Adaptive Single-Event Latch-up Protector for Space Applications

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ALTER TECHNOLOGY

UNIVERSIDAD DE SEVILLA

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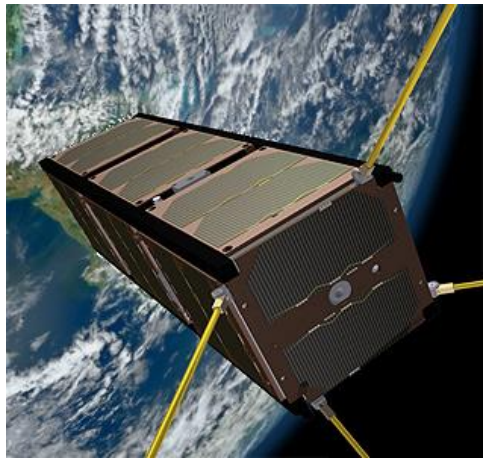
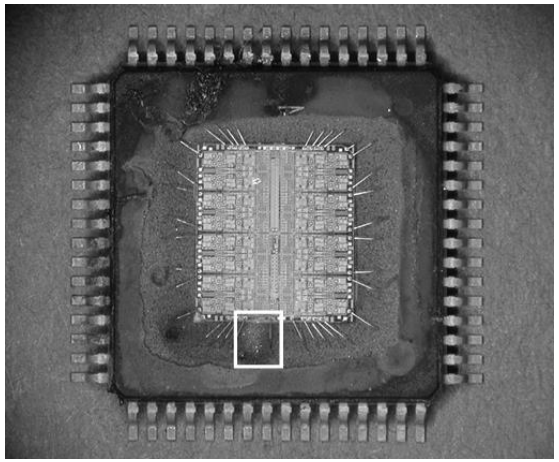
I. INTRODUCTION

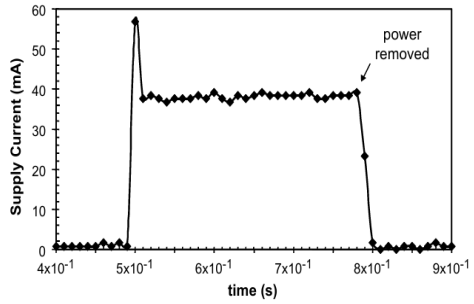
CUBESATS, NEW SPACE & COTS



source: GOMSpace



source: Martha V. O'Bryan1, Member, IEEE, Kenneth A. LaBel2, Member



source: Martha V. O'Bryan1, Member, IEEE, Kenneth A. LaBel2, Member, IEEE

PROBLEM

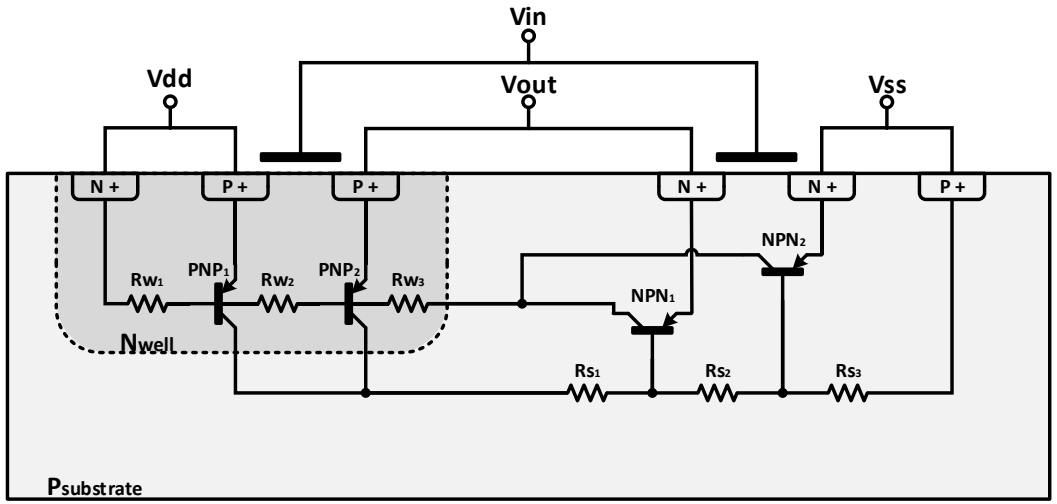
- **COTS** components in small satellites are **vulnerable** to **space radiation** especially to **SEL**

GOAL

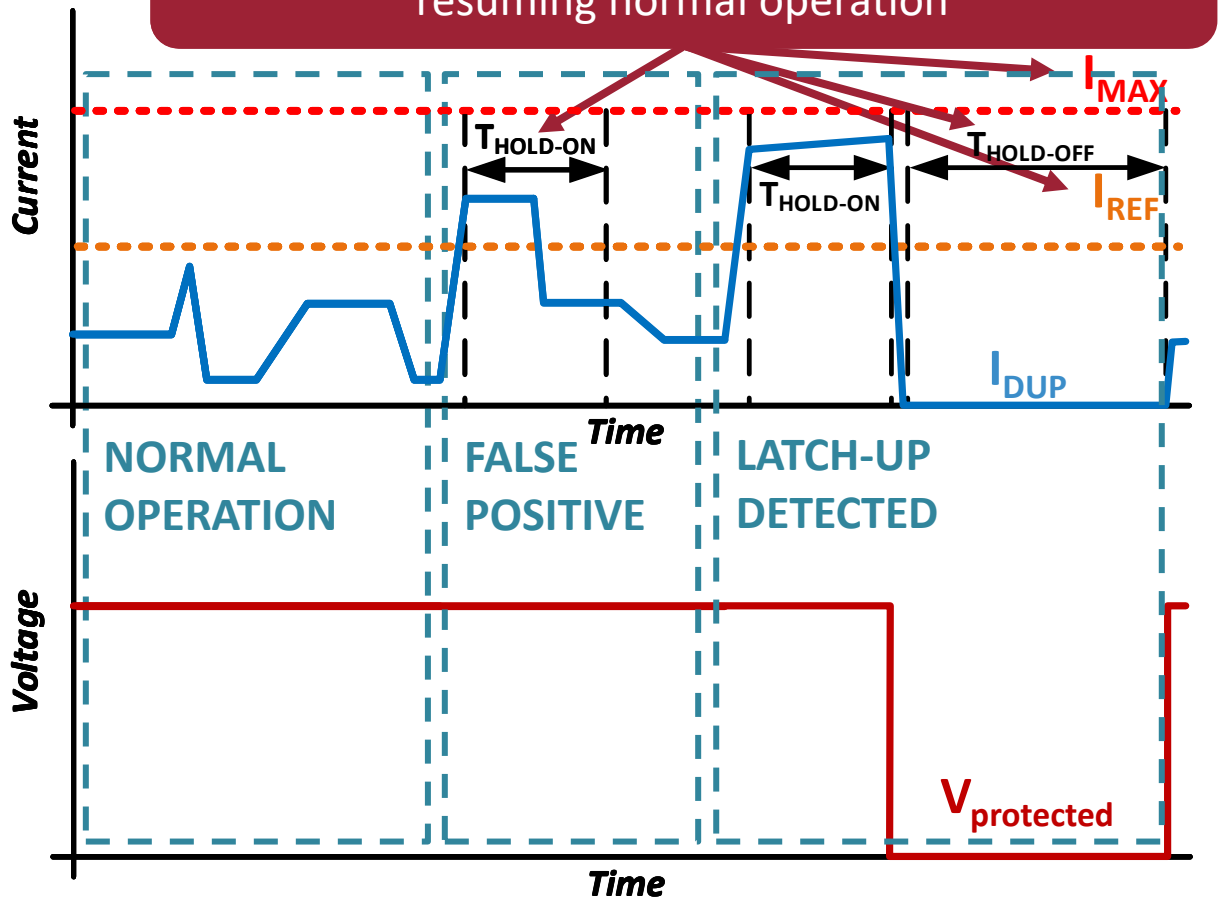
- Propose an **adaptative, low-power solution** to protect **COTS** components against **SEL**

II. RADIATION IN SPACE AND ITS EFFECT ON ELECTRONICS

SINGLE EVENT LATCH-UP IN CMOS DEVICES

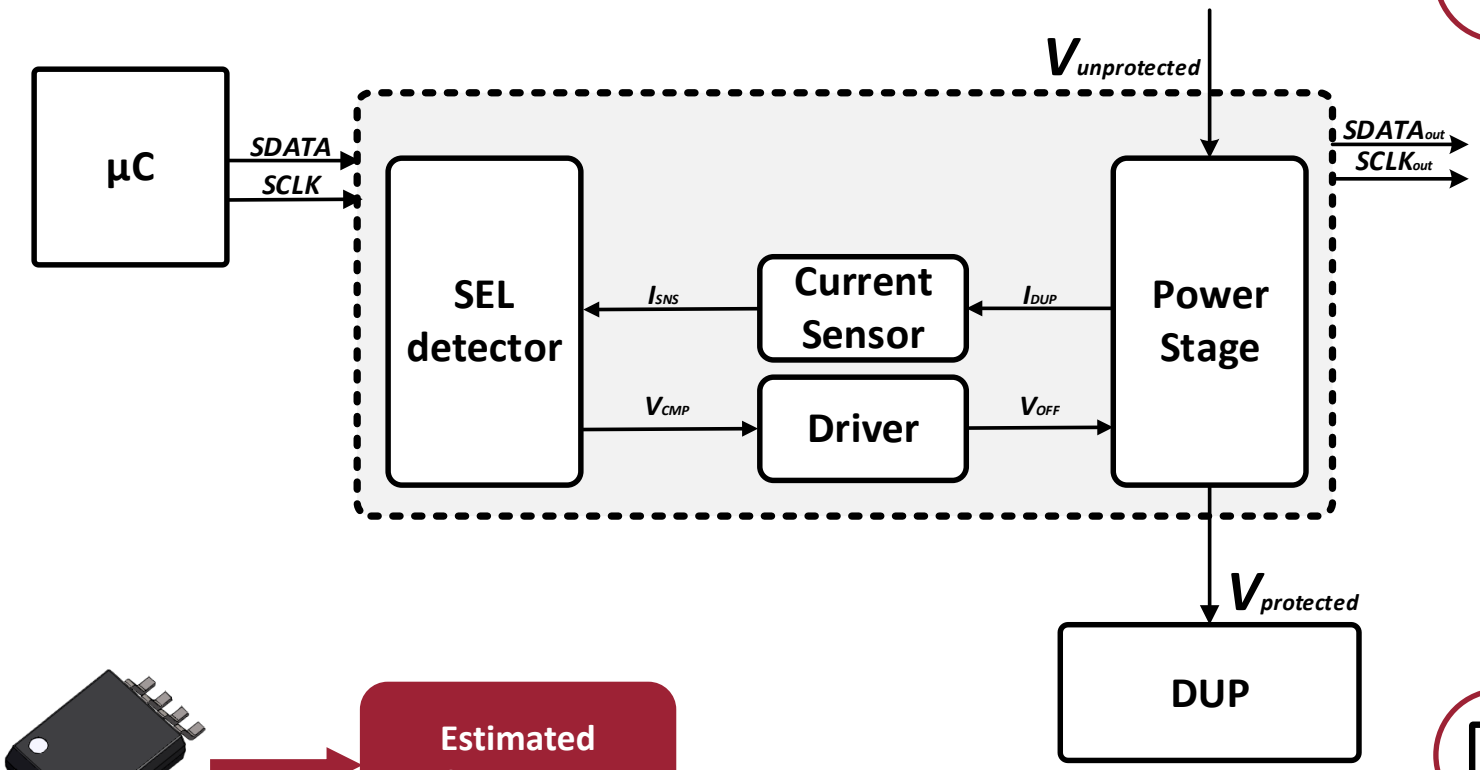


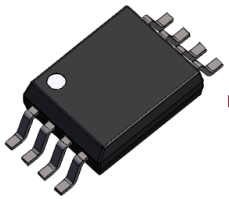
$T_{HOLD-OFF}$ → Time that DUP is disconnected before resuming normal operation



III. DESCRIPTION OF THE PROPOSED SOLUTION

SEL-PROTECT BLOCK DIAGRAM



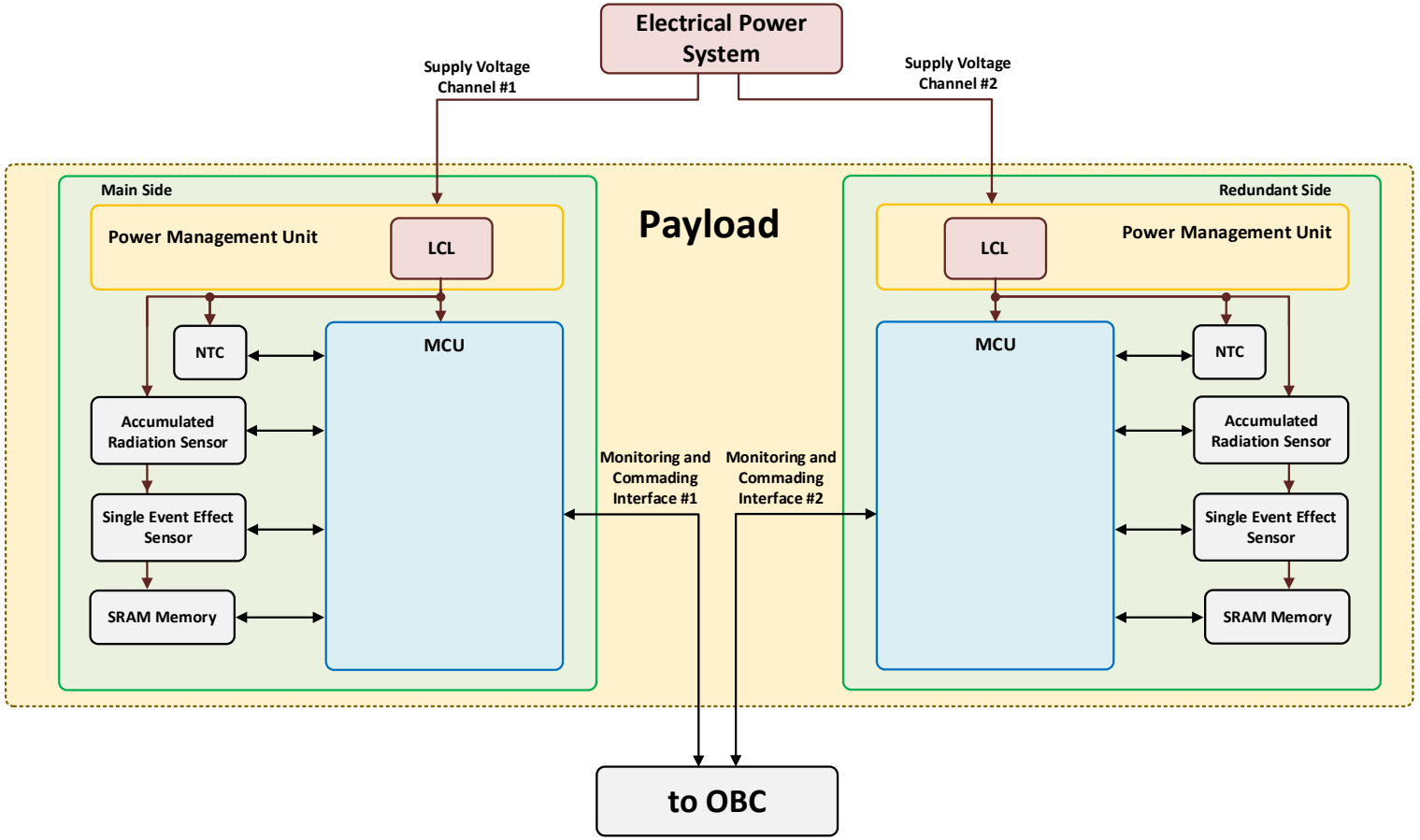


Estimated package TSSOP8

- ADAPTIVE PROTECTION
- DYNAMIC THRESHOLD
- COMPACT DESIGN
- LOW POWER OPERATION
- PROGRAMMING INTERFACE
- WIDE RANGE OPERATION

IV. USE CASES

CONVENTIONAL CASE



TOTAL INTERRUPTION

Stops the entire system, resulting in data loss and long recovery times.

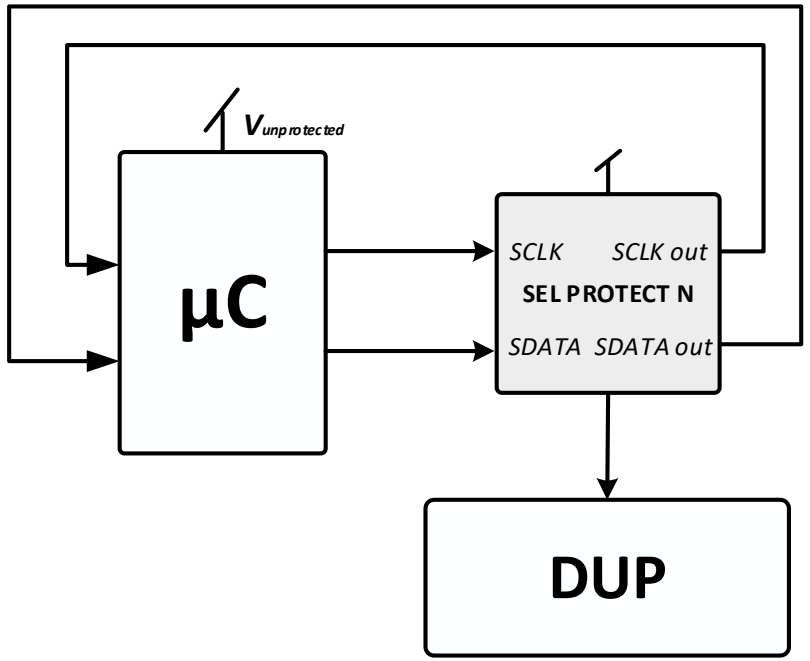
FIXED THRESHOLD

Lacks adaptability to radiation effects (TID) and ageing in electronic devices.

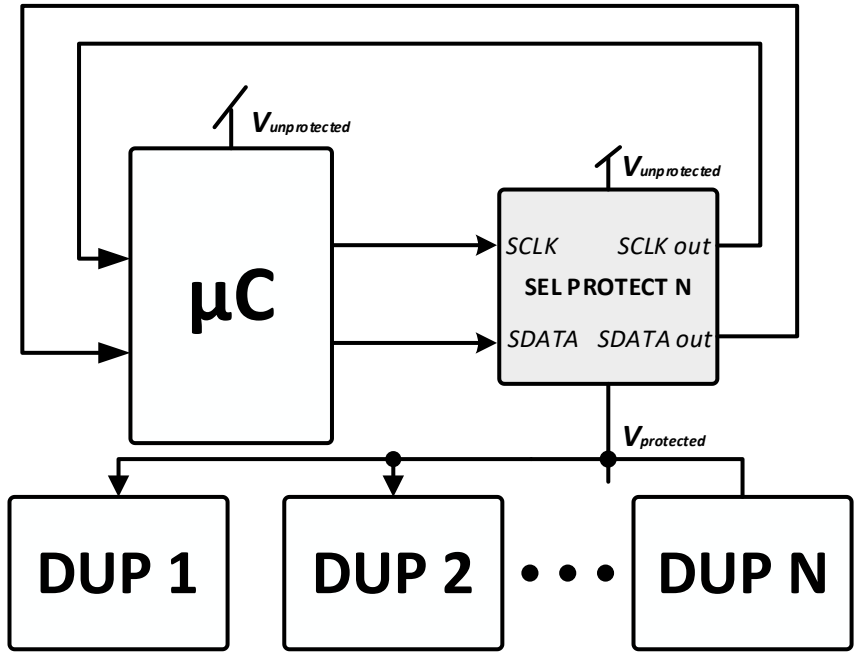
IV. USE CASES

CASE I

SINGLE CIRCUIT PROTECTION



VOLTAGE DOMAIN LEVEL PROTECTION



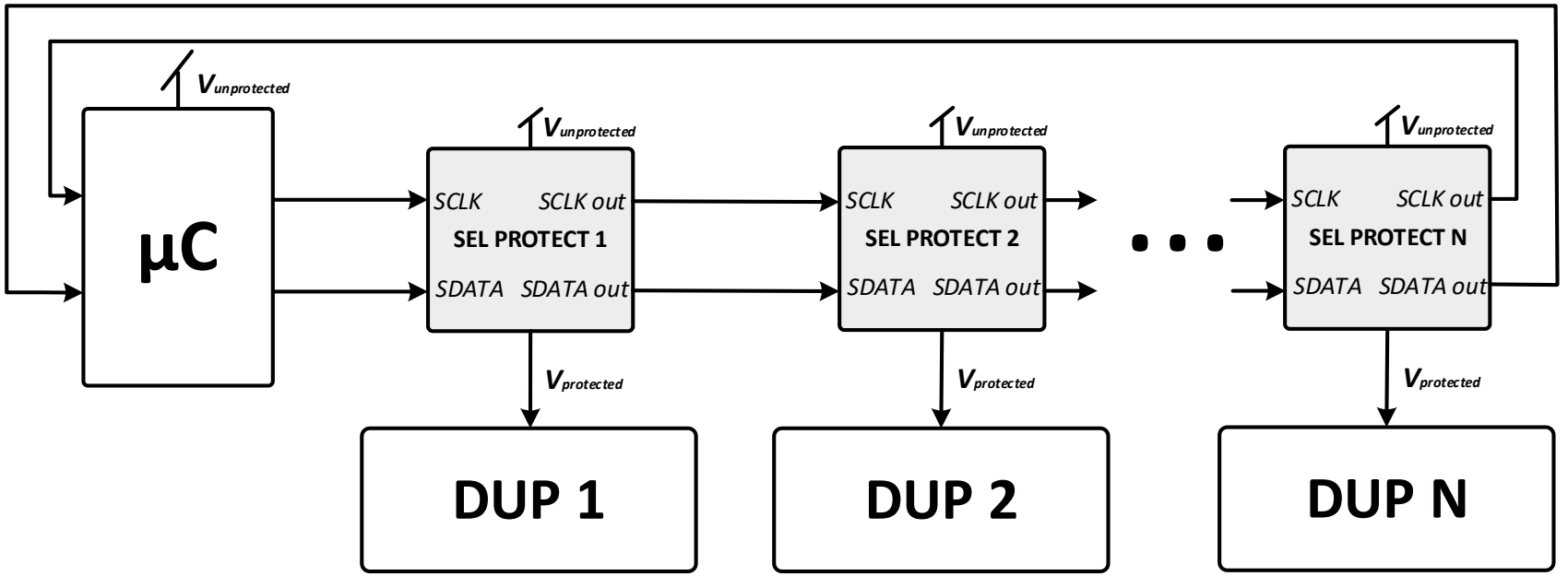
- SELProtect chip can protect several DUPs.
- SEL-Protect chip can protect also an individual DUP

DAISY CHAIN

- Will be used to implement active policies of protection

IV. USE CASES

CASE II



DAISY CHAIN

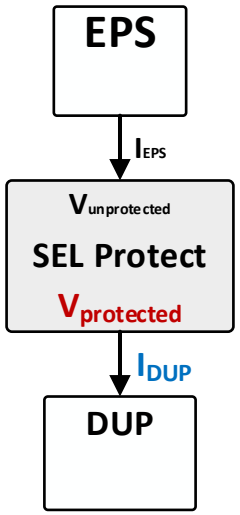
- We can use a single µC to control as many chips as we want.

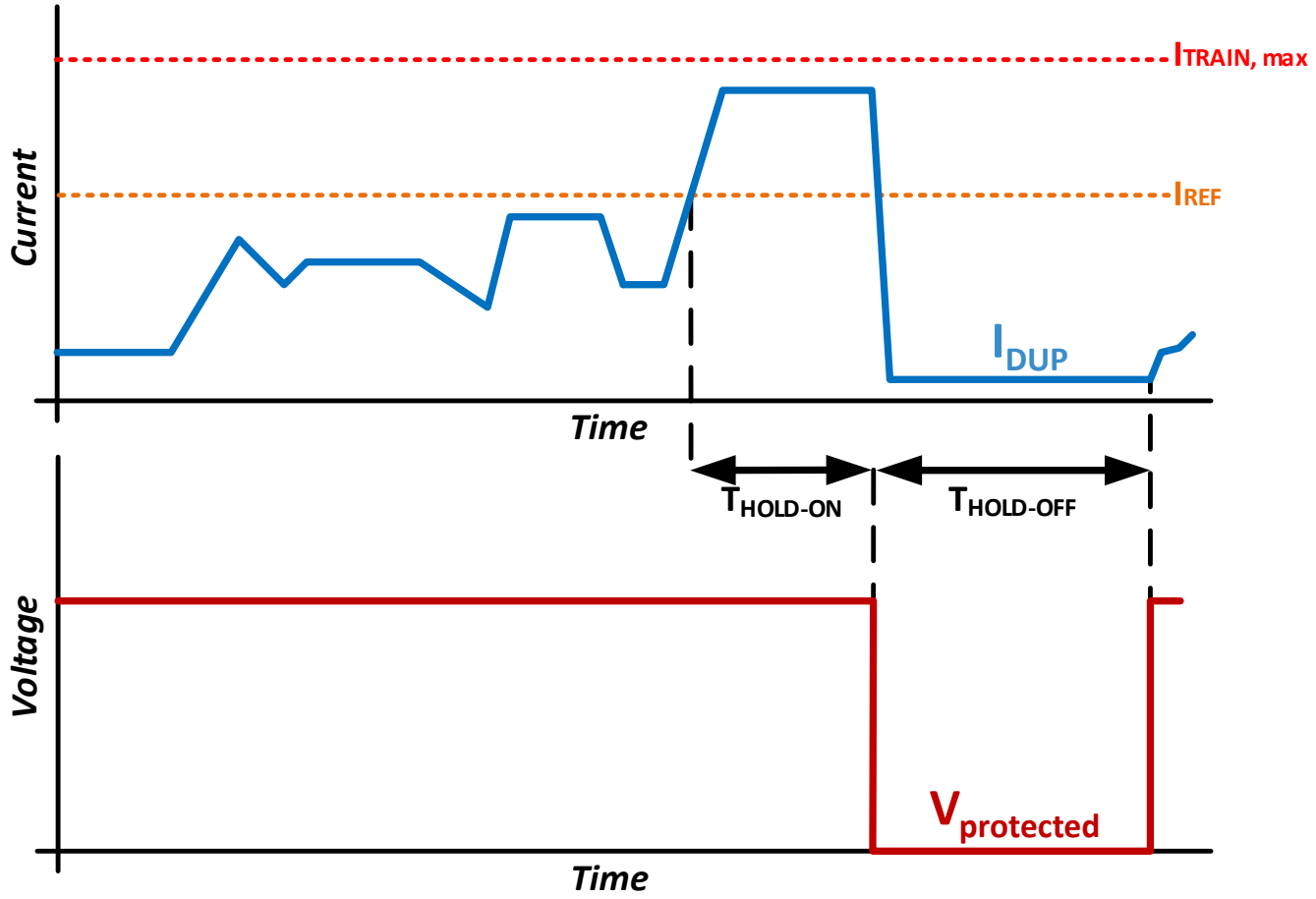
SINGLE CIRCUIT PROTECTION

- Each SELProtect chip protects one COTS from SEL.

V. OPERATING MODES

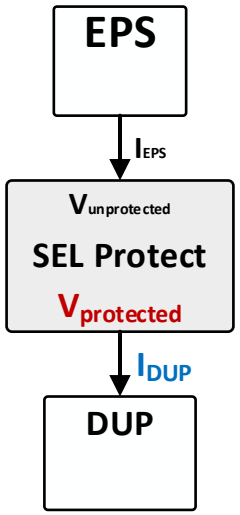
PROTECTION MODE (REFERENCE CURRENT)

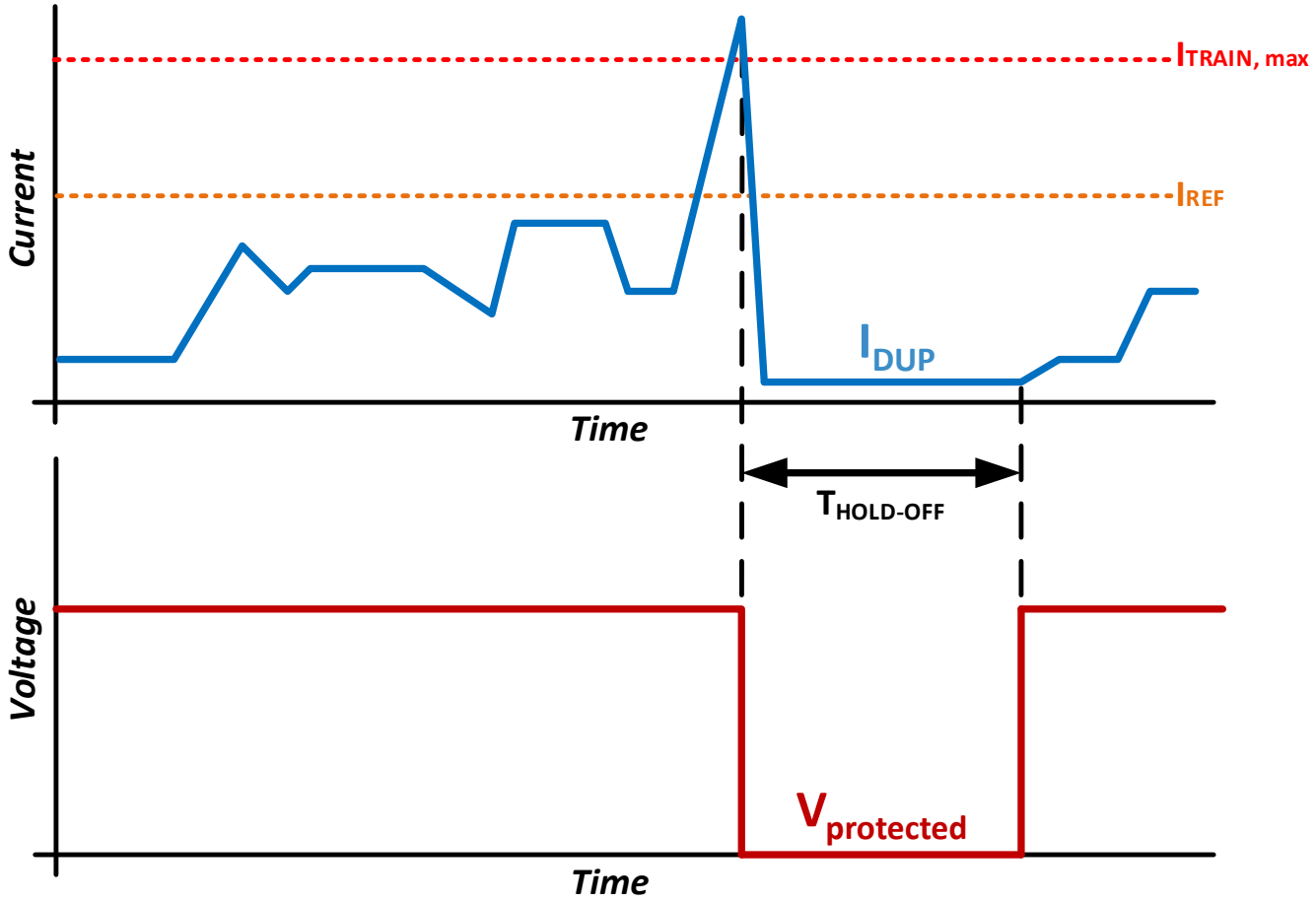




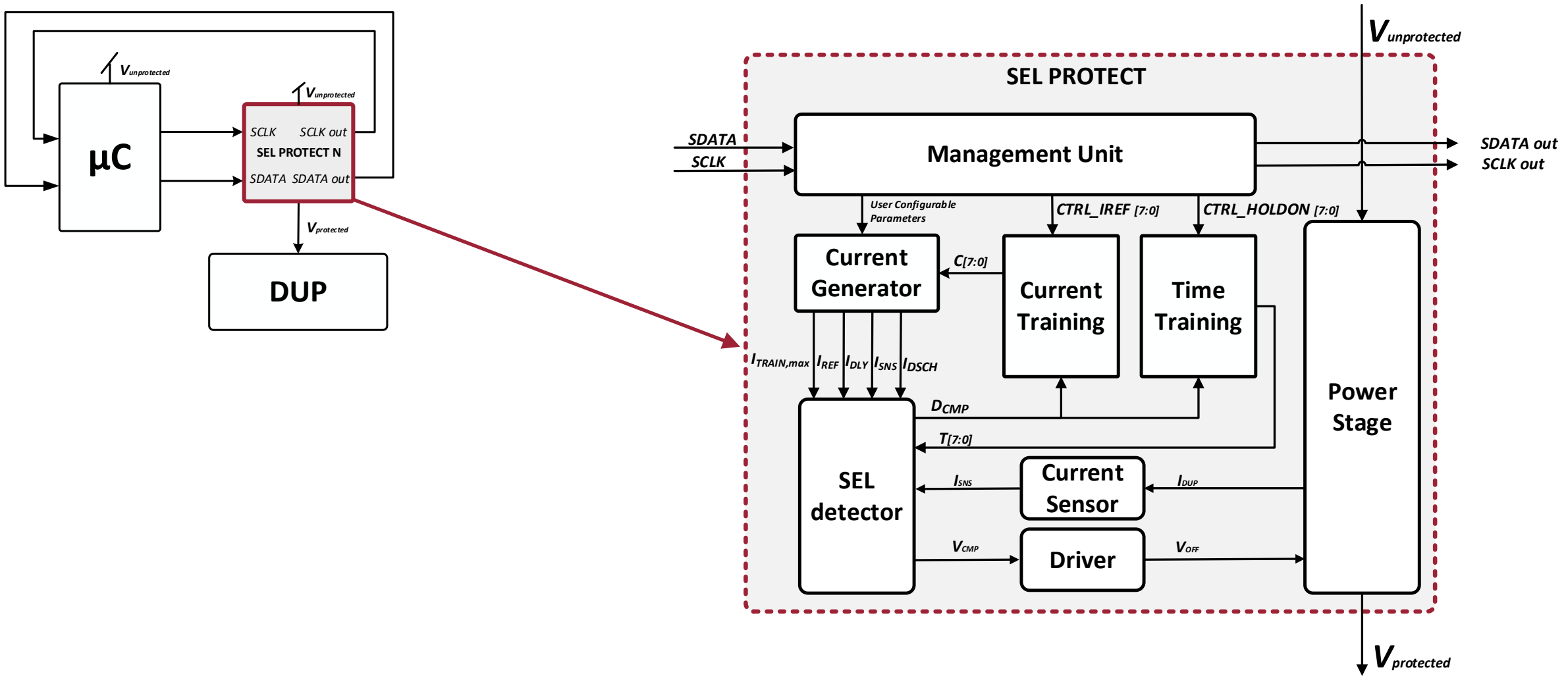
V. OPERATING MODES

PROTECTION MODE (MAXIMUM PROTECTION CURRENT)



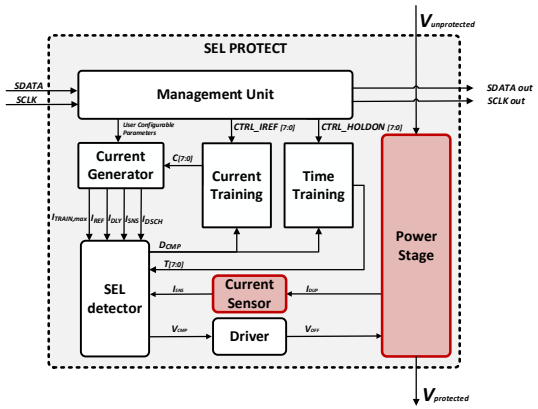


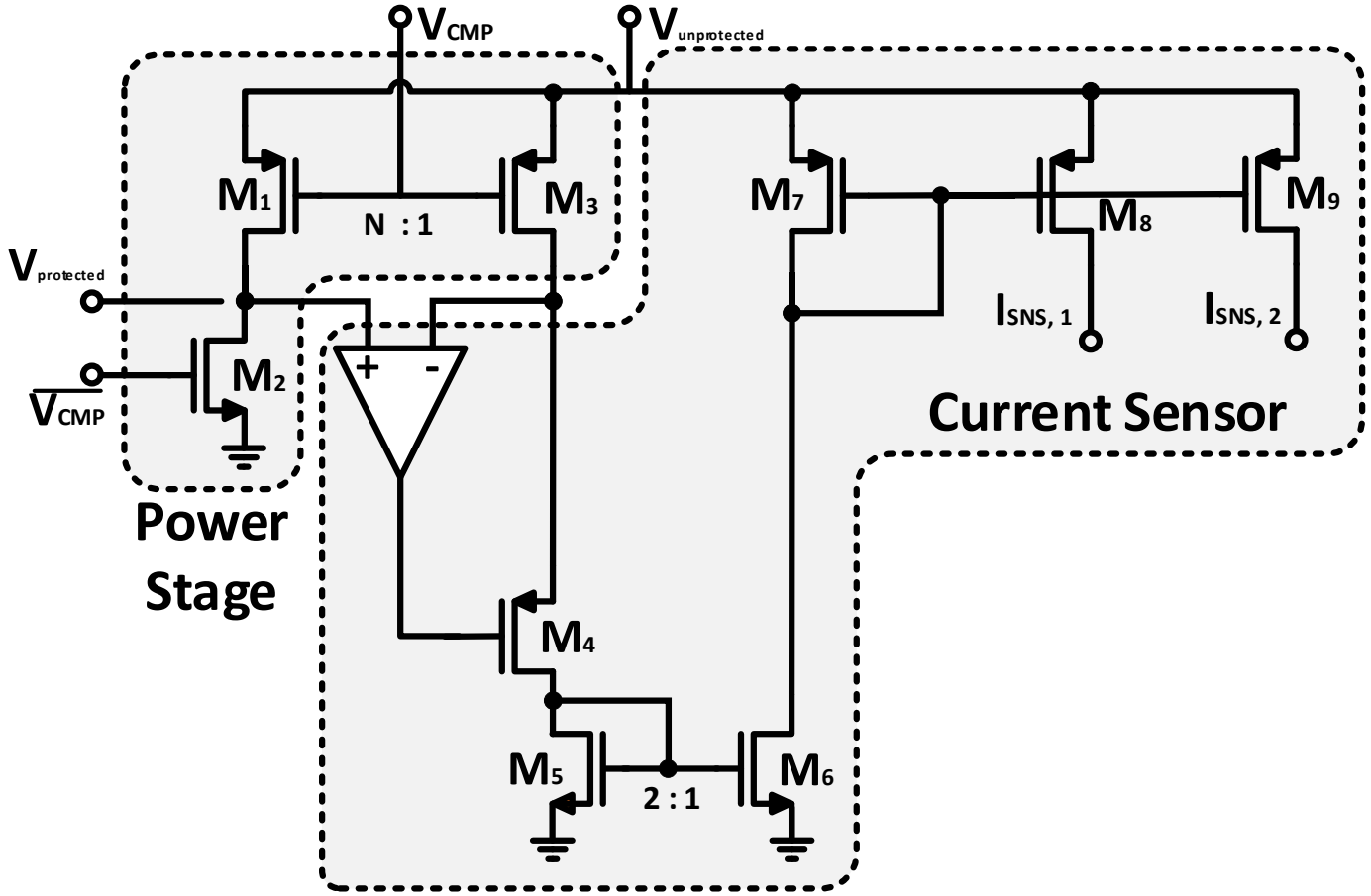
VI. SYSTEM OVERVIEW



VI. DETAILED OVERVIEW

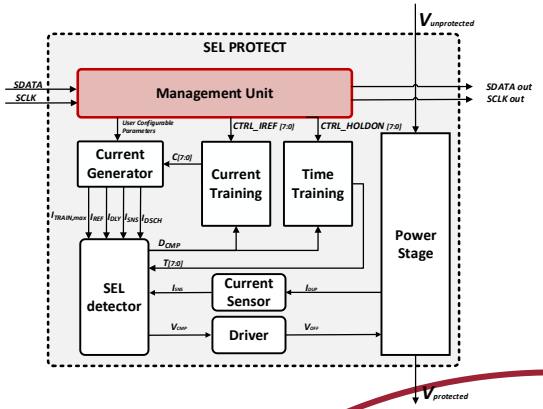
POWER STAGE + CURRENT SENSOR

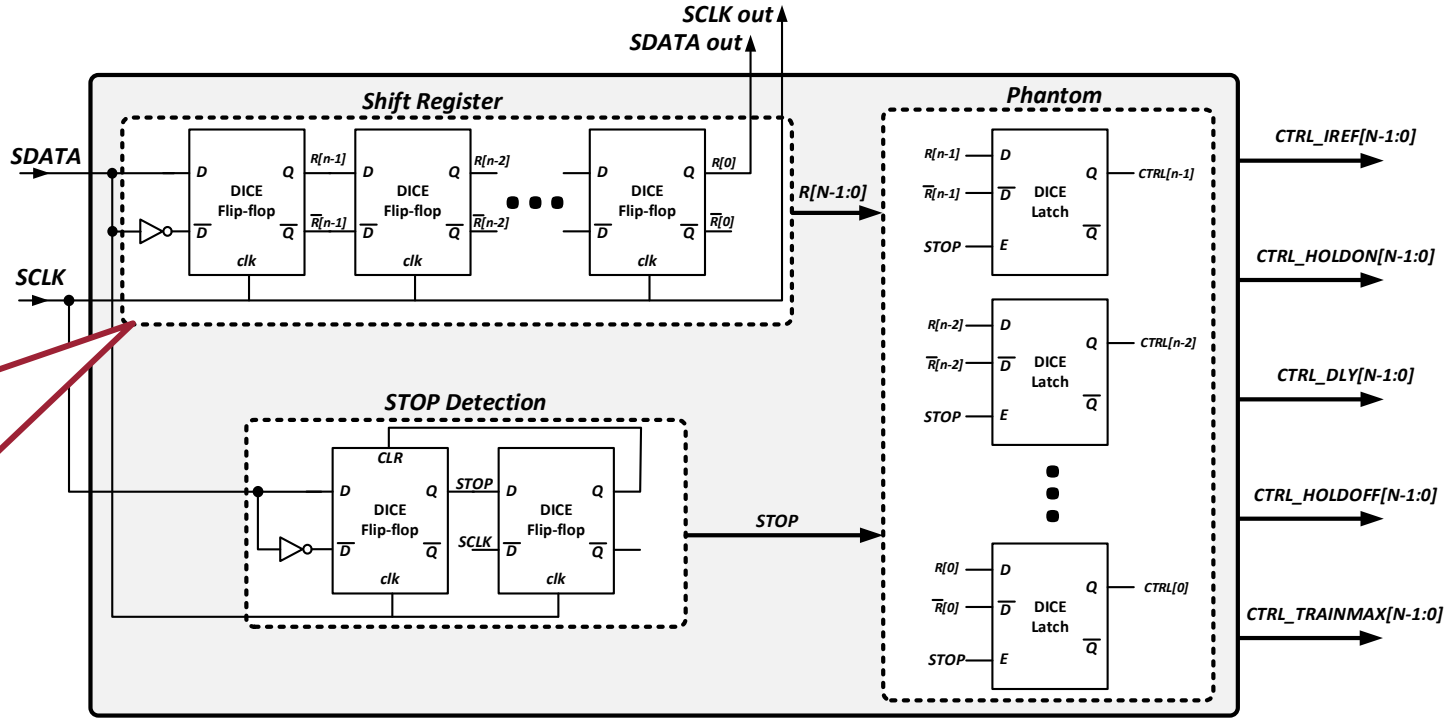




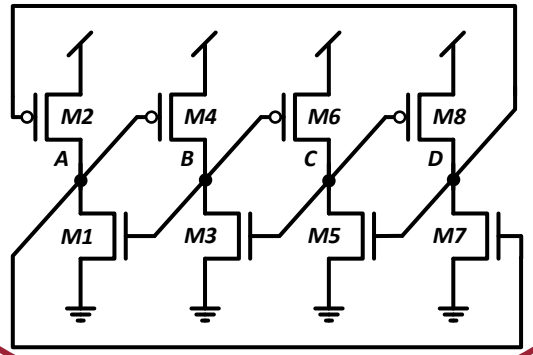
VI. DETAILED OVERVIEW

Management Unit



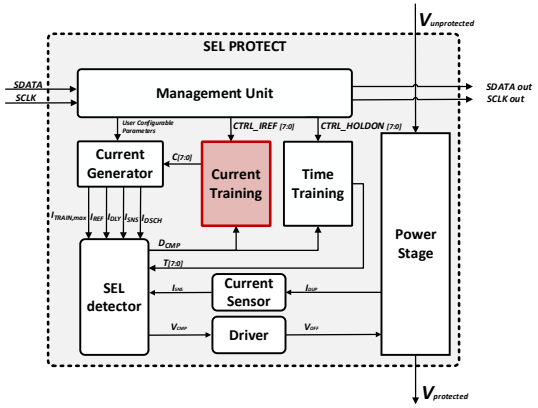


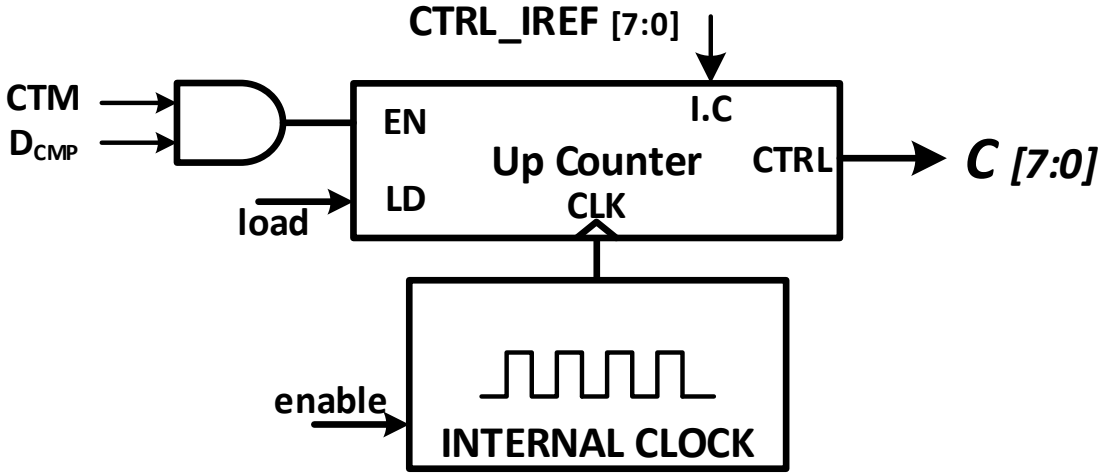
Dual Interlocked Cells (DICE)

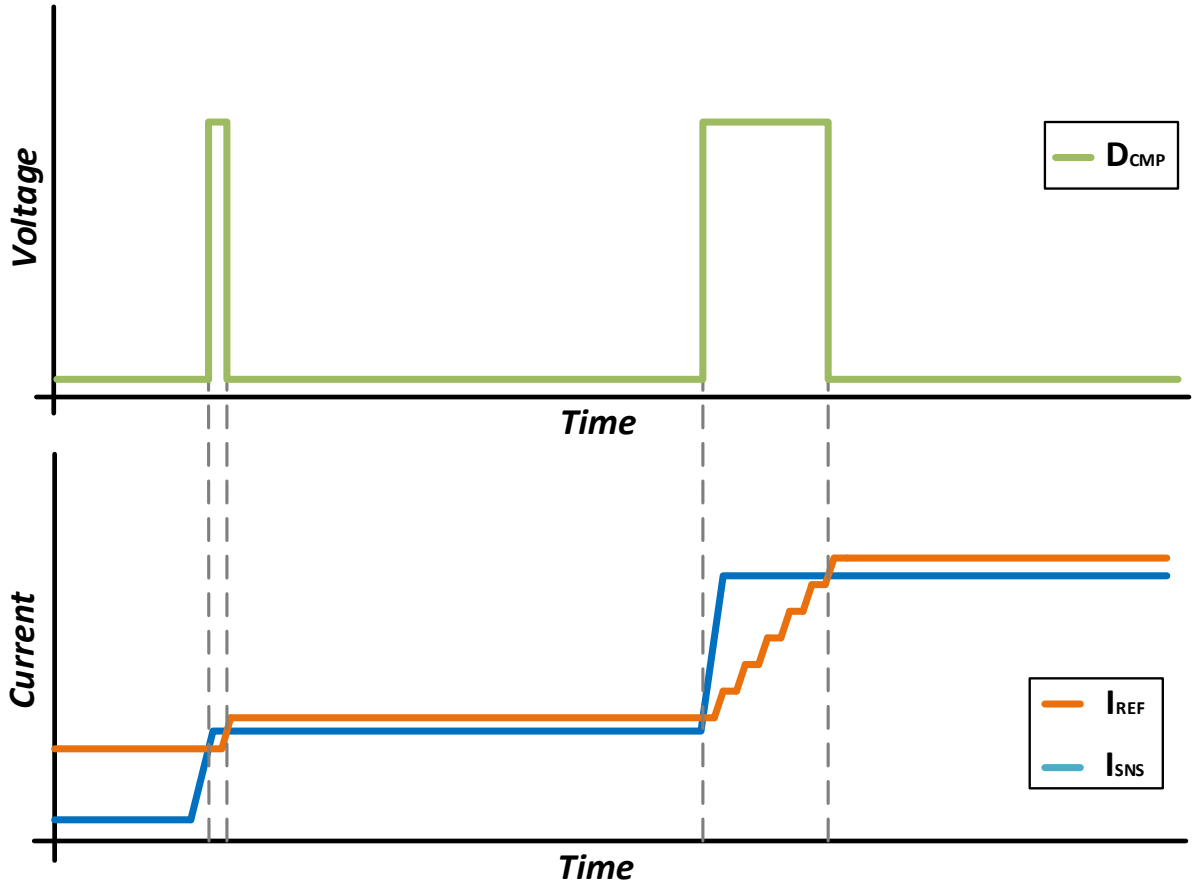


VI. DETAILED OVERVIEW

Current Training

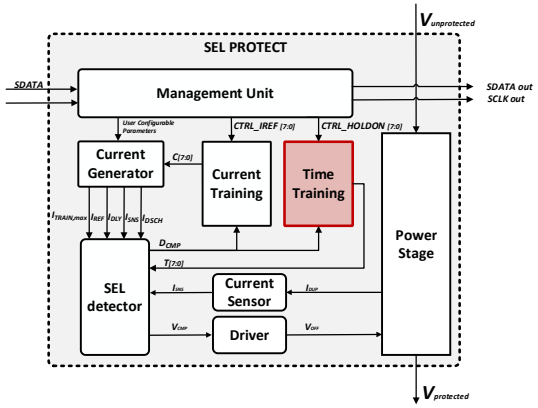


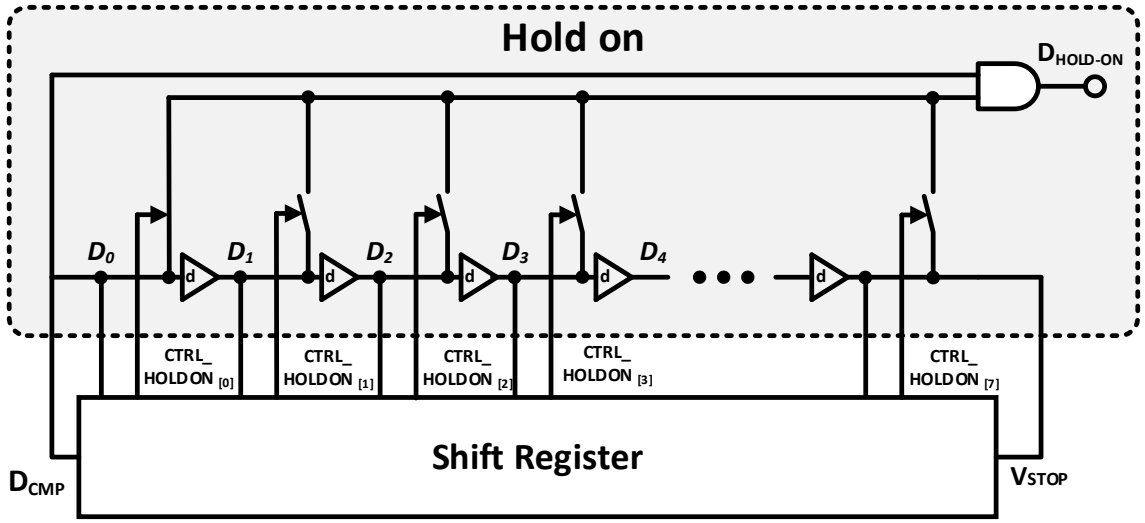


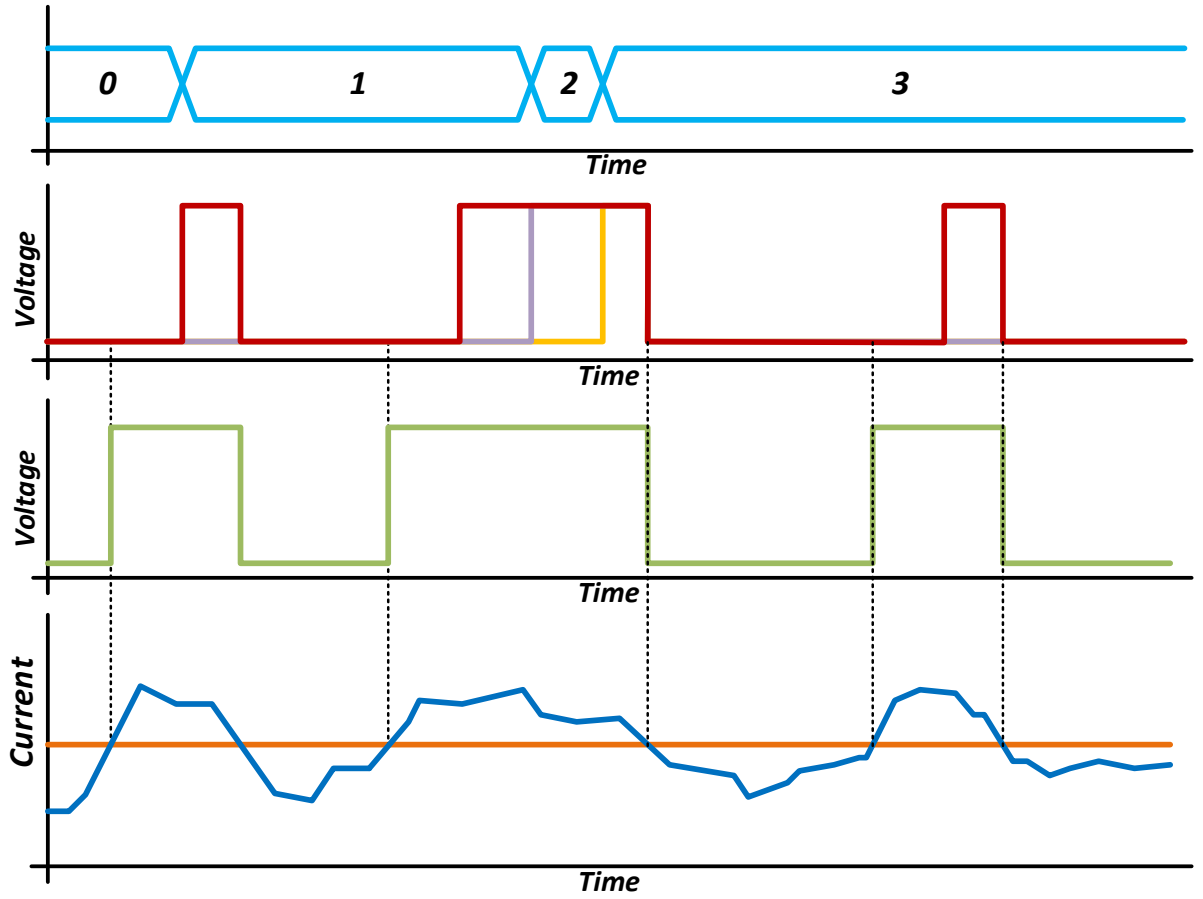


VI. DETAILED OVERVIEW

Time Training

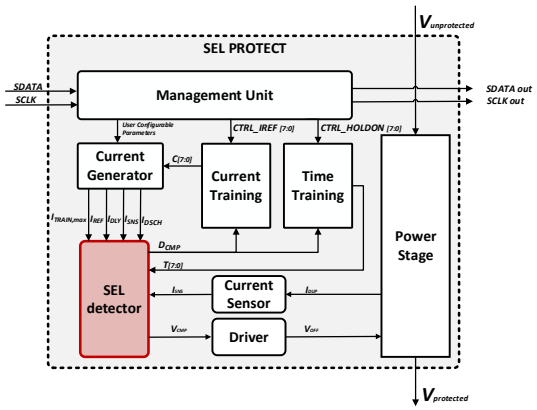


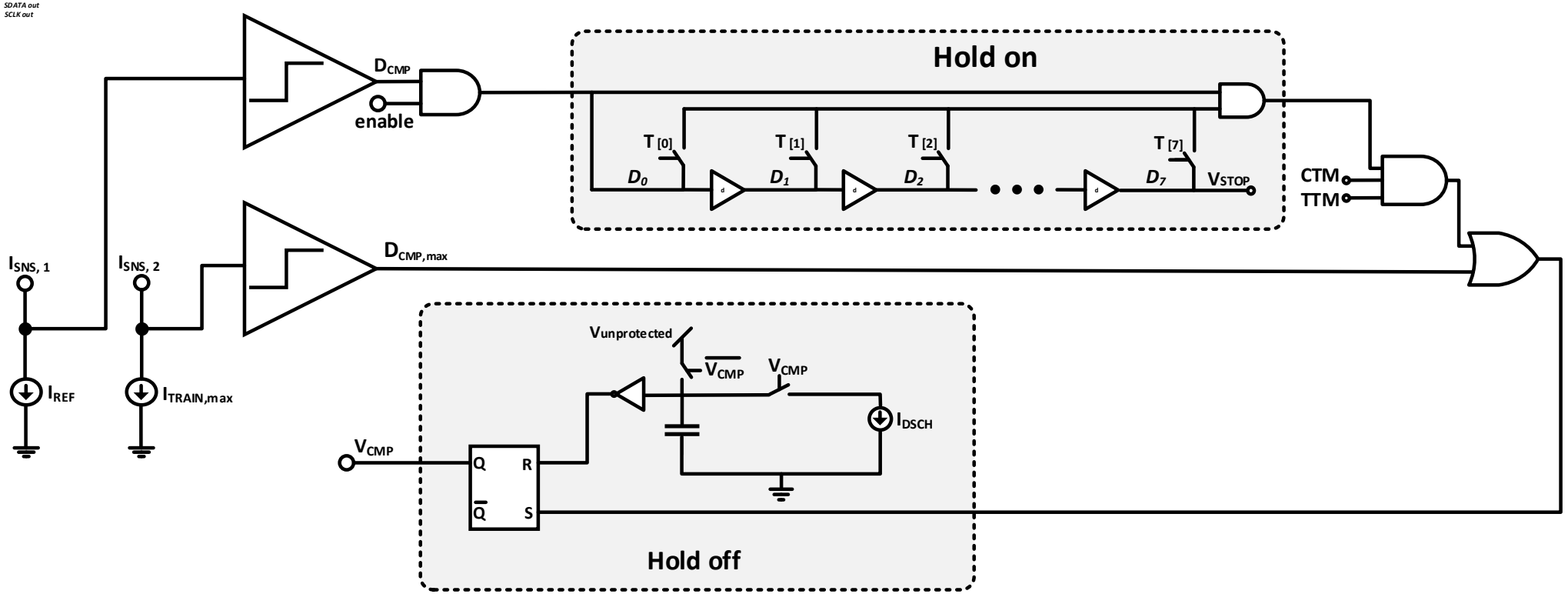




VI. DETAILED OVERVIEW

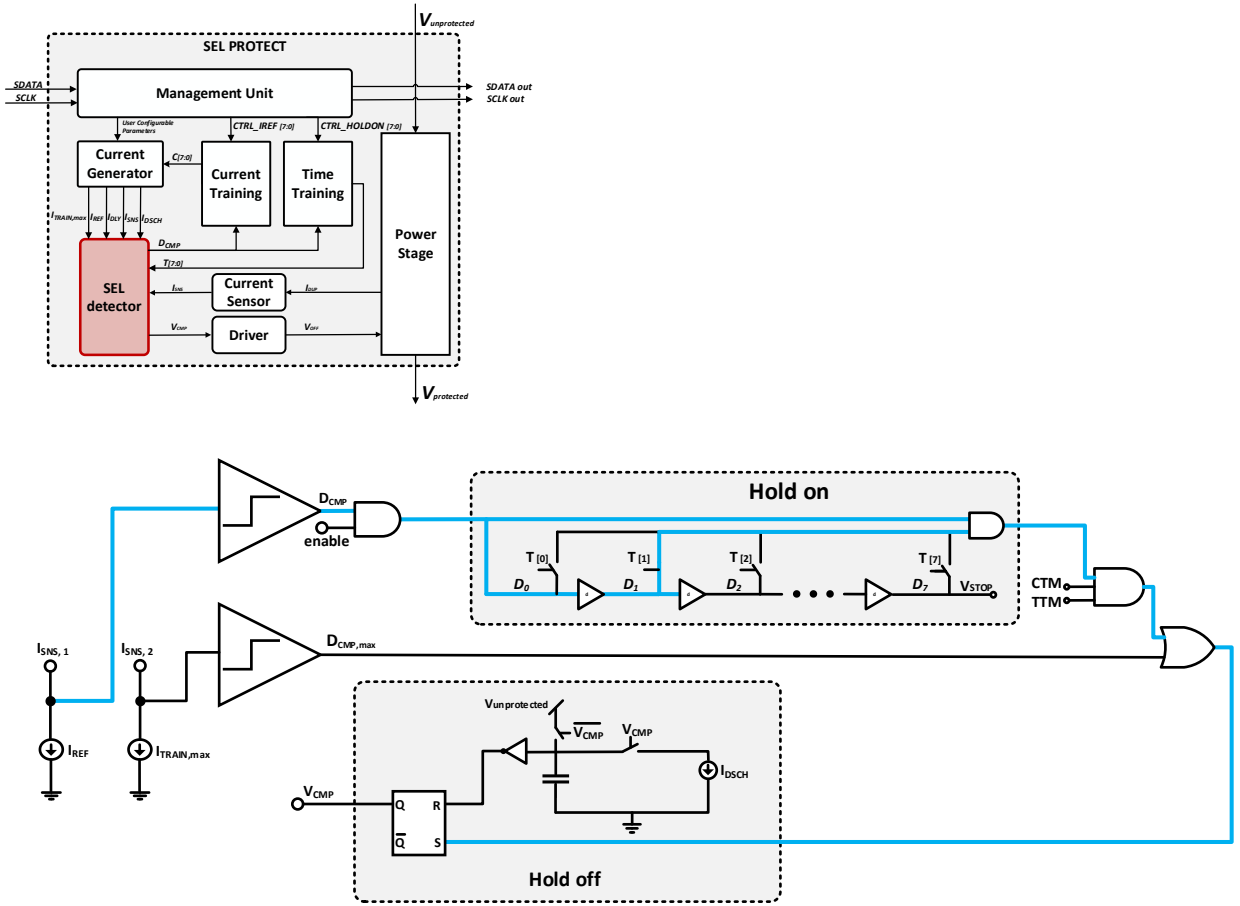
SEL Detector

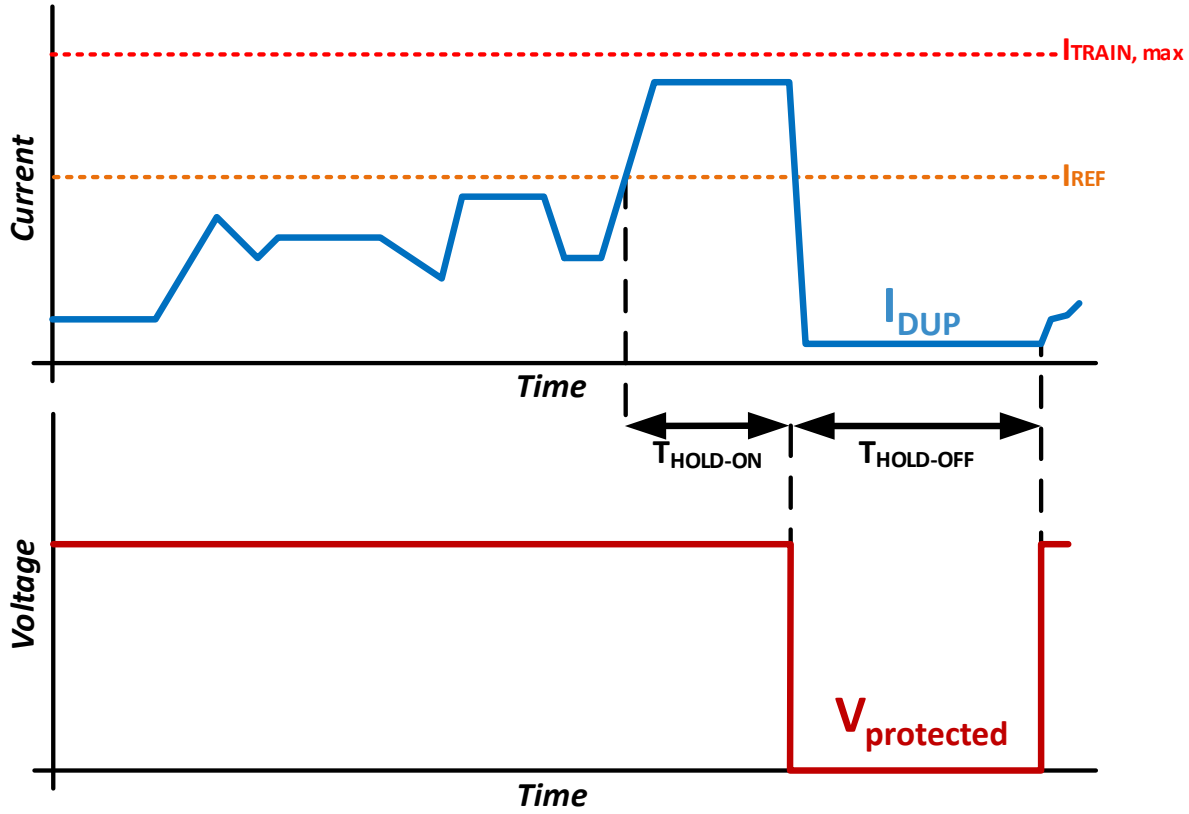




VI. DETAILED OVERVIEW

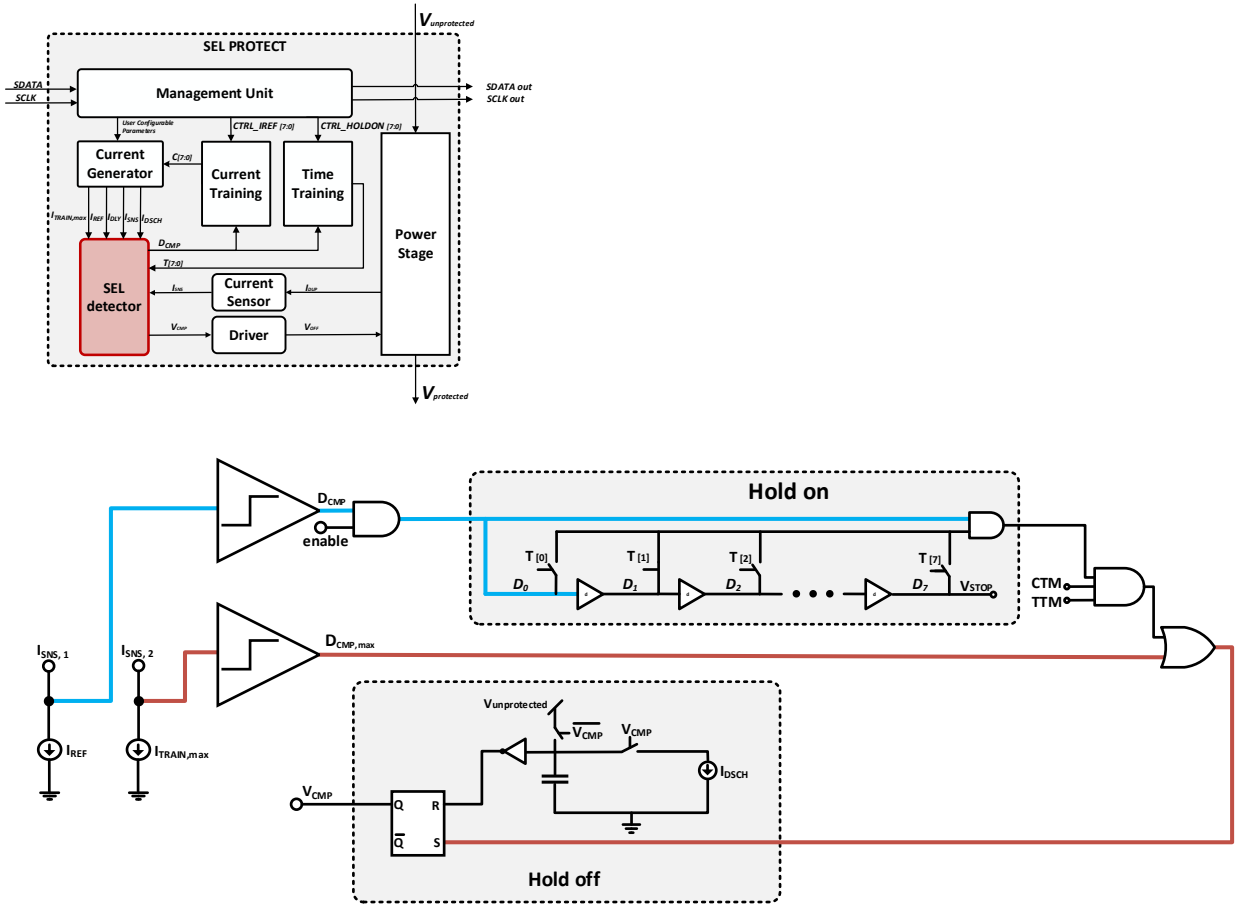
SEL Detector (reference current detection)

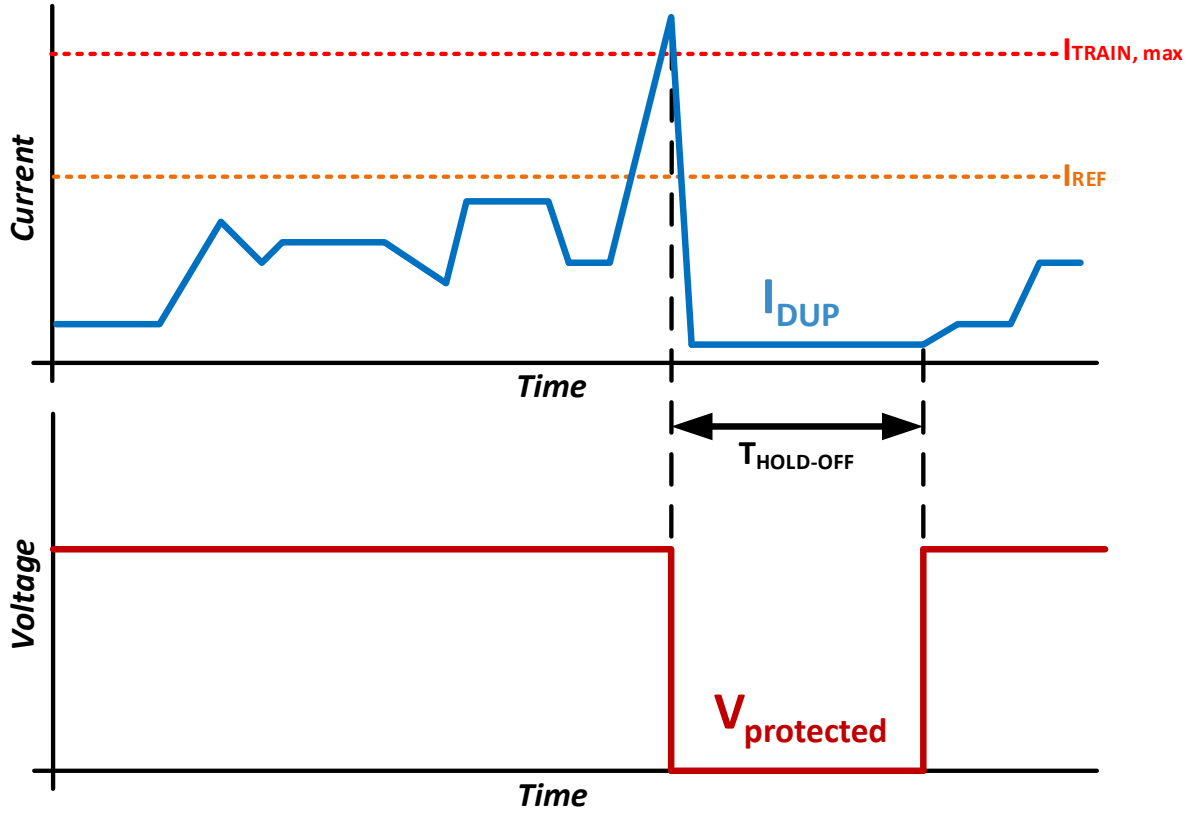




VI. DETAILED OVERVIEW

SEL Detector (maximum current detection)

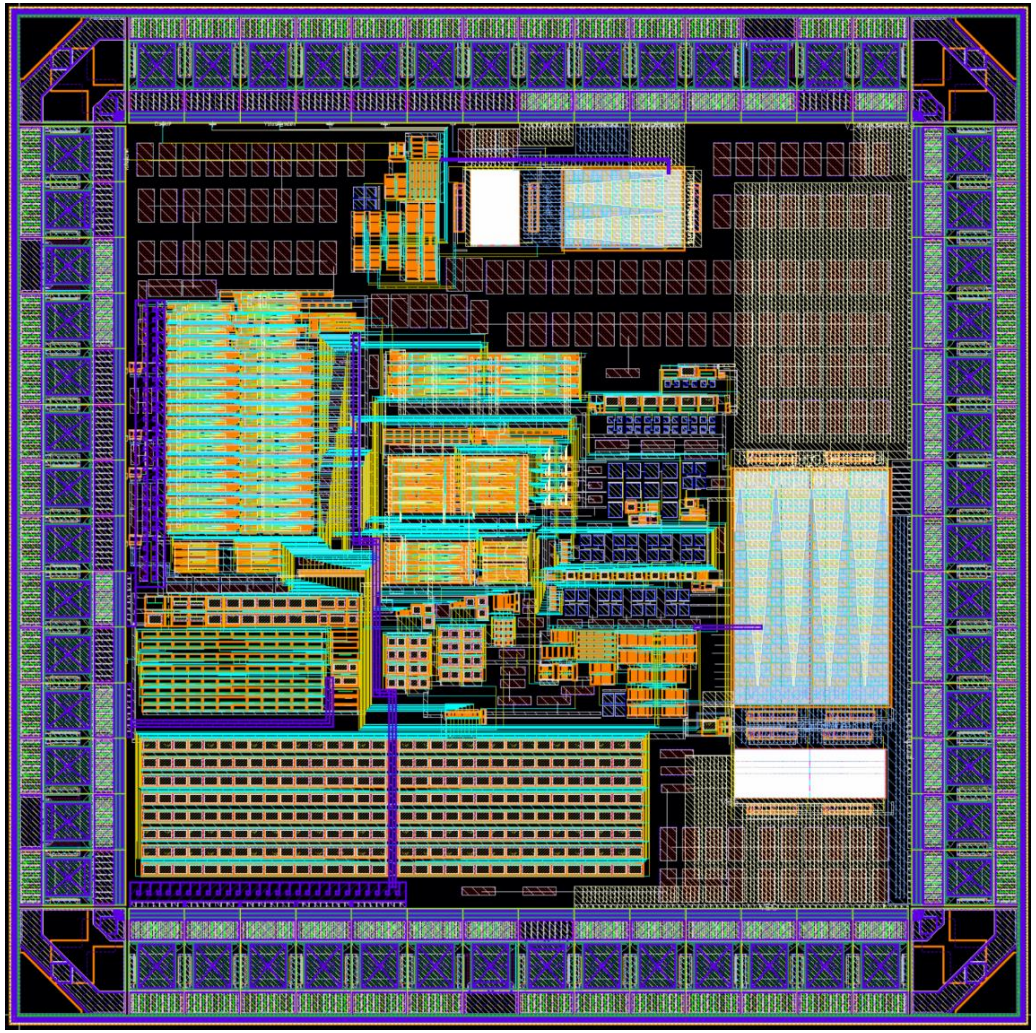




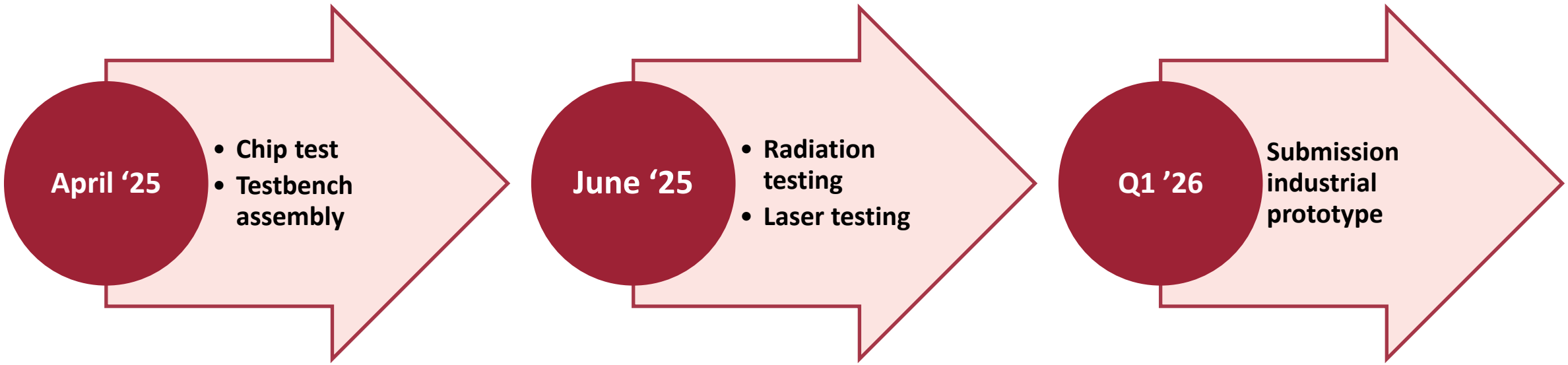
VII. CHIP DESIGN

- **TECHNOLOGY**: XFAB XT018
- **SUBMITED:** November 2024
- **ESTIMATED DATE:** April 2025

	MIN	TYP	MAX	UNIT
SUPPLY CHARACTERISTICS				
Input Voltage Range	2.5		5.5	V
OUTPUT CHARACTERISTICS				
Output Current	0		300	mA
Quiescent Current Consumption	0.03	0.65	10	mA
Capacitive Load	0		100	nF
Voltage Drop	10		100	mV
PERFORMANCES				
Switch Off Delay	40		60	ns
Switch Off time	0.33		5.3	ms
Hold On time	0.013		1725	µs
Configurable protection current threshold	0.05		12.8	µA



VII. ROADMAP


April ‘25
• Chip test
• Testbench assembly
June ‘25
• Radiation testing
• Laser testing
Q1 ’26
Submission industrial prototype

Thanks for you attention

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