APV25 S1 Low T^{o} Measurements

Outline:

- Recap of July 2001 Results
- Testing Setup
- Transistor Parameters
- ADC Input
- Low Gain Results
- High Gain Results
- Comments

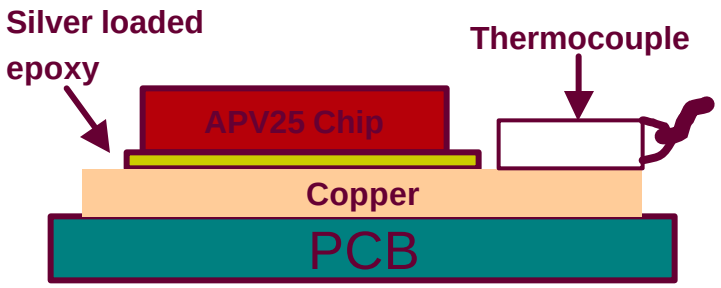
Recap of July 2001 Results

- Following trends occur for a drop in temperature:
  - Baseline increases ⇒ lower baseline by increasing VPSP
  - Gain increases
  - Noise decreases
  - Pulse shape changes ⇒ tune by changing ISHA and VFS
  - Calibrate pulse changes
  - Current consumption increases
    ⇒ lower consumption by decreasing bias register settings for chip currents (IPRE, IPCASC, IPSF, ISHA, ISSF, IPSP, IMUXIN)
- Dependence of noise on temperature:
  - Expected 16% decrease in noise for a 54^{o}C drop in temperature.
  - Results showed 8% decrease in noise.
- Junction temperature unknown.

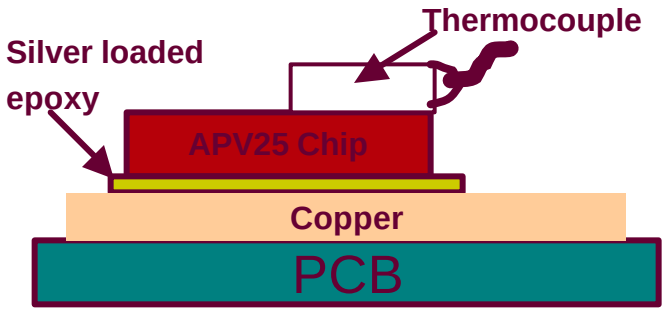
Testing Setup

- APV25 Chip placed in Environmental Chamber.
- Testing range:
  $-30^{o}C \leq T_{chamber} \leq 40^{o}C$.
  $-13^{o}C \leq T_{chip} \leq 58^{o}C$.
- Pulse shape tuning in Peak mode determines values of ISHA and VFS to be used for each step in temperature.
- VPSP changed to obtain a constant baseline corresponding to roughly ¼ of the full APV output frame.

▪Previously: Chip temperature measured on copper plate on which the chip is glued.



▪Now, chip temperature is measured directly on the surface of the chip.



ΔT between two methods = $10^{o}C$

Transistor Parameters

- Threshold voltage, 1mV/K variation
- Mobility……. $\mu_n(T) = \mu_n(T_{nom})\left(\frac{T}{T_{nom}}\right)^X$
- Transconductance…. $g_m \propto m_n(T)$
- Noise……. $S_V \propto \sqrt{\frac{T}{g_m}}$

$$S_V(T) = S_V(T_{nom})\sqrt{T^{1-X} \times T_{nom}{}^{X-1}}$$

- X = -0.86 from g_m vs T^o data.

ADC Input

- The ADC input range is 0 → 2V.
- The output from the APV is ~ 500mV. It is further amplified before being digitised by the ADC.

Two possibilities:

Low Gain: ~4

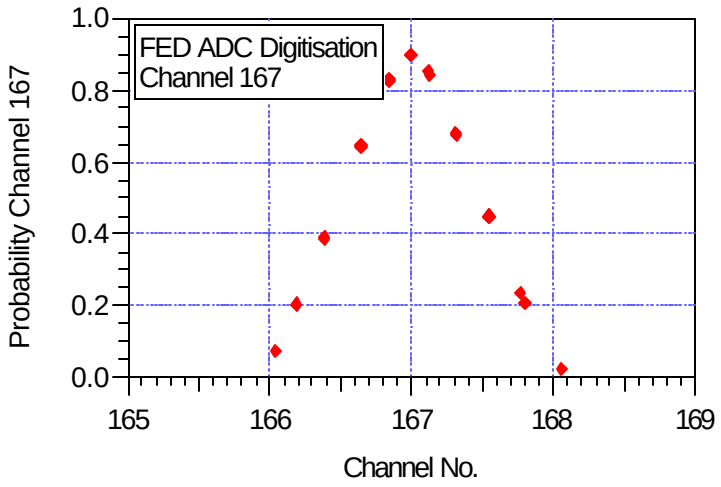
- 👍 Whole output from APV is digitised, digital header + analogue signal.
- 👎 Noise level is around 1 ADC unit in Peak mode and 1.7 ADC units in Decon mode.
  ⇒ digitisation noise is significant and has to be subtracted in quadrature from total noise.

High Gain: ~17

- 👎 Only analogue signal from APV output frame is fully digitised.
- 👎 Saturation affects the first few channels in the analogue signal.
- 👍 Noise level is around 3.5 ADC units in Peak mode and 6 ADC units in Decon mode.
  ⇒ digitisation noise is no longer significant.

Digitisation Noise

Measured ADC Noise

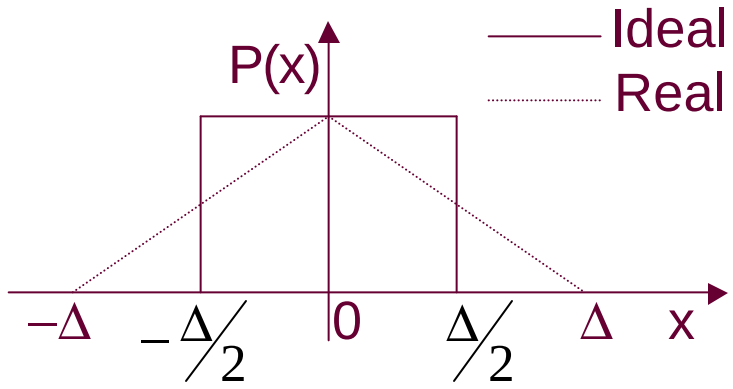


$$s = \frac{\Delta}{\sqrt{6}} = 0.41\Delta$$

- Noise associated with source used in digitisation noise measurement
  $\Rightarrow$ ADC response is broadened .

$$0.29\Delta \le s_{real} \le 0.41\Delta$$

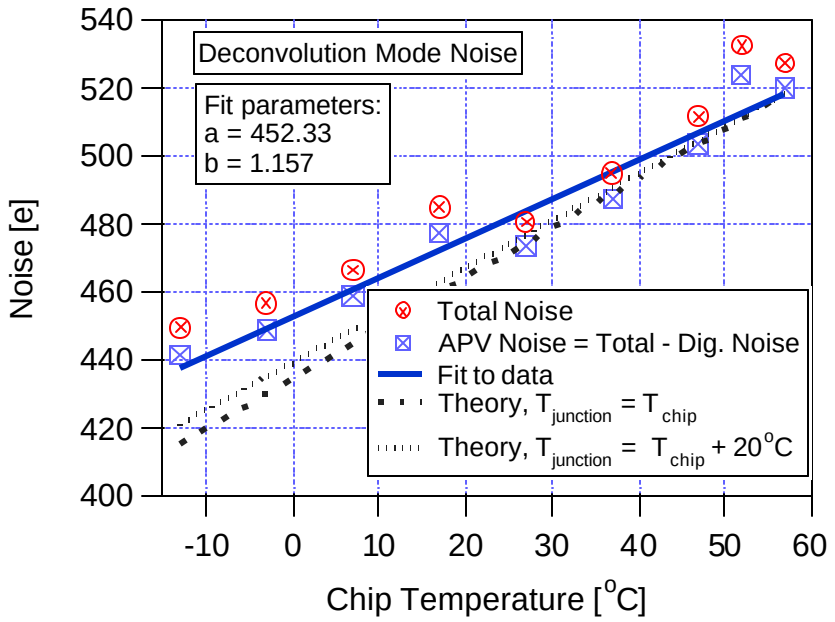
Ideal ADC



$$s = \frac{\Delta}{\sqrt{12}} = 0.29\Delta$$

Low Gain Results

- Deconvolution Mode

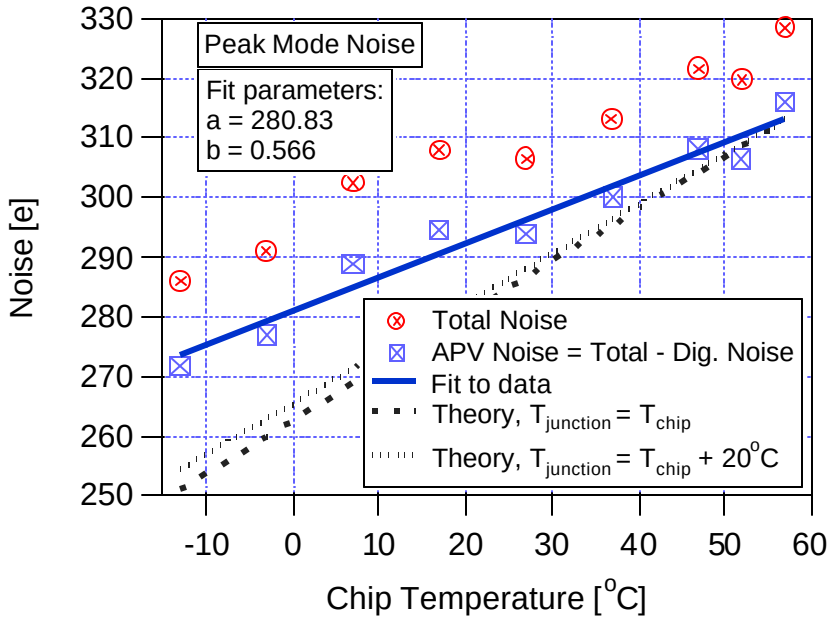


- Prediction: $\Delta T = 70^{o}C$

  $\Delta S_v = 20\%$

- Results: $\Delta S_v = 15\%$

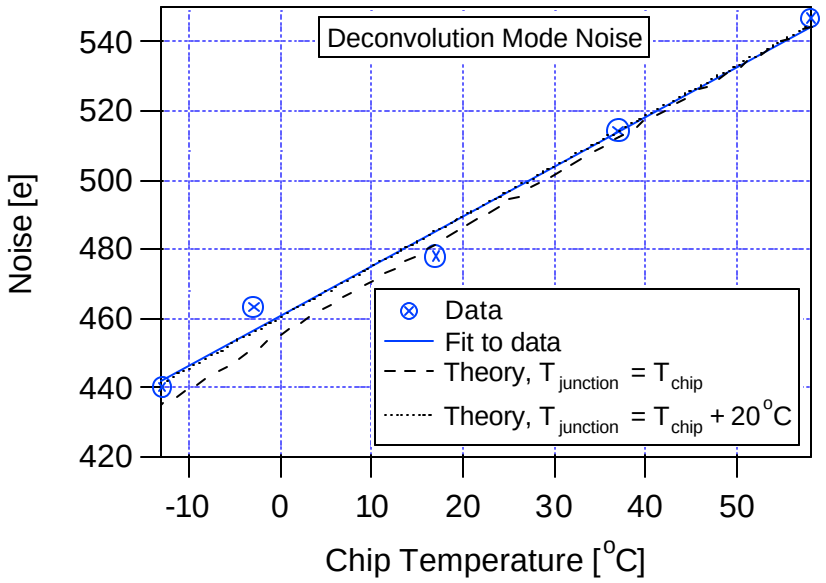
- Peak Mode



- $\Delta Sv = 14\%$

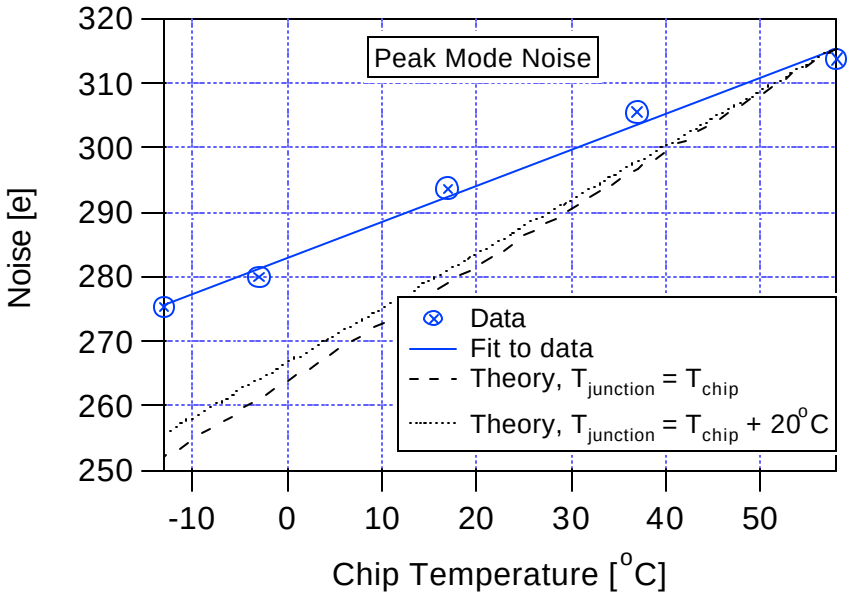
High Gain Results

- Deconvolution Mode



- Prediction: $\Delta S_v = 20\%$
- Results: $\Delta S_v = 19.5\%$

- Peak Mode



- Results: $\Delta S_v = 12.2\%$

Comments

- $T_{junction} > T_{chip}$
  $\Rightarrow$ taking this into account would lead to closer match between predictions and results.
- Deconvolution and peak mode data show some differences, $\Delta S_v(peak) < \Delta S_v(decon)$
  $\Rightarrow$ Need more data to confirm this.
- APV25 operated at low temperature
  $\Rightarrow$ Lower noise.
- Bias register settings have to be carefully chosen, especially ISHA and VFS which determine the pulse shape and VPSP which determines the analogue signal baseline.