DTCP Weekly meeting slides

EMG Design: ADS1299 Specs and Example Applications

Dmytro Stavskyi

10/21/2025

University of Florida

Objective

- Determine whether ADS1299 is suitable for EMG recording and whether the specs are adequate in the context of a battery-powered system

Methods

- ADS1299 datasheet
- Literature Review:
    1. B. Rodríguez-Tapia, I. Soto, D. M. Martínez and N. C. Arballo, ”Myoelectric Interfaces and Related Applications: Current State of EMG Signal Processing–A Systematic Review,” in IEEE Access
- EMG system stages: Sensing -> Amplifying -> Filtering -> ADC

Results (General characteristics)

- Two power supplies:
  1. Analog: from 4.75 V to 5.25 V (will need to add a 5V boost converter)
  2. Digital: from 1.8 V to 3.6 V (we have 3.3 V power for the MCU)
- Internal clock frequency (can use external clock of up to 2.25 MHz): 2.048 MHz
- Assuming AVDD - AVSS = 5V, DVDD = 3.3V, data rate of 250 SPS and 6 channels (there are options for 4, 6, or 8 channels):
  1. Passive power (power-down mode) consumption: 10 µW
  2. Active power (normal mode) consumption: 30-33 mW

Results (SPI, PGA)

- SPI:
    1. Can setup and control the device with SPI (commands include: WAKEUP, STANDBY, START, STOP)
    2. Serial CLK: minimum period of 50 ns (maximum frequency of 20 MHz; MCU can generate 12 MHz SCLK at most)
- Programmable Gain Amplifier:
    1. Gain of up to 24x
    2. EMG signals are in range of 0 - 10 mV [1]

Results (Filtering)

- Filtering:
    1. Frequency of EMG signal is 0 - 500 Hz [1]
    2. For the EMG systems of ”muscular activation monitoring”, filters used includes band-pass of 500 Hz and low-pass filters [1]

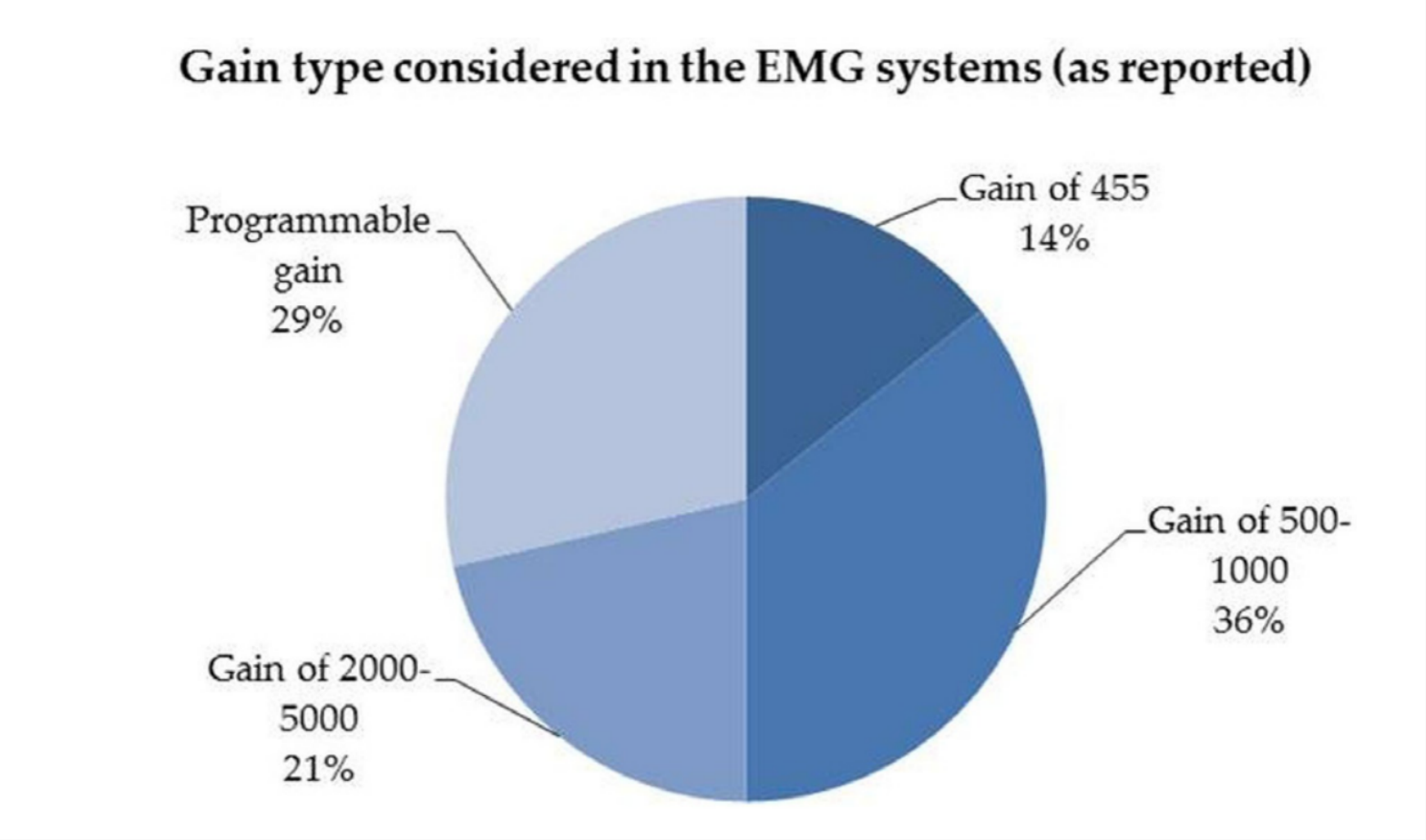
Results (ADC)

- ADC:
    1. Resolution: 24 bits (Assuming reference of 4.5V, (4.5V / 2ˆ24) = 0.268 µV)
    2. Sampling (data) rate: from 250 SPS to 16 kSPS
    3. ”21 papers reported sampling frequency values ranging from 1000 to 1500 samples per second; for the remaining 3 papers, the sampling frequency ranges from 2000 to 23434 samples per second” [1]

Observation / Conclusion

- Power Consumption
    1. Meets the constraints?
- Gain
    1. We probably want the gain to be far more than the maximum of 24x provided by the ADS chip
    2. For the application of ”muscular activation monitoring”: there are work examples of gains of 600, of 1000, of 4000, and of low noise and variable gain amplifier [1].

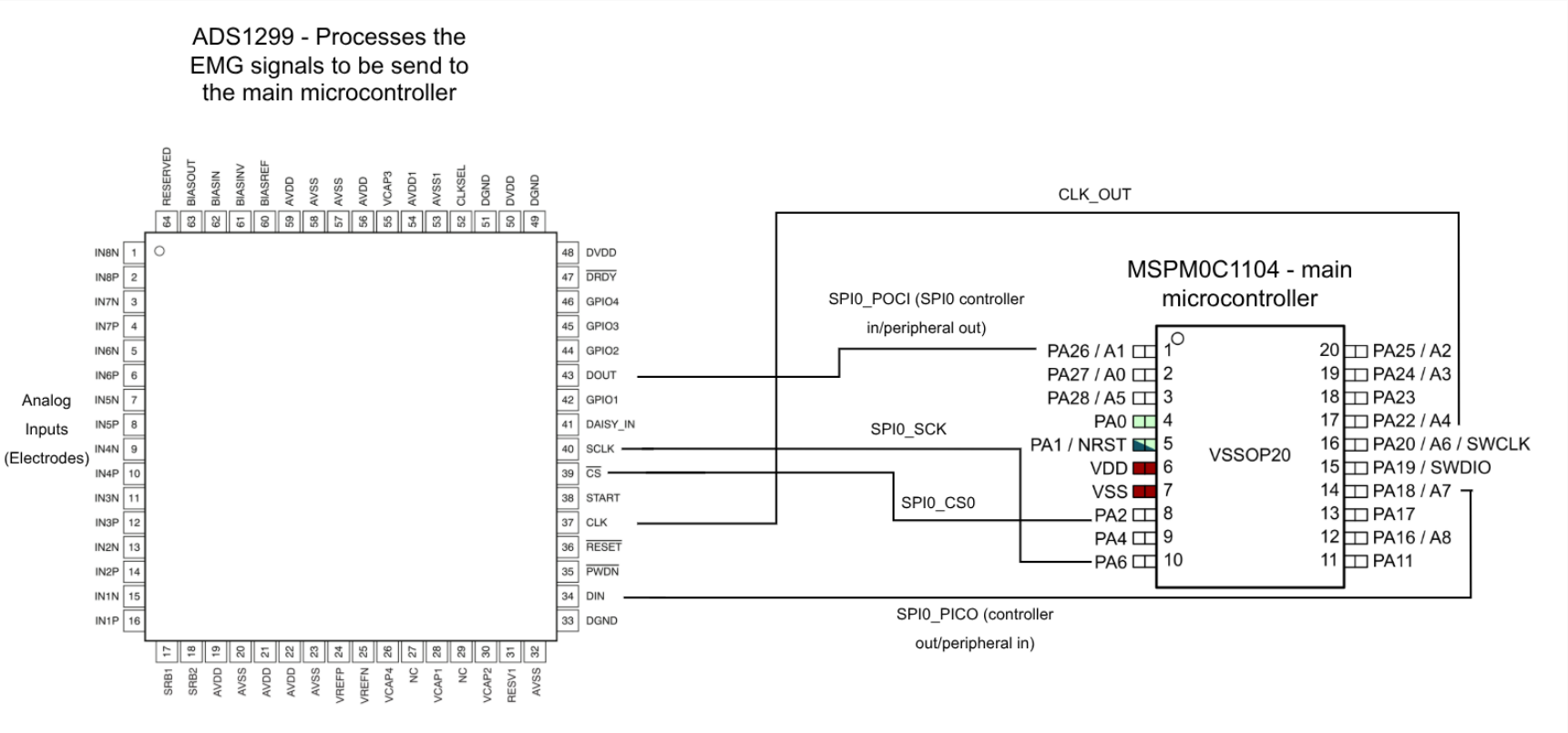
Results: Gain



Distribution of the gains used in EMG systems (overall) [1]

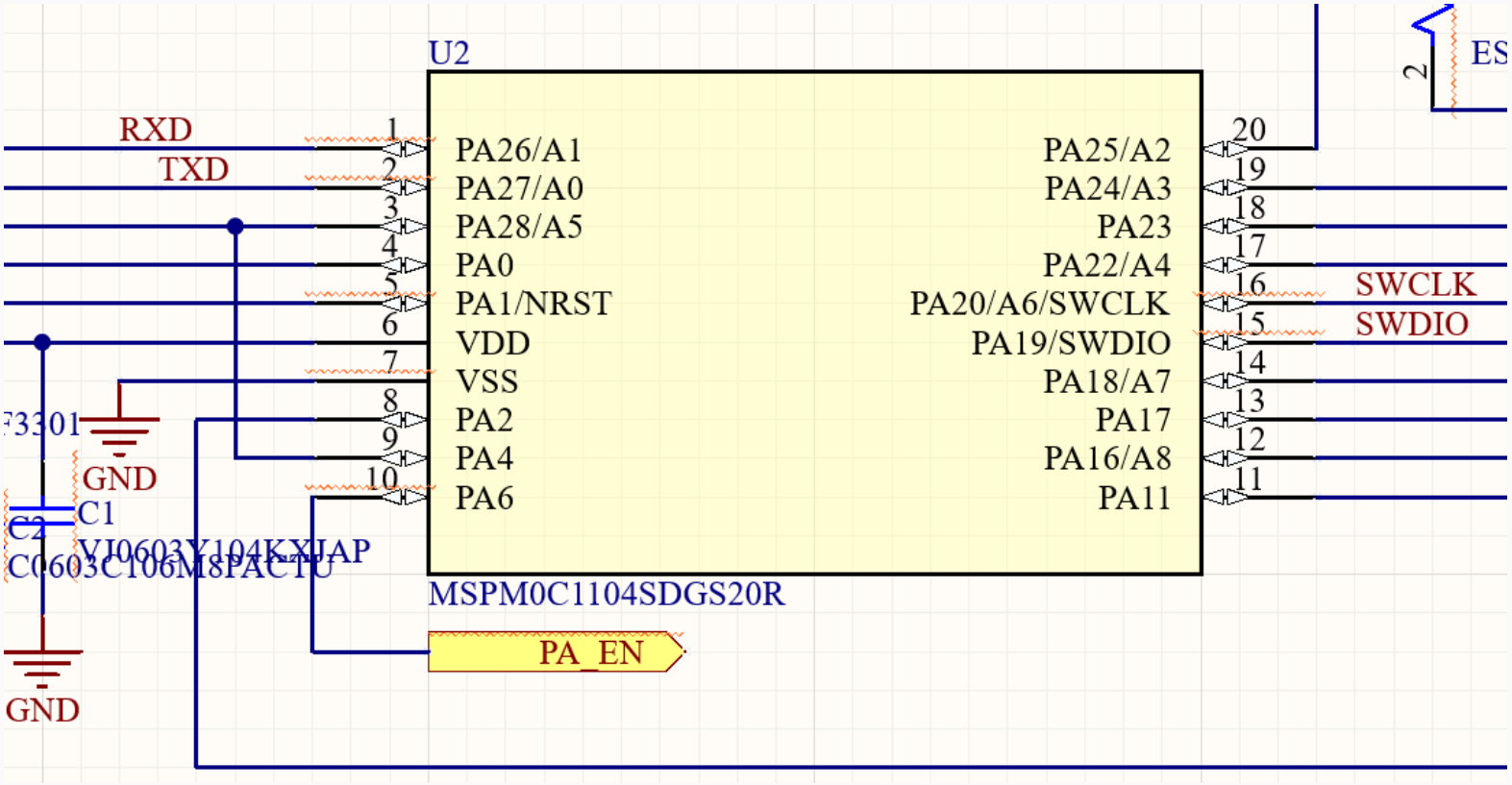
Next Steps

Next Steps



SPI Pins

Next Steps



Most, if not all, of the current MCU pins are already in use

References

[1] Bernabe Rodríguez-Tapia et al. **“Myoelectric Interfaces and Related Applications: Current State of EMG Signal Processing–A Systematic Review”.** In: *IEEE Access* 8 (2020), pp. 7792–7805. DOI: *10.1109/ACCESS.2019.2963881*.