EMBEDDED RESISTOR TECHNOLOGY FOR MEMORY MODULE DESIGN

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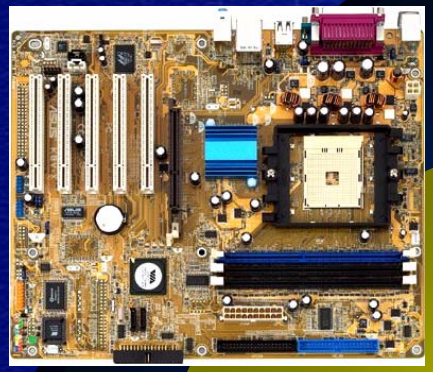
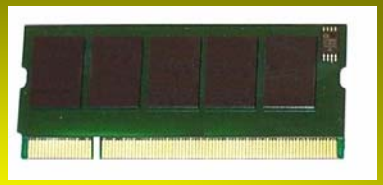
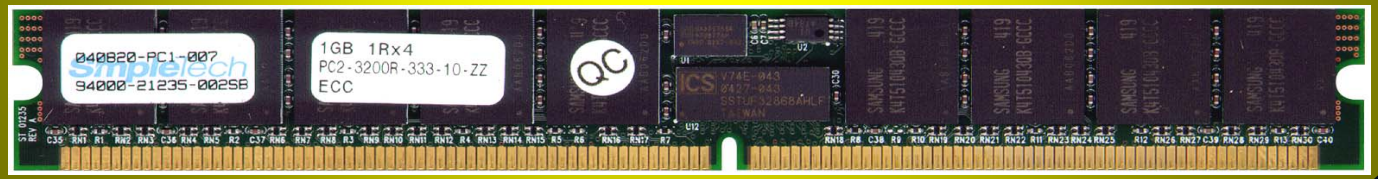
Modules for PCs, Servers, Gadgets





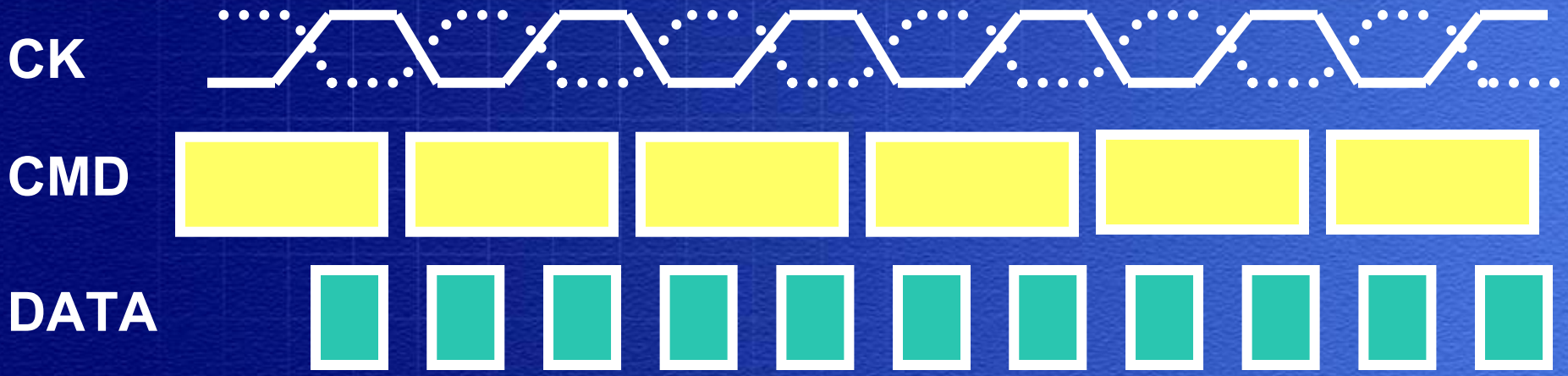


What Customers Pay For

- Registers?
- Phase Locked Loops?
- Memory Buffers?
- Resistors?
- Capacitors?
- PCBs?

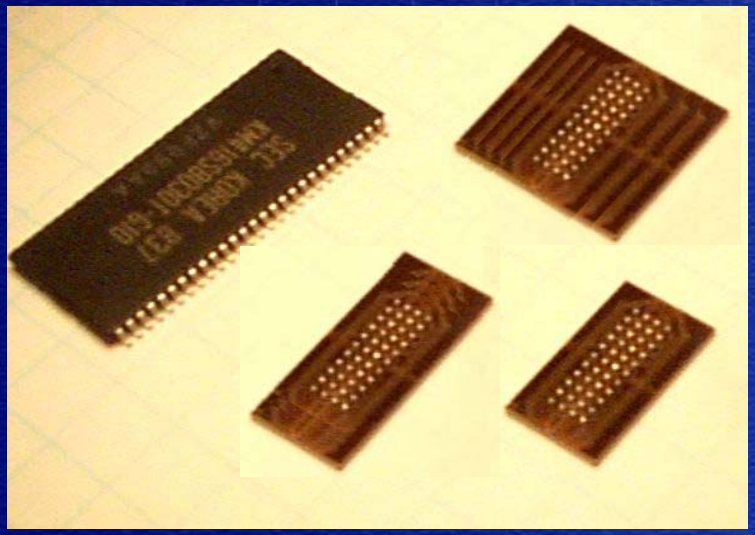
- Gigabytes per cm^3

State of the Art



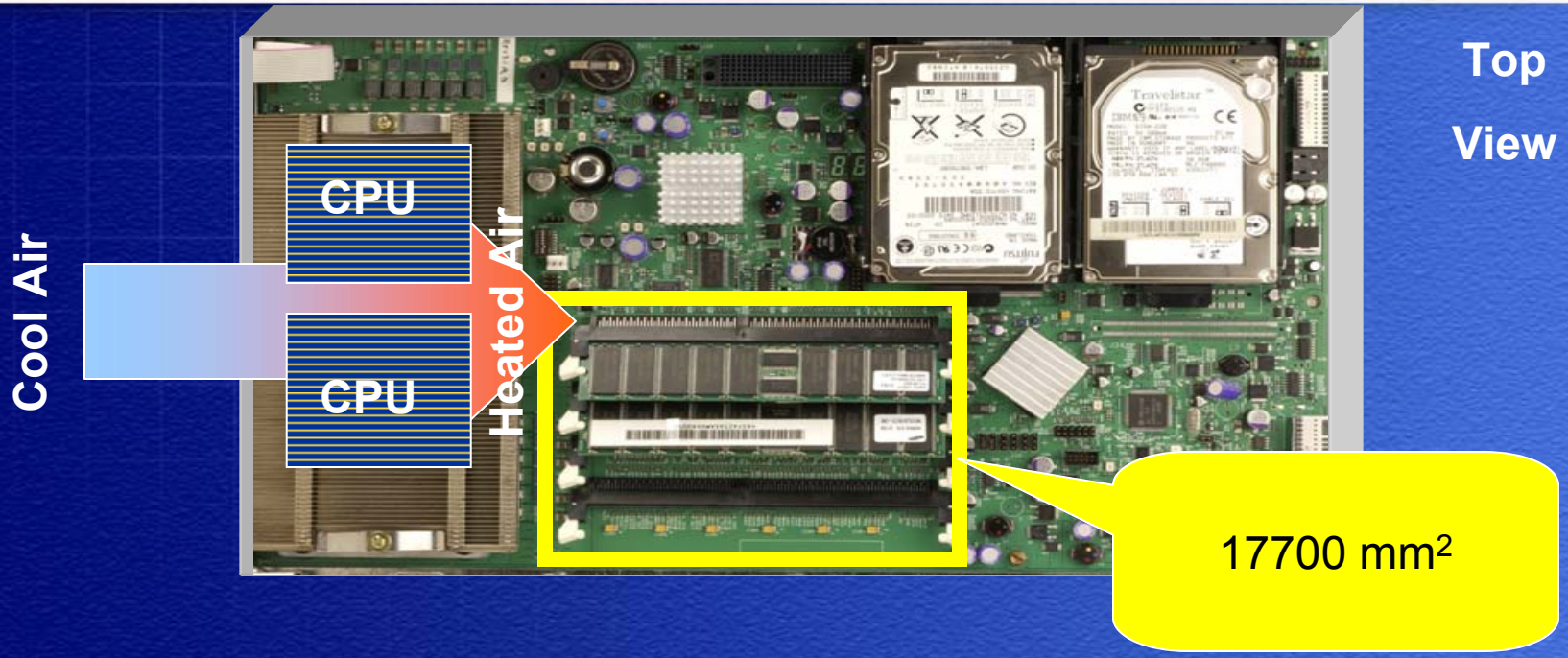
- Today's DDR2 modules perform at 800 MT/s over a 72 bit data bus and 400 MT/s over a 26 bit command bus
- DDR3 modules (2006) perform at twice DDR2 speeds
- FB-DIMM 14-bit 4.8GHz differential bus → 9.6GHz
- All must be implemented using standard grade PCB materials and low cost edge connector technology

10 Pounds in a 5 Pound Sack

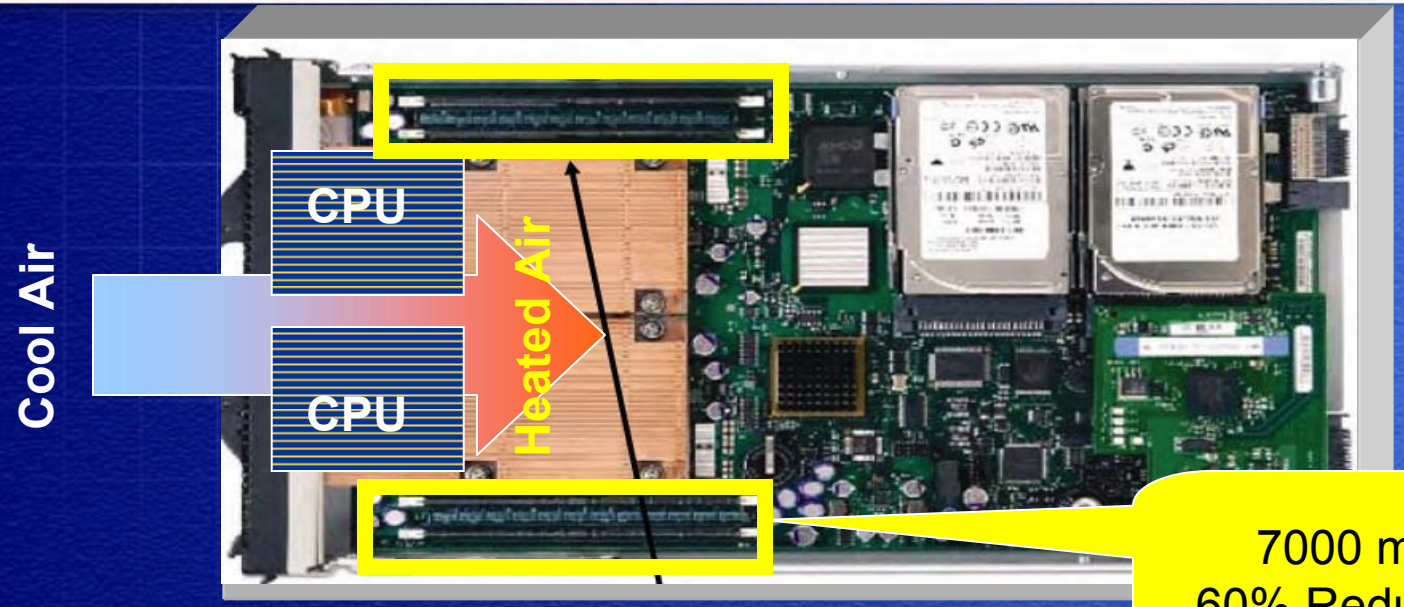


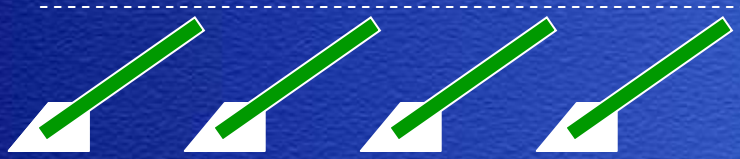
- Customers are demanding smaller DIMMs
- TSOP (fixed size) → BGA (all different)
- High frequencies demanding more termination resistors

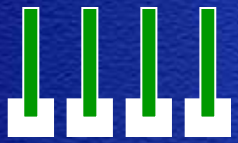
Case Study: Blade Server, Tall DIMM



Case Study: Blade Server, VLP DIMM

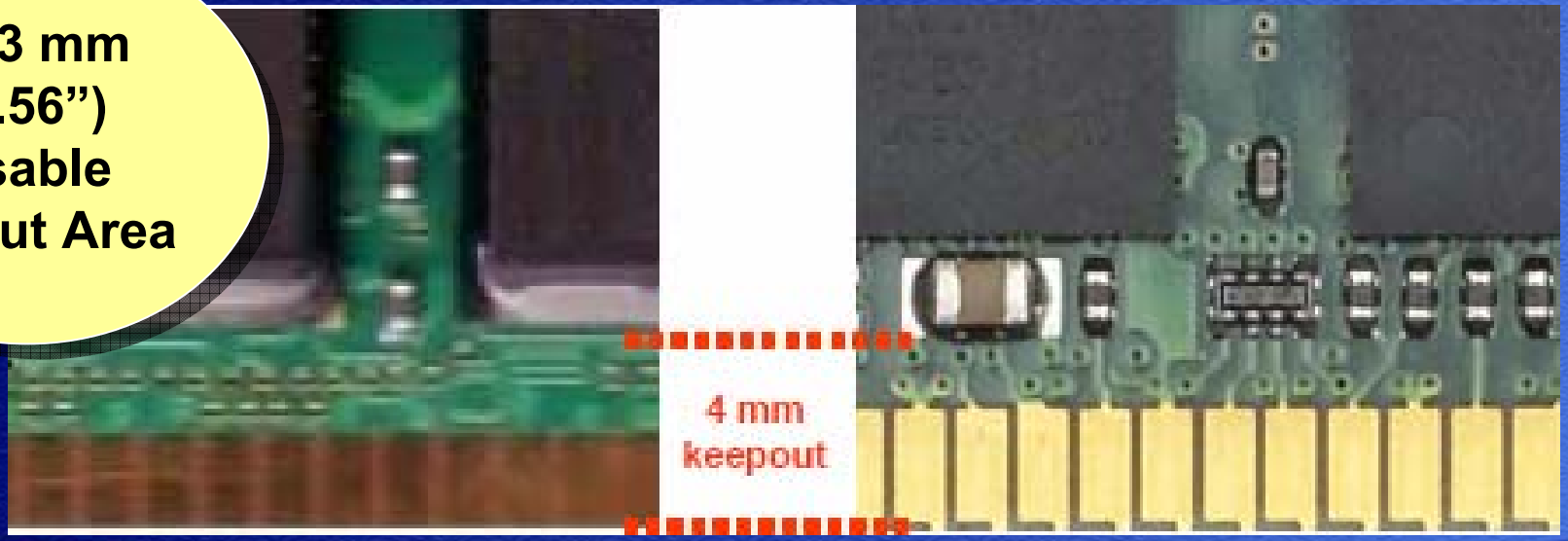






The VLP Form Factor

14.3 mm (0.56”) Usable Layout Area



Which DRAMs Fit?

	Monolithic	Stack 1	Stack 2	Stack 3
AAA	12x19	12x19	16x20	12x19.2
BBB	11x13	11x13	15x14	12x13.2
CCC	11x11.5	11x11.5	15x12.5	12x11.7
DDD	10x10.5	10x10.5	14x11.5	12x10.7
EEE	10x11.2	10x11.2	14x12.2	12x11.4
FFF	12x14	12x14	16x15	
GGG	11.3x13.8	11.3x13.8	15.3x14	

DRAM sizes by supplier including various stacking technologies

Monolithic

EP	0201	0402
CCC	DDD	DDD
DDD	EEE	EEE
EEE		

Stack 1

EP	0201	0402
CCC	DDD	DDD
DDD	EEE	EEE
EEE		

Stack 2

EP	0201	0402

Stack 3

EP	0201	0402
CCC		
DDD		
EEE		

Which VLP configurations can support the various DRAM sizes & stacks?

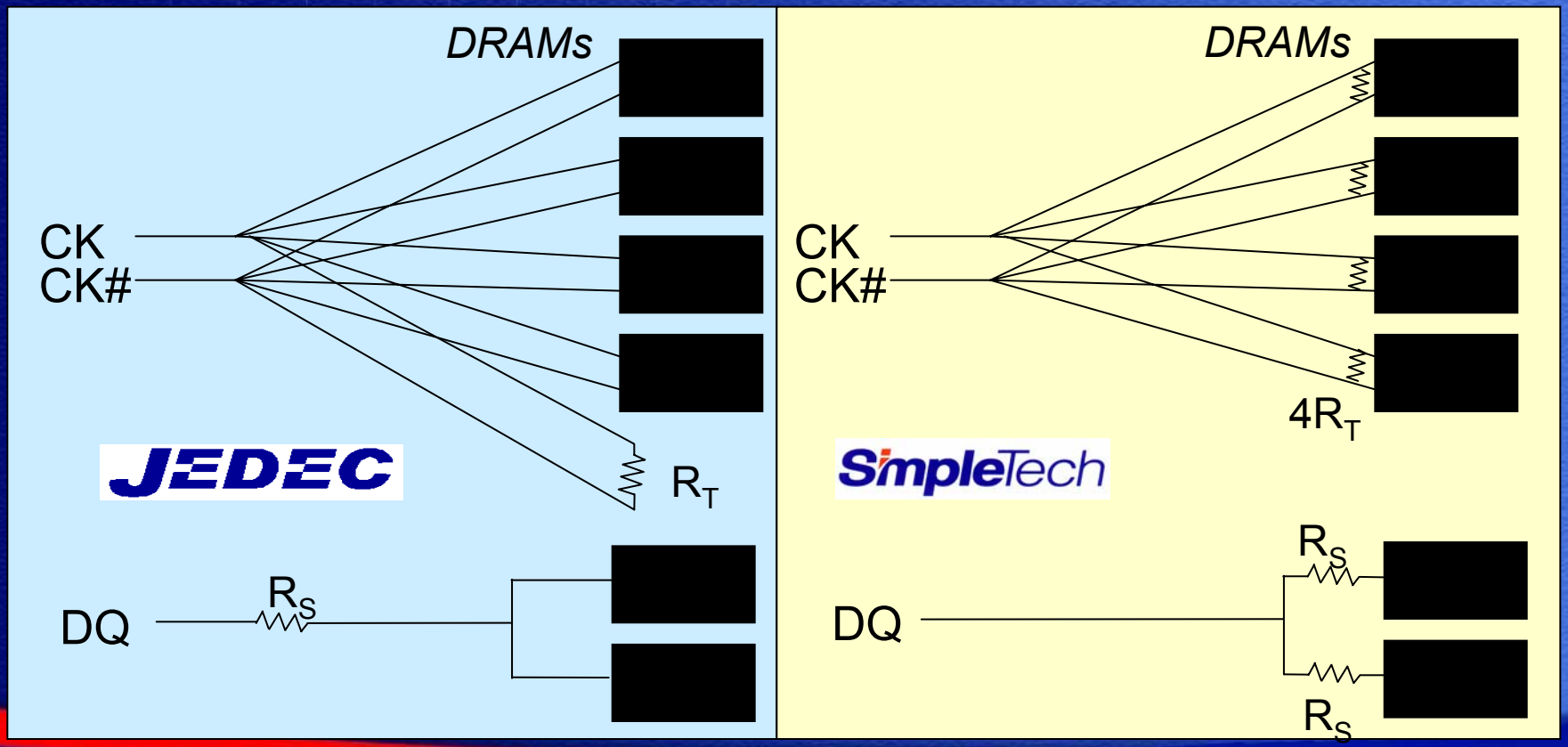
It's Cost of Manufacturing, Stupid

- Yes, use of embedded resistors increases the $BOM

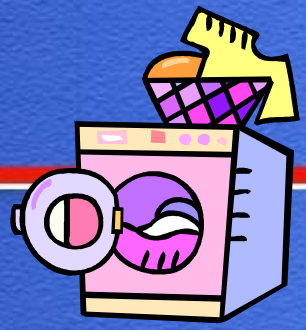
- True cost of manufacturing includes:
  - Reduction in placed parts count
  - Reduction in inspection time
  - Reduction in rework
  - Reduction in solder bridging on r-packs

Signal Integrity Improvements

- Free resistors placed anywhere you want
- Changes the way you think about design



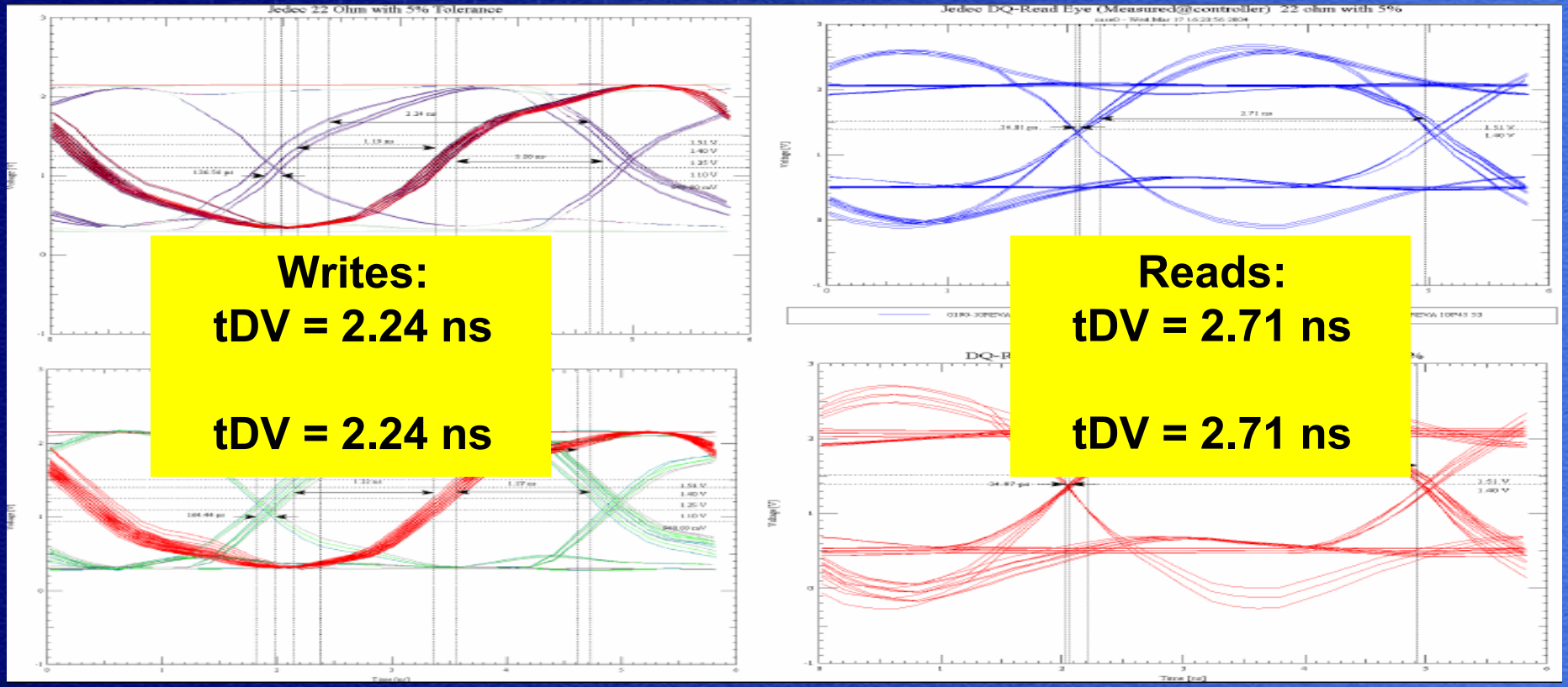
ER's Clean Laundry List



- Please resistors where needed
- No need to compromise for placed parts reduction
- Lower parasitic inductance
- Reduced EMI due to inner plane shielding
- Reduced EMI due to routing simplification
- Eliminate need for tiny parts (01005s???)

15% Tolerance

- ±15% tolerance without trimming
- Is that good enough for DDR?



Fear Factor

- Are embedded resistors reliable?
- Tests performed:
  - Bare board: Reflow shock, thermal cycle, humidity cycle, thermal soak, vibration
  - Assembled board: Biased humidity cycle, full memory test
  - Simulation: Push to tolerance, push to failure
- Conclusion: At least as good as SMT

Embedded Resistors Make Sense

- When a design can't be done any other way
- When signal integrity improvements are needed
- When 15% tolerance is good enough
- When shrinking fits more modules per panel

- When $COM is lower
- Break even formula:

($Cost per placement
X
Number of replaced parts)
≤
$Cost of embedded resistors

Call to Action

We are here to encourage you to invest in embedded passives

- Stimulate the adoption of EP
  - Increase availability: more choices
  - Drive down the cost
  - Drive up the quality
  - Accelerate future research
  - Demand improved CAD tool support

Thank You

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