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TestConX™

Archive

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Power Supply Sequencing and Monitoring

Illia Volkov, Mohana Chavan,
Katlynne Jones, Ramana Tadepalli
Texas Instruments

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Contents

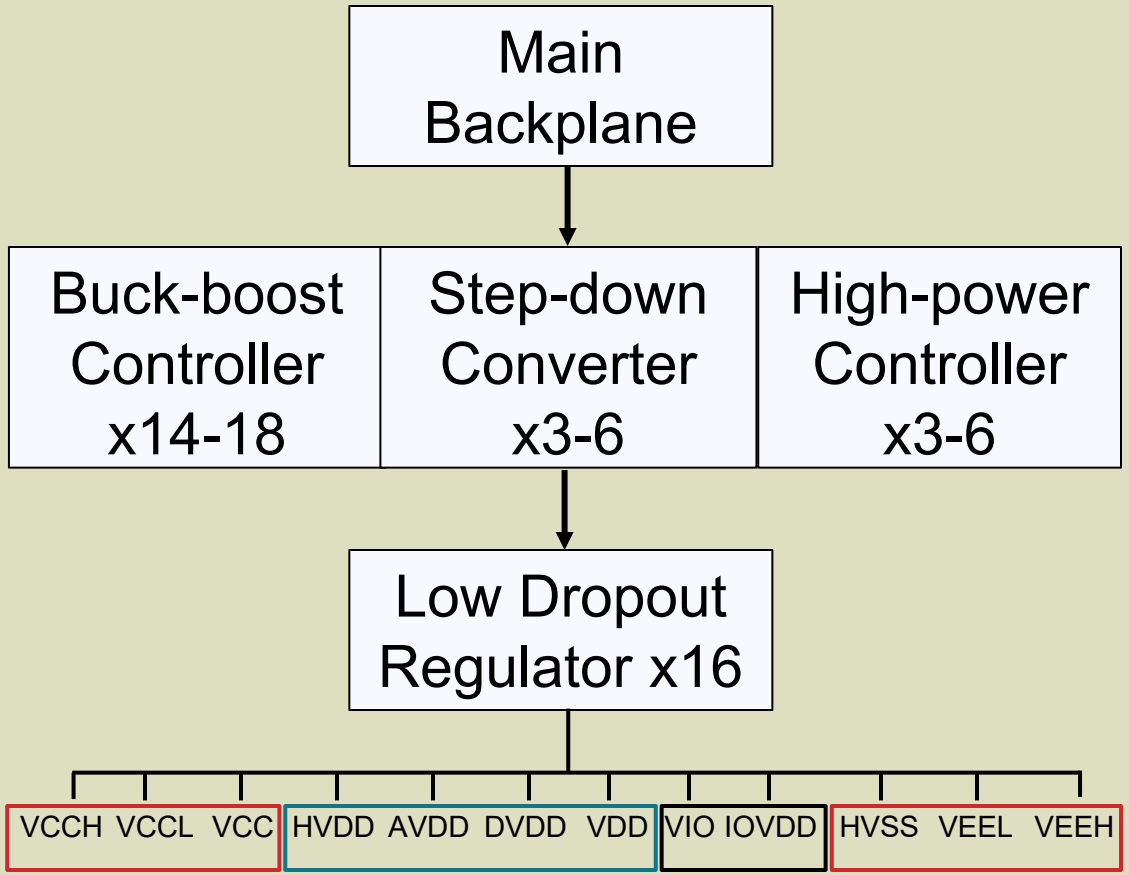
- Background
  - Review of 3 typical power trees for test equipment
    - Oscilloscope, source measurement unit (SMU), parametric measurement unit (PMU)
  - Summary of power supply types in test equipment development
- System specifications
  - Explain complexity of challenge (up/down) + error events
- Existing solutions and challenges
- Evaluation
  - Proposed solution experiment
  - Result

PMU Power Tree Example

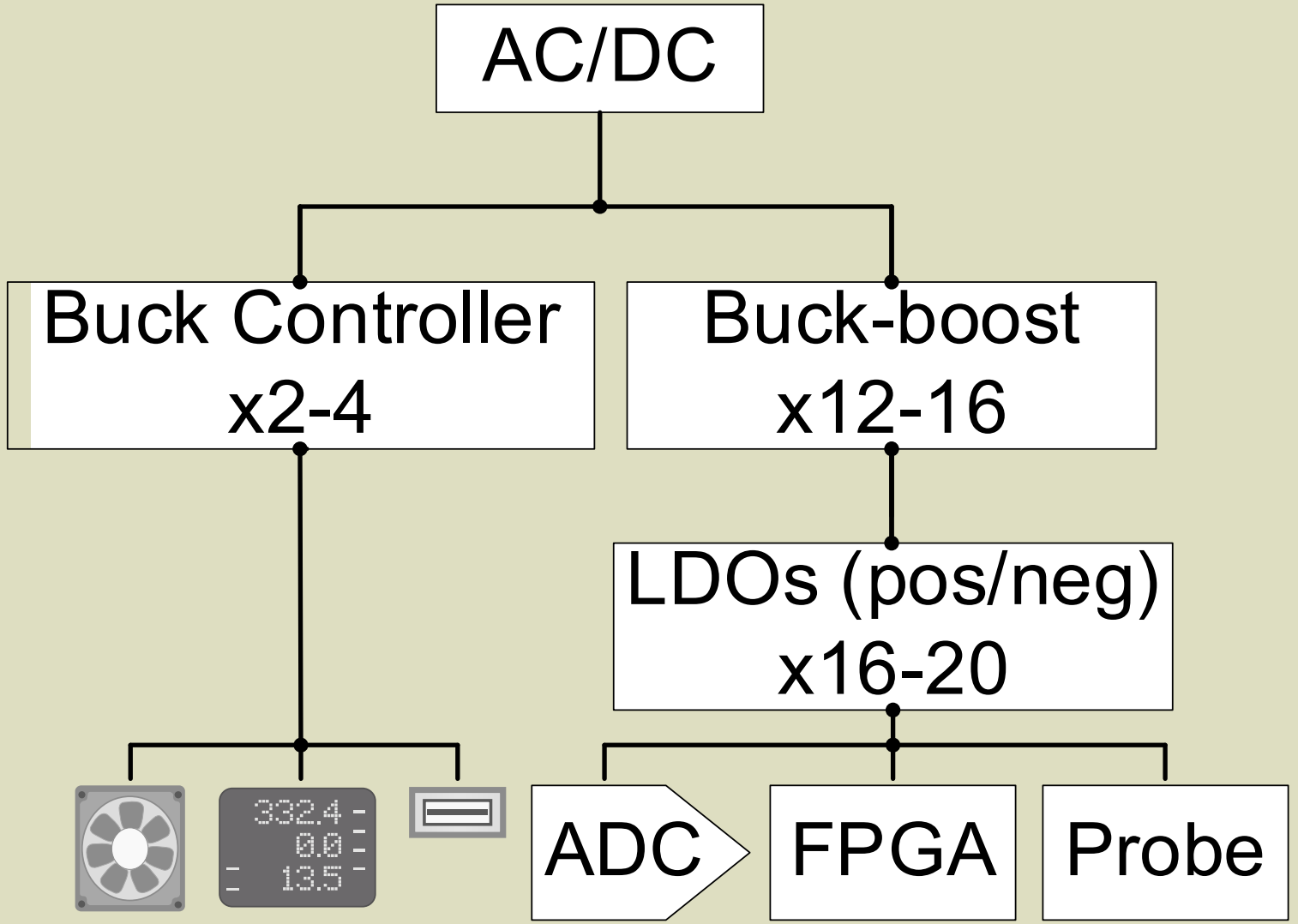
- Power (PWR) up/down sequence
- Interdependent sequence for each block
- Space limited

Power supply types:

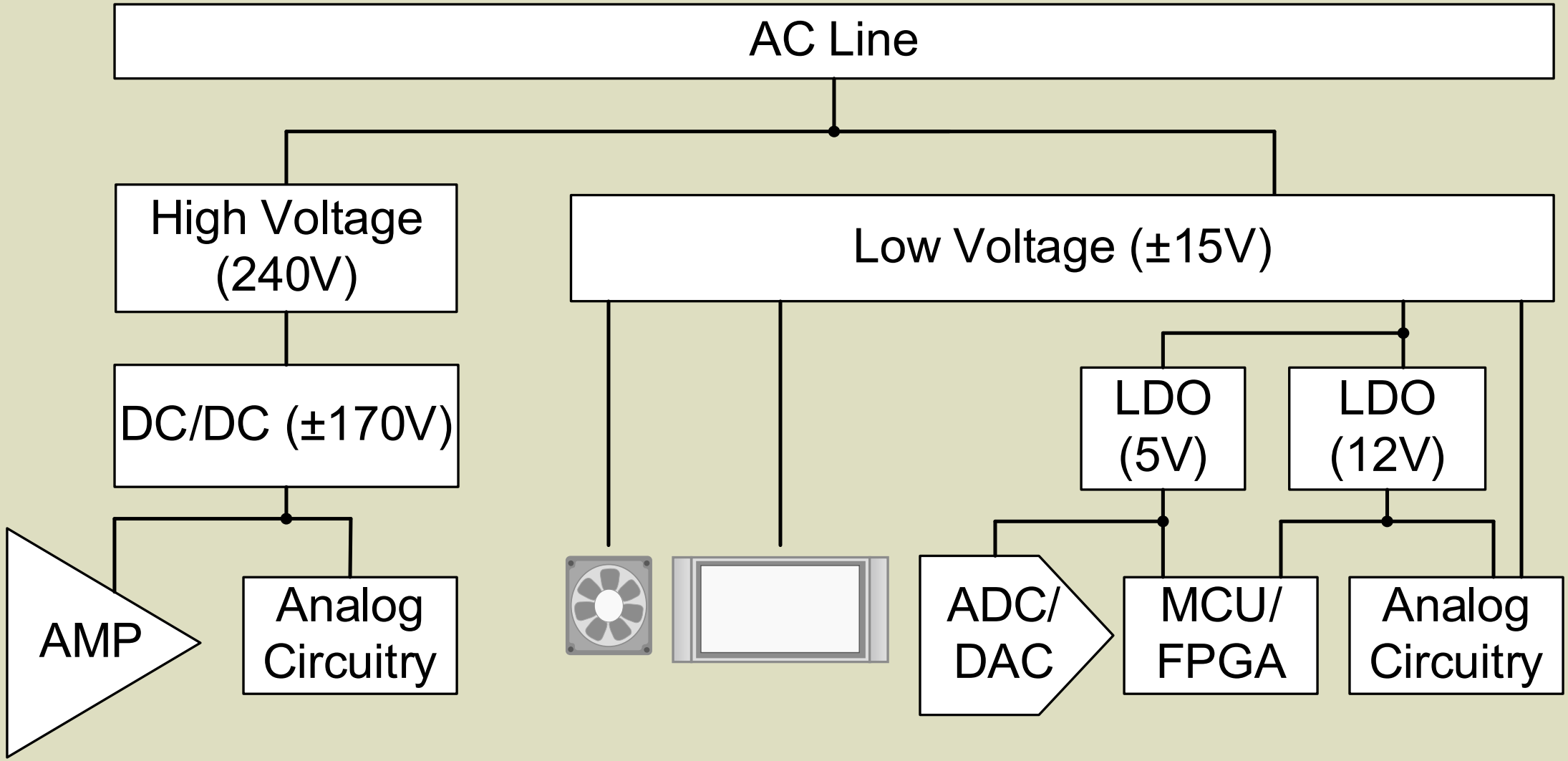
- Processor logic (0.8V to 1.8V)
- I/O (1.8V to 5V)
- Analog voltage (±24V)
- High voltage for actuation biasing (up to 200V)



Oscilloscope Power Tree Example



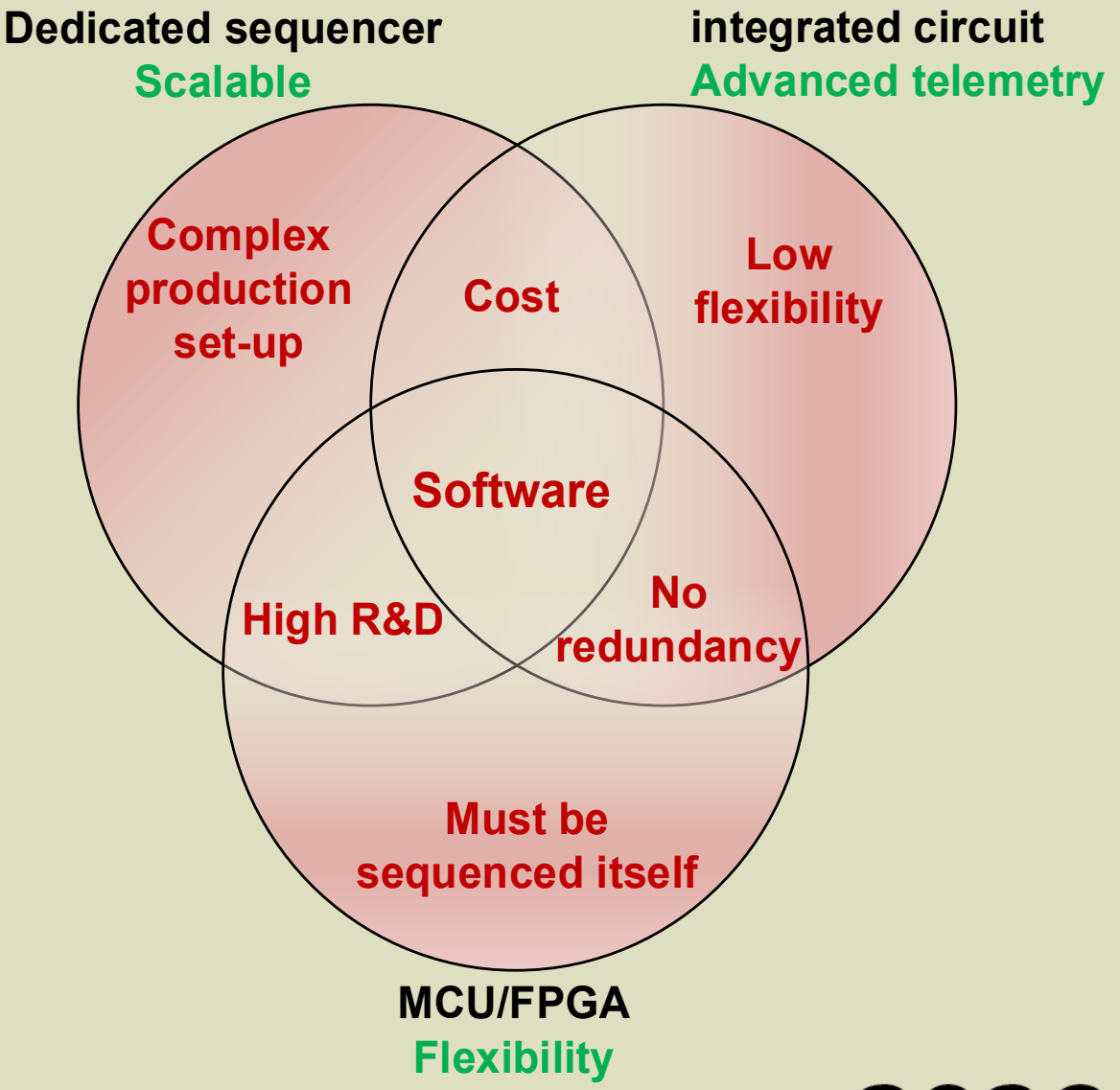
SMU Power Tree Example



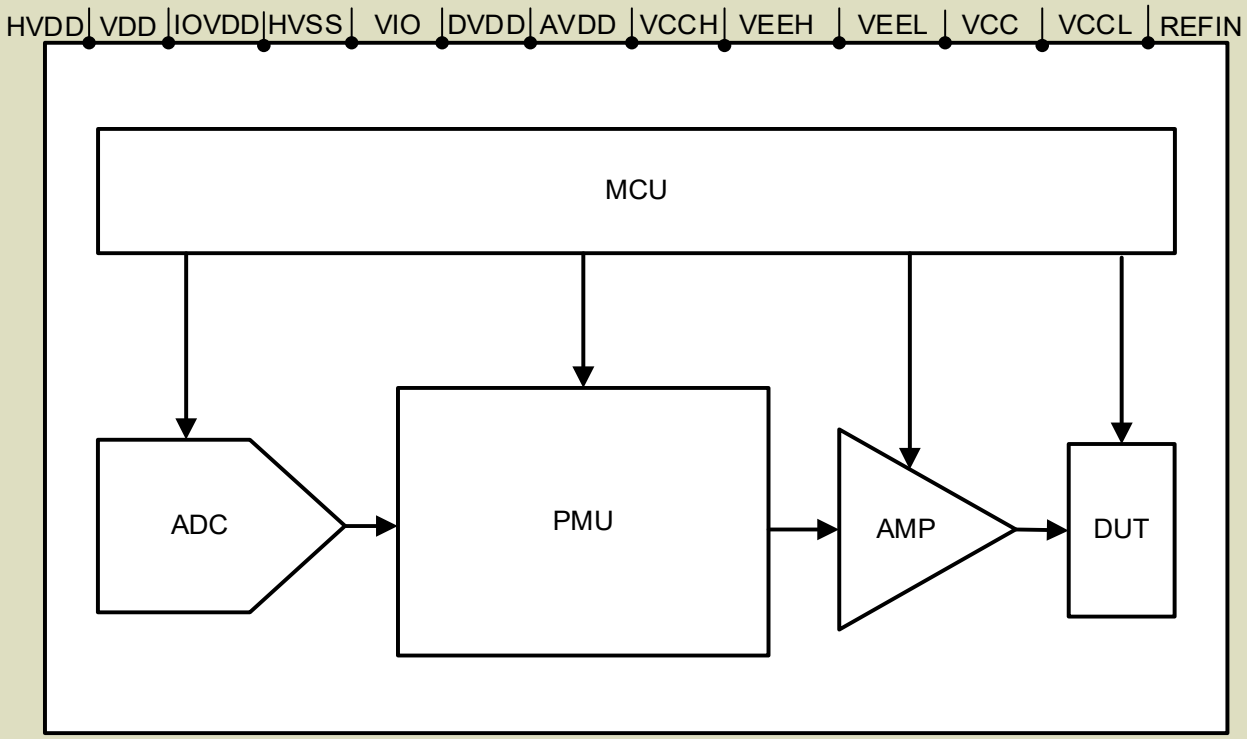
Background

Challenges:

- *Software*
  - Writing FPGA/MCU code to properly ramp-up large amount of rails
  - Managing ramps of device under test (DUT) located remotely from the micro controller unit (MCU)
  - Continuous monitoring of supply rails
- *Mismatch of rise times*
  - Difference in load can alter the timing for a power rail
  - Specific ramp-up window (e.g. VCORE must reach 0.5V within 5ms before VIO starts rising)
- *Fault management*
  - What to do if power line is faulty?
  - How fast can software react to the fault and is it fast enough?

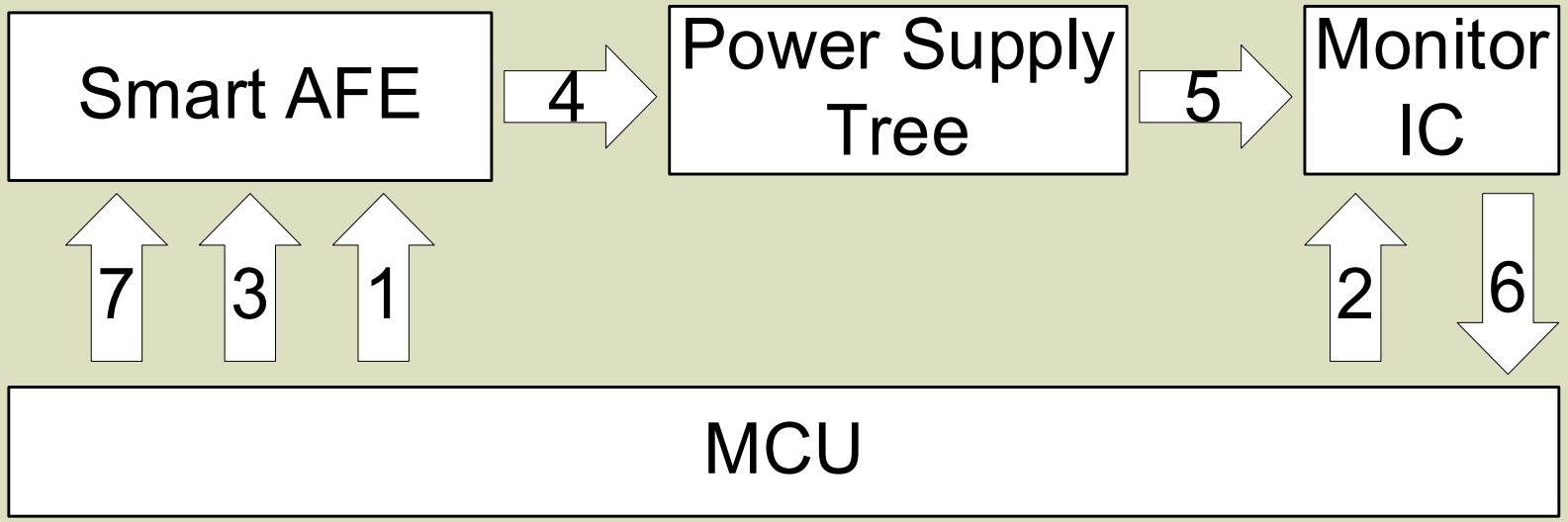


System Specification



ON Sequence	Function	PIN	Turn on Sequence	Turn off Sequence	Turn off Sequence
			1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	
1	MCU	IOVDD			
2	MCU	VDD			
1	AMP	HVSS			
1	PMU	VIO			8
2	PMU	DVDD			7
3	PMU	AVDD			6
4	AMP PMU	VCCH			5
5	PMU	VEEH			4
6	AMP PMU	VEEL			3
7	PMU	VCC			2
7	AMP	VCCL			2
8	PMU	REFIN			1
(any time)	ADC	HVDD			

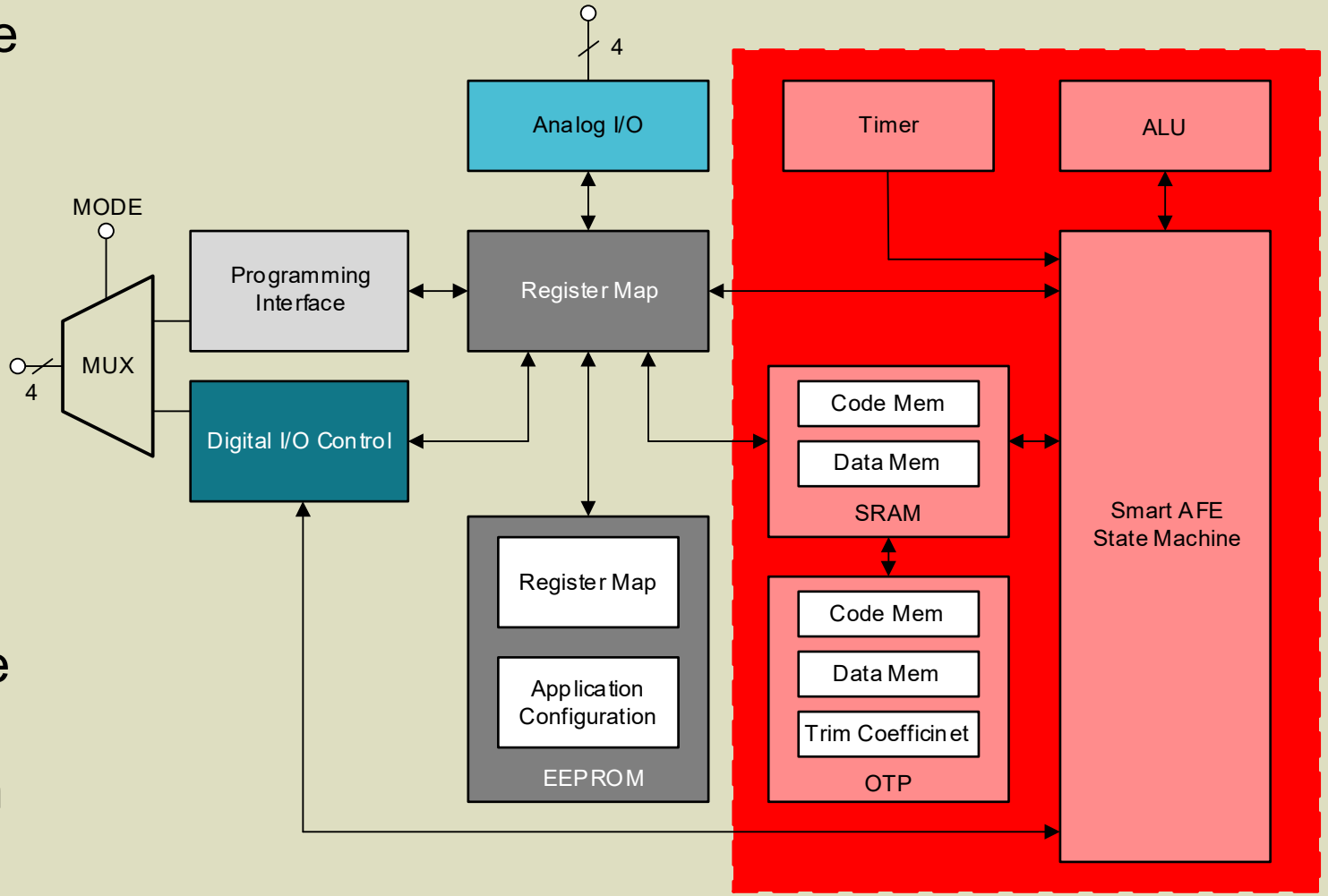
Solution



1. Sequence parameters write one-time (I^2C/SPI)
2. Monitor parameters write every power-cycle (I^2C/SPI)
3. Initiate power up/down sequence (GPIO)
4. Execute power up/down sequence (DAC/GPIO)
5. Continuous monitoring (ADC)
6. Send alarm if fault detected (GPIO)
7. Fault response command (GPIO)

What is Smart Analog Front-end (AFE)?

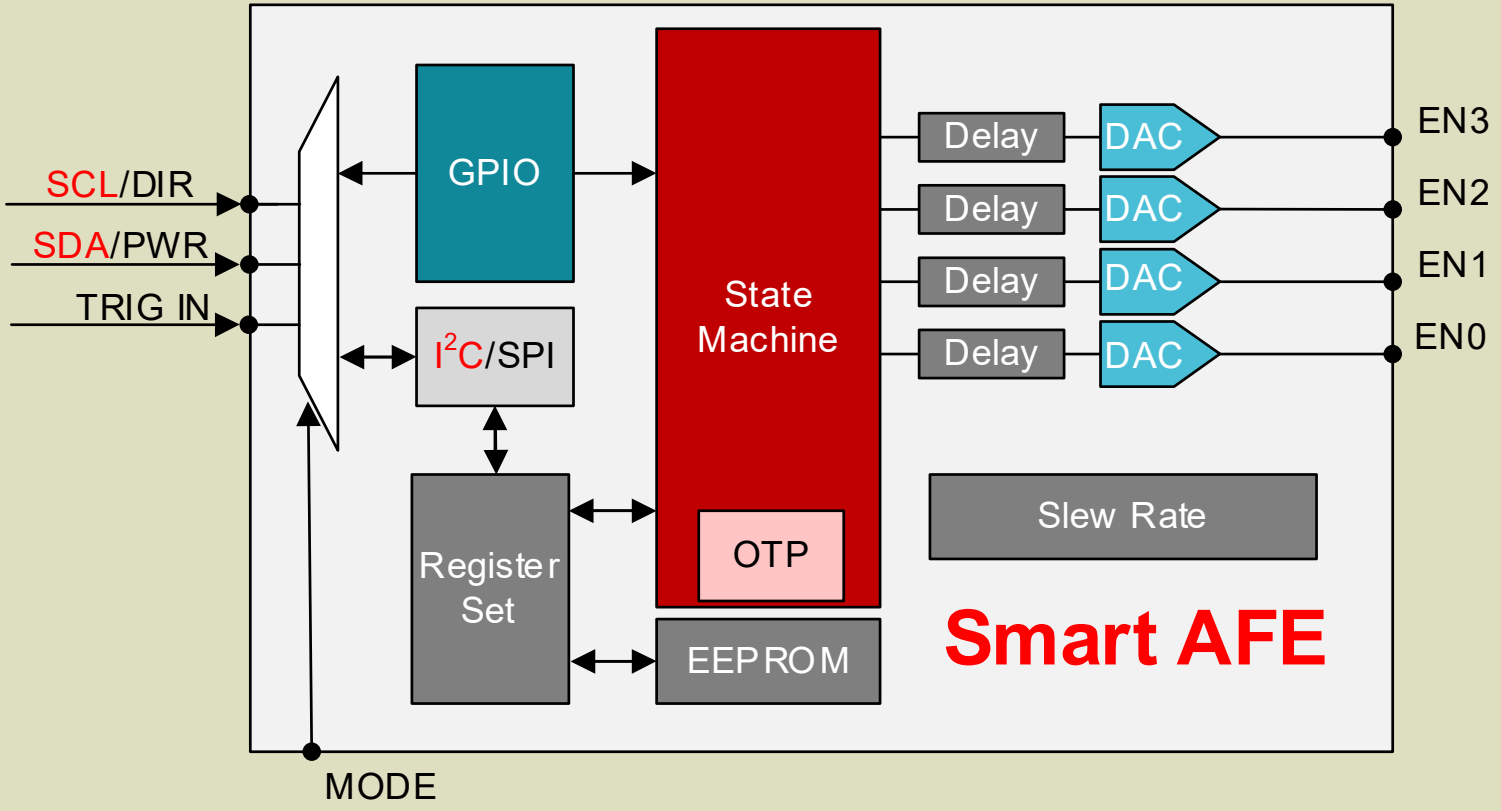
- State machine (SM) allows flexible and fast creation of custom parts without changing silicon
  - Control loop, GPIO, fault management
- SM supports multiple instructions, ALU, timer, and SRAM space for firmware
- SM logic is stored in the one-time programmable (OTP) memory
- Parameters to the SM, and device configurations are stored in the EEPROM and can be adjusted on the fly



State machine | Digital IO | Analog IO | Features | Inaccessible

Sequencing | Solution

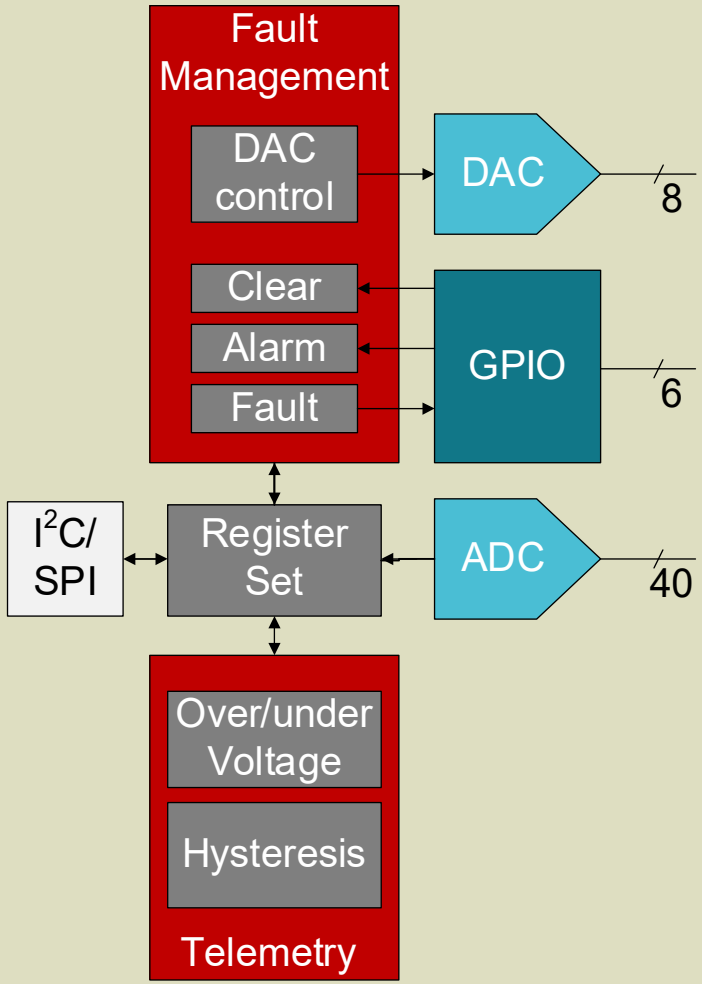
- Independent configurable delay, and sequence for PWR UP and DWN
- PWR UP/DWN is selected by the DIR pin
- TRIG IN to initiate the sequence
- PWR pin to immediately disable all channels in case of fault
- Programmable slew rate per channel to control the speed of power supply ramp



State machine | Digital IO | Analog IO | Features | Inaccessible

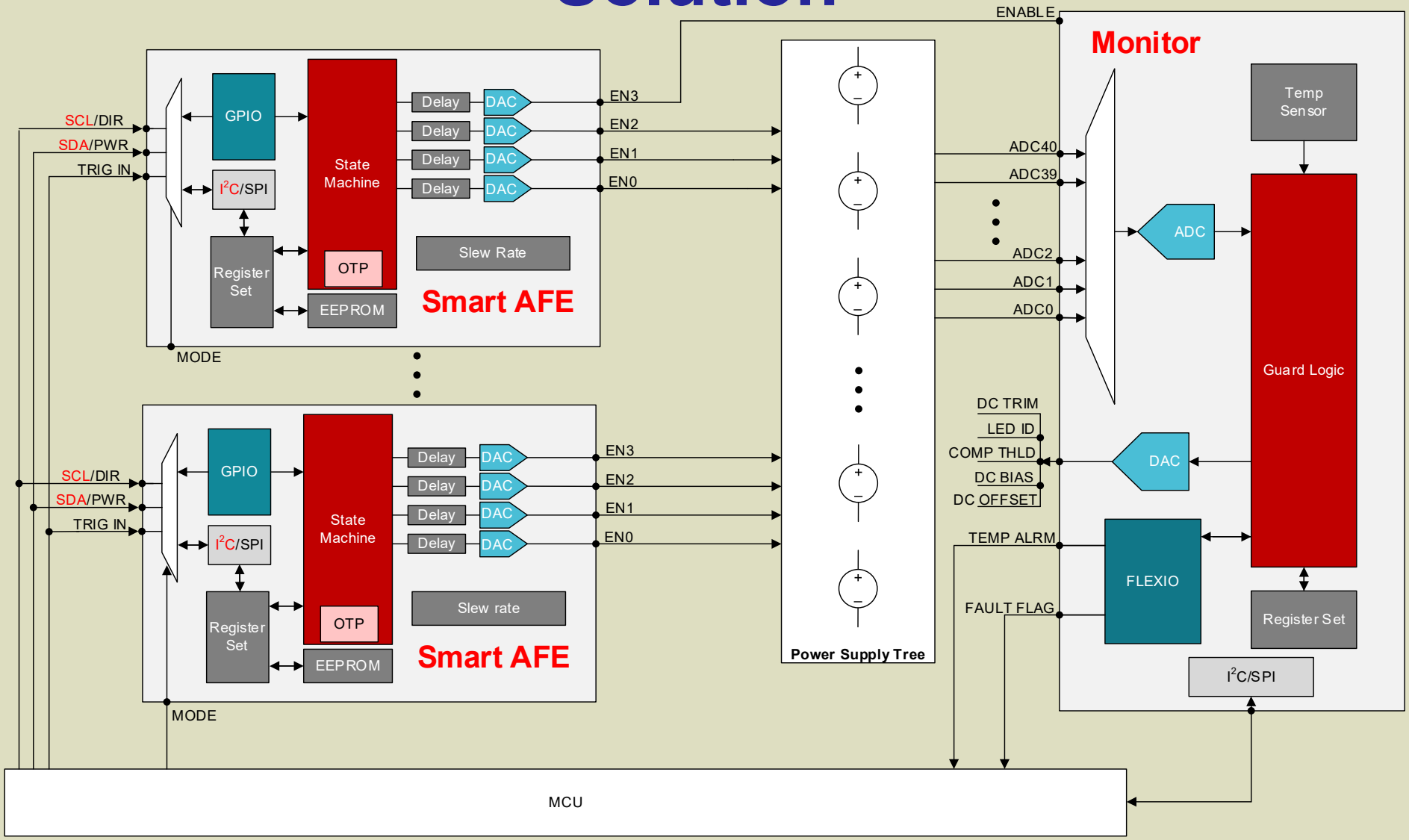
Monitoring | Introduction

- Guard logic:
  - Monitoring of each channel
  - Under voltage/over voltage
  - Programmable hysteresis
- Alarm:
  - Generate alarm when fault is detected
  - Control DAC outputs in the event of fault
- Configurable via internal registers



Guard logic | Digital IO | Analog IO | Features | Inaccessible

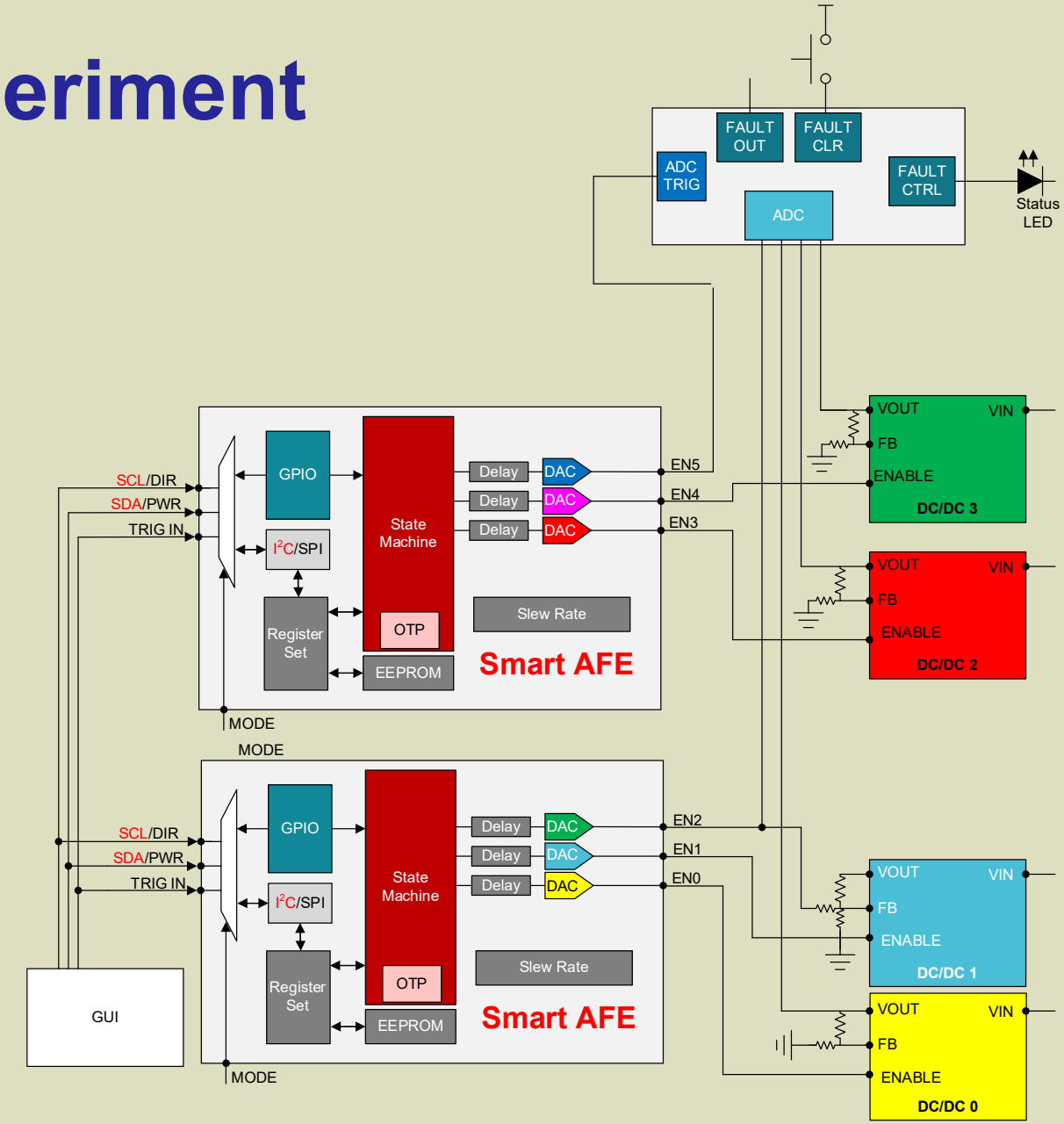
Solution



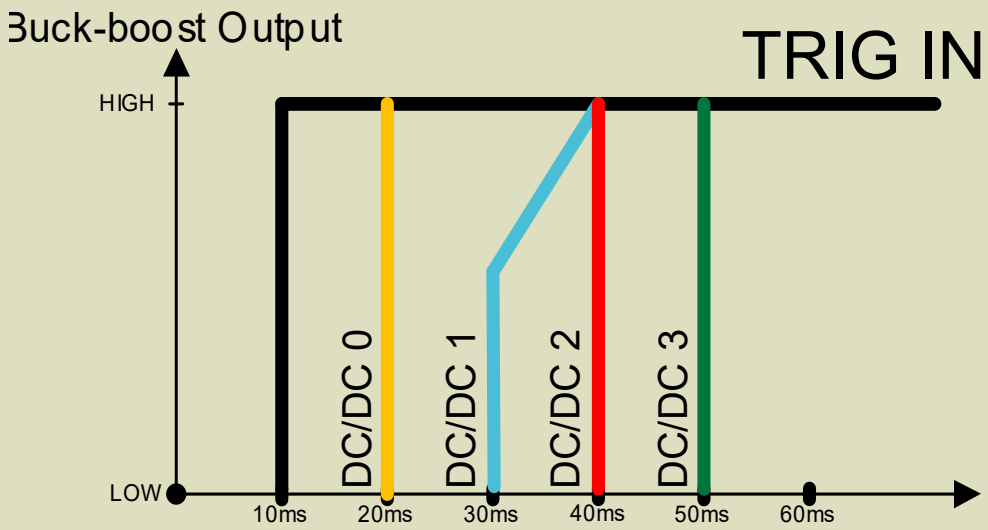
State machine/guard logic | Digital IO | Analog IO | Features | Inaccessible

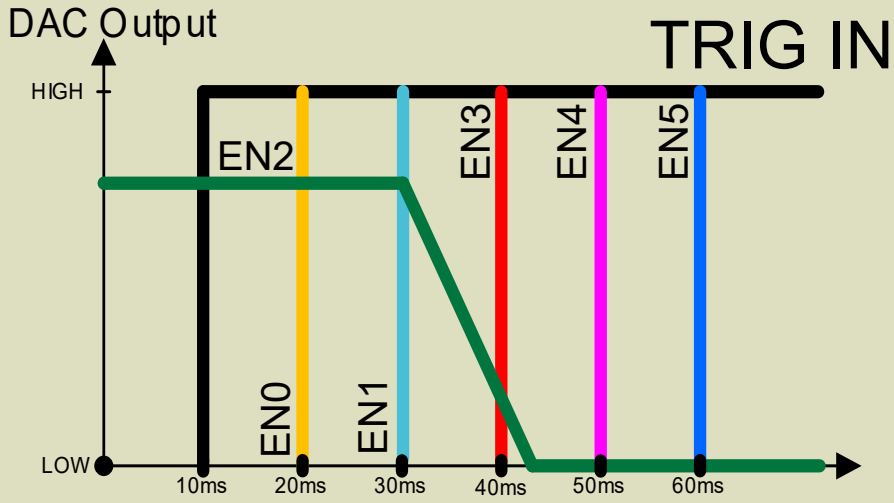
Experiment

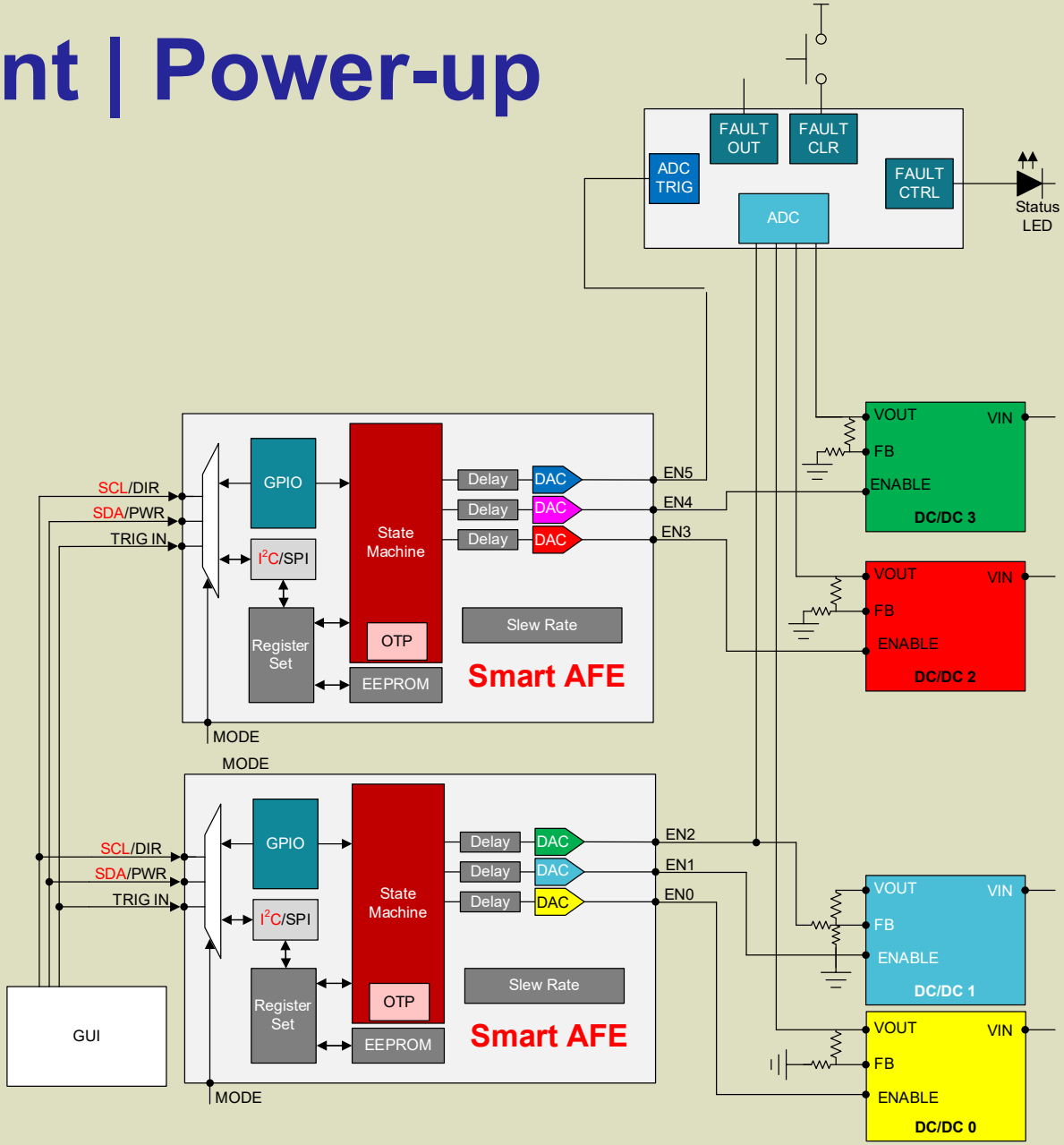
TRIG-IN	DIR	PWR	SYSTEM
0	X	1	Do nothing
1	1	1	Start power-up sequence
1	0	1	Start power-down sequence
X	X	0	Immediately shut off all channels. Latches until reset



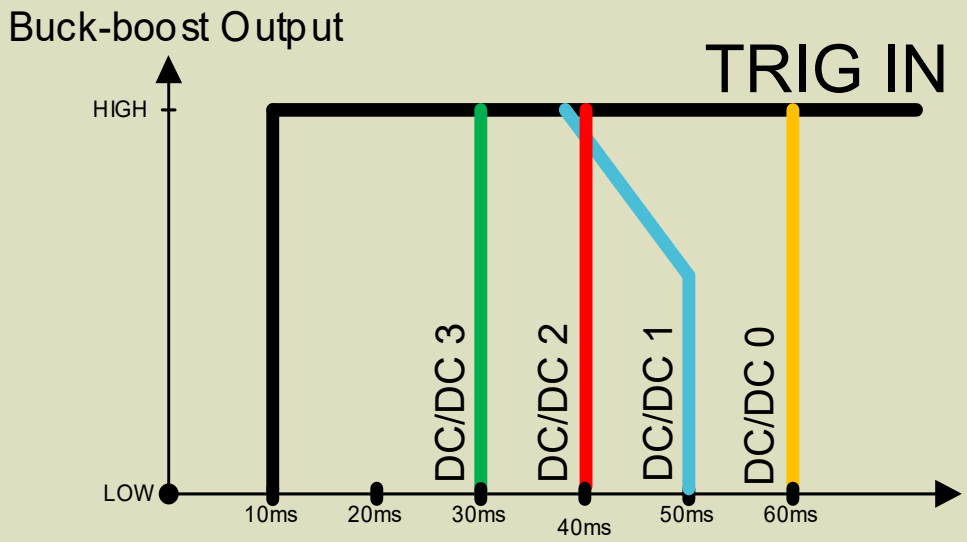
Experiment | Power-up

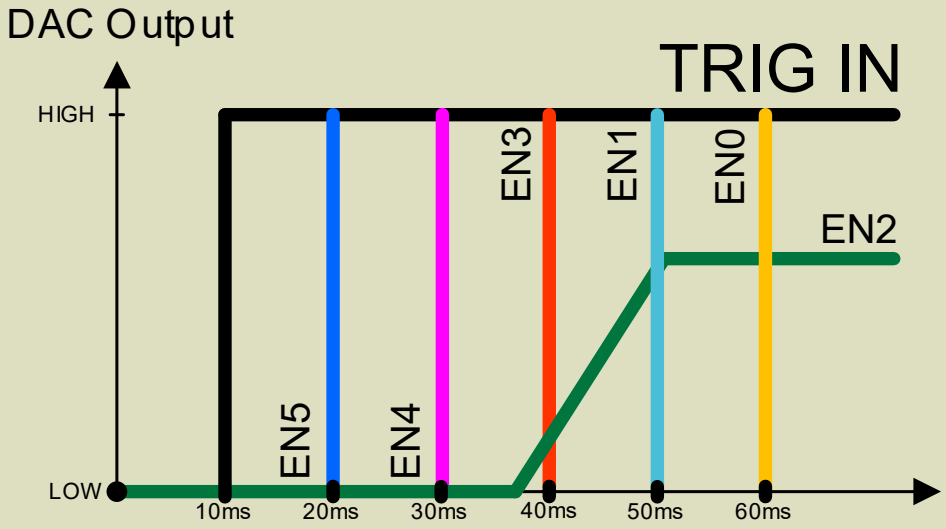


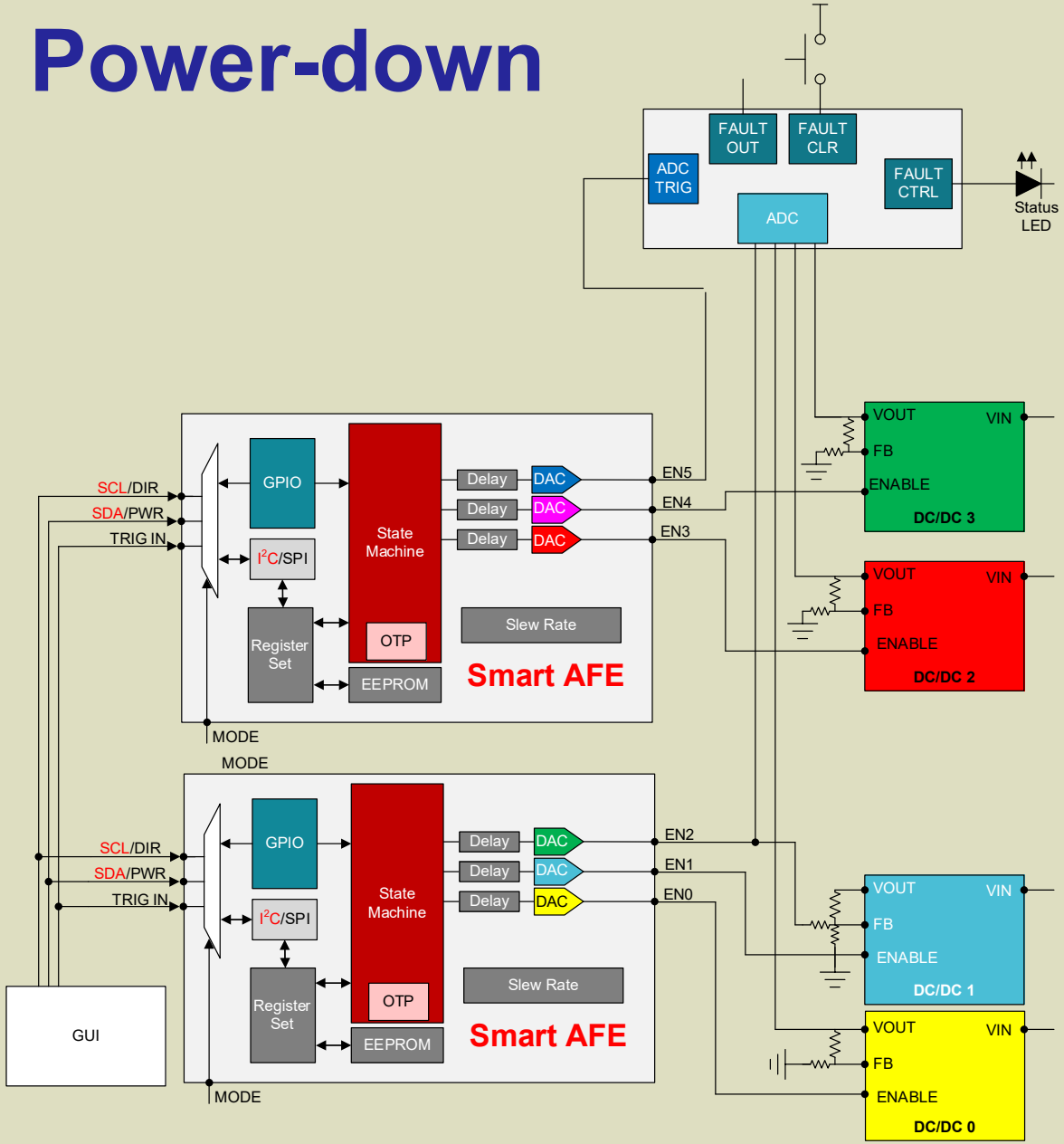




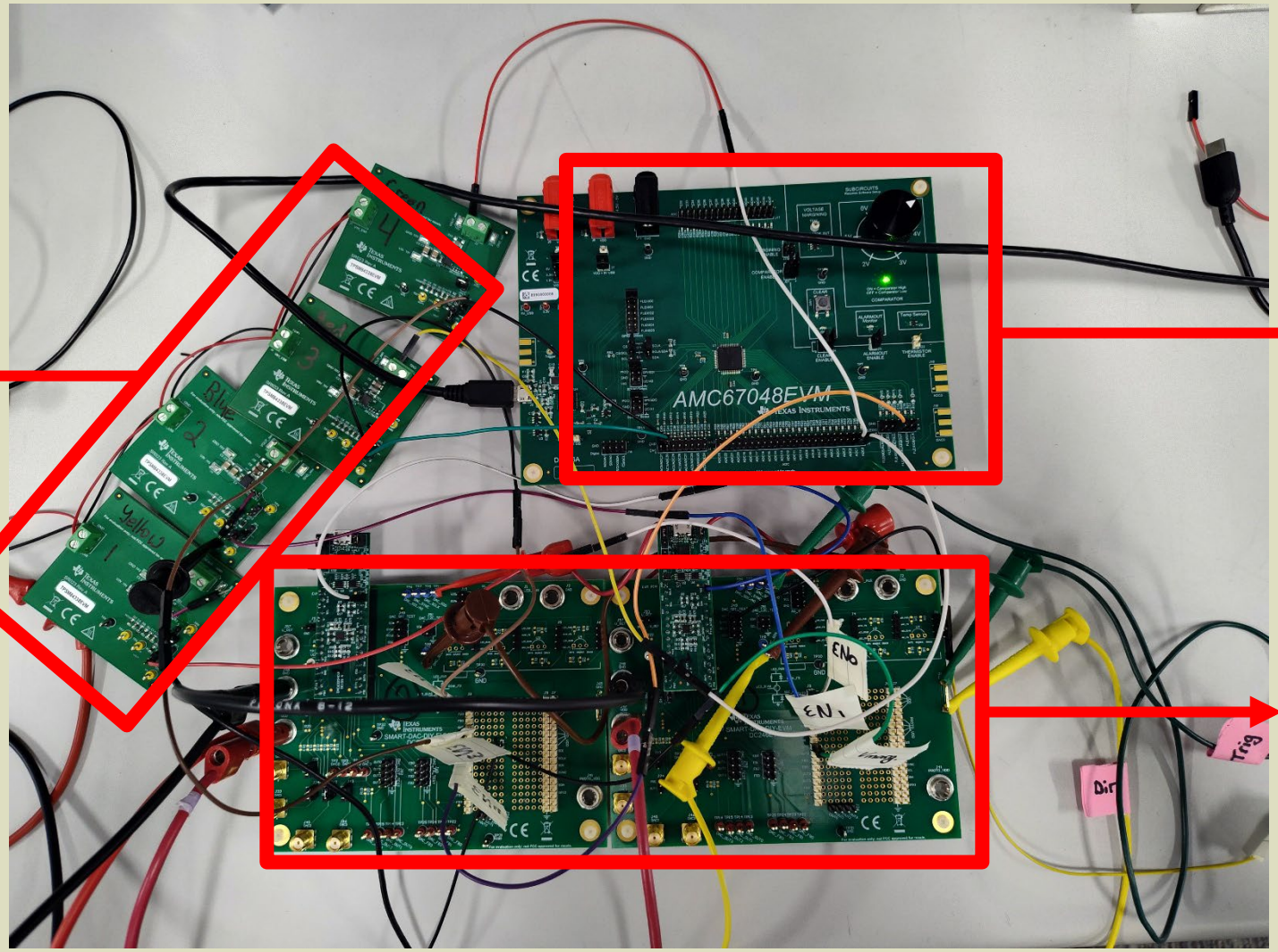
Experiment | Power-down







Results | Set-up



Results | Software-free Controlled AFE Sequence

Power-up

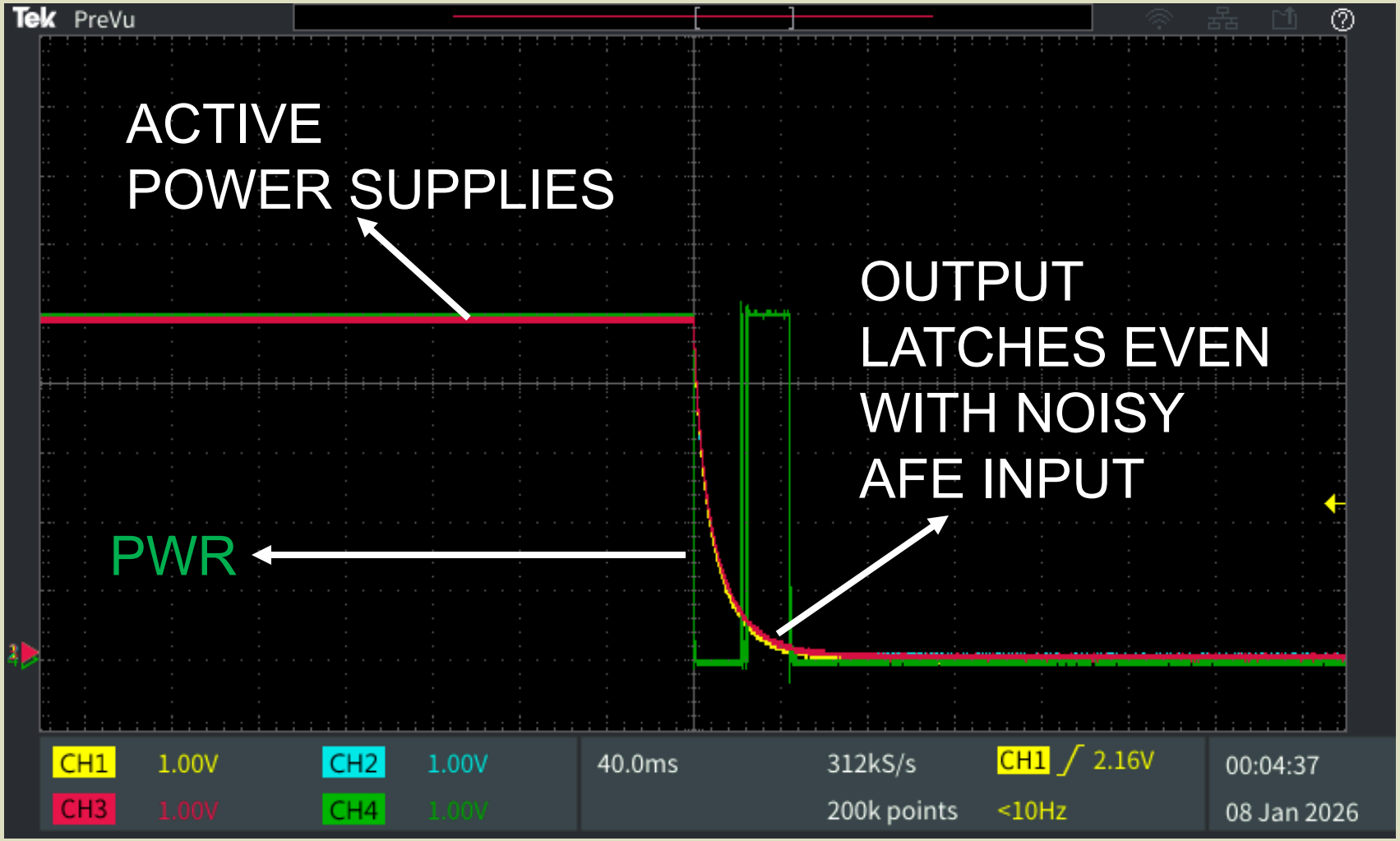
Power-down

Results | DC/DC Controlled Power Sequence

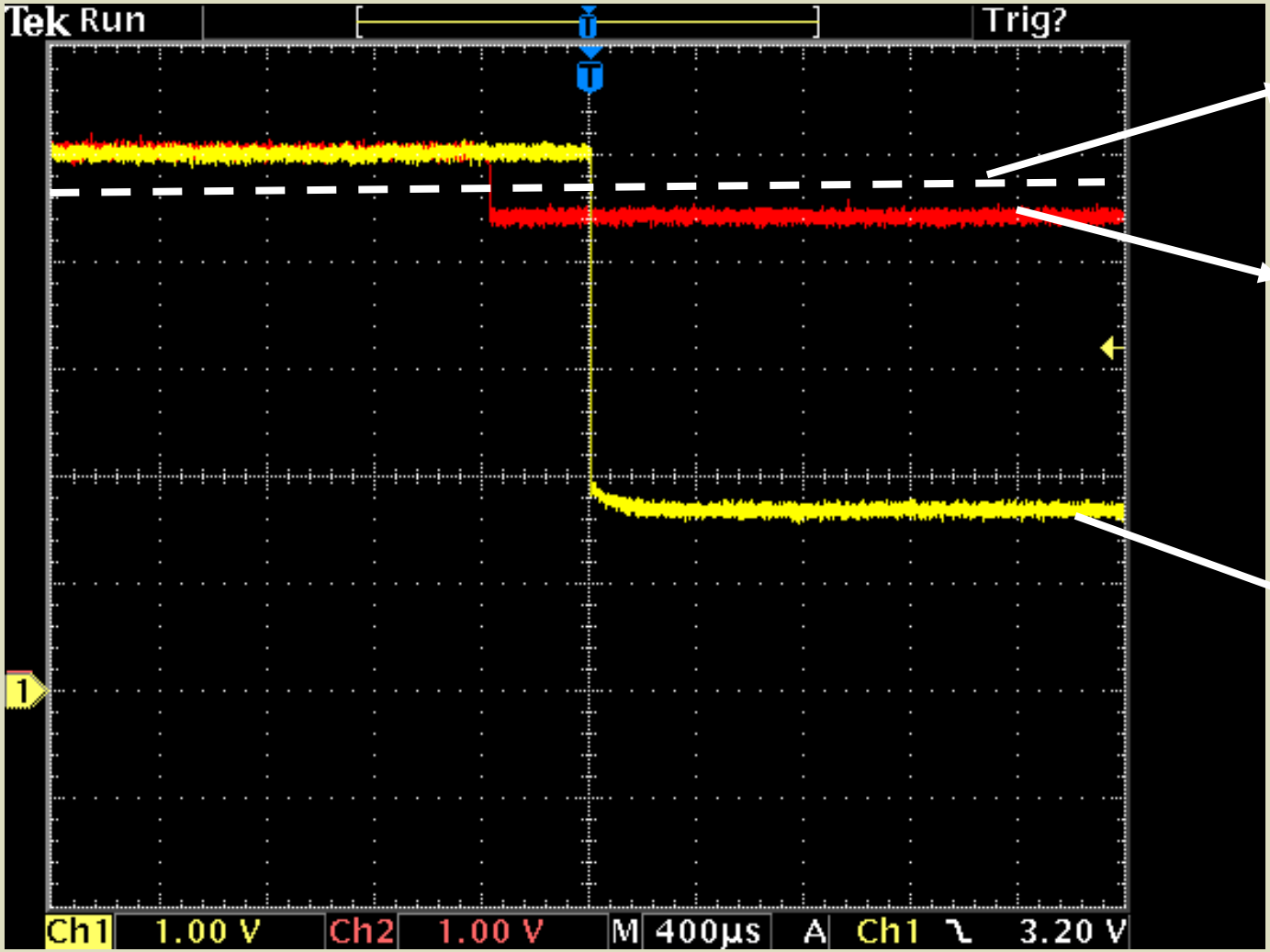
Power-up

Power-down

Results | AFE Shut Down Command Response



Results | Monitor IC Power Rail Fault Response



FAULT THRESHOLD

POWER

ALARMOUT (active LOW)

In Summary

- Power management in tester equipment requires extensive R&D
  - Some systems require over 40 channels of dynamic power supply control
  - Software/hardware development
  - Trade off between common sequencing and power management solutions
- Flexible solution with minimal software
  - State machine configured for the sequencing and power supply ramp control
  - Adjustment of timing on the fly via internal registers
  - High channel density monitoring
  - Predictable response

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