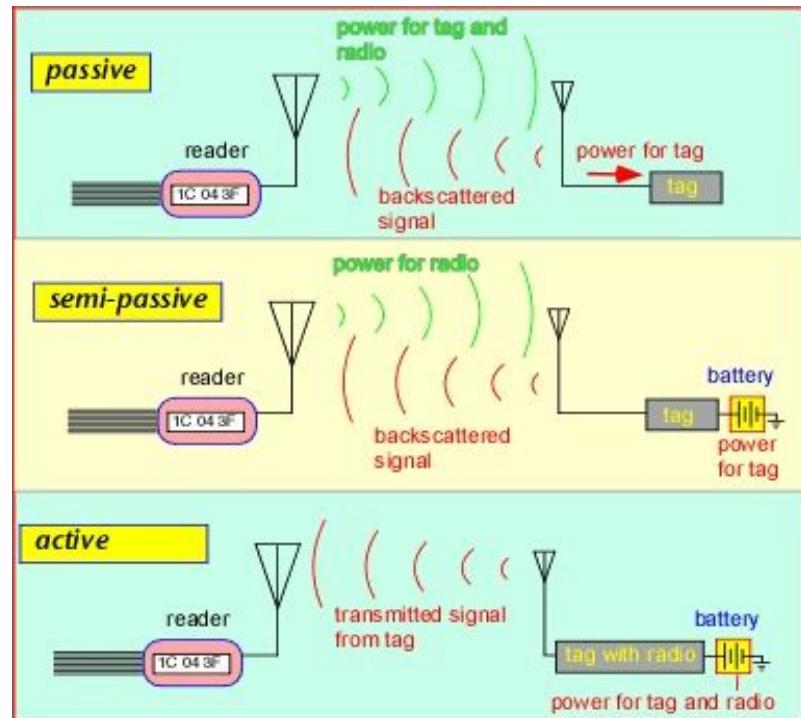


# Mixed Signal NFC Temperature Sensor

Giovanni Michel, Jack Thoene, Yuqing Wang

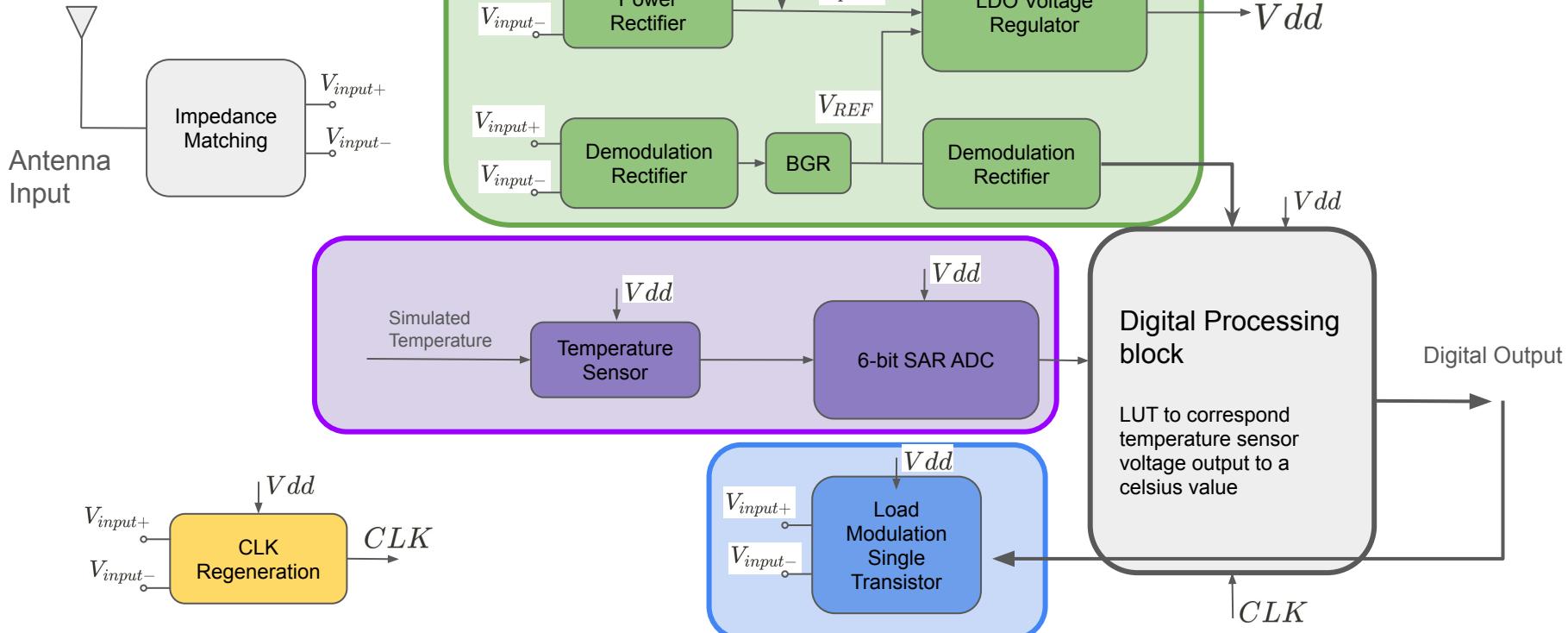
# Project Background: Semi-Passive NFC

- Send temperature data using RF backscatter
  - Specific frequency 13.56MHz, applicable for short distances (~20cm)
  - e.g. secure contactless payment, key cards, etc
- Power harvesting through inductive coupling
- Small battery to enable logic on chip

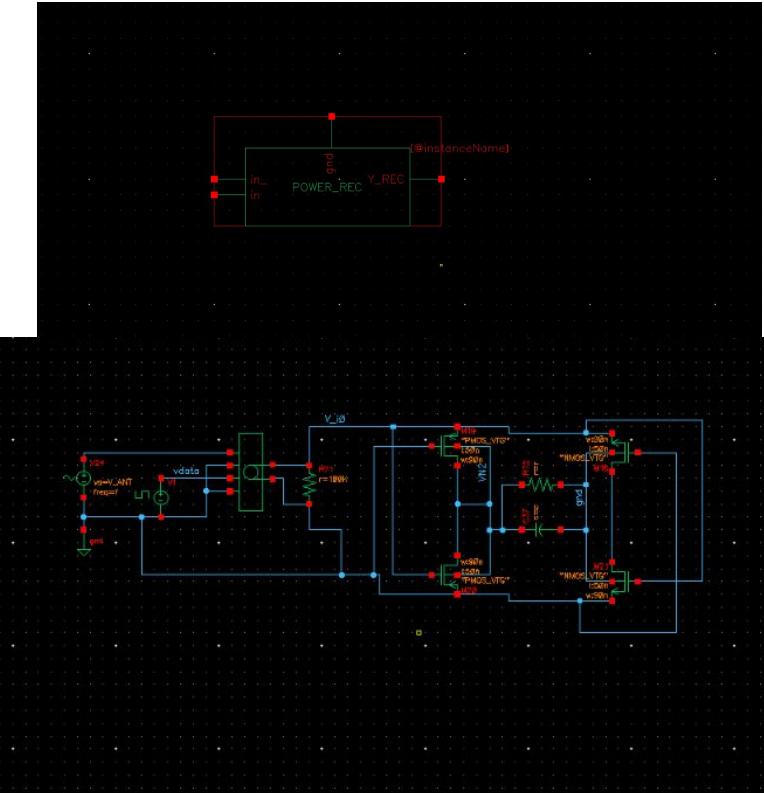
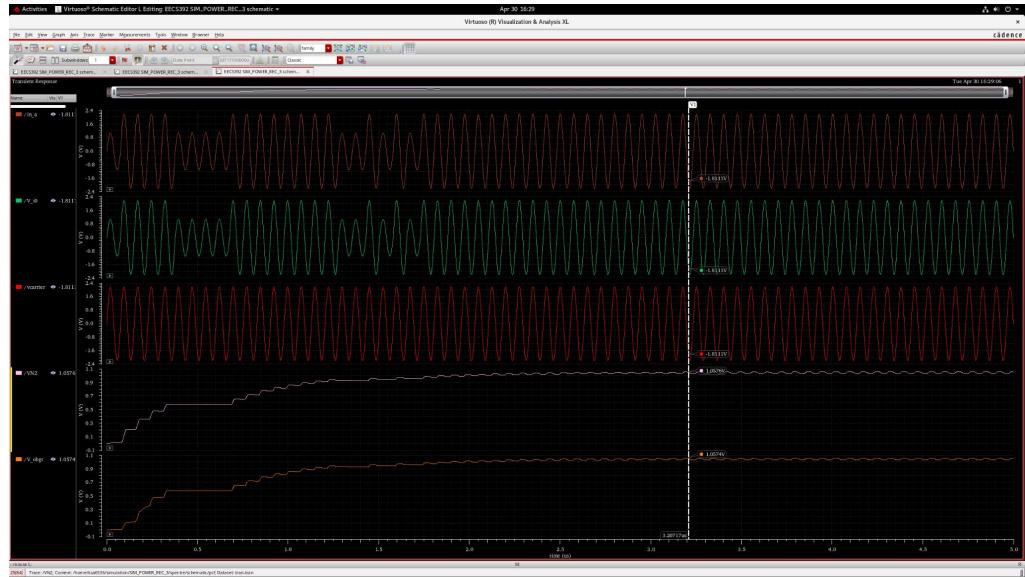


<https://www.mikroe.com/blog/what-is-rfid>

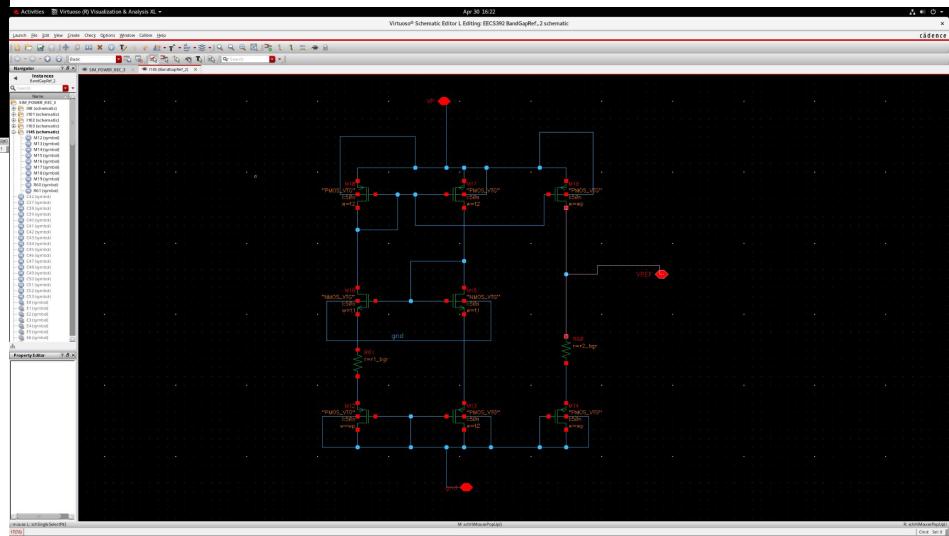
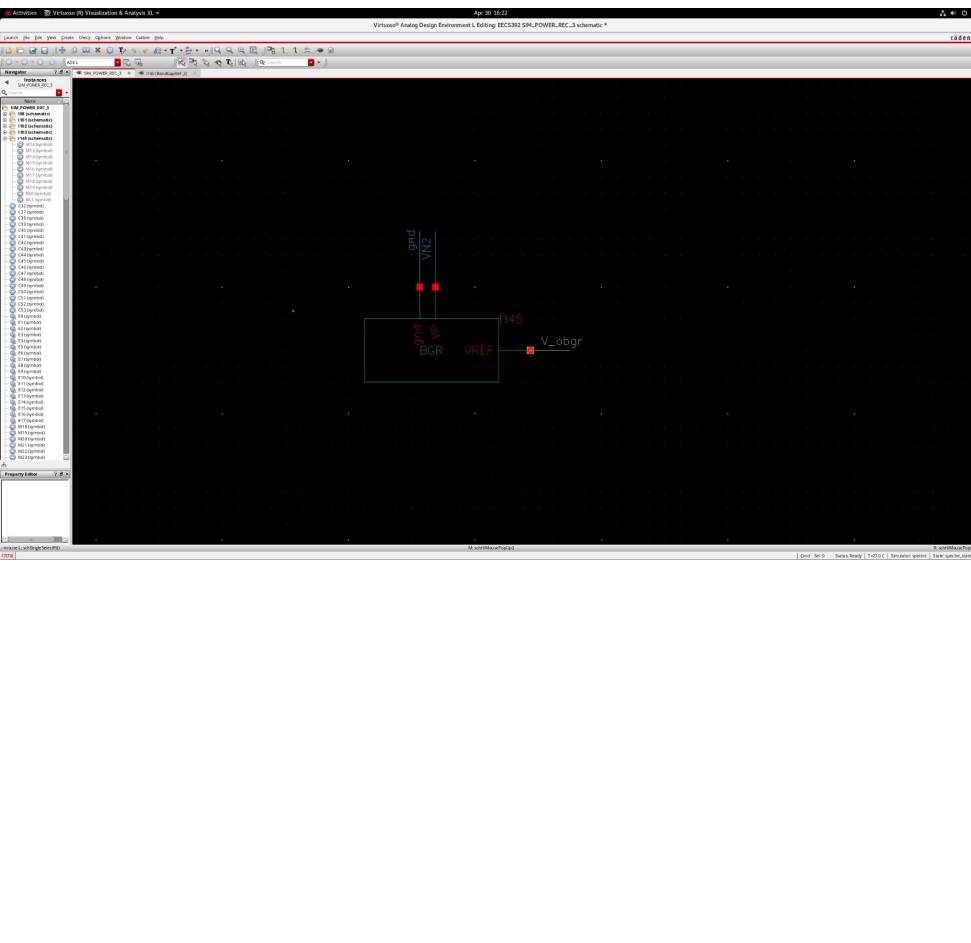
# Circuit Block Diagram



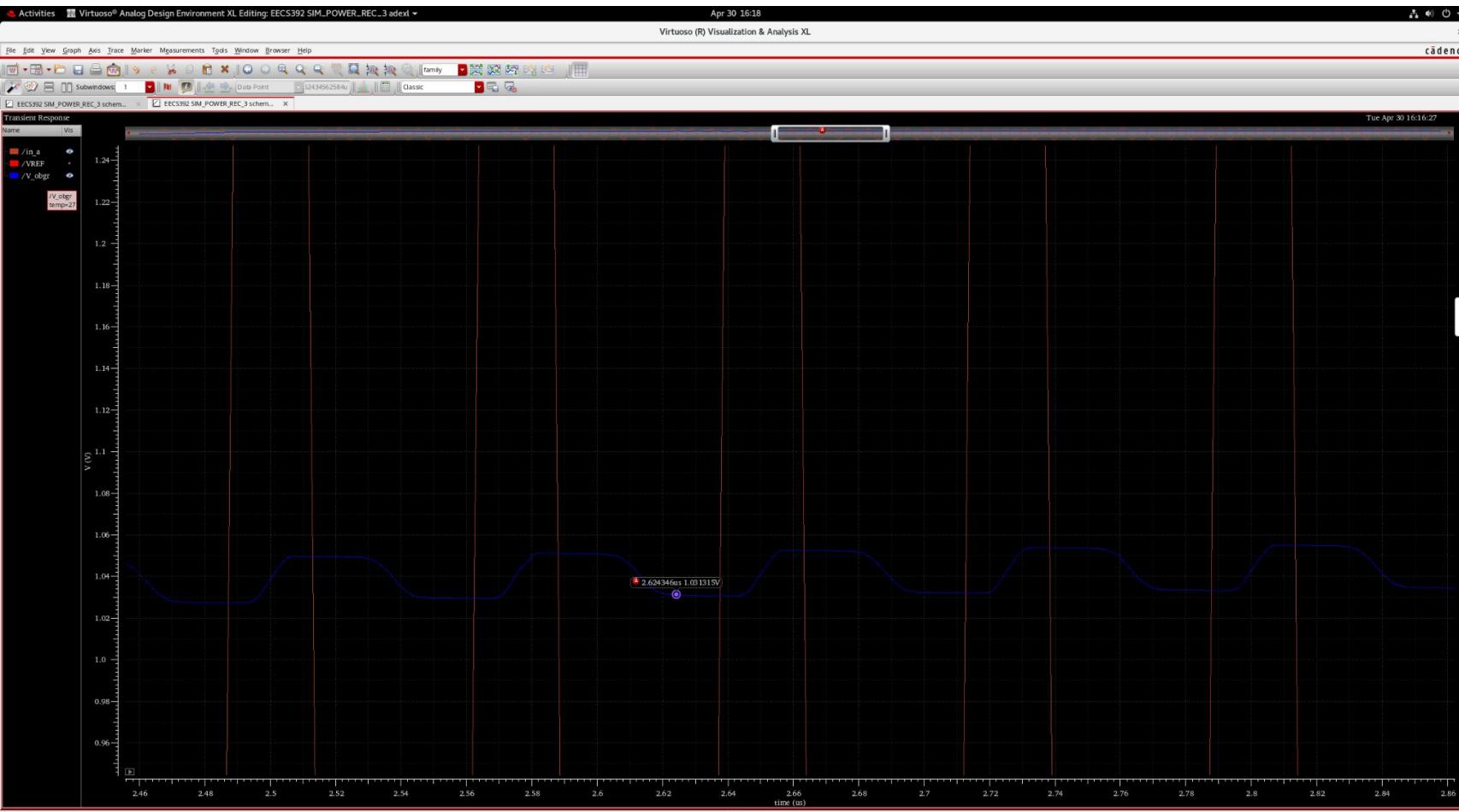
# Power Rectifier



# Bandgap Ref circuit



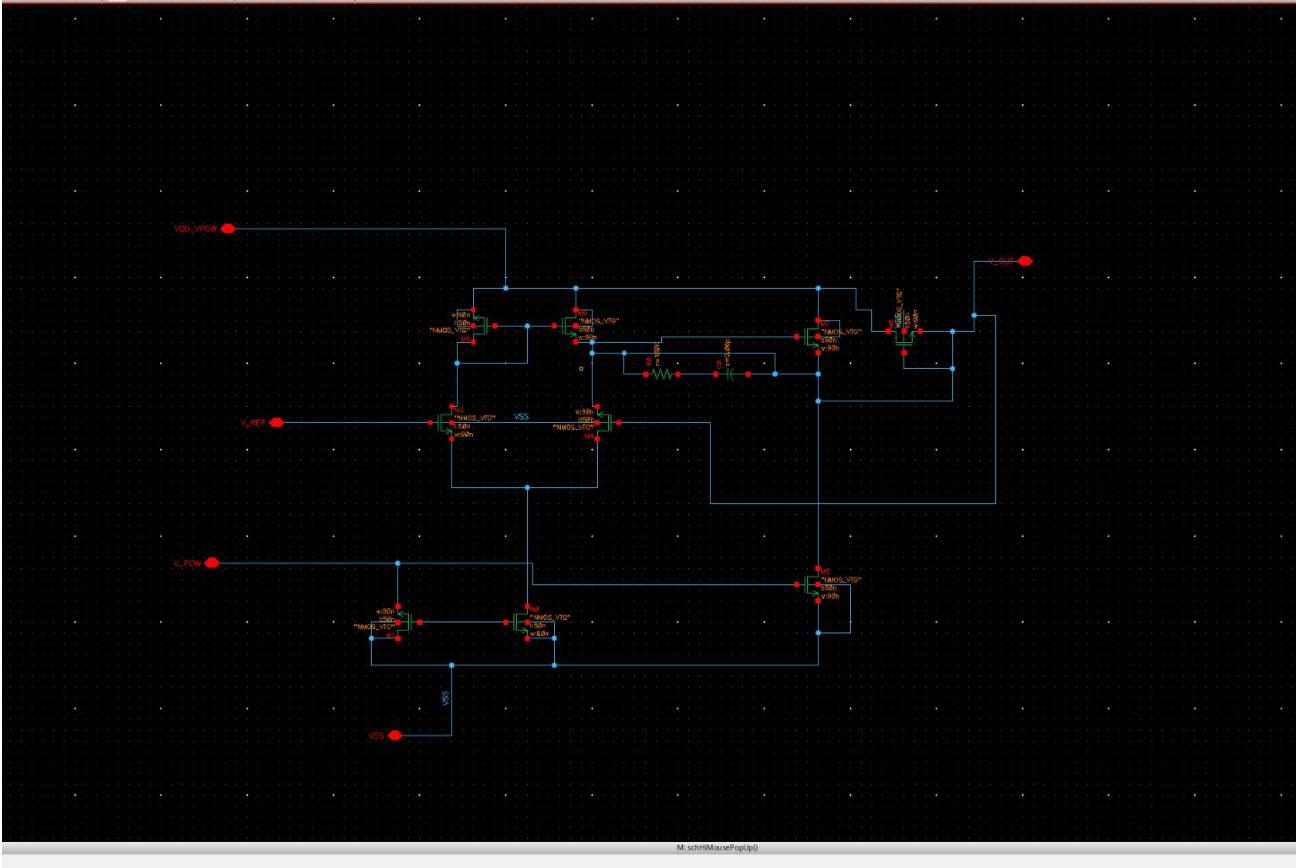
# Bandgap Ref circuit @27C



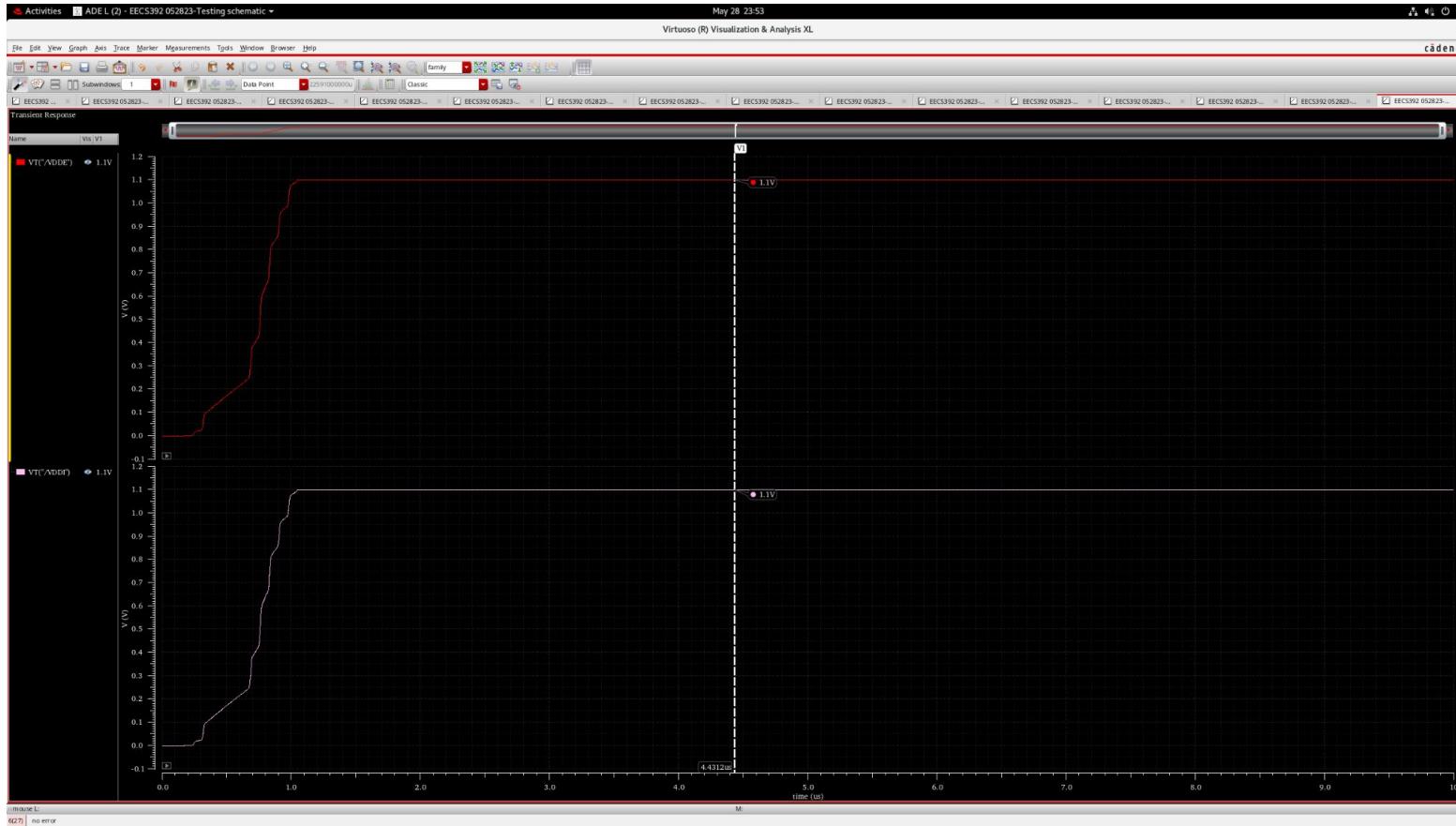
# Bandgap Ref circuit @-27C



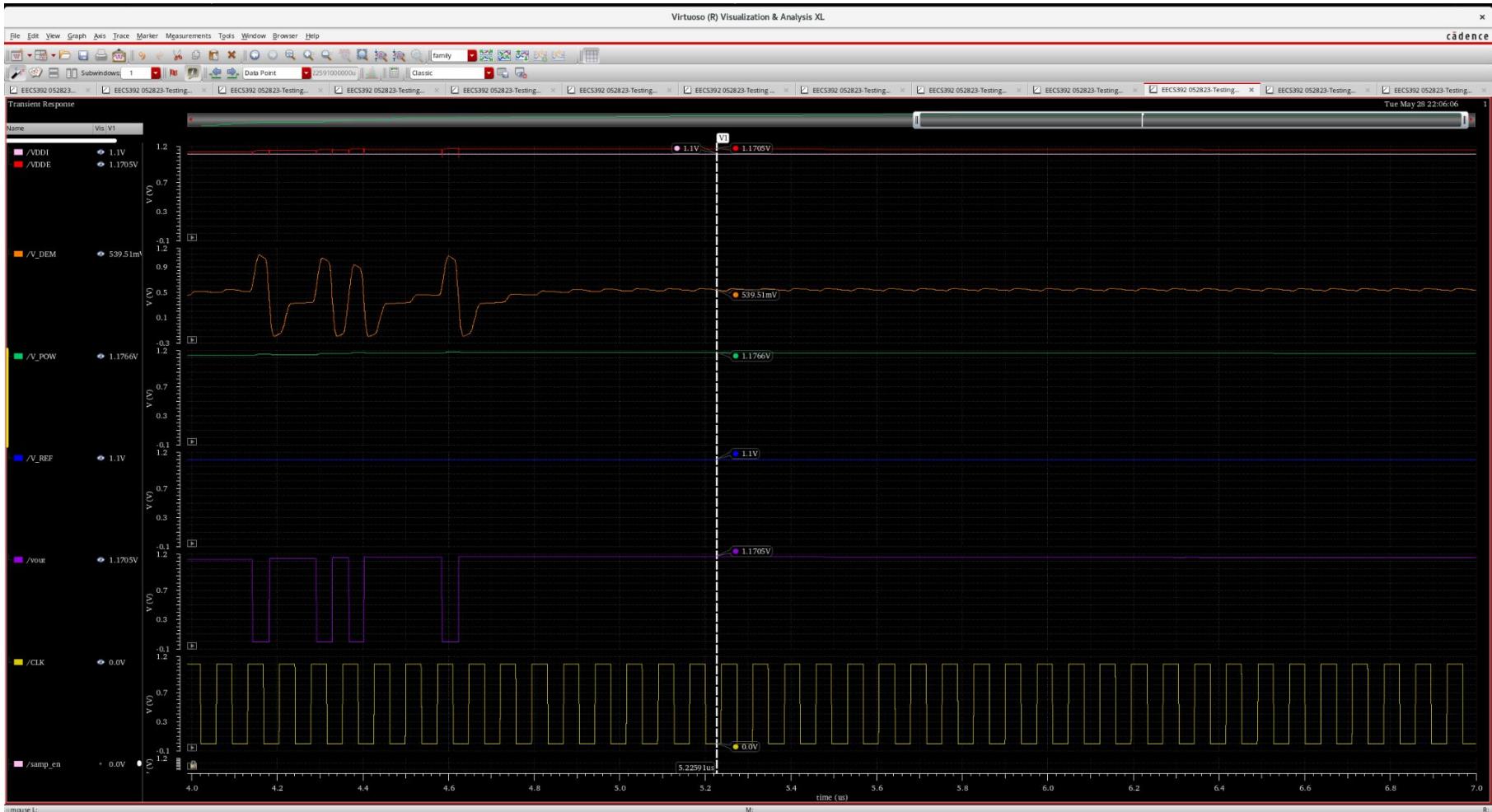
# Error amplifier (LDO)



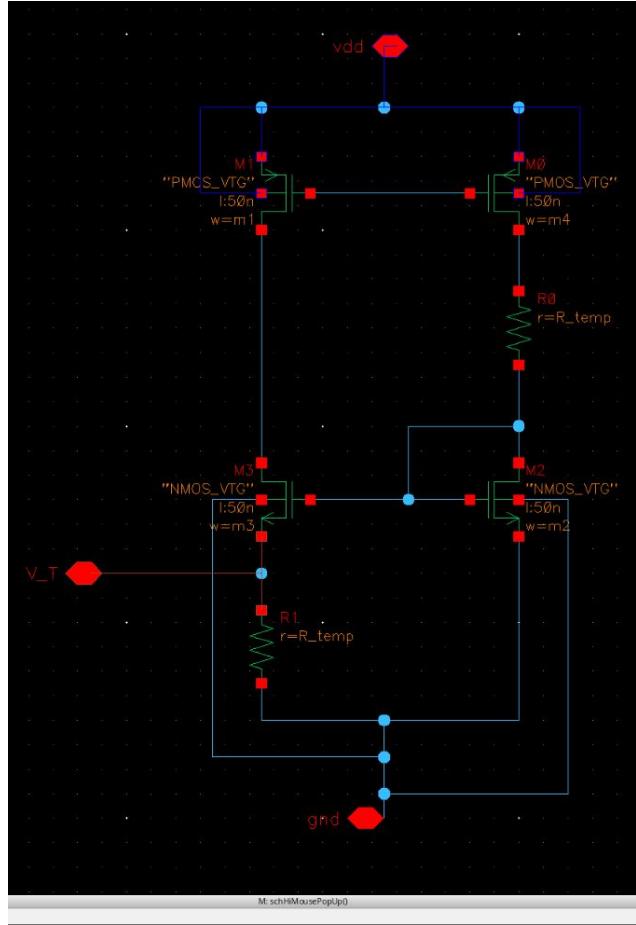
# LDO Voltage Regulator



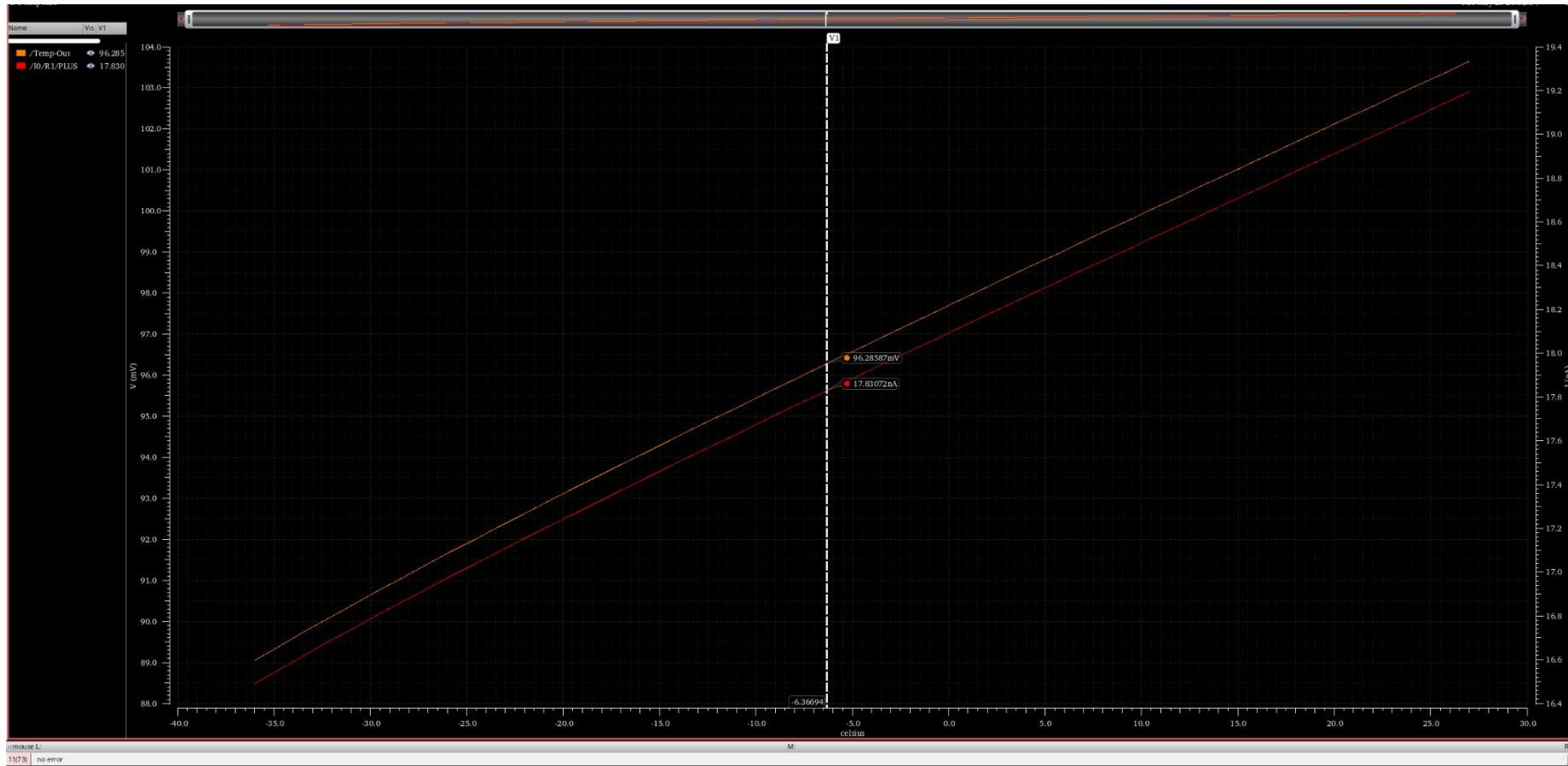
# Power Components



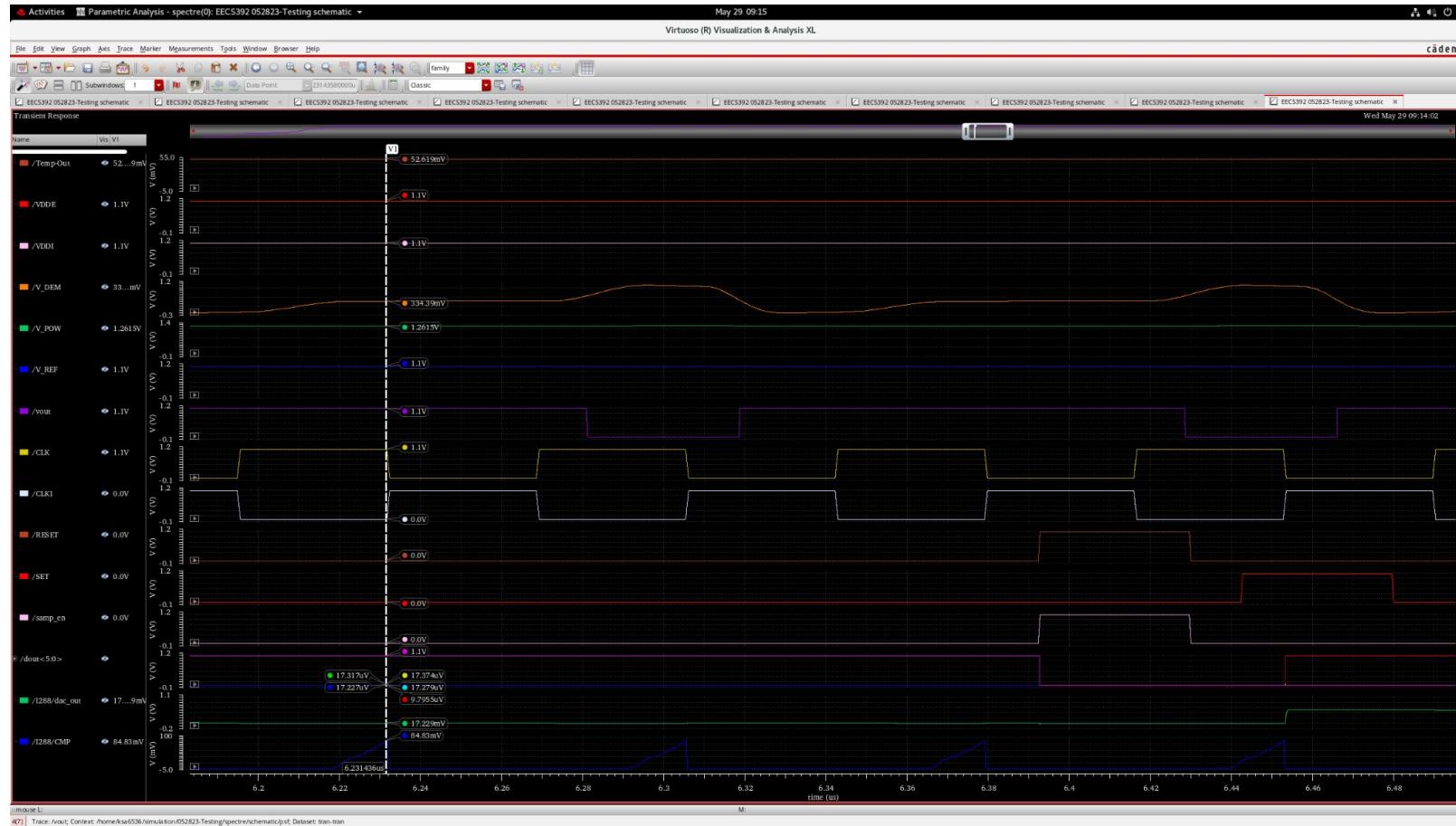
# Temperature Sensor Schematic



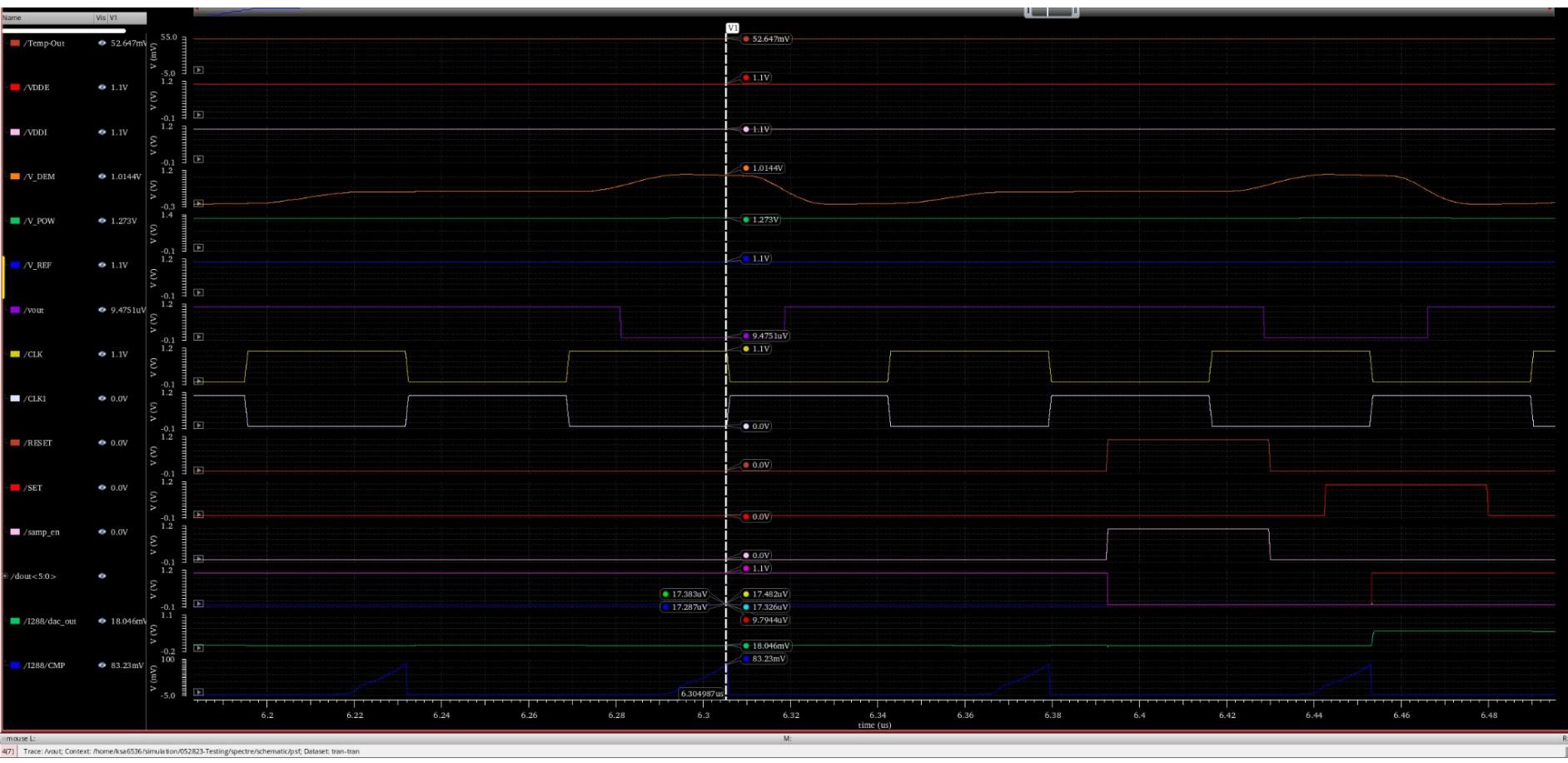
# Temperature Sensor Simulation



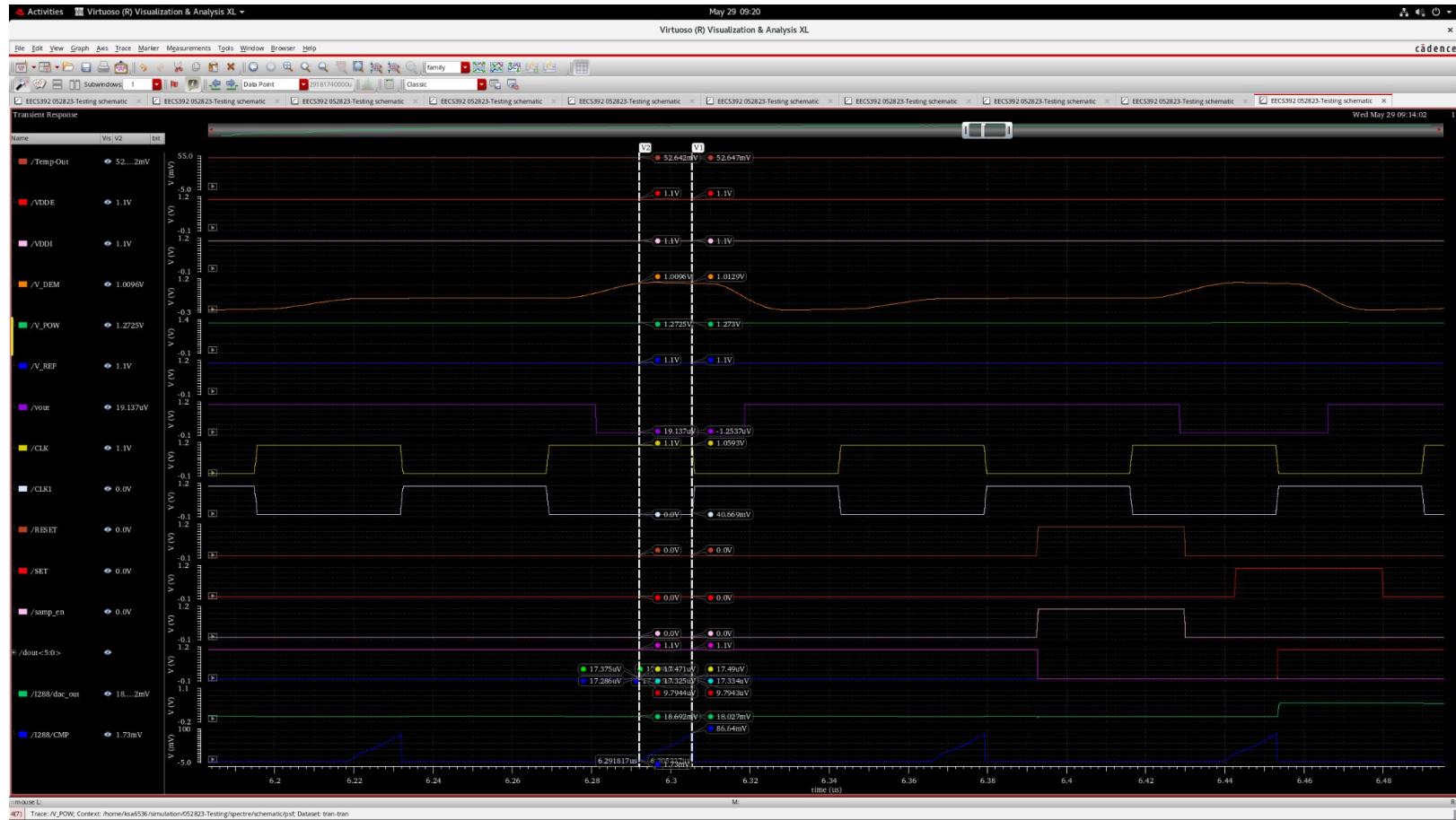
# Temperature Sensor and Power Components with ADC/DAC



# Temperature Sensor and Power Components with ADC

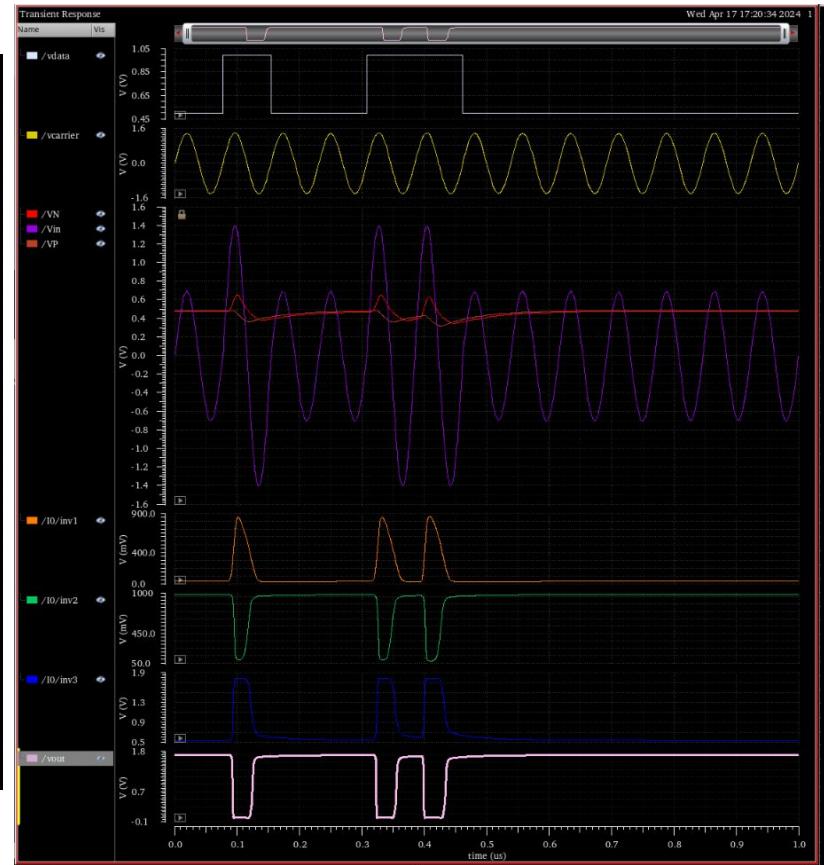
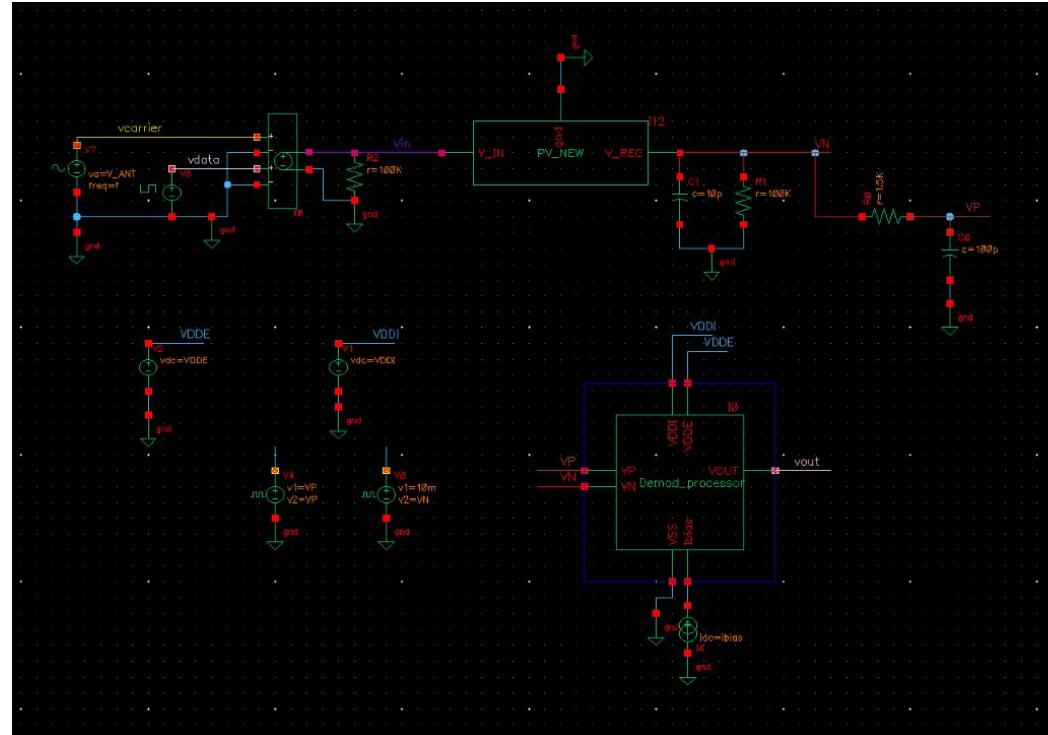


# Temperature Sensor and Power Components with ADC/DAC



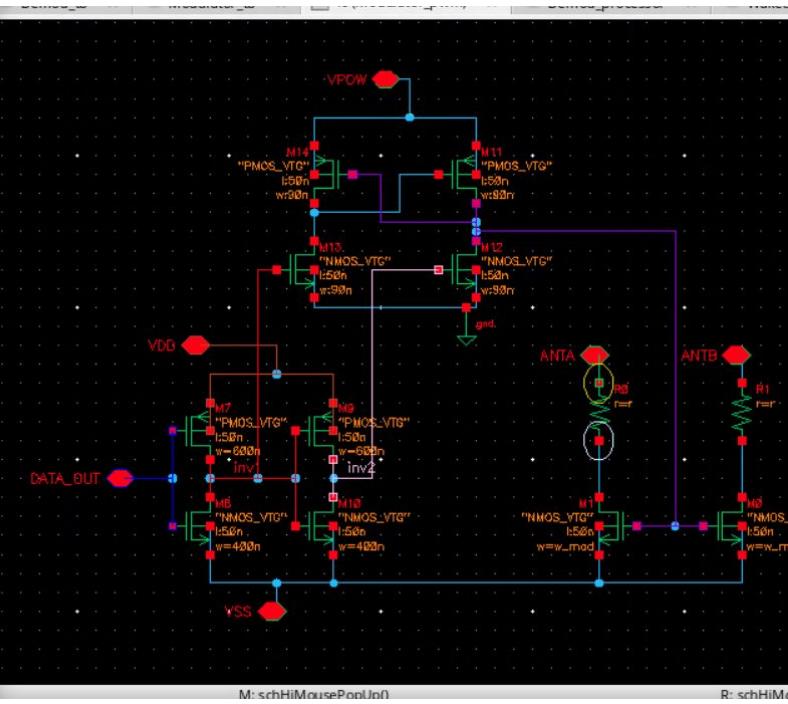
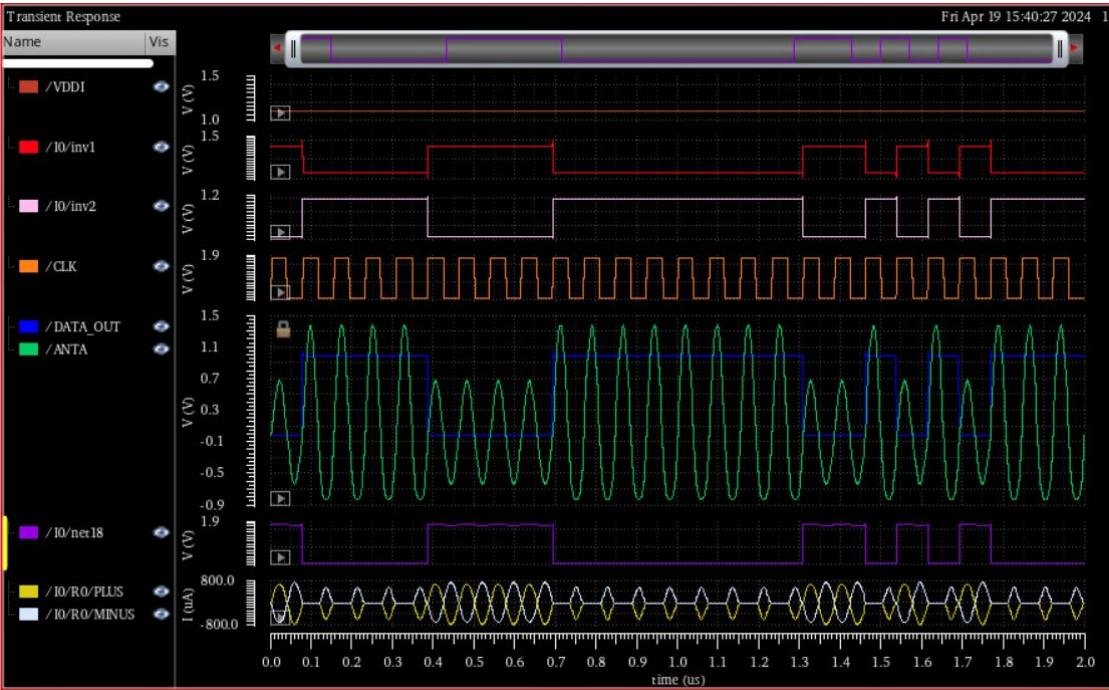
# Demodulation & Output Modulation

# Input Demodulation



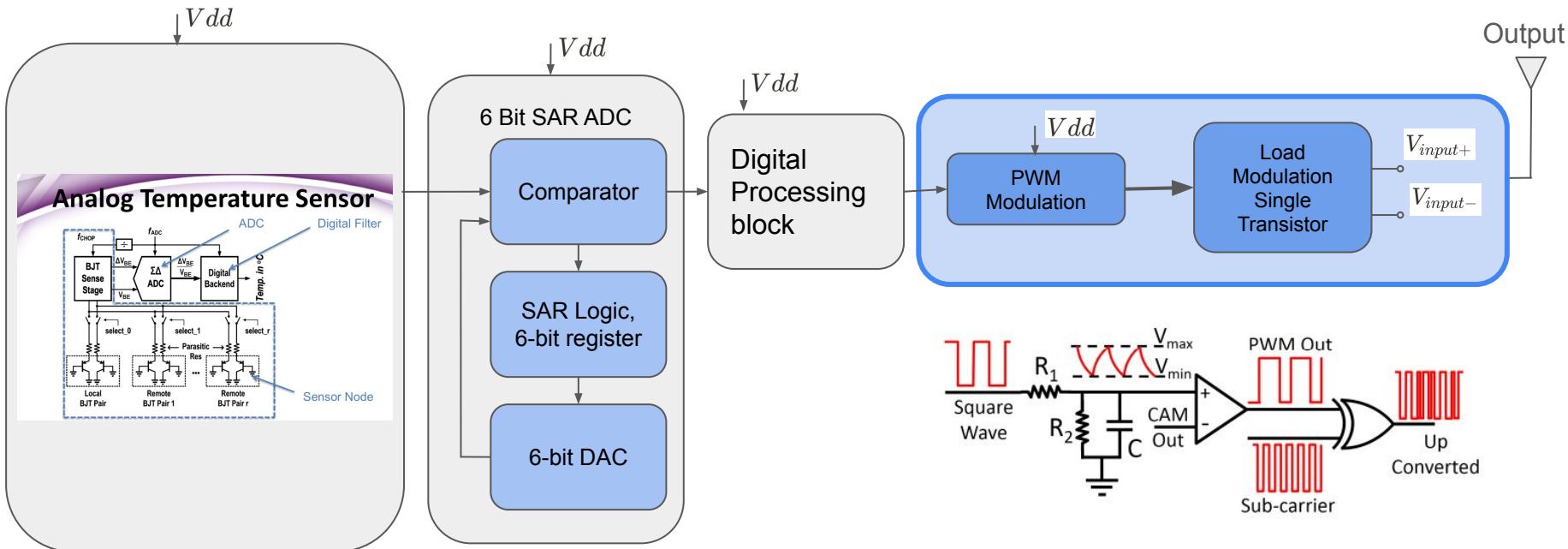
# Output modulation

Takes output from digital block(blue) and modulates the antenna voltage (green)

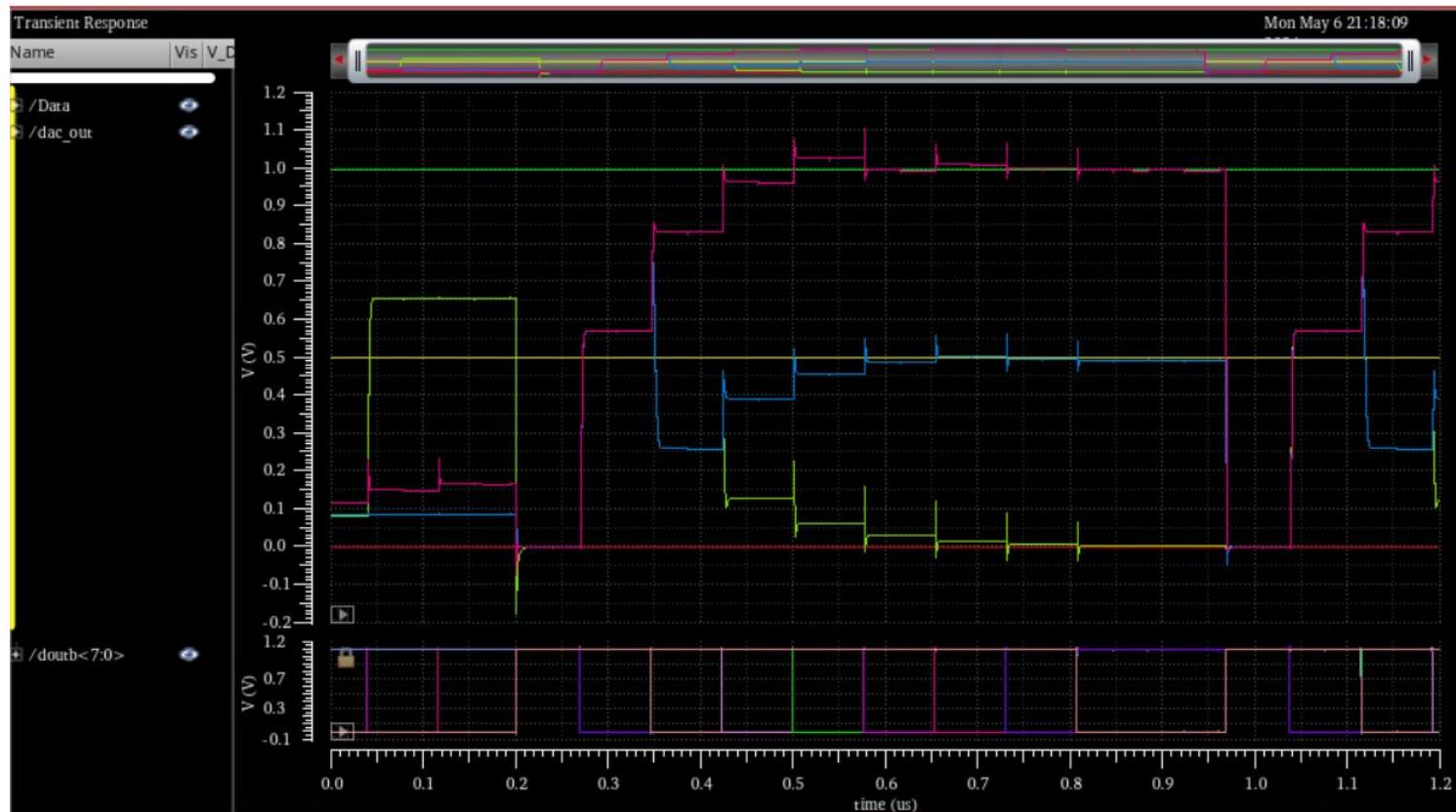


# Sensor datapath

- Low power consumption Successive Approximation Register ADC
- Digital (ASK/PSK) and analog PWM modulation on output signal



# SAR ADC

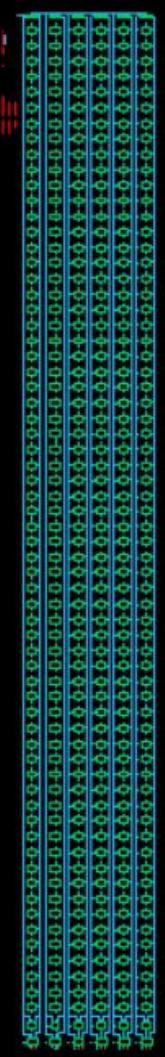
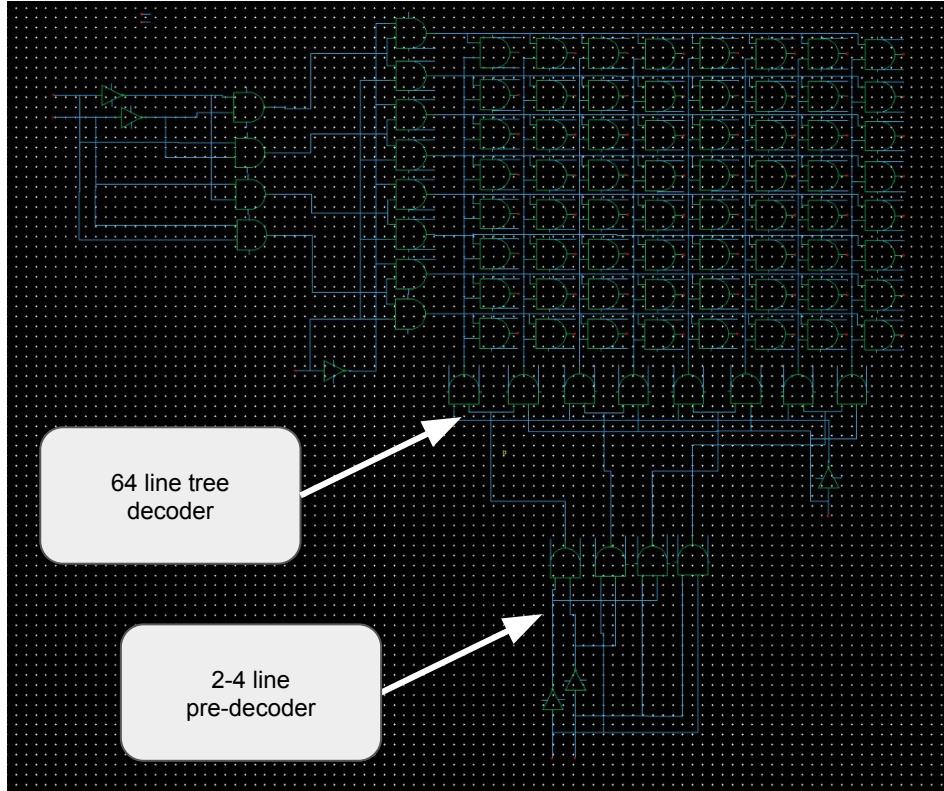


# SAR ADC -> Register shifted output

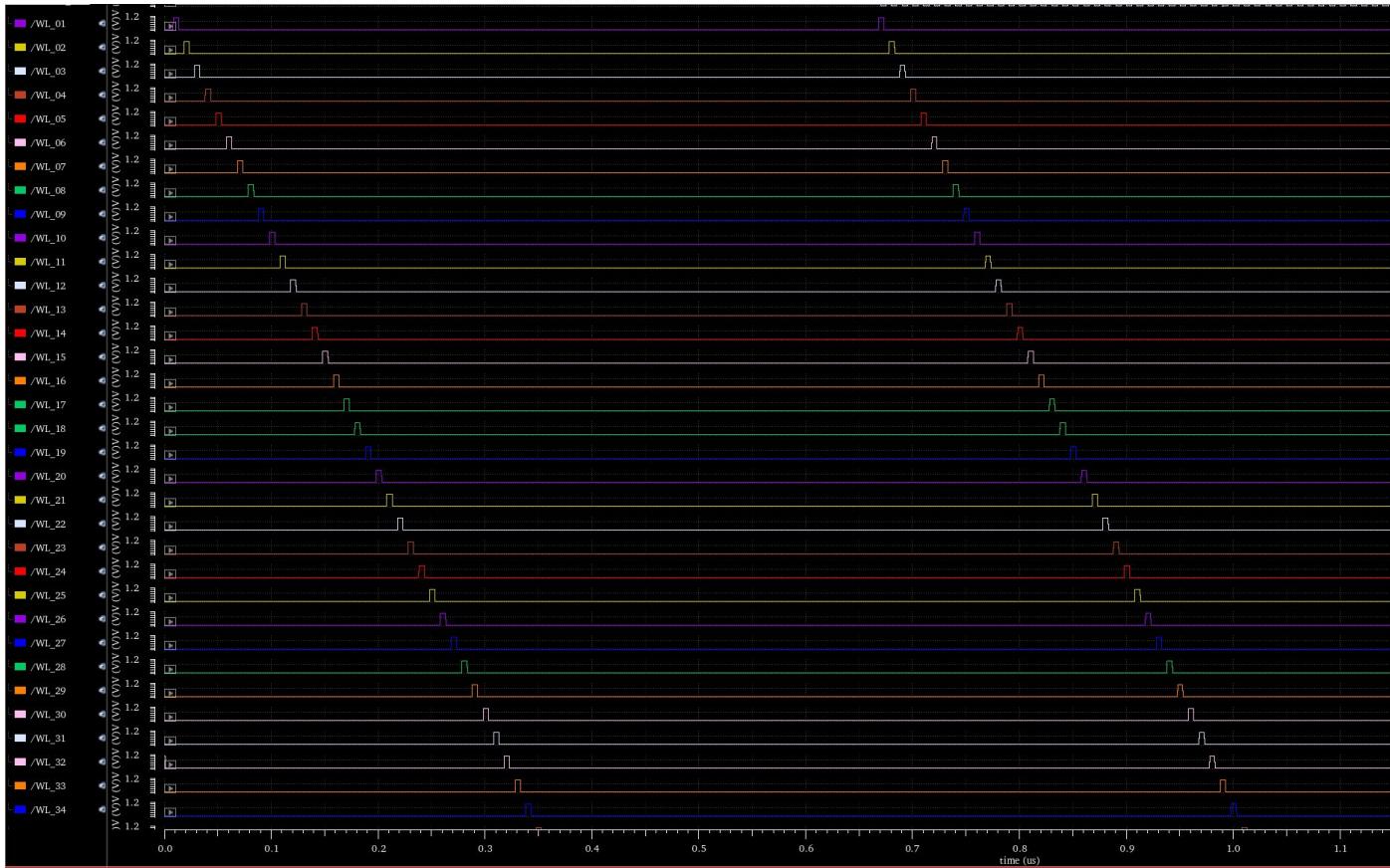


# 6-64 Decoder & SRAM

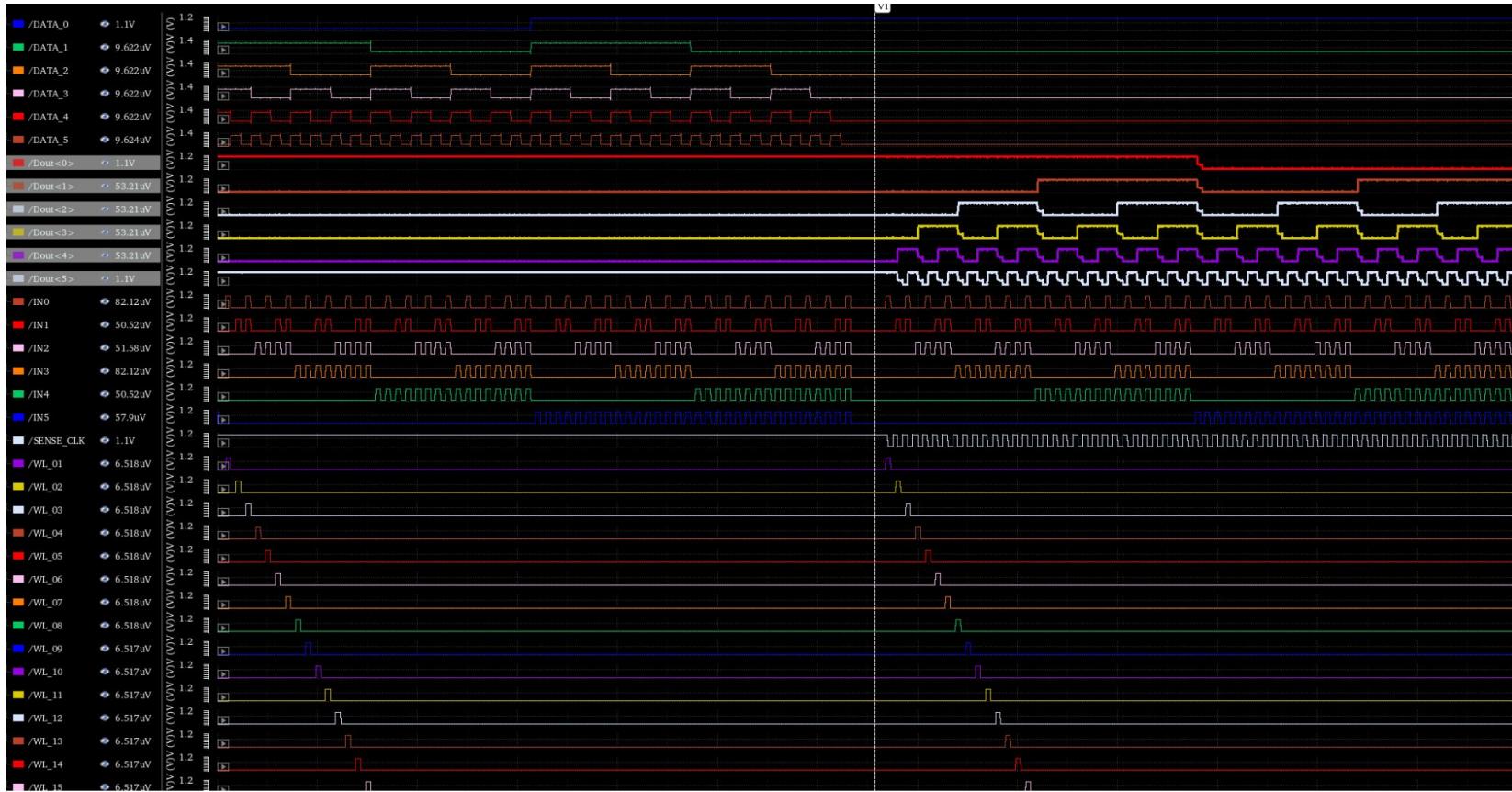
# 6-64 Decoder → 6x64 SRAM



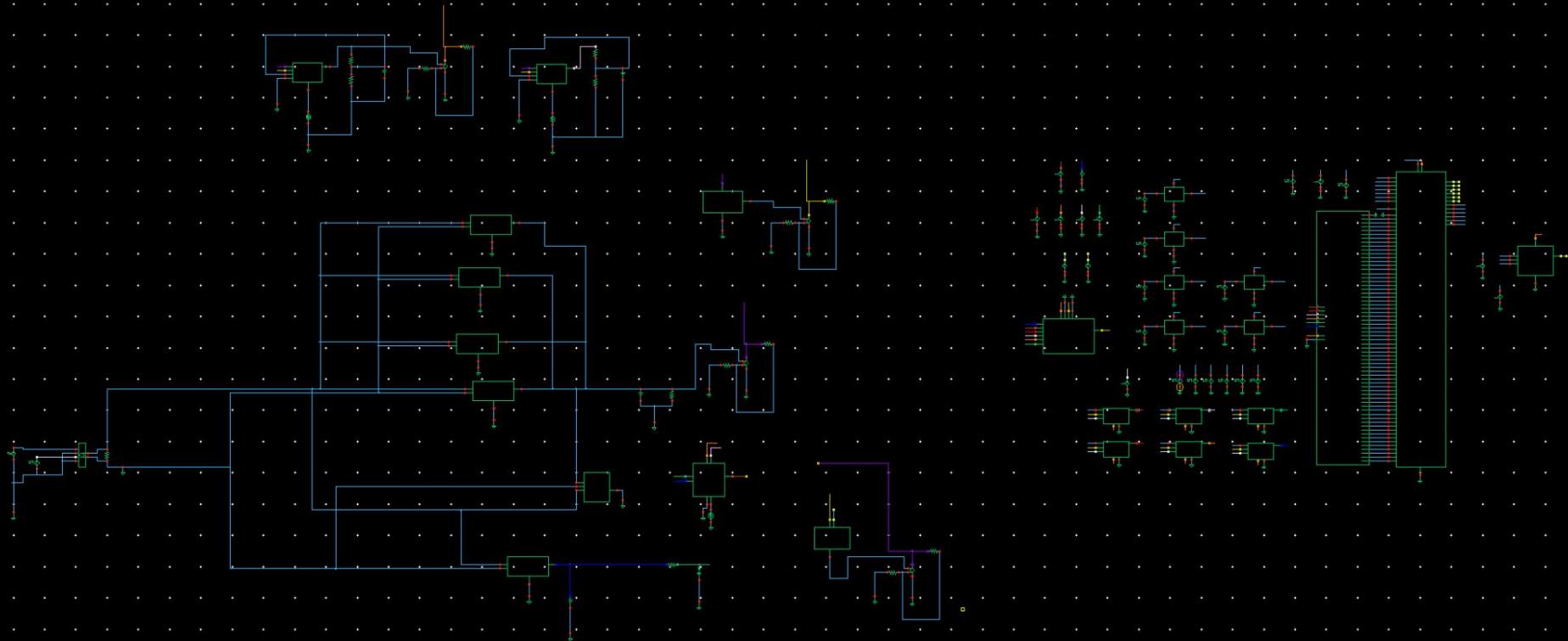
# 6-64 Mux Ouput Simulation



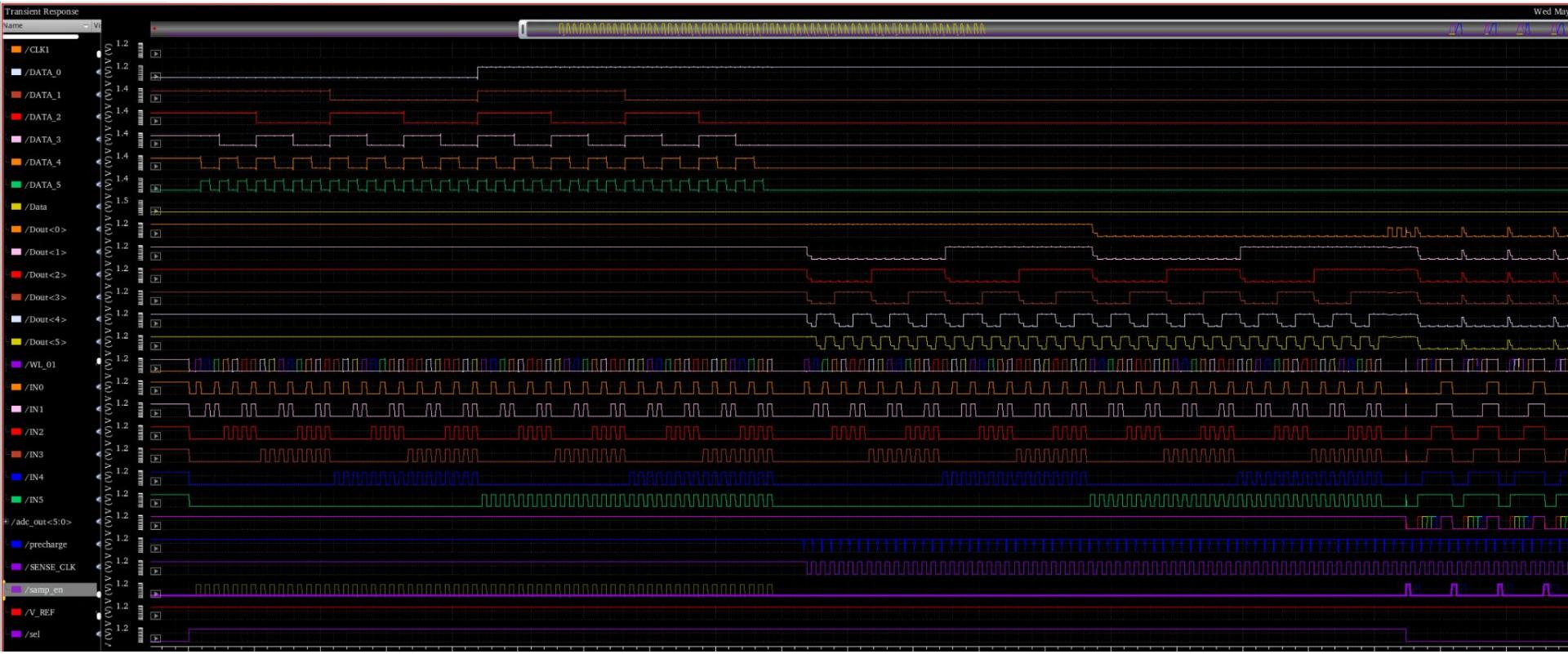
# Digital LUT simulation: Read & Write



# Combined Testbench



# Combined Testbench



# Results & Other considerations

- Overall deliverable completed: ASIC Chip Simulation in Cadence Virtuoso (analog components as well as the schematic equivalent of the digital LUT)
  - Input: Temperature data for corner analysis, RF signal voltage and resistance
  - Output: data sent through RF (shown through modulation of the antenna voltage) of a binary value representing the temperature sensor reading in celsius
- Ethicality: disposable asic environment risk, security
- Future: self-generated or RX programming capabilities, further reducing power

<u>Giovanni</u>	<u>Yuqing</u>	<u>Jack</u>
Power Rectifier	Demodulation RX & Load modulation TX	Digital LUT
LDO	SAR-ADC	SRAM integration
Temp Sensor	SRAM & shift register	Digital Filter