Model Based Estimation for Mixed Signal System Optimization

A guide to design first time correct systems

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NXP SECURE CONNECTIONS FOR A SMARTER WORLD

Overview:

Agenda

- Learning a top-down design methodology through which first time success is possible

What will be told

- **What to do** in terms of methodology and design flow

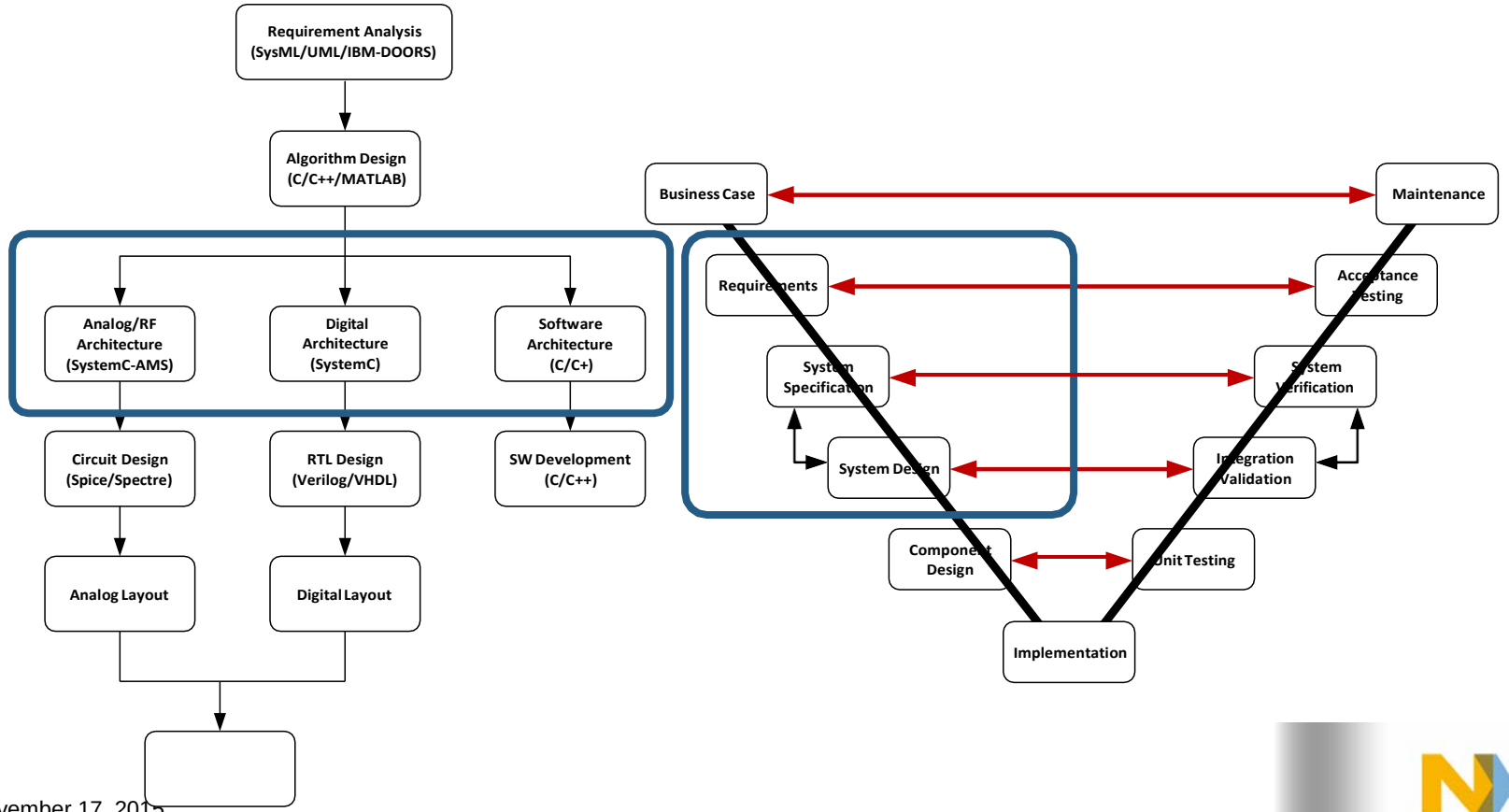
What will be not told

- How to do (specially in connection to modelling and detailed design)

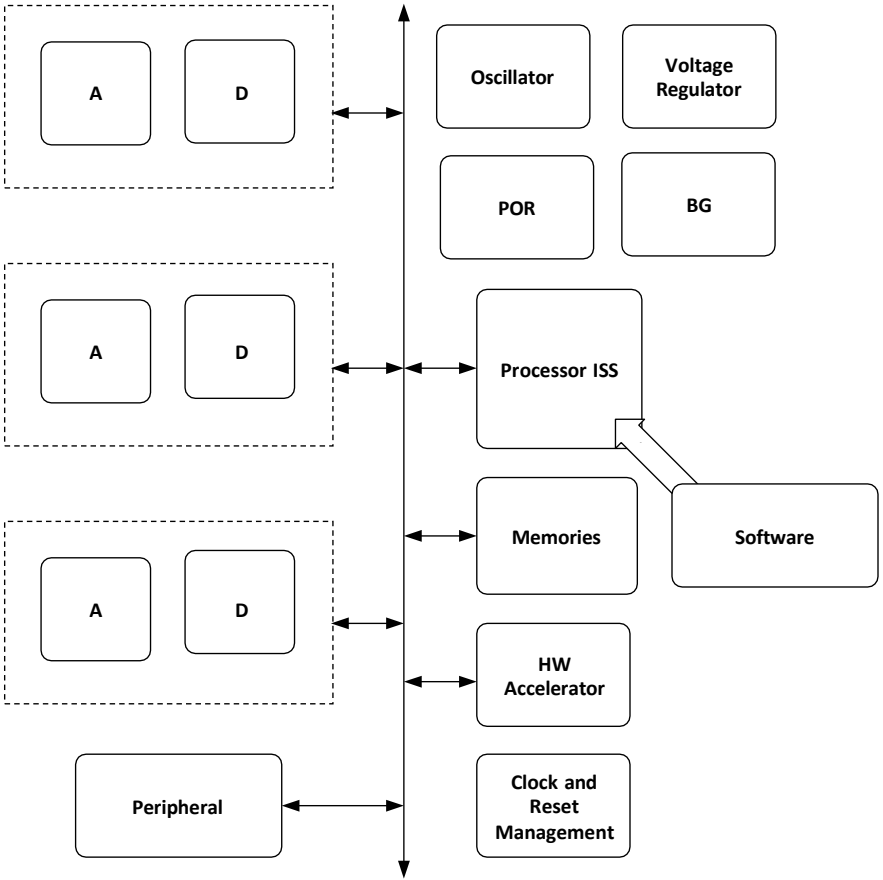
Assumption

- Everybody in my audience is a SystemC-AMS / COSIDE user
- I do not need to speak about the motivation of using it

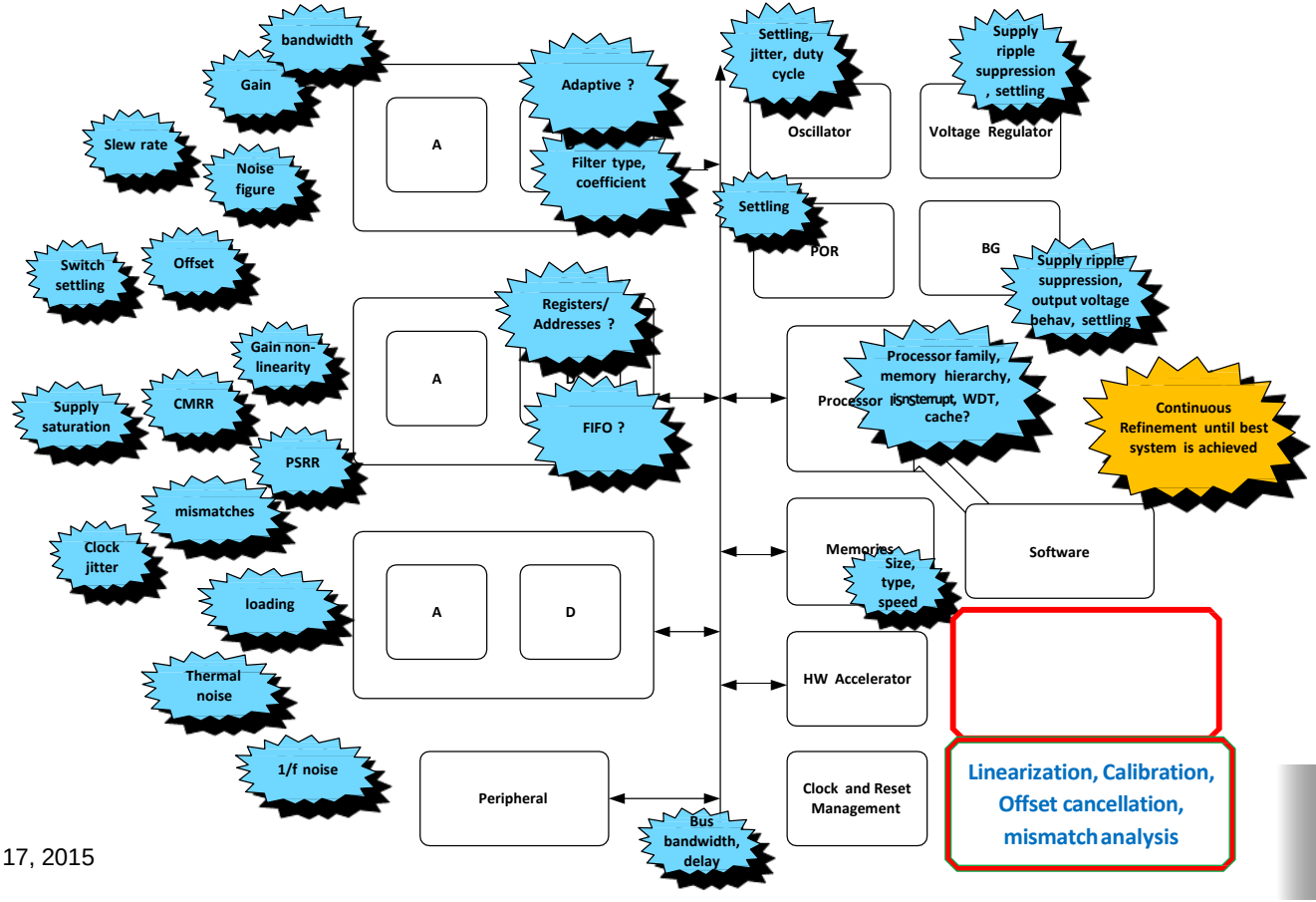
What is I am going to talk in 20mins!



The Problem You See As -

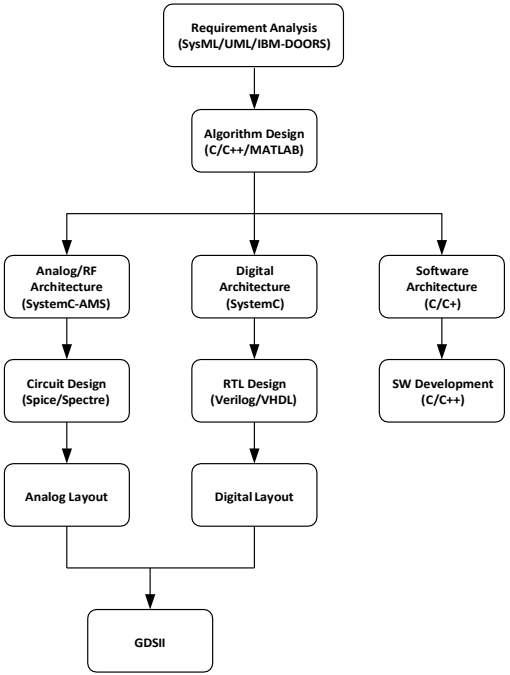


The Problem You are Actually Dealing With!!



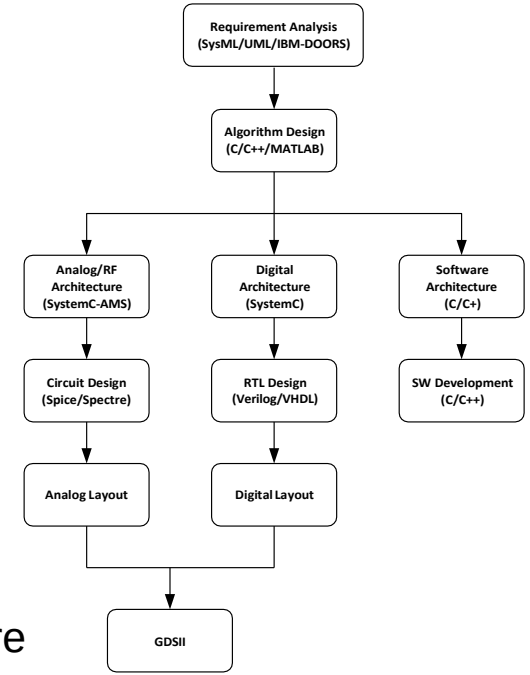
Top down design refinement flow – Steps (1)

- Algorithm Design
  - Find the algorithm and all “algorithmic parameter” using MATLAB.
- Architecture Level Design (Level I)
  - Implement the architecture from algorithm in SystemC-AMS + SystemC
  - Algorithm refinement using transfer functions, switches, passives, accurate regulation loop, thermal noise, 1/f noise and non-idealities (small and large signal both).
  - Co-simulate and optimize the architecture level design

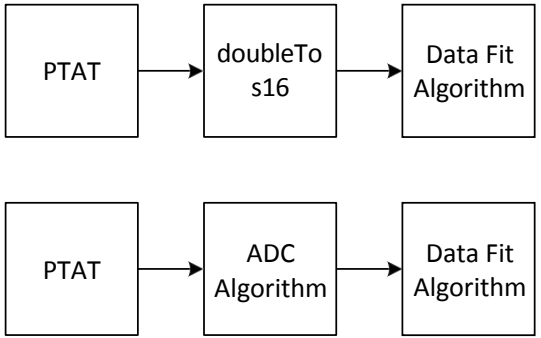


Top down design refinement flow – Steps (7)

- Design optimization and design centering (Level II)
  - Talk to process team for passive components and model them.
  - Characterize closest possible available active components and include characterized behavior in your model. Do not forget to fit temperature variations.
  - Co-simulate and optimize the design for parameters
- Design for reliability and robustness (Level III)
  - Perform 5 sigma Monte Carlo to prove the design.
  - Apply extensive failure injection and analysis
  - If MC or failure analysis fails, re-optimize system architecture



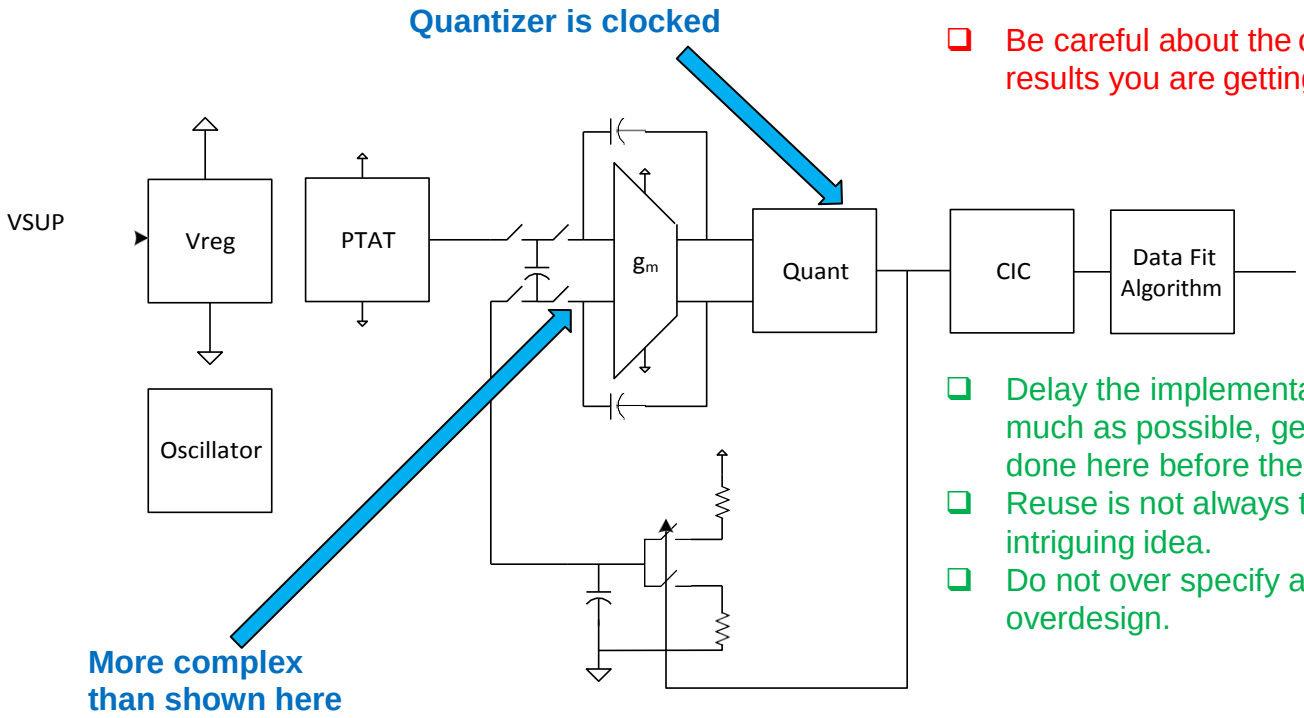
Temperature Sensor, An Example – Algorithm (The MATLAB)



- The world of MATLAB ends here.
- More you struggle with speed, less you analyze.
- Focus more on full system design and optimization.

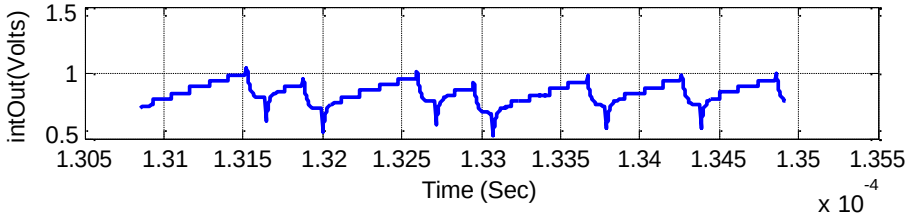
- You are correct – you cannot reuse or extend what you did till now!

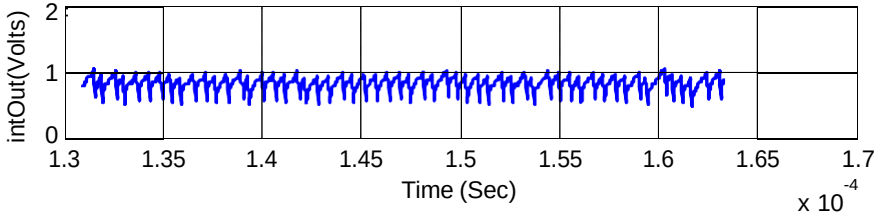
Temperature Sensor, An Example – Architecture
(SystemC(-AMS) Starts Here)

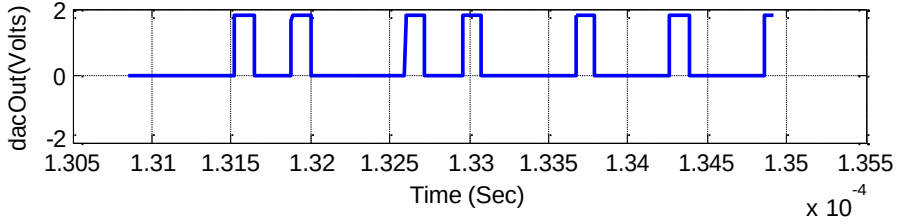


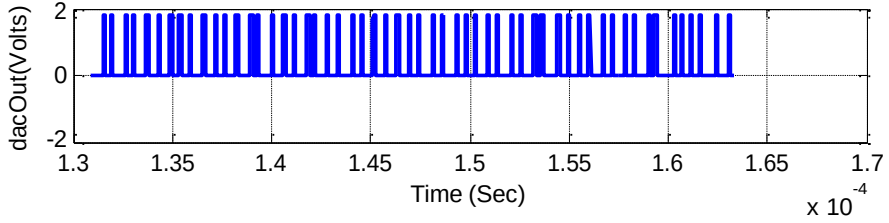
- Be careful about the characterization results you are getting
- Delay the implementation phase as much as possible, get all analysis done here before the design starts.
- Reuse is not always the very intriguing idea.
- Do not over specify and do not let overdesign.

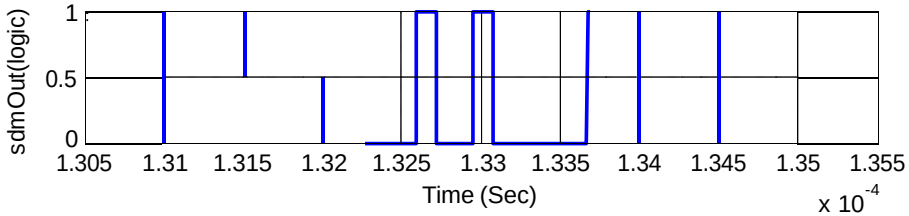
Get some feeling on modulator Internals!

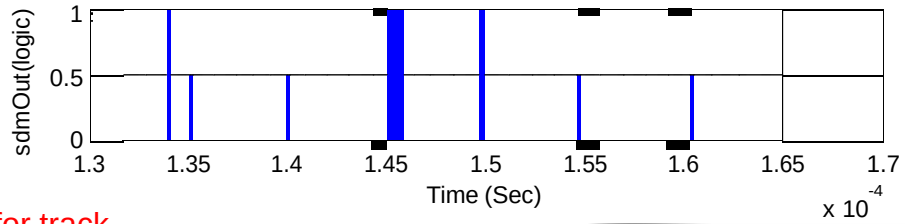






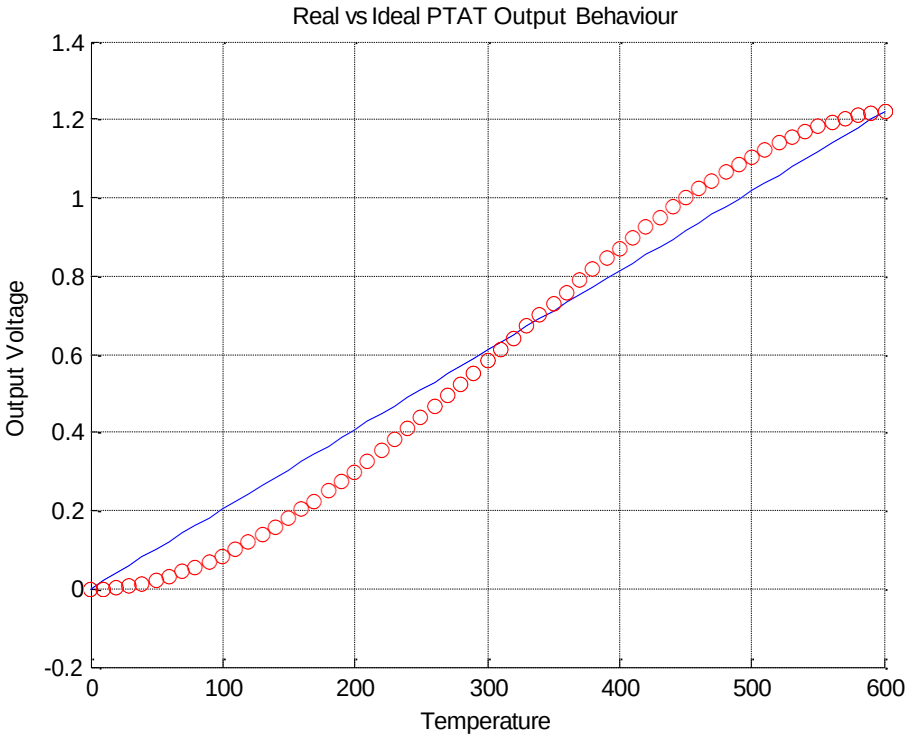


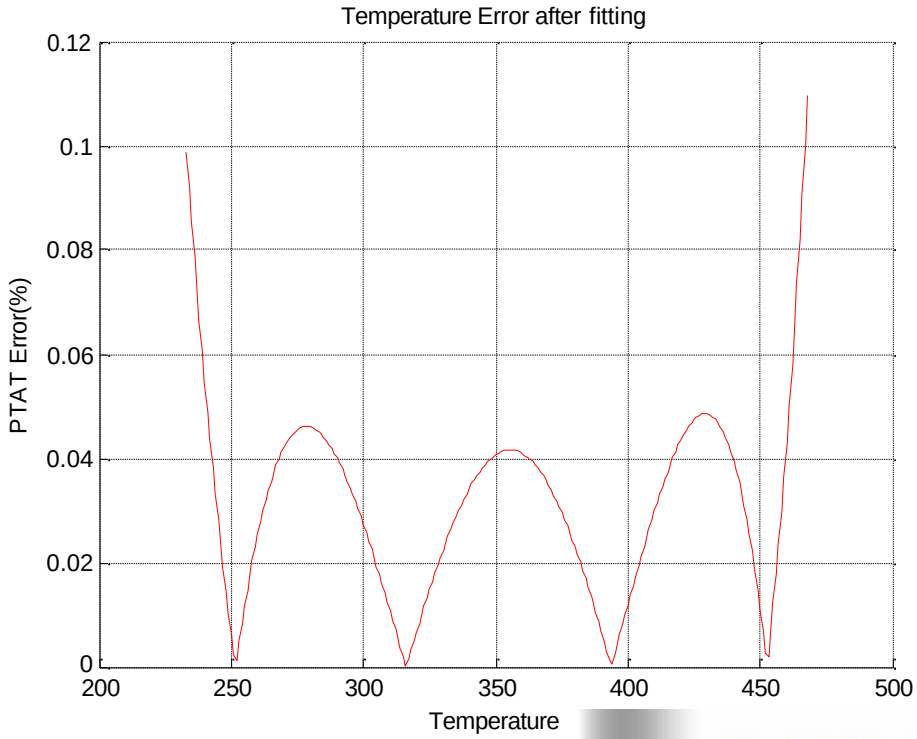




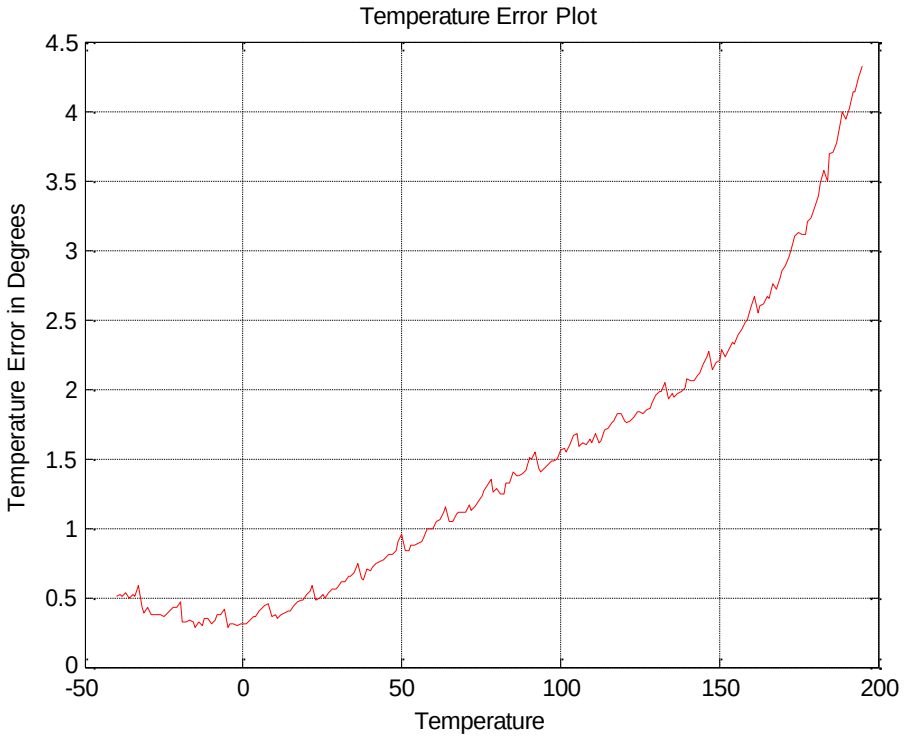
- Effect of OPAMPs and Switches are clearly seen, check for track and hold

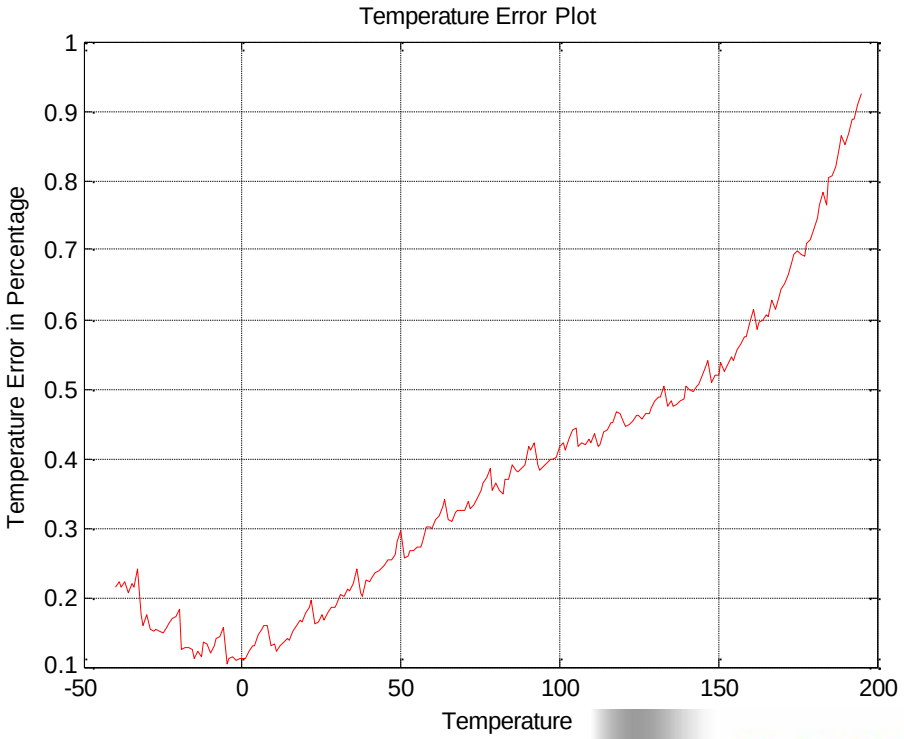
Sensor Behaviour and Algorithmic Error after Poly-Fit



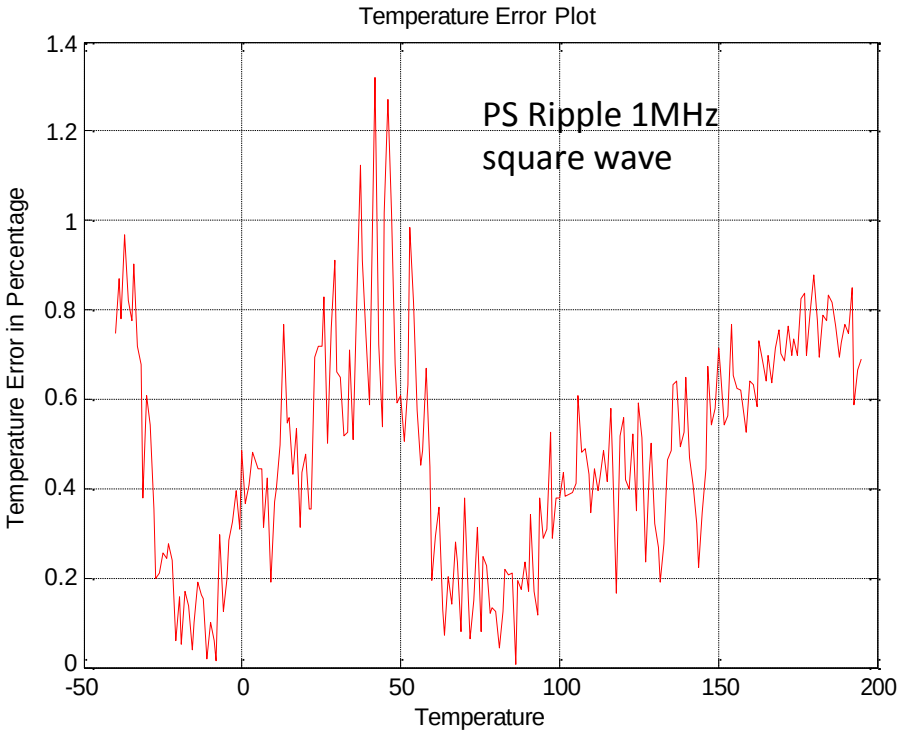


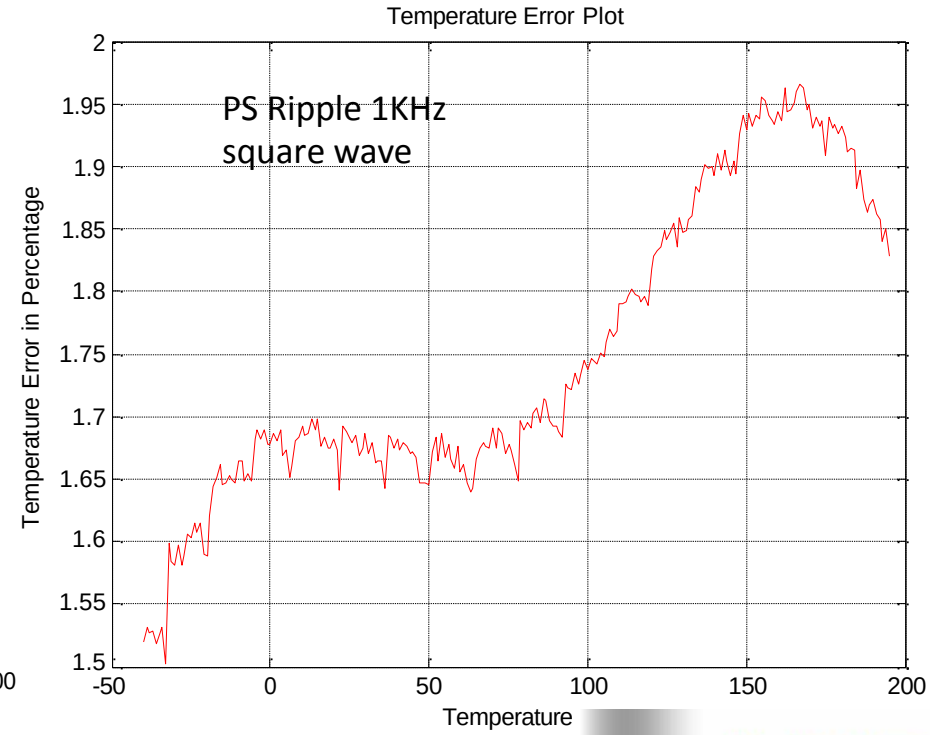
Error Output from System



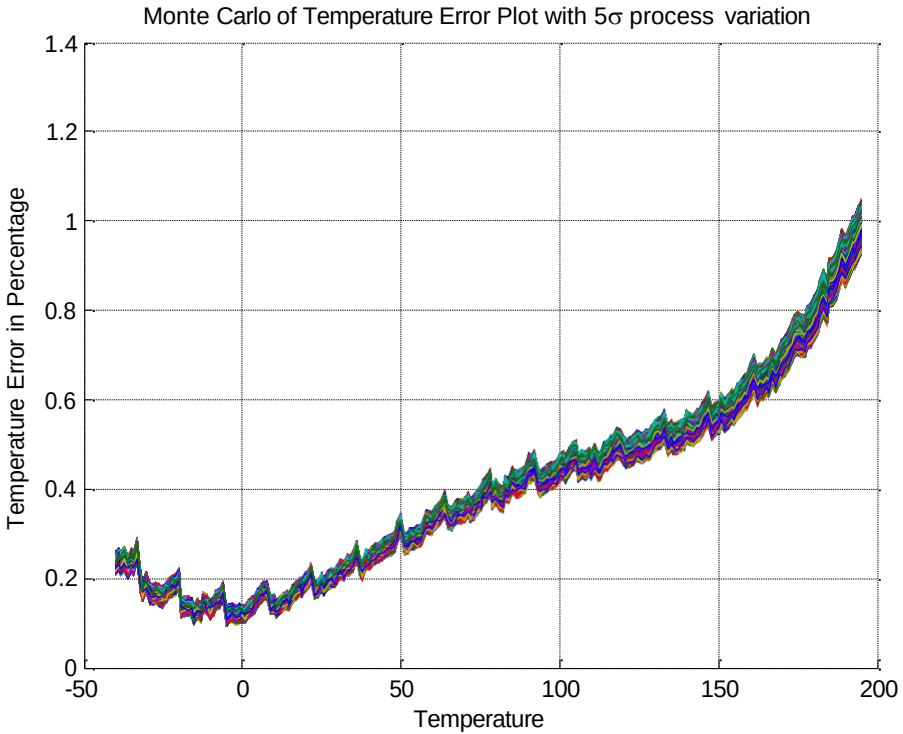


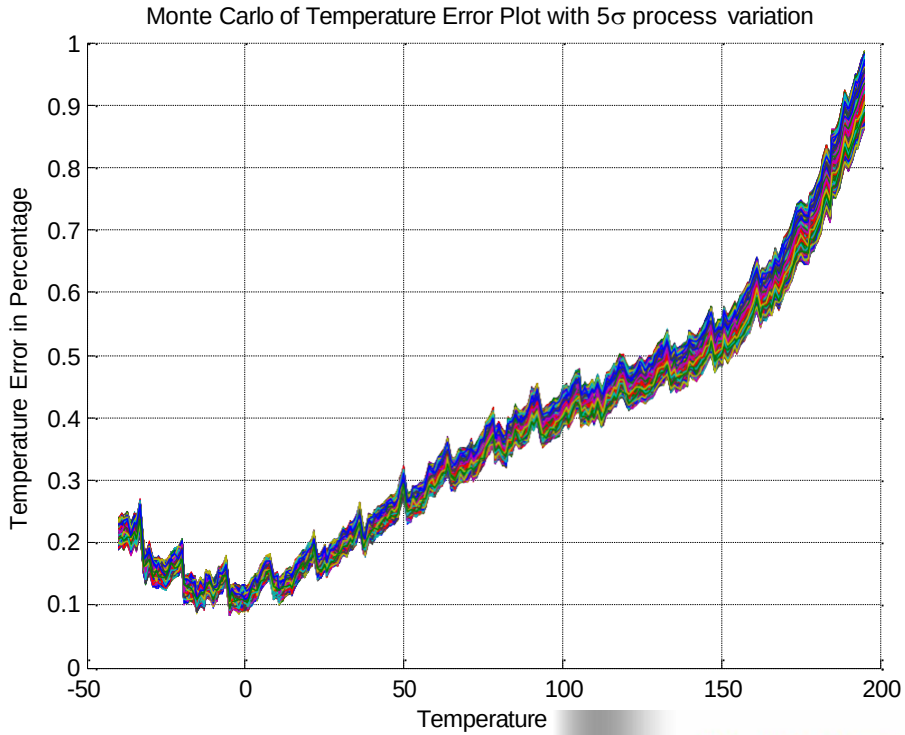
Error Output from System (In presence of power supply ripple)





Monte Carlo Simulation (Before and After Further Optimization)





COSIDE / SystemC-AMS Improvement Requests

- ELN MoC Improvements :
  - ELN Noise sources (voltage & current),
  - abstract ELN transfer functions and saturation elements (current & voltage),
  - slew rate,
  - temperature dependent ELN primitives
  - temperature behaviour spec for abstracts.
- Pole Zero (Stability) analysis – Complex Plane notation should be fine.
- Multicore SystemC-AMS – analog solver for speed improvement

Summary and Conclusion

- We presented a flow using which
  - Accurate DS can be extracted at earliest phase of development.
  - Feasibility of the system, complete behavior of the system is well understood at the earliest phase.
  - Cost reduction using few architects instead of entire design team experimenting over spins.
  - No re spins due to lack of understanding.
- Outlook
  - Engaging most of the activities during Architecture phase (using SystemC-AMS + SystemC) is highly beneficial and the correct direction to follow.
  - Additional COSIDE and/or SystemC-AMS features in the area of ELN MoCs and Analysis appreciated to further improve our design flow

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