"Flash Test Experience at Extended Temperatures"

…and other experiences of a test house

Presented by

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Test House Focus

- Upscreening
  - Typically for Military Temperature -55ºC to 125ºC
    - But can(has) ranged between -190ºC & 225ºC
    - I/T & A/T temps very popular as well
- Qualification Extension
  - HTOL, HAST, THB, T/C, T/S, A/C, LTOL, etc…
    - Endurance, Data Retention, Characterization
  - COTs validation for Space, Mil/Aero
  - MSL, pre-cond, C-scan, X-Ray, DPA, etc…..
- Counterfeit Detection & F/A
- Full Turnkey Mgmt probe-to-qual & production

Standard Non-Volatile Memories in MIL/Aero/Defense/Space

- DLA Land & Maritime SMD's(Standard Military Drawing)
  - Mil-Prf-38535/Mil-Prf-38534 & Mil-Std-883 process standards (QML)
  - Comprised of ~6000 base parts in Hermetic packages.
  - How many SMD parts are NON-Volatile Memories?

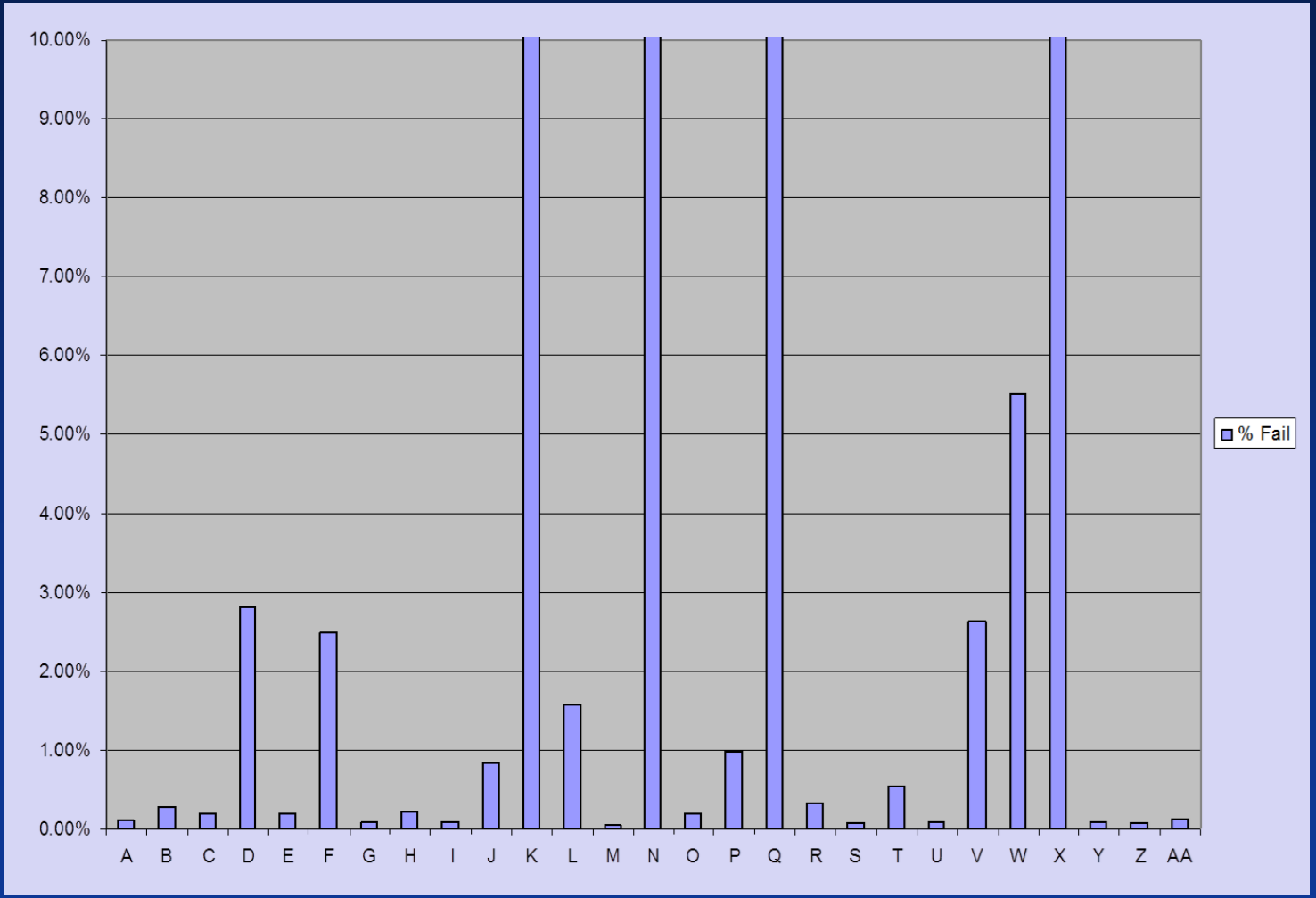
Type of Non-Vol	Density range	Unique part types
NOR Flash	1Meg to 64Meg	22
EEPROM	4K to 4Meg	14
uvEPROM	16K to 4Meg	19
NAND Flash	n/a	none

  - WHY so few ?

- COTs proliferation to the rescue
  - Many 1000's of device types/mfger's utilized after the paradigm shift mandated in the 1994 by the secretary of defense William Perry memorandum.
  - Virtually boom to the Test Labs

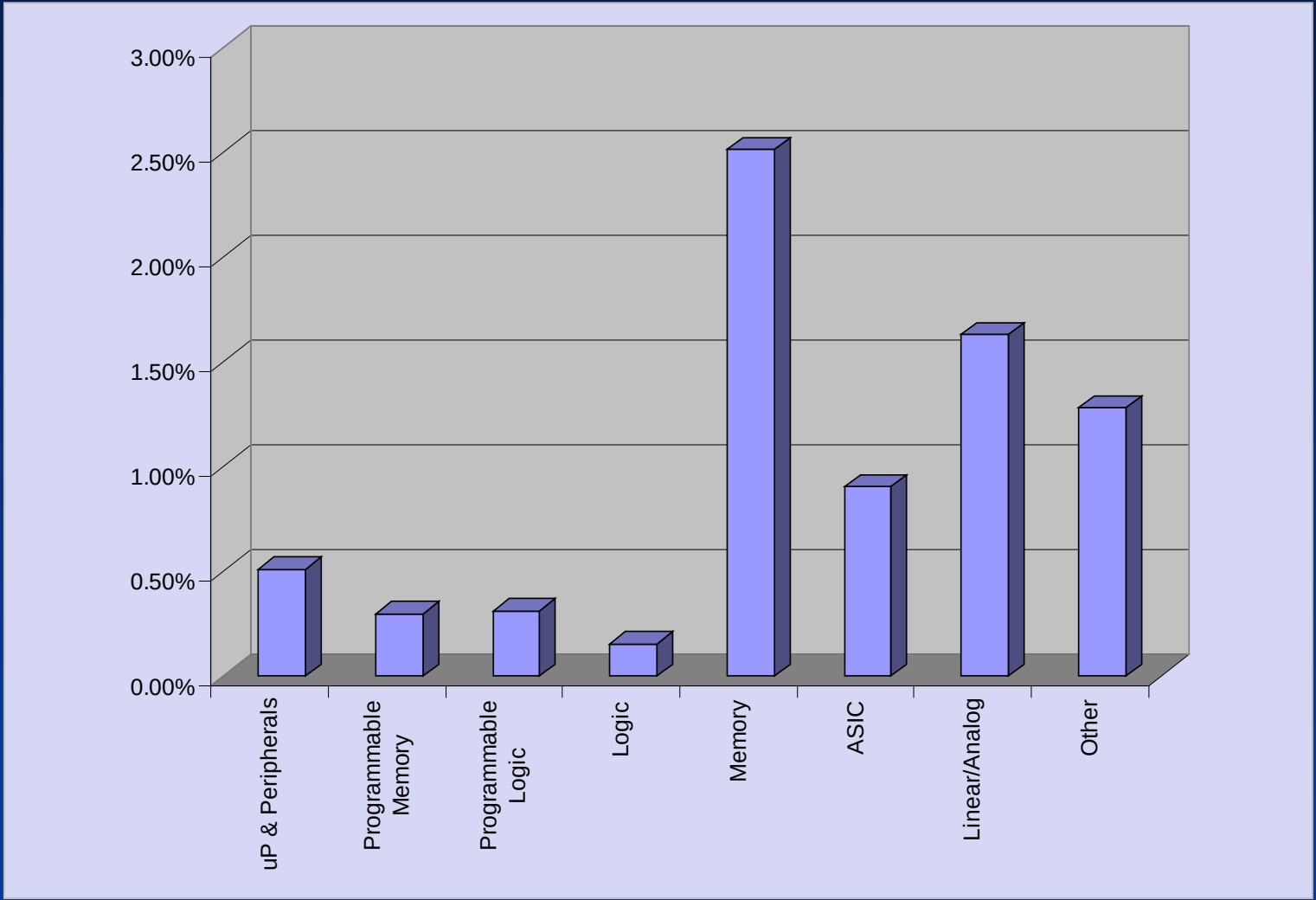
Supplier vs. Upscreen Yield

[data collected over past 15 years]

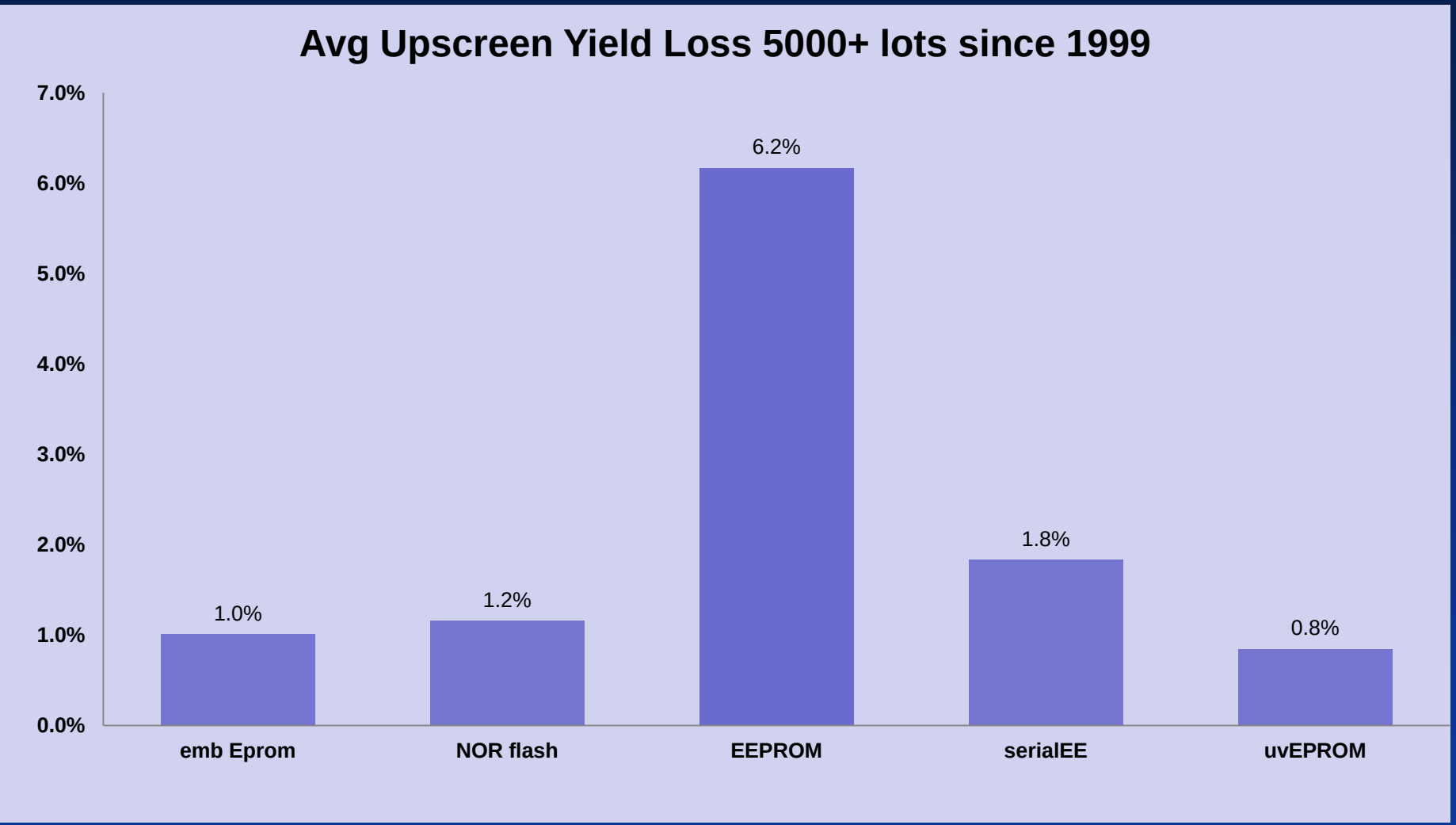


Upscreen Yield loss across device types

[data collected over past 15 years]

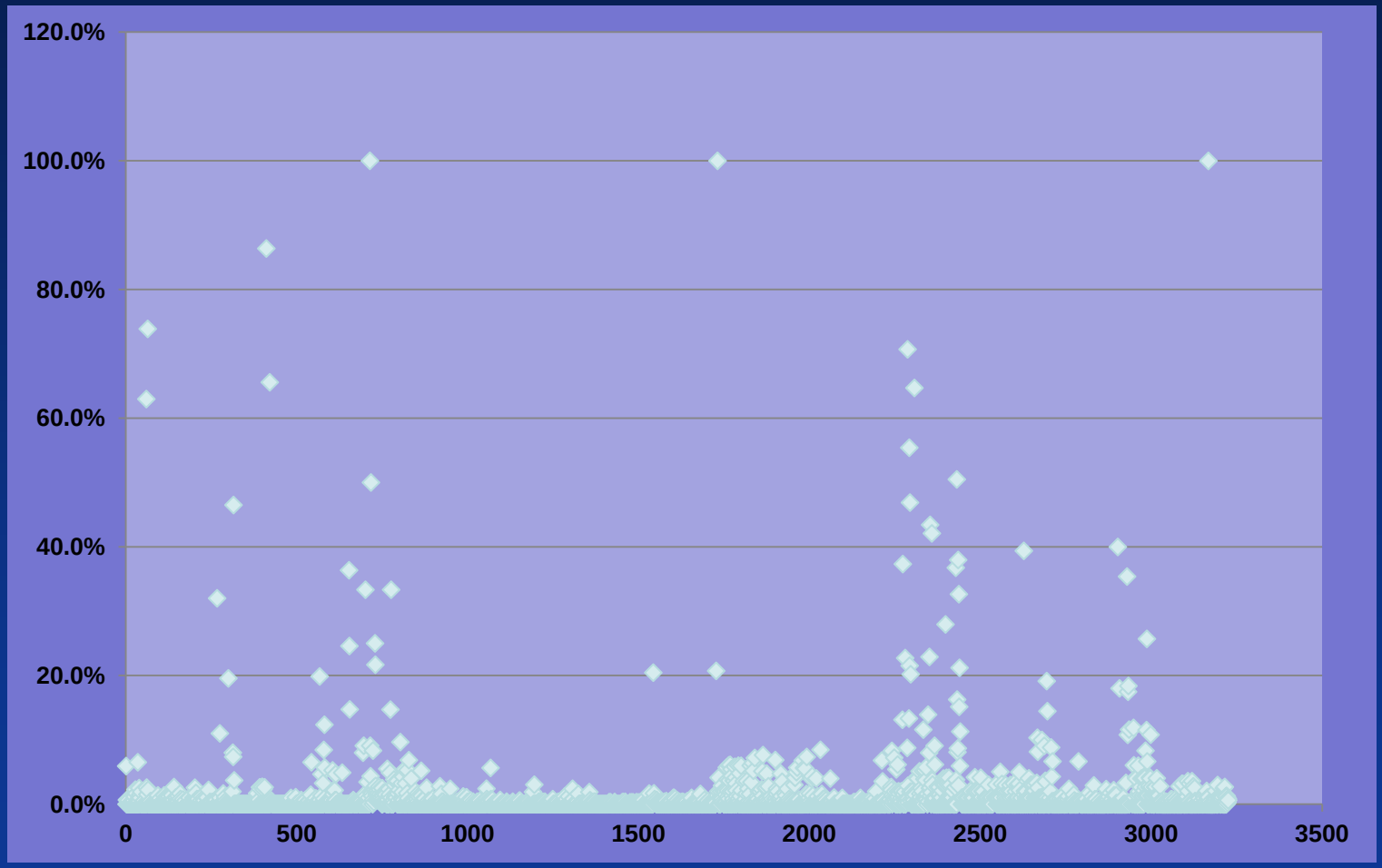


Flash Upscreen Lot Yield Avg

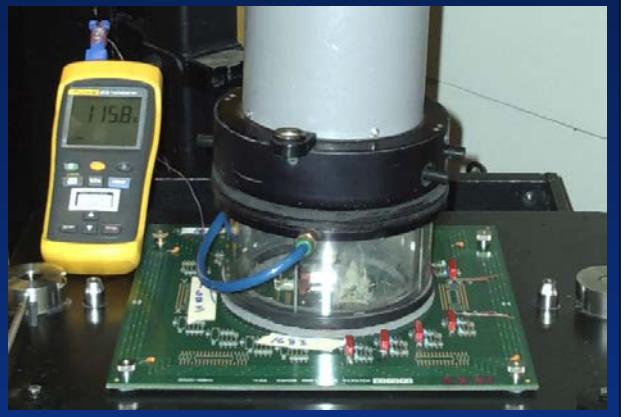


NOR FLASH lot Yield Scatterplot

[3000+ yield points for Upscreen typical -55C/125C]

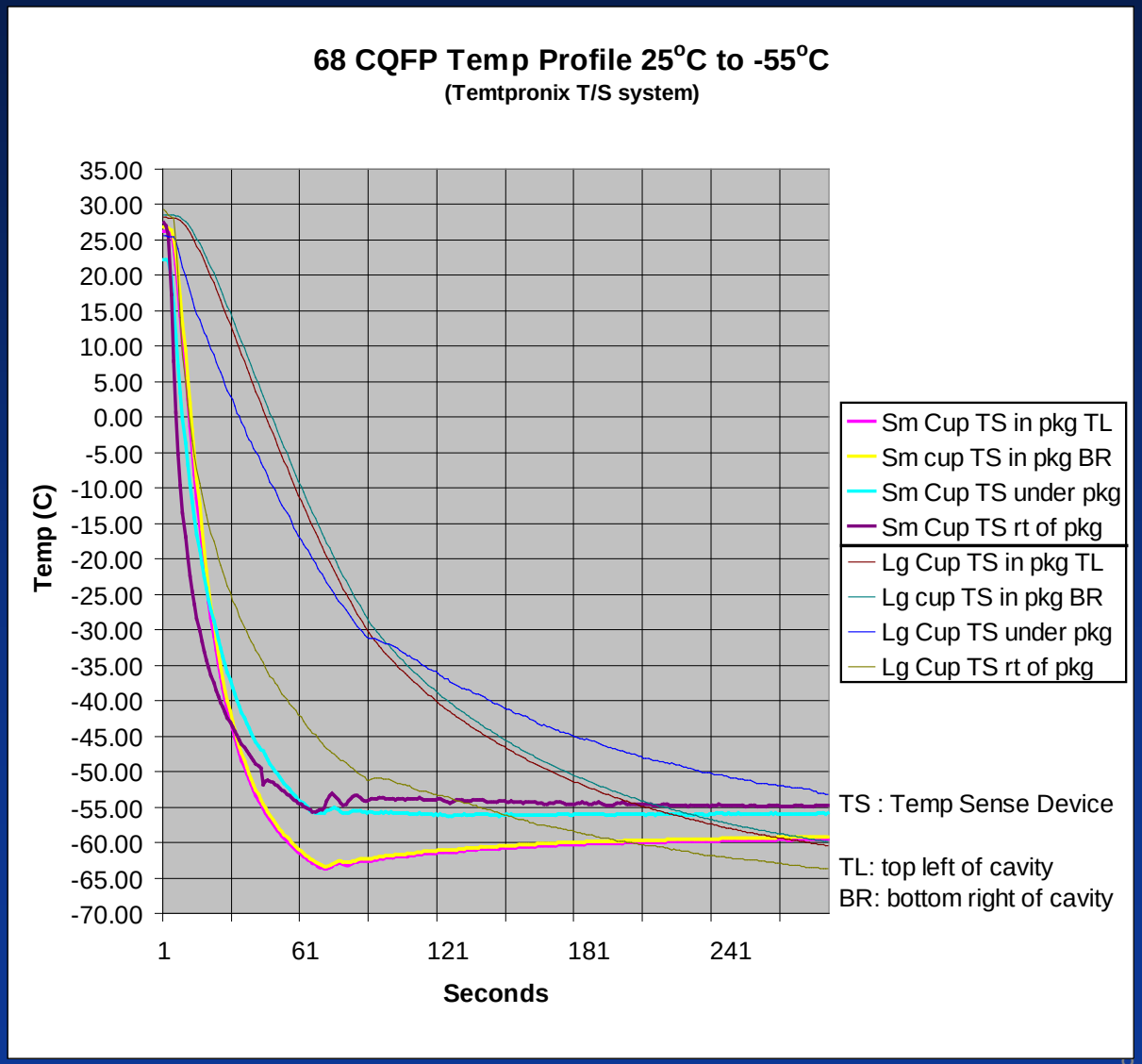


Thermal Cup & Soak Relationship



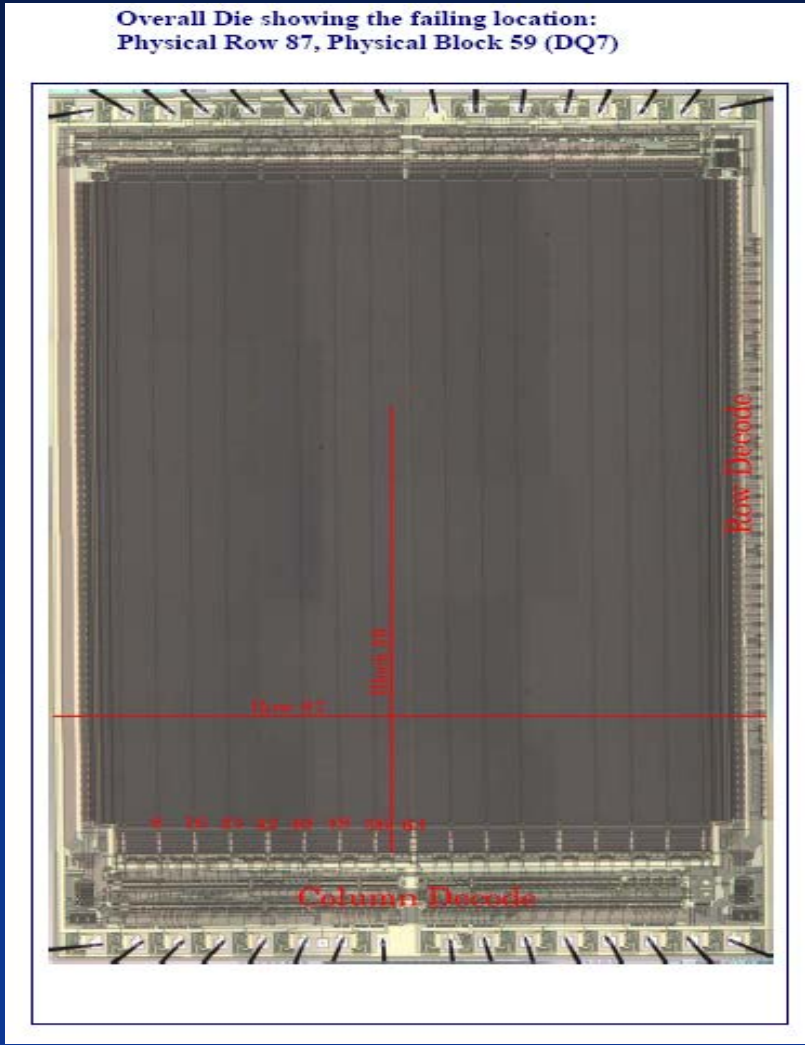
Standard Sm Cup Temp enclosure example

- Must run studies on unique packages
- Thermistor placement key
- 100% monitored during testing
- Automated temp control



F/A of Single Bit RMA failure (I of II)

- Customer Return for -30C S/B Fail
  - 1 die on 128Kx32 MCM w/ 4 die total
  - Mapped out single bit Address & DQ
  - Determine Symptoms of fail
    - failed to hold '0' programmed state
    - Pass at -20C, Fail at -30C
  - Process De-layering to ID defect
    - Physical location isolated * NOT a Simple Matter *
    - Address scrambled
      - Logical to Physical translation
      - Package routing
    - Redundancy Caution !
  - Micro-probing with EBIC
    - insitu in SEM
    - provides added confidence in location
    - Great tool for this die because of near-Zero ICCq
- Deprocessing by Analytical Solutions Inc
  - Defect identified in the Tunnel OX
  - Wafer Fab process defect
    - resulted in weak cell for tunneling electrons
    - reduced charge with temperature threshold
- Most Probable Cause
  - See formentioned thermal soak chart



F/A of Single Bit RMA failure (part II of II)

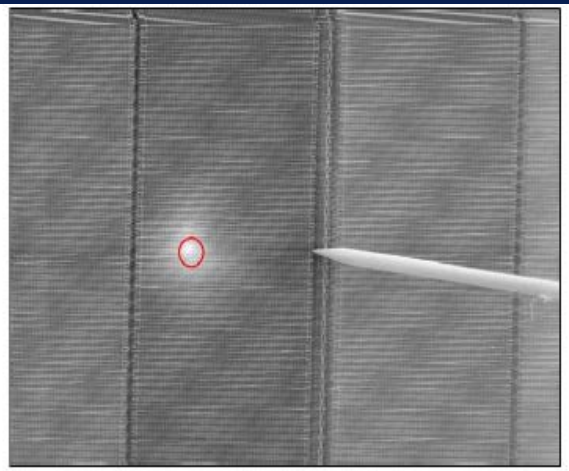


Figure 5

Caption:
Further close-up SEM view showing microprobing of the failing row and EBIC signal (red circle) at the failing bit.

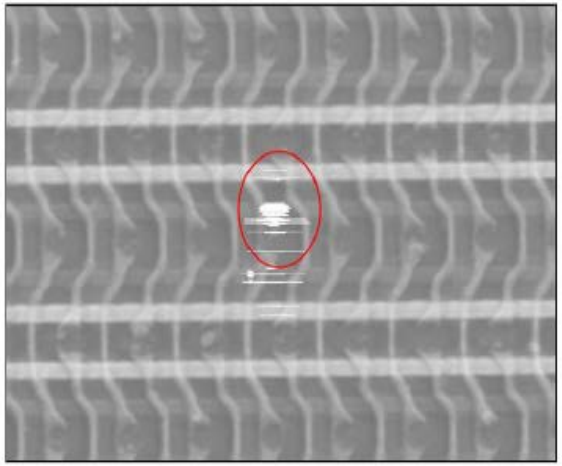


Figure 6

Caption:
Detailed view showing EBIC signal at the failing cell location (red circle).

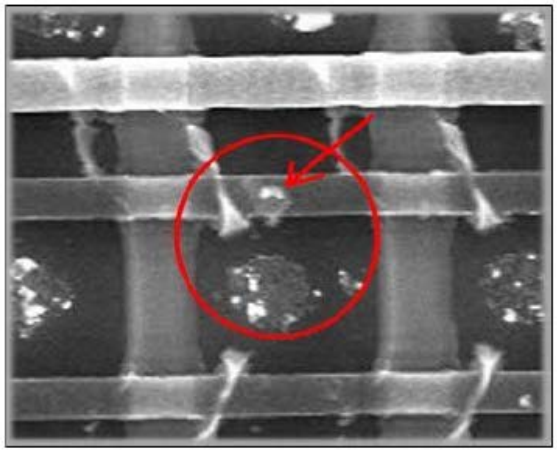


Figure 9

Caption:
Detailed SEM view showing the failure site identified by EBIC; note an apparent defect (arrow) was observed within the poly directly over the failing EEPROM bit.

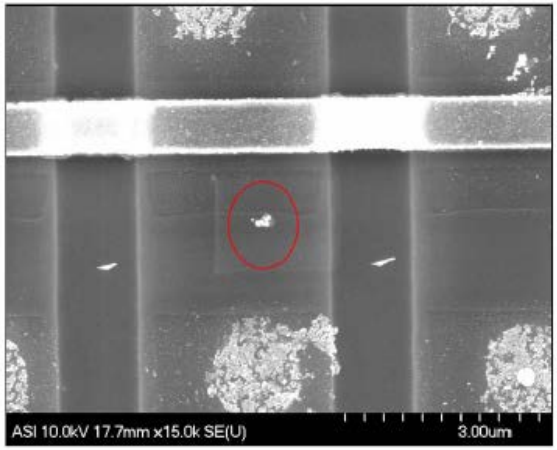
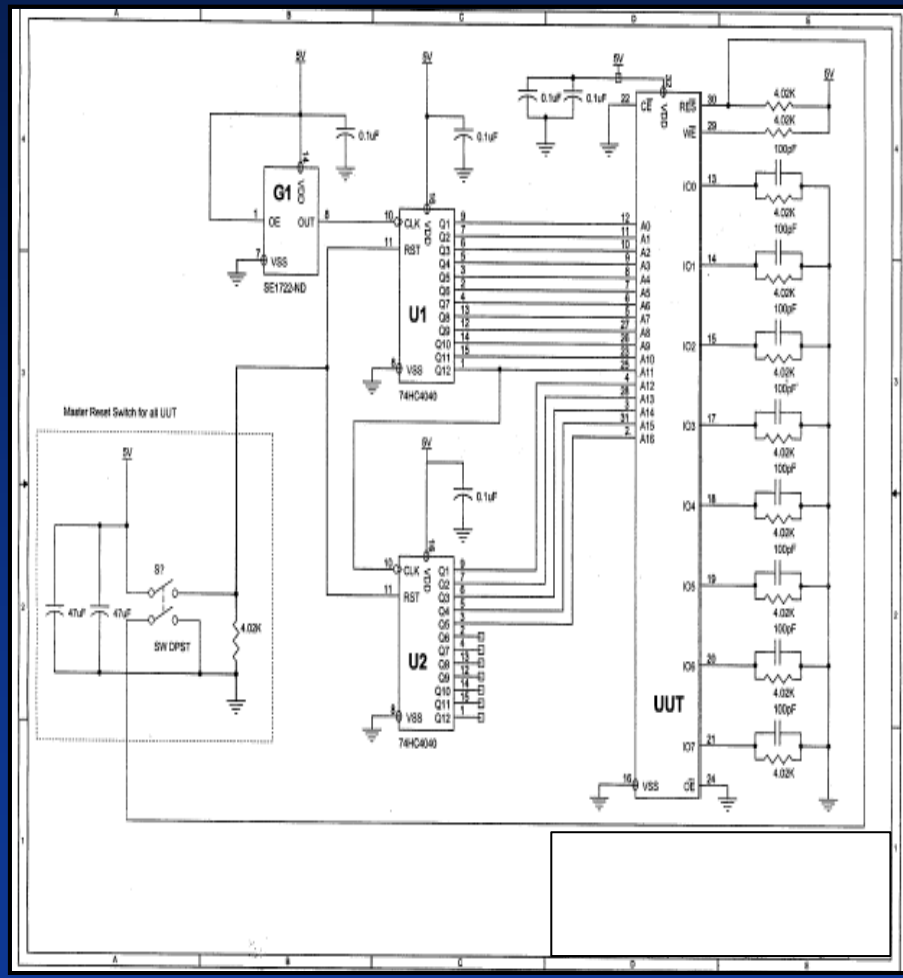


Figure 10

Caption:
Close-up SEM view showing the failing bit following removal of the polysilicon; note the particle remained in the tunnel oxide.

Read Cycle Endurance Exercise

- Contracted by Space customer
  - Determine if EEPROM Read Cycle limited
  - Customer Board designed
    - on board logic to drive addr sequence
    - Controlled PU & PD
    - CE/=Vss, OE/=WE/ = VCC
- Total Dummy Reads to entire Array: **$348x10^6$**
  - 147 days, Verify Array every 7th day
  - March Addr Sequence
  - VCC=5V, Temp = 50°C
  - Read cycles = ~3.6Mhz
  - Random Array pattern
- Total of 22 device
  - **RESULTS: 22/0** (used/fail)
  - 21 read points, NO fails at any.



- Counterfeit Discussion

Counterfeit Avoidance checks

Typical Tests and Sampling

- Incoming Inspection- AQL, Table II, .065 to MIL-STD 883, TM2009 40X magnification is key, 100X-2000X if needed for Die

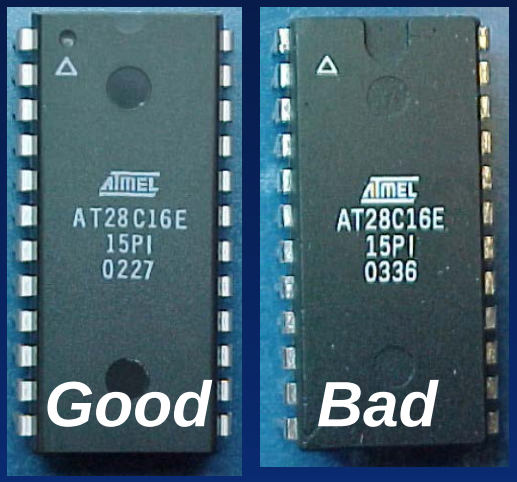
- IDEA1010 External Inspection 5 units
- Resistance to Solvents- 1 unit
  - Blacktop Verification - 3 units 1-Methyl 2-Pyrrolidinone test
  - Dynasolve 711/750
  - UreSolve Plus

- X-Ray (AQL, Table II, .065 to MIL-STD 883, TM2009)
- XRF -3 unit
- Fine & Gross Leak Test- (Ceramic & Metal packages only) 100%
- De-Cap with Internal Inspection- 1 units
- Electrical Test (Based on risk level and complexity of device)
  - Curve Trace minimum
  - Basic to complete DC / ICC
  - Full Testing (AC/DC/Functional)

Counterfeit example

- Visual Inspection (no clear issues)
- Marking testing passed
- Die inspection found the correct generic but wrong manufacturer
  - Catalyst acquired by On Semi
- Testing Results
  - All units passed functionally
  - Only failure was one parameter

    Slower TWC (write cycle) then the Atmel data sheet



Counterfeit Detection Matrix

- Military & Defense/Aerospace market is especially targeted on legacy & obsolete components
- The best defense is good offense

Counterfeit Type			Detection Methods								
			External Visual & Phys Dim	XRF	X-Ray	Marking Perm Blacktop	Internal Visual	Basic DC Test	Min Func Test 25C	Full Spec Extended Temps	Test & Qual
	Non Functioning Devices	No Die	Possible	No	Yes	Possible	Yes	Yes	Yes	Yes	Yes
		Wrong Die Re-Marked	Possible	No	Likely	Possible	Likely	Yes	Yes	Yes	Yes
	Functioning Devices	Failed Real Parts	No	No	No	No	No	Possible	Likely	Yes	Yes
		Pulls Refurbished	Possible	Likely	No	No	No	Possible	Possible	Possible	Yes
		Speed /spec &temp up-marking	Possible	No	No	Possible	No	No	Possible	Yes	Likely
		Recovered Die	No	No	No	No	Possible	No	Possible	Possible	Likely
		Similar/ Substitution	Possible	No	No	Possible	Possible	No	Possible	Yes	Likely
		Pb Free Re-marked	Possible	Yes	No	Possible	No	No	No	No	No
		Lesser part (knock-off)	Possible	No	No	Possible	Possible	Possible	Possible	Likely	Yes

Closing Remarks

"I want to thank-you for making this day necessary" -Yogi Berra

- No Military/Aero NAND flash standard drawings
- 2013 has been good year thus far
- US TAM for NV COTs upscreening exceeds $100M
- Counterfeit Vigilance US industry wide
  - Integra chairing & participating in many industry counterfeit detection standards groups (Jedec G-12, SAE G-19