NMI Quality & Reliability Network Event

Safe Product Launch with Fast Reliability Feedback

5th February 2009 – Unisem Europe, South Wales

Zwolle (NL)

Dresden (D)

Noerdlingen (D)

Stuttgart (D)

Agenda

- **Introduction**
- **Challenges of fast reliabilty feedback**
- **Measures and means to shorten qualification & development times**
- **Burn-In and HTOL with monitoring**
  - Benefits
  - Possiblities
- **Summary**

Introduction

- **RoodMicrotec as Service Provider for**
  - Qualification, reliabilty tests & burn-In
  - Failure Analysis & FIB services
  - Functional & parametric testing
  - Consulting (Qualification/Reliability/ESD)
  - Test & product engineering
  - Opto electronics testing, qualification & analysis

- **Speaker**
  - Thorsten Bucksch
  - As of 1993 in ELMOS, Infineon/ Qimoda, RoodMicrotec
  - Test & Product Engineering, R&D

Challenges of Fast Product Introduction

- **New product with few application experience**
- **Specification & test concept are developing during the product development process**
- **Parallel branches with interdependent activities**
  - Product design with test mode definitions
  - Test concept development
  - Test definition & load board implementation
  - Definition of qualification concept
  - Burn-In & stress test board implementation
- **Early time to market**
- **High quality expectation from customers**

Product Ramp in Outsourced Model

Design Team

Application Team

Test Engineering

Qualification Engineering

Backend

Foundry

Assembly

Interleaved Development Process

- **Design process with test mode definitions**
- **Load board design and tester resource allocation**
  - External test hardware definition
- **Functional test**
  - Split up into qual requirements, characterization and production test requirements
  - Test temperature definition & test time reduction roadmap
- **Burn-In & Stress Testing (HTOL, HAST)**
  - Board definition & layout
  - Board manufacturing

Schedule Interleave

Test Concept | Test Editing

Qual Program | Production TP | Characterization | Final TP

Design Specification + Test Modes | Implementation | Validation | Tape Out | 1st Si

Test Mode Def | Board Implementation | Manufacturing | Final Board Ass. | Qualification

Profile for Qualifications

- **Customer requests: automotive**
  - Lifetime: 10 – 20 years
  - Operating time: 6,000h – 12,000h
  - Rest period: 120,000h – 145,000h
  - Driving cycles: 4,000 – 100,000 cycles
- **Customer requests: industrial electronics**
  - Lifetime: 5 – 10 years
  - Operating time: 30,000h – 60,000h
  - Operating cycles: 3,000 – 10,000 cycles
- **Customer requests: Communications**
  - Lifetime: 5 – 25 years
    (mobile, submarine)

Test Acceleration – Temperature Storage 1

- **Arrhenius model**

  Increasing the operating temperature by 10°C halves the expectation of life of electronic devices.

  10°C -> 1/2x; 33°C -> 1/10x; 100°C -> 1/1000x

  Example: specified lifetime for one device

  a) 2,000 hours @ 85°C

  b) 2,000 hours @ 105°C

85 °C/ 2,000h	2,000 h / appr. 12 weeks
55 °C	16,000 h / appr. 22 months

105 °C / 2,000 h	2,000h / appr. 12 weeks
85 °C	8,000h / appr. 11 months
55 °C	64,000 h / appr. 7,5 years

Test Acceleration – Temperature Storage 2

Operating temperature at the device	Lifetime	Weeks (168h)	Months (720h)	Years (8760h)
105°C	2,000 h	11.9	2.8	0.2
95°C	4,000 h		5.6	0.5
85°C	8,000 h		11.1	0.9
75°C	16,000 h			1.8
65°C	32,000 h			3.7
55°C	64,000 h			7.3
45°C	128,000 h			14.6
35°C	256,000 h			29.2

- The lifecycle is the result of the real temperature variations during operation.
- Therefore the operating conditions are important for considering the lifecycle.

Test Acceleration – Humidity Storage

- **Lawson model**

  For the default picture electro migration an activation energy of 0,5 eV is applied.

1000h test	**at 40°C, 93% rh**
equals	
215h	**at 85°C, 85% rh**
equals	
20h HAST	**at 130°C, 85% rh**

- Depending on the default picture and the activation energy (between 0,2 eV und 1,5 eV) the conversions vary.

Test Acceleration – Temperature Cycles

- **Coffin-Manson**

  1000 cycles -55°C +125°C
  equals
  2732 cycles -55°C +85°C
  equals
  805 cycles -40°C +150°C

  - Coefficient 4 has been assumed
  - General examinations during the conversion to lead-free process showed that leaded and lead-free solder have different coefficients.

Example Qualification Flow: BGA Device

Test Sequence

1 Test FT1 0/30
External Visual

30 BE (2 x 15 BE)

2 Test FT 2 0/30
Funct. Electrical

3 Test FT 3 0/30
SAM

5 Test FT 5 -/30
Preconditioning
Level 1, 3

6 Reflow 0/30
260°C peak,

7 Test FT 3 0/30
SAM

8 Test FT 2 0/30
Funct. Electrical

9 Test FT 6 -/30
Temp. Cycles
100 x -55°C/+125°

10 Test FT 2 0/30
Funct. Electrical

12 Test FT 3 0/30
SAM

13 Test FT 7 -/30
96 h
130°C/85 % RH

14 Test FT 2 0/30
Funct. Electrical

15 Test FT 8 0/9
Corrosion Check

16 Test FT 7 -/21
HAST cum. 240 h
130°C/85 % RH

17 Test FT 2 0/21
Funct. Electrical

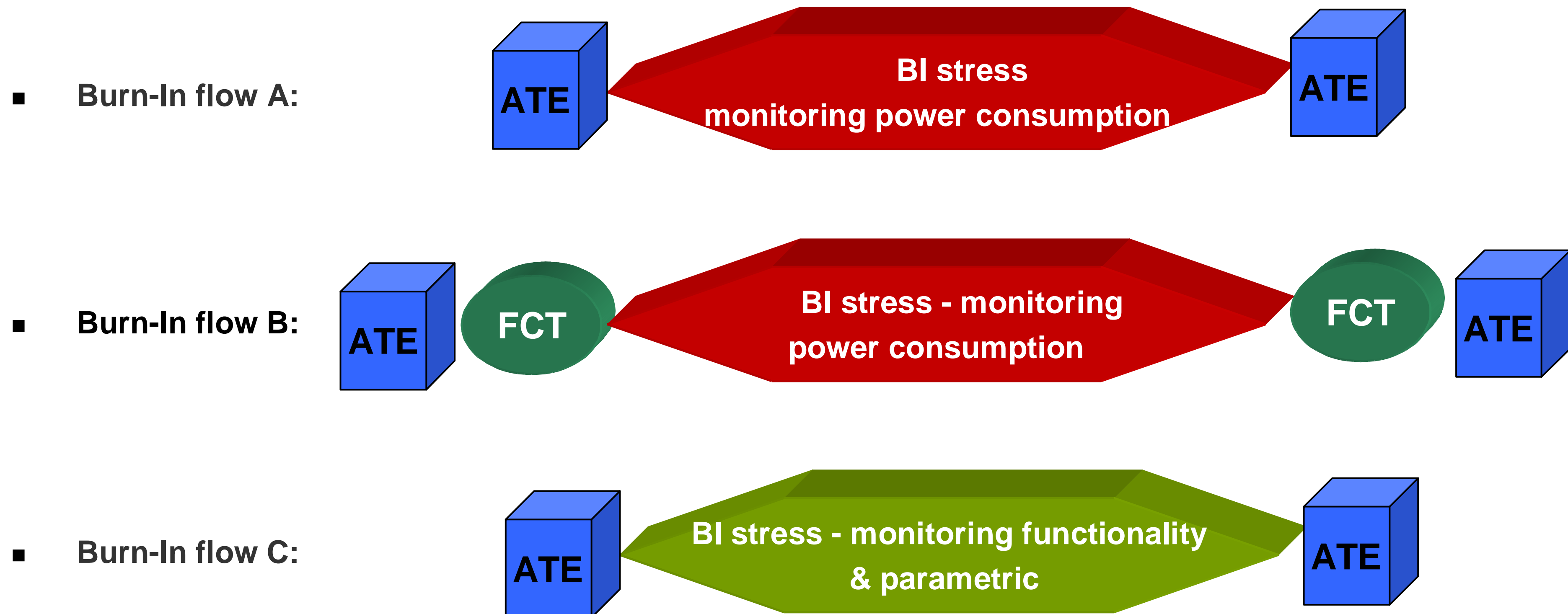
18 Test FT 8 0/9
Corrosion Check

01-15 Level 1 168 h 85°C/85% rel. Hum.

16-30 Level 3 192 h 30°C/60% rel. Hum.

Monitoring Burn-In

- **Monitoring of functionality of each individual DUT during the dynamic operation**
- **Individual DUT monitoring under stress conditions in the chamber**



FCT = Function test within the chamber

EDA System DA48

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powerful solutions

EDA Board with Visualisation

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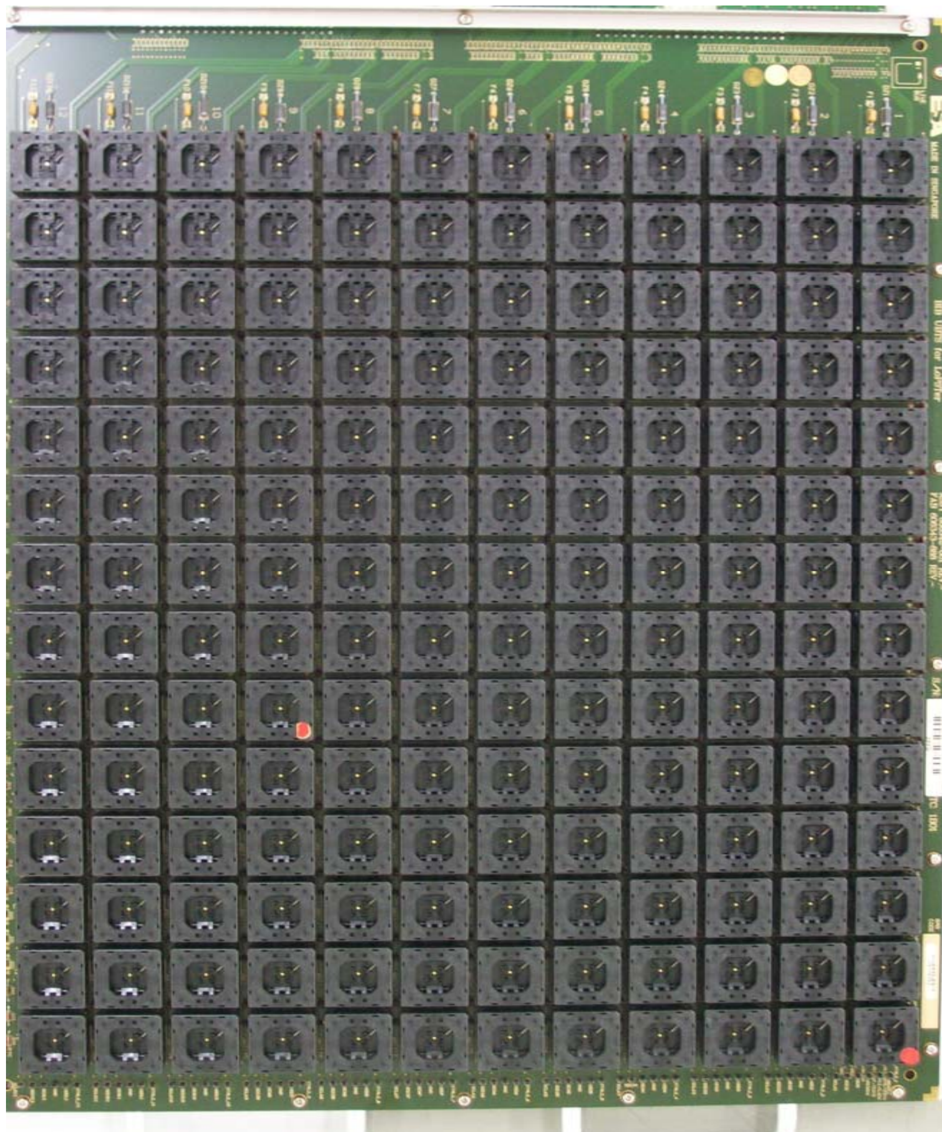
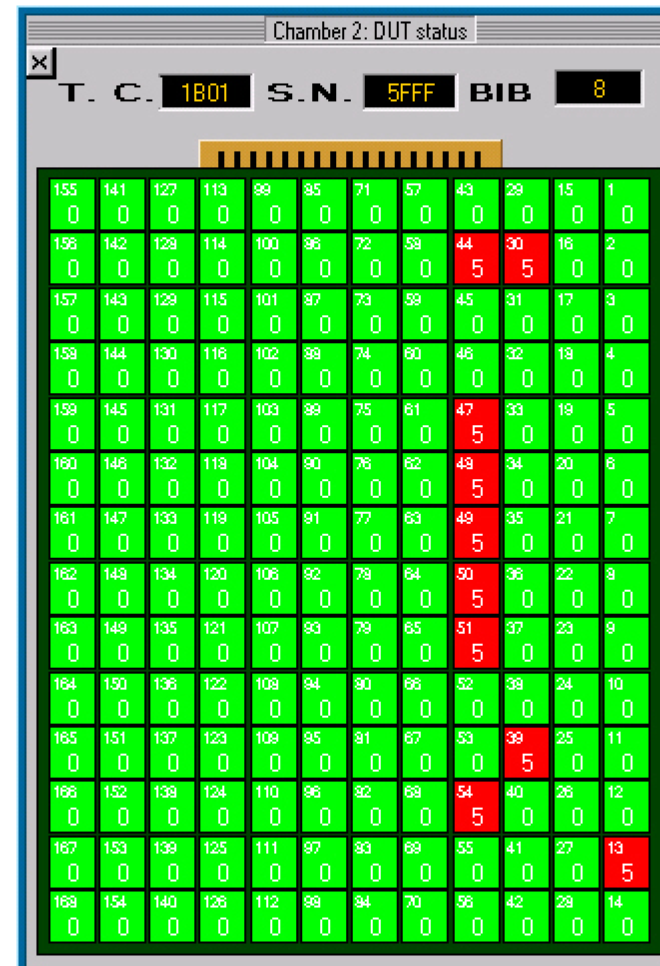
powerful solutions





Drivers

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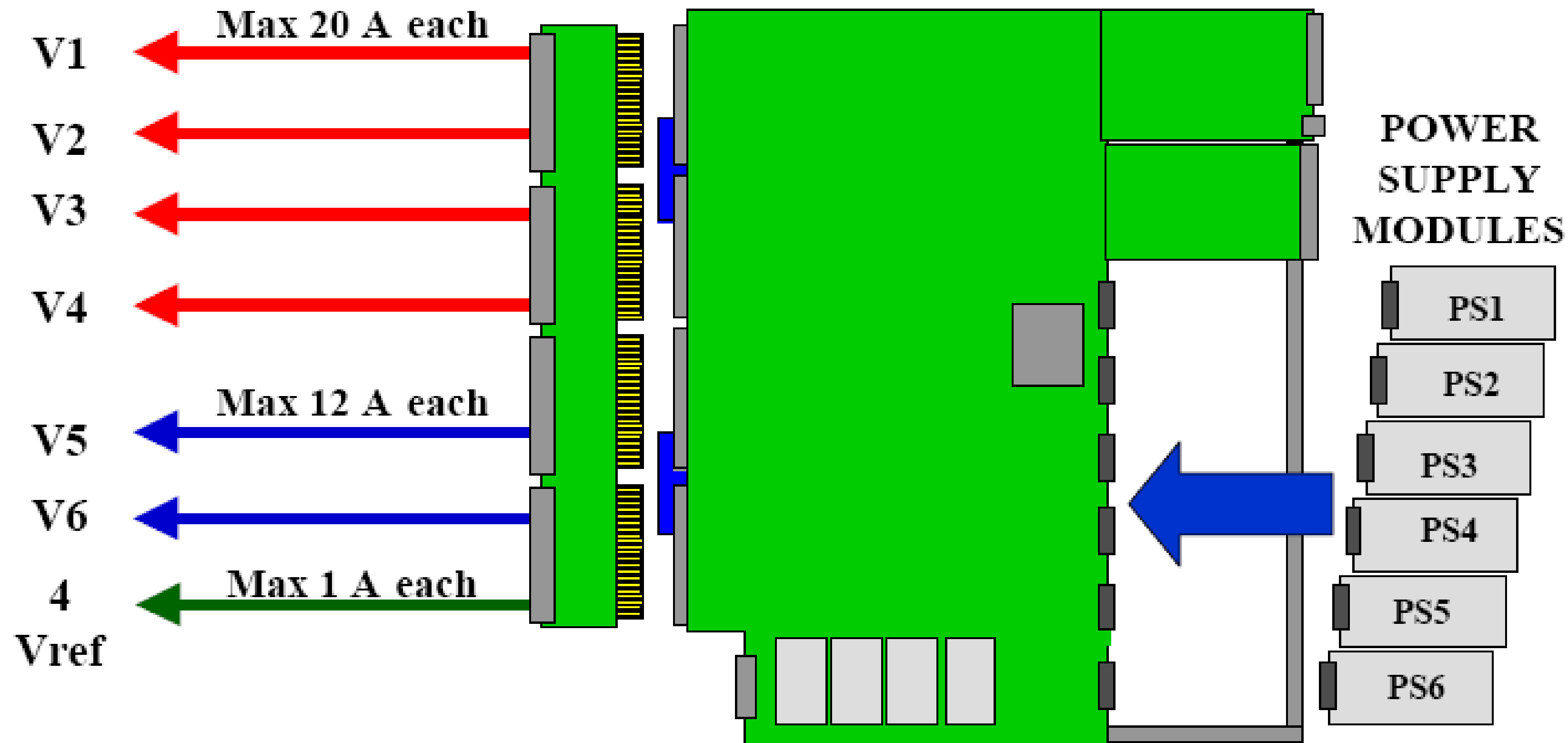

Drift Analysis Example

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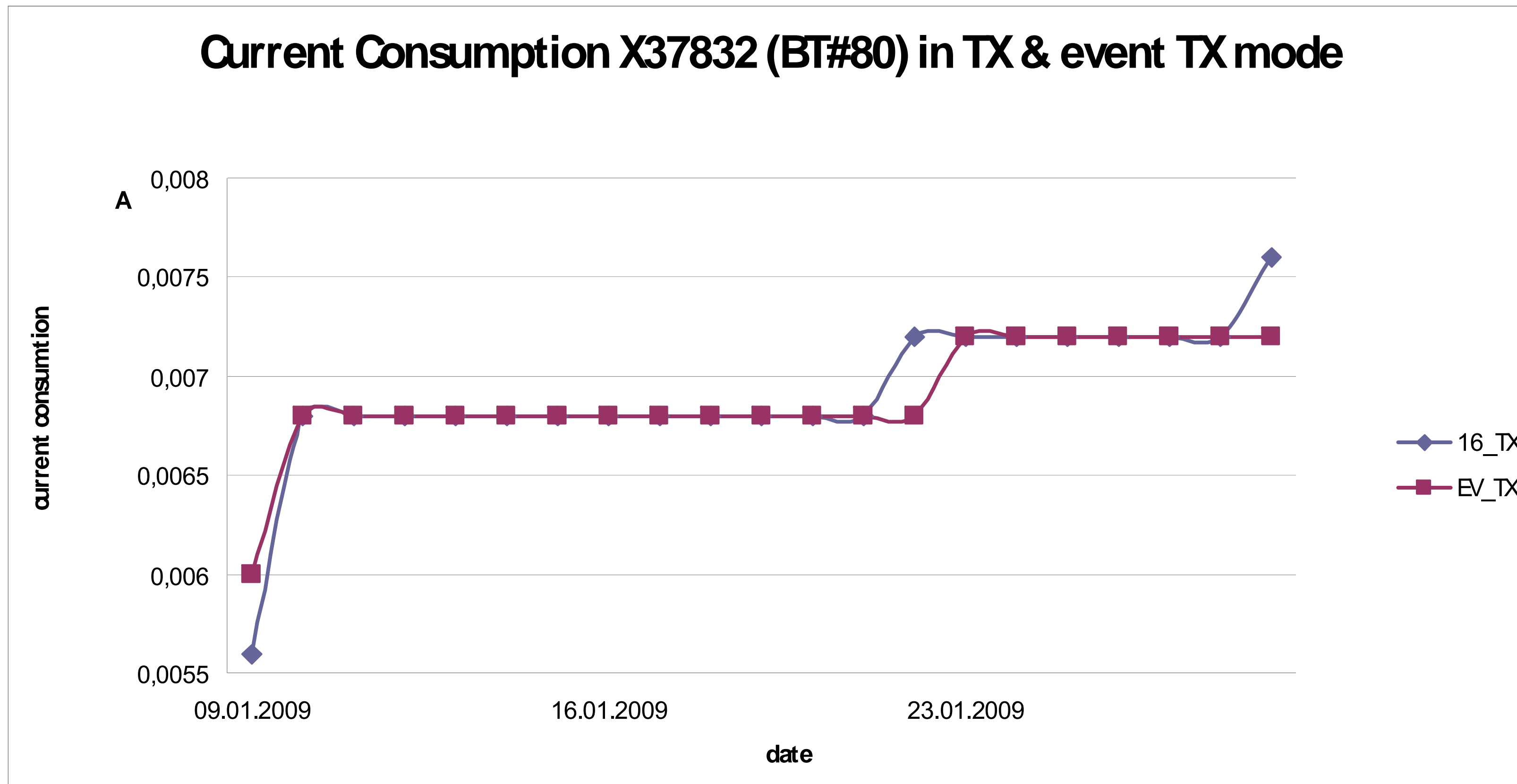
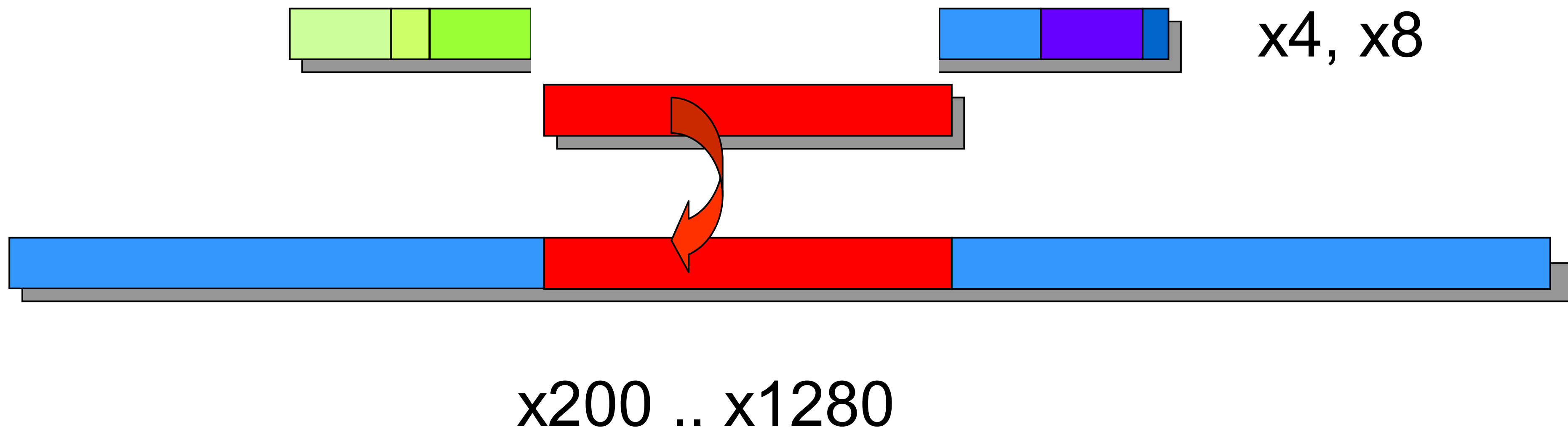


Possibilites for Test Time Reduction

- **Move long running test from functional ATE test into BurnIn stress test & increase paralelism**



Test Modes

- Test modes to be considered to guarantee effective stress

- PLL bypass
- Regulator off
- BI monitor control
- …

Important Factors for Successful Process

- Experienced engineers
- Short communication paths
- Close interaction between design, test, product engineering and qualification teams
- Parallelization of development activities
- Usage of Dfx methodolies
- Start building test & reliability concept as of kick-off

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Thanks a lot for your attention & patience!