.70
H7	-119.46
HR	-132.86

**PSI Controls**

# OPA828 Stability Check - Improved Solution



$$A_{OL\_LOADED} = V_o / V_{fb}$$

$$1/\beta = 1 / V_{fb}$$

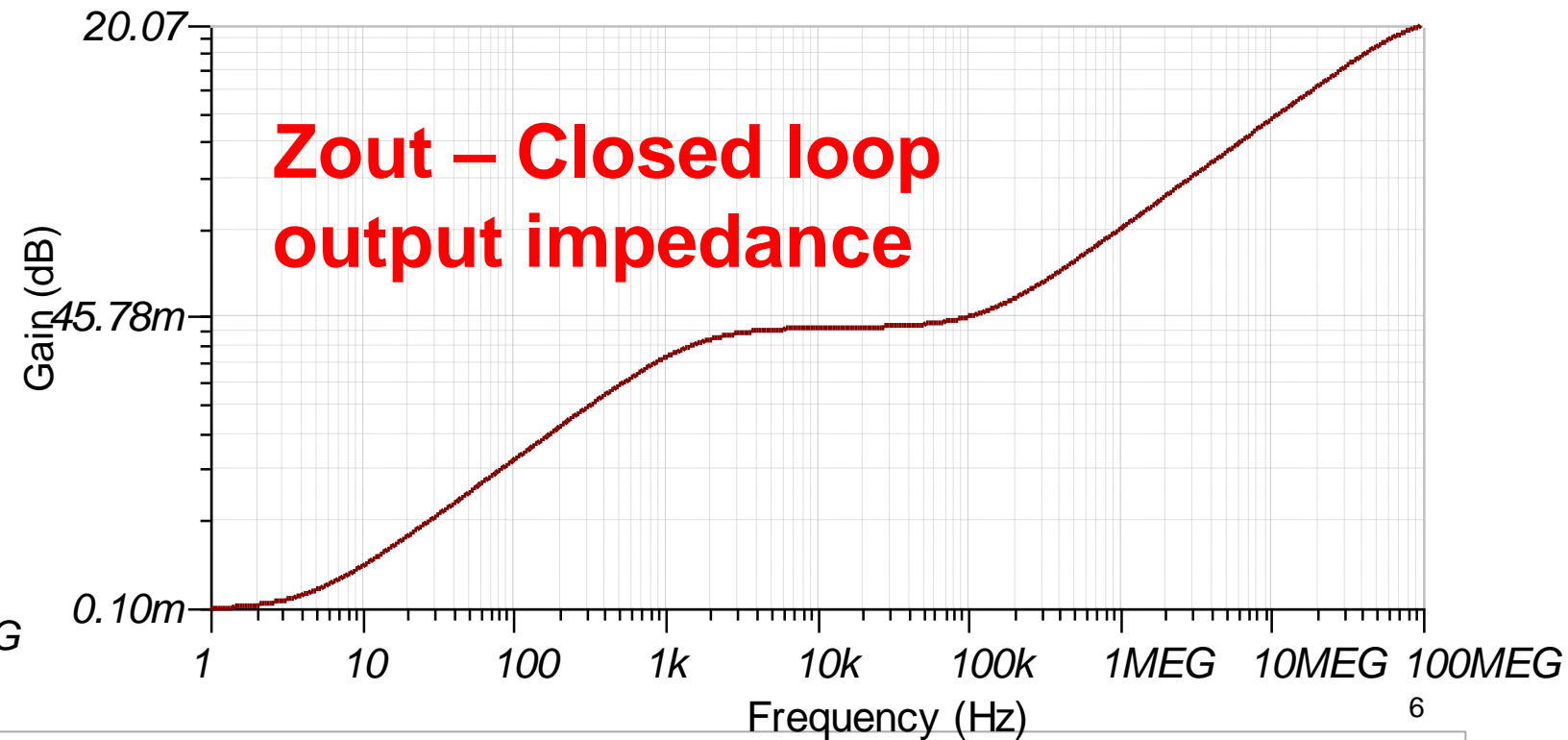
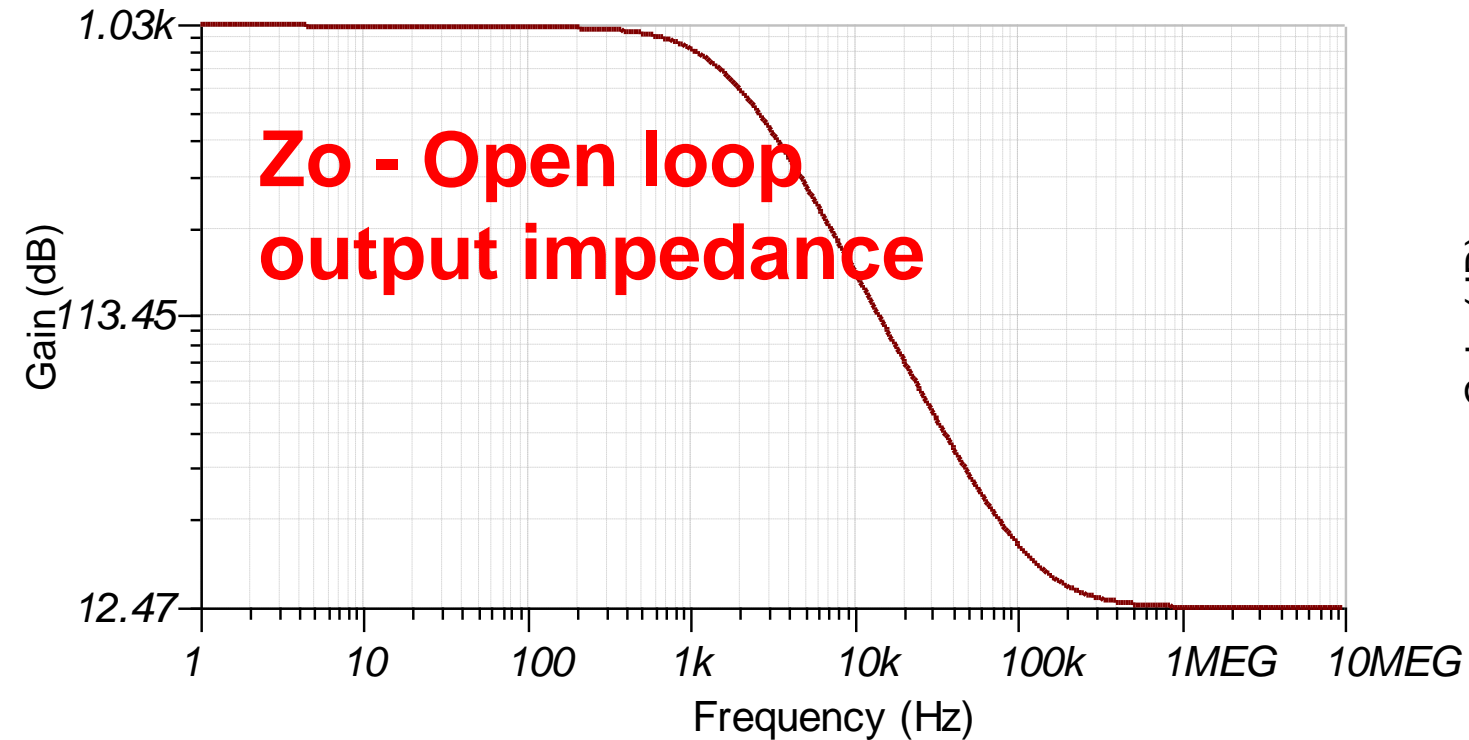
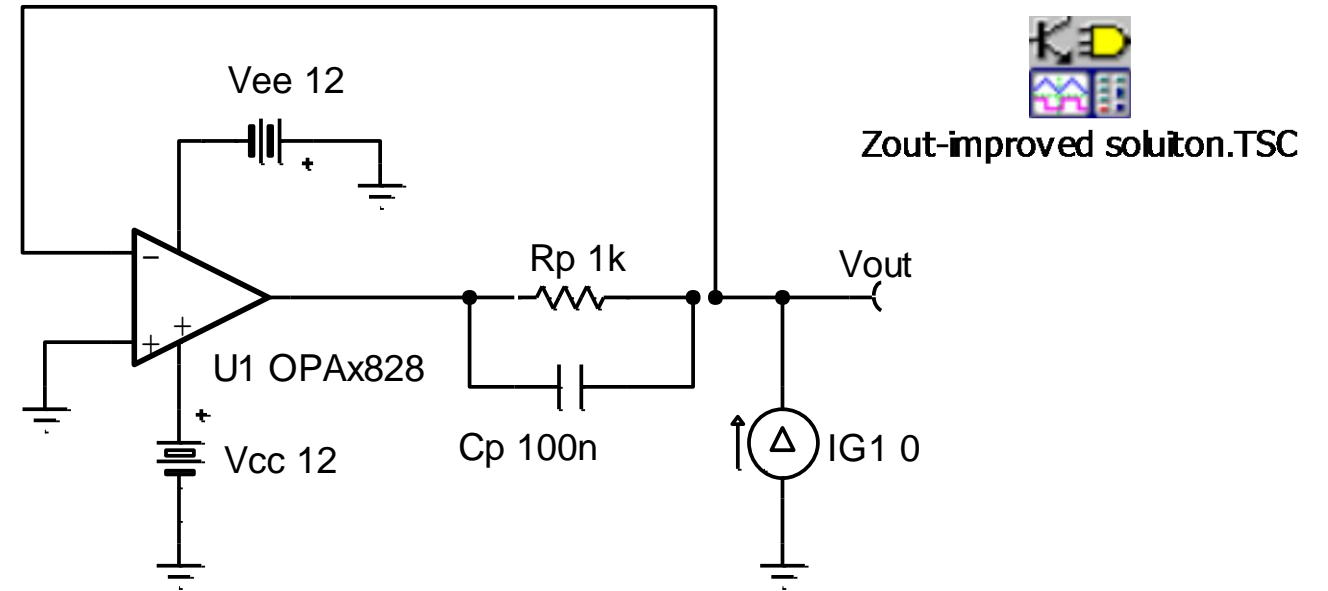
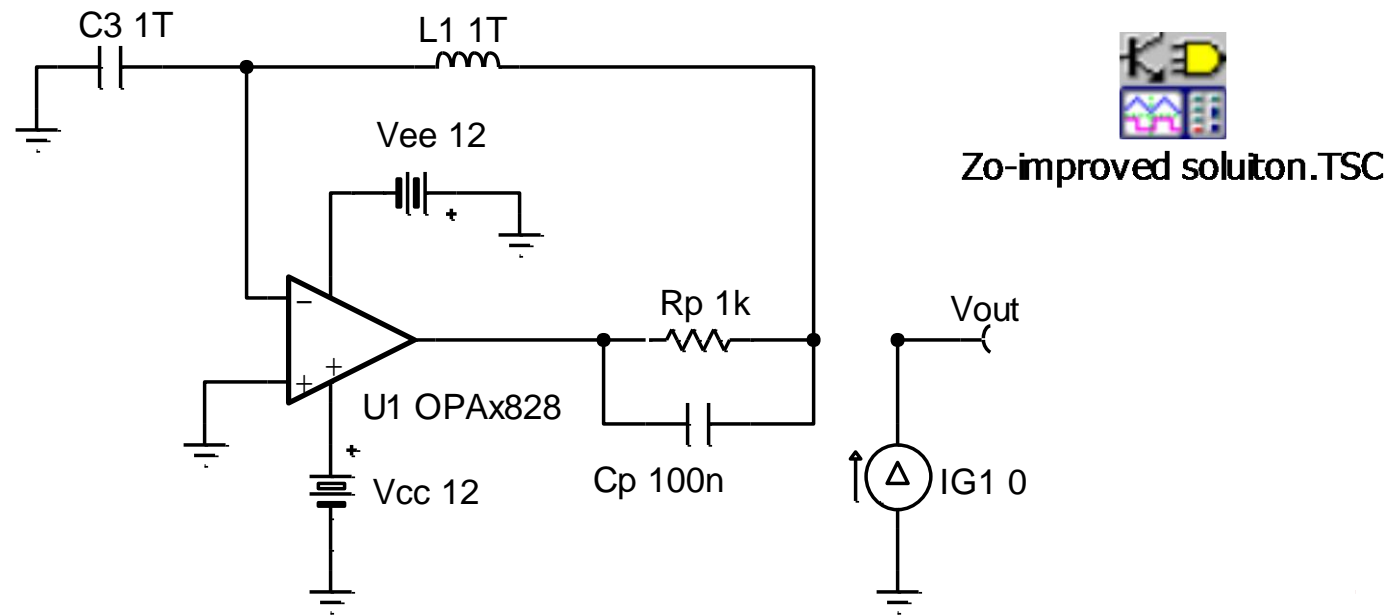
$$A_{OL}\beta = V_o$$

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01/2019 - DL



OPA828\_Stability Check.TSC

# Zo and Zout with Improved Solution



**Thanks for your time!**  
**Please try the quiz.**

# Questions: Protecting Low Voltage ADC

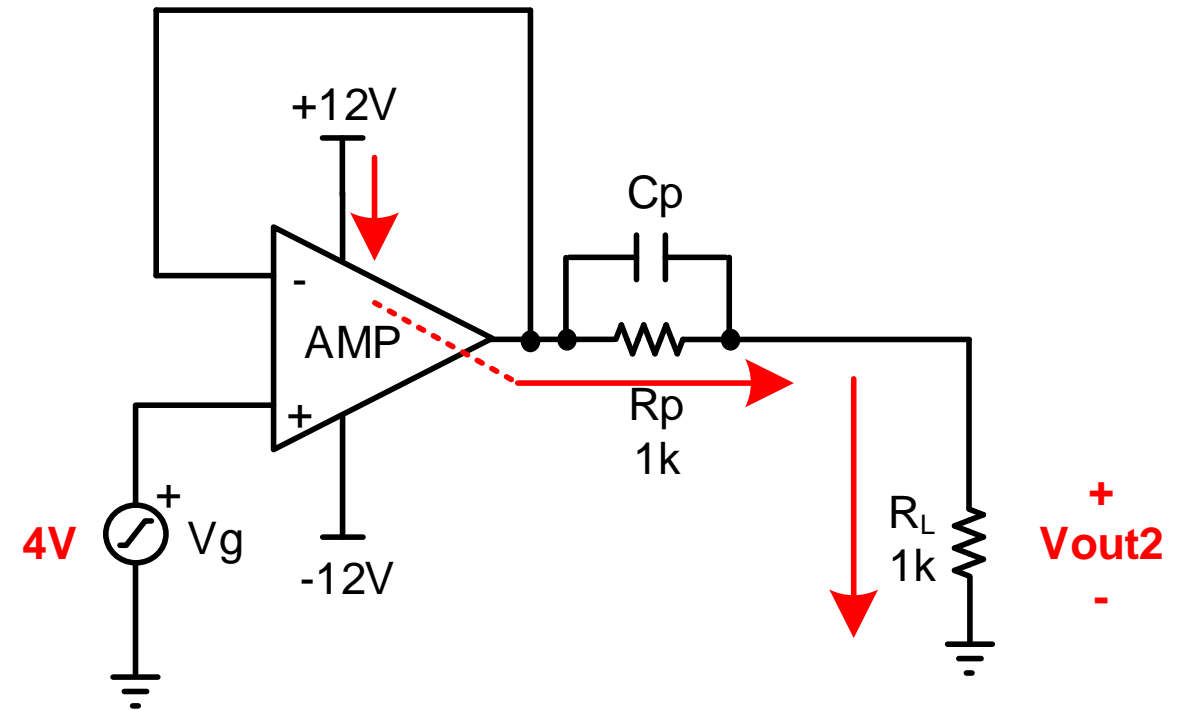
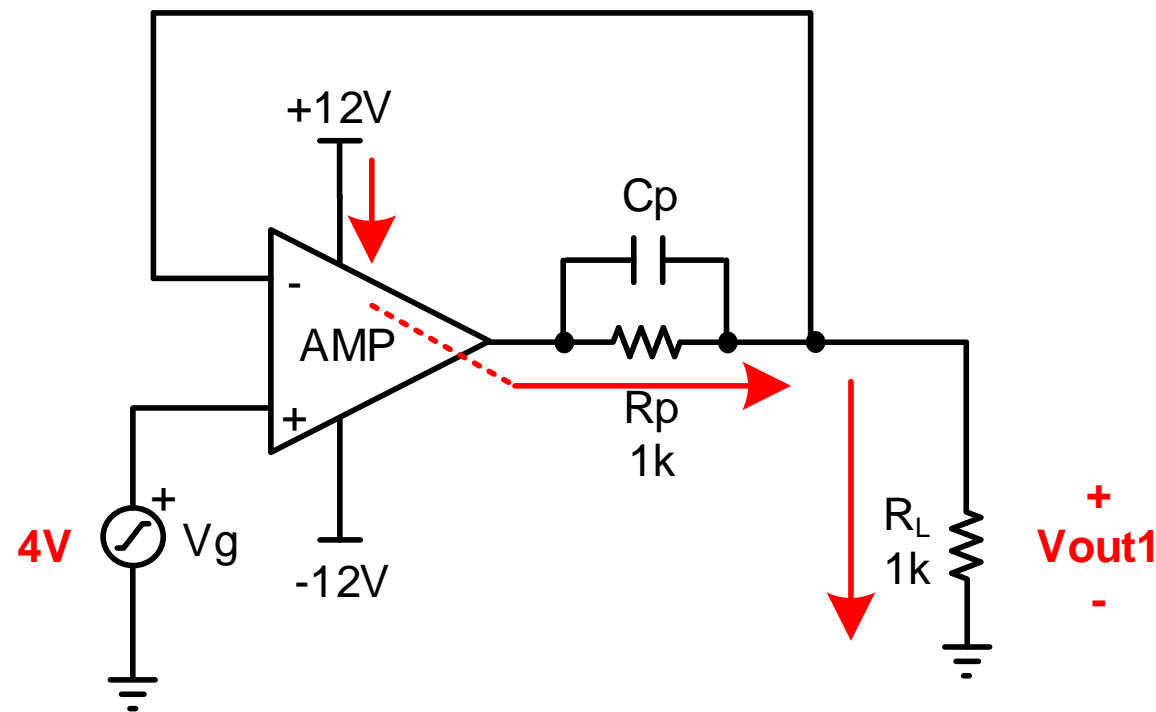
1. For the circuits below, what is the voltage delivered to the load?

a.  $V_{out1} = 4V$ ,  $V_{out2} = 4V$ .

b.  $V_{out1} = 2V$ ,  $V_{out2} = 4V$ .

c.  $V_{out1} = 4V$ ,  $V_{out2} = 2V$ .

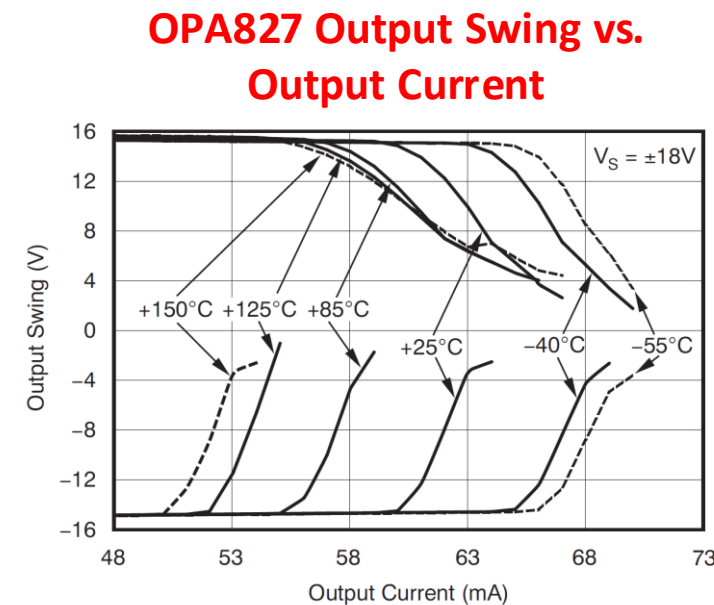
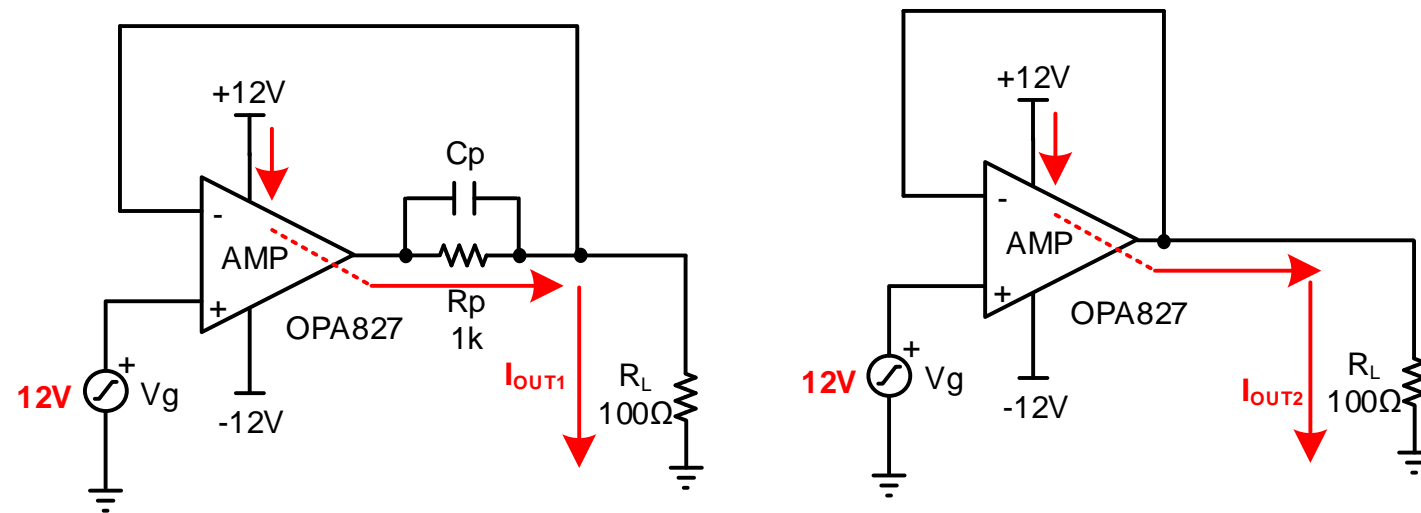
d.  $V_{out1} = 2V$ ,  $V_{out2} = 2V$ .





# Questions: Protecting Low Voltage ADC

2. For the circuits below, what is the current delivered to the load?
- a.  $I_{out1} = 12\text{mA}$ ,  $I_{out2} = 120\text{mA}$ .
  - b.  $I_{out1} = 120\text{mA}$ ,  $I_{out2} = 120\text{mA}$ .
  - c.  $I_{out1} = 12\text{mA}$ ,  $I_{out2} = 60\text{mA}$ .**
  - d.  $I_{out1} = 120\text{mA}$ ,  $I_{out2} = 60\text{mA}$ .



**Thanks for your time!**



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