In-Circuit- or Functional Test?

or
why test at all?

Hans Baka - CEO
Digitaltest GmbH

Product Overview

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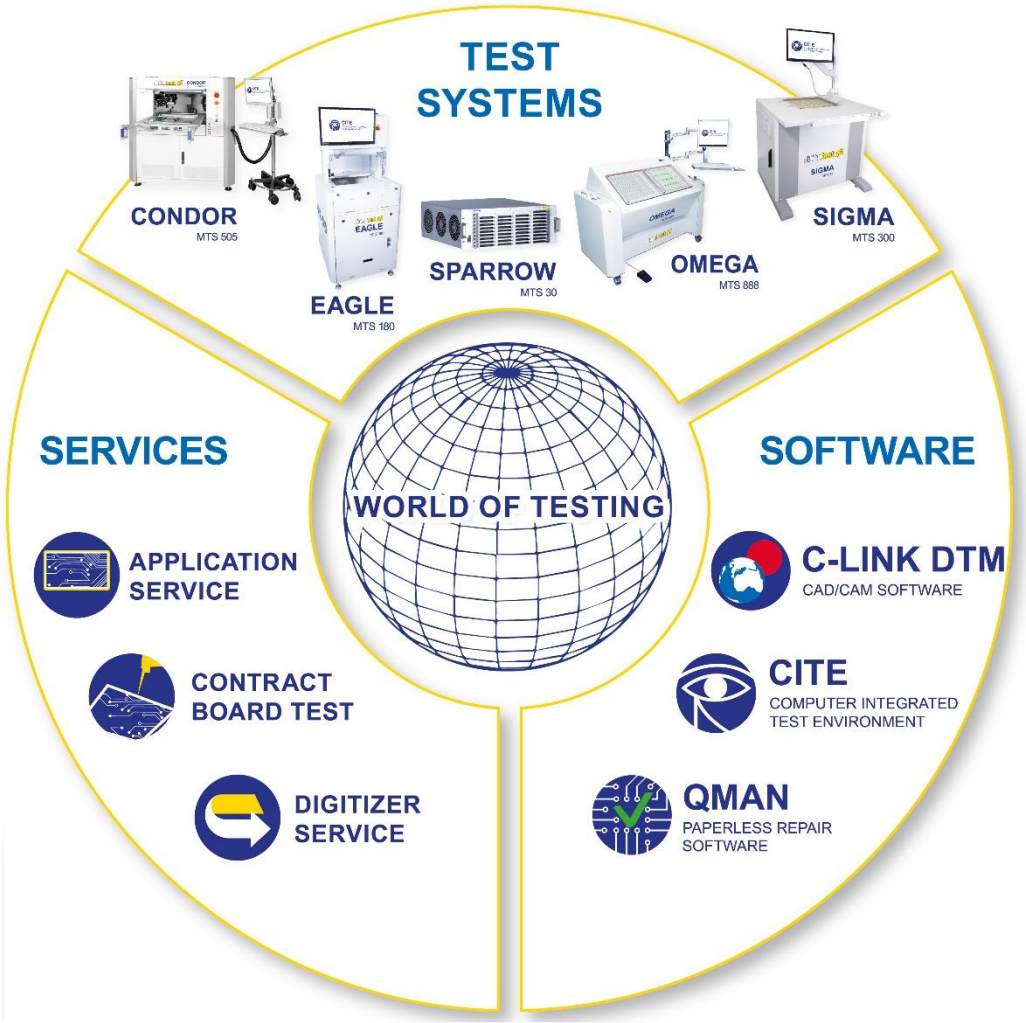
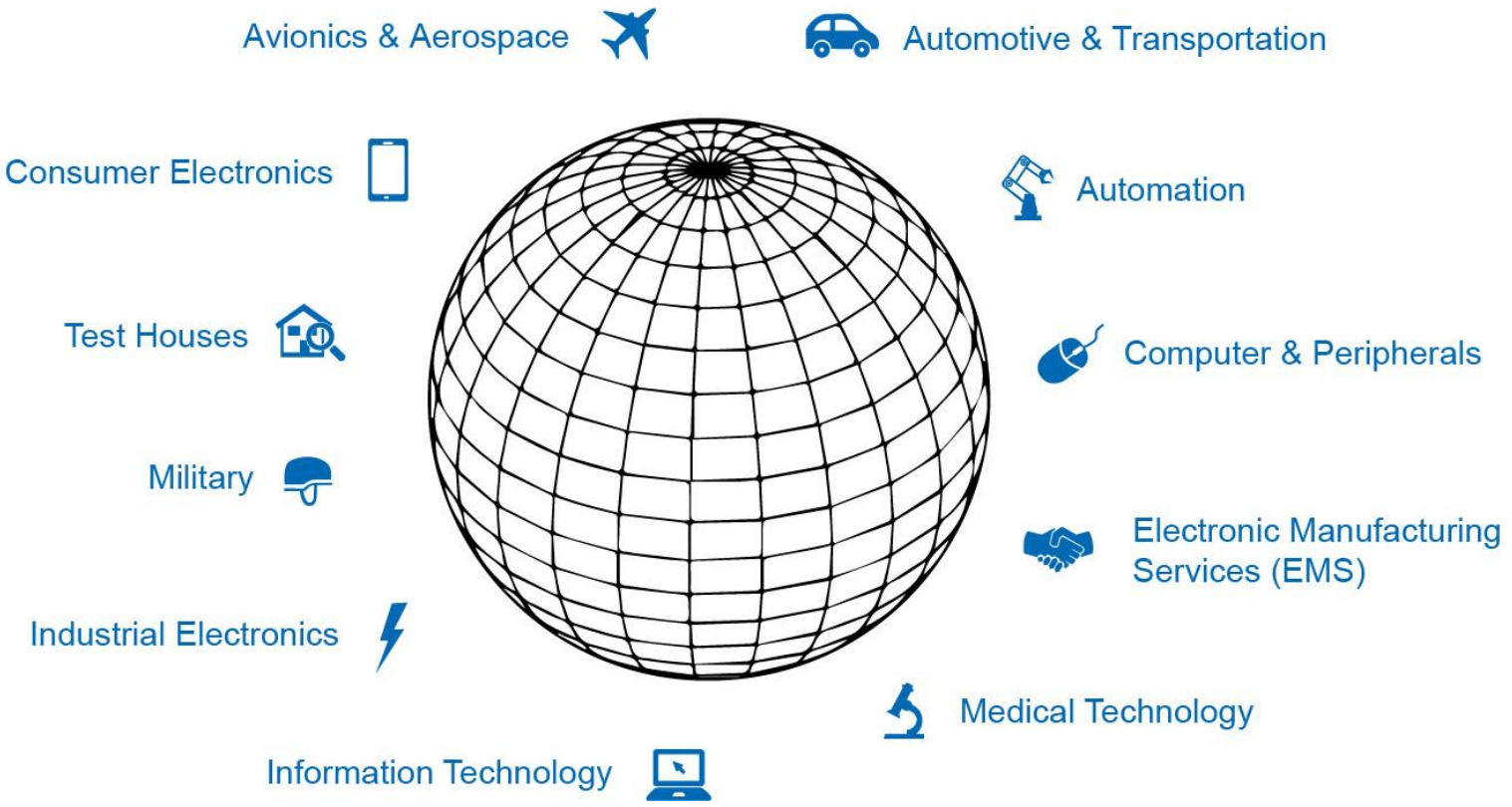
Electronic Board Test Systems & Electronic Manufacturing Software



About 2.500 installations

Our Experience

Electronic Board Test Systems & Electronic Manufacturing Software



Complete Solution – One Provider

Some of our users

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BOSCH

SAGEMCOM

SEW EURODRIVE

Lenze

GE Medical Systems

PEPPERL+FUCHS PRODUCTS

BECKHOFF

ABB

Gigaset

Itrón

SIEMENS

Schneider Electric

Continental

HUBBELL

SMC Matsushita Automation Controls

TRUMPF

EMERSON

Honeywell

Some more…

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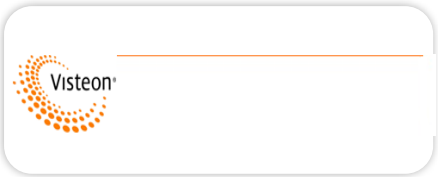

Do I have to test?

This question is related to my product and my customers

- **Safety Products:**
  Automotive, Medical, Military, Avionics,..



Yes, the more the better

- **Machinery:**
  100.000 € machine stands still because one little electronic part (10€) has a defect: maybe high Service cost, damaged reputation (credibility).

- **Consumer-Electronics:**
  high end products are more critical than low cost products. Failure in a 20€ coffee machine is not as critical as failure in a 900€!

?


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What can or must be tested:

This question is related to the quality of my components and my production process

- Component Failure: delivery quality of the Components?
- Process Failure: what process, depending on machine park?
- Production Failure: Shorts, wrong mounting, solder problems!
- Functional Failure: Dynamic, functional and environment
- Design Failure: not at series production!

→ **actual** failure classes need to be detected and reviewed,
What kind of machines are used, is there AOI before?

What can or must be tested:

If the first two questions are answered, the next question is about the Test Coverage

- **Protection parts:**
  EMV, PullUp, serial termination, protection parts:
  → only with ICT rationally testable

- **Partly-ICT / Cluster-ICT + Cluster-FCT:**
  e.g. at restricted contactability, Simplification / Standardization of Tests, Cost-reduction (Adapter, Testprogram development, ...)

- **Product innovation:**
  Design based on existing Cluster (Schema/Layout...)
  If constant Layout- Cluster why not constant Test-Cluster (Circuit structure, Testpads, ...)
  → Fixture re-usable?

What is my test coverage?

How can I investigate the depth of test and the coverage

Coverage:

of the de facto possible / occurring Failures

- **ICT:** easy to declare
- **FKT:** declaration → **impossible, not easy to investigate!**

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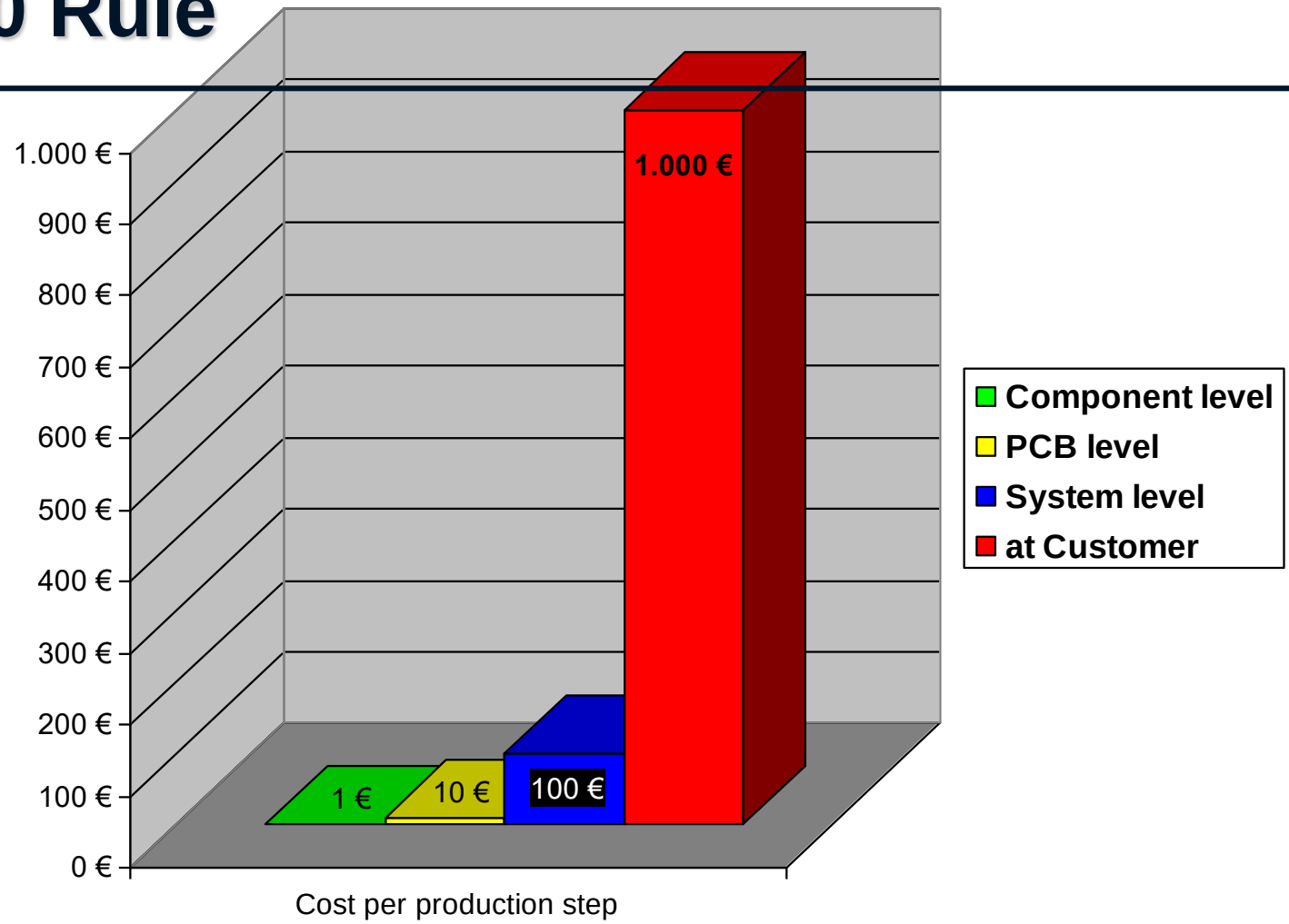
Factor 10 Rule



The cost for the identification and repair of a failure increases by factor 10 after each production step!

The Methods

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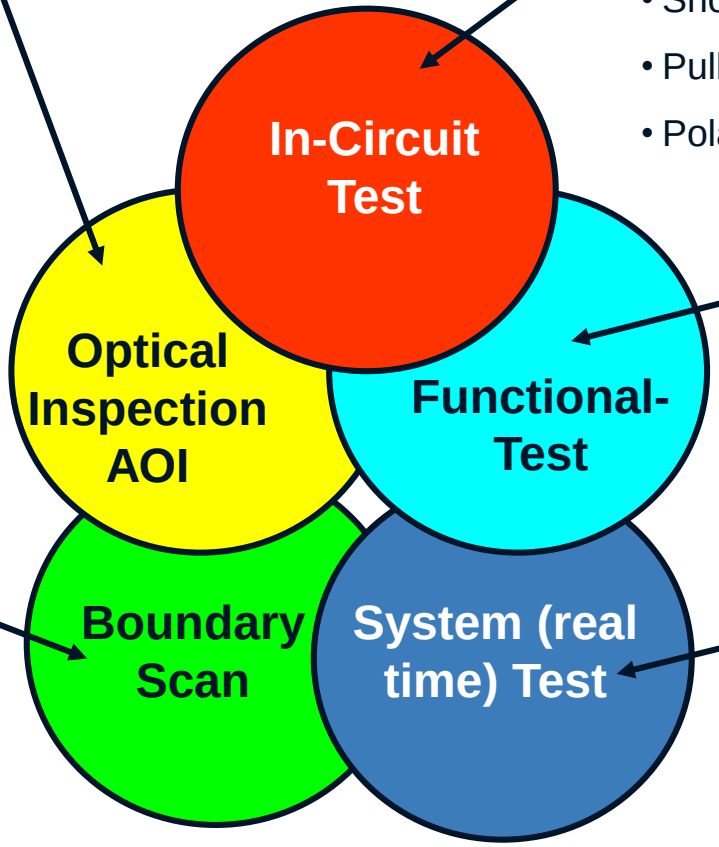
Detecting and Localizing of:

- Insertion Failures
- Solder Failures
- Mechanical Problems

Detecting and Localizing of :

- wrong or missing Components (static)
- Shorts, Opens
- Pullup/Pulldowns, Protection parts
- Polarity



Detecting and Localizing of:

- Functional Failure (Powerup)
- Interactive Problems
- Under real Power

Detecting and Localizing of:

- Open solder joints at IC‘s
- Solder problems
- Wrong IC‘s

(if the IC‘s are BS compliant)

Detecting and Localizing of:

- Dynamic Failure
- System Test
- Real environmental parameters

The Methods

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In-Circuit Test (ICT)

(Test of Components in a circuitry)

Analogue and digital Components will be tested for their Values & Functions. The tests include Component Values, Polarity, Contact, and shortage between the electrical nets.

The test of components in between complex circuitry will be performed by isolating the components with a “Guarding” technique

Functional Test (FCT)

(Test of the Functionality of the PCB or parts of the PCB)

By stimulating digital and/or analogue parameters at the inputs of the circuit, the output parameters are measured and verified.

The interaction of the components in the real circuitry will be tested and a correct function can be investigated.

Advantage of each Method

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In-Circuit Test (ICT)

Component values are tested.
Production failures can be detected.
When a failure is detected the problem will be pinpointed and the failure will be localized.
With this level of Diagnostics the repair of the PCB is easy and can be performed by an operator and does not require an engineer.

Easy automatic development of the test program by reading the CAD-Data and the BOM lets the APG (automatic program generator) generate the test program with all needed parameters for each component. The test time is fast and a high throughput can be reached.

Functional- Test (FCT)

The Functionality of the PCB or parts of the circuitry will be tested. By changing the parameters the feedback of the components, in a small tolerance band, can be forced. Functional test can also detect development failures (wrong dimension of components).

A Functional test can be performed static, dynamic or up to real time.

The FCT doesn’t need complex fixturing and in most cases it can be performed by using only the edge connectors.

Disadvantage of each Method

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In-Circuit Test (ICT)

For a complete test a fixture with spring probes on each electrical net will be needed. This fixture can be expensive. (maybe Flying Probe?)

Real dynamic tests are almost impossible.

Design problems will be not detected.

Each time the layout changes a new fixture may be necessary.

Functional- Test (FCT)

No automatic development of the test program is possible. Knowledge and know-how of the functionality of the PCB is necessary.

A failure will not automatically pinpoint the defective component. The diagnosis and repair of the board is complex, time consuming and requires highly qualified personnel.

Even if the functional test passes, incorrect components can be mounted (Pullup…) and can cause problems at the customer's side.

The test time can be very long.

Example ICT (1)

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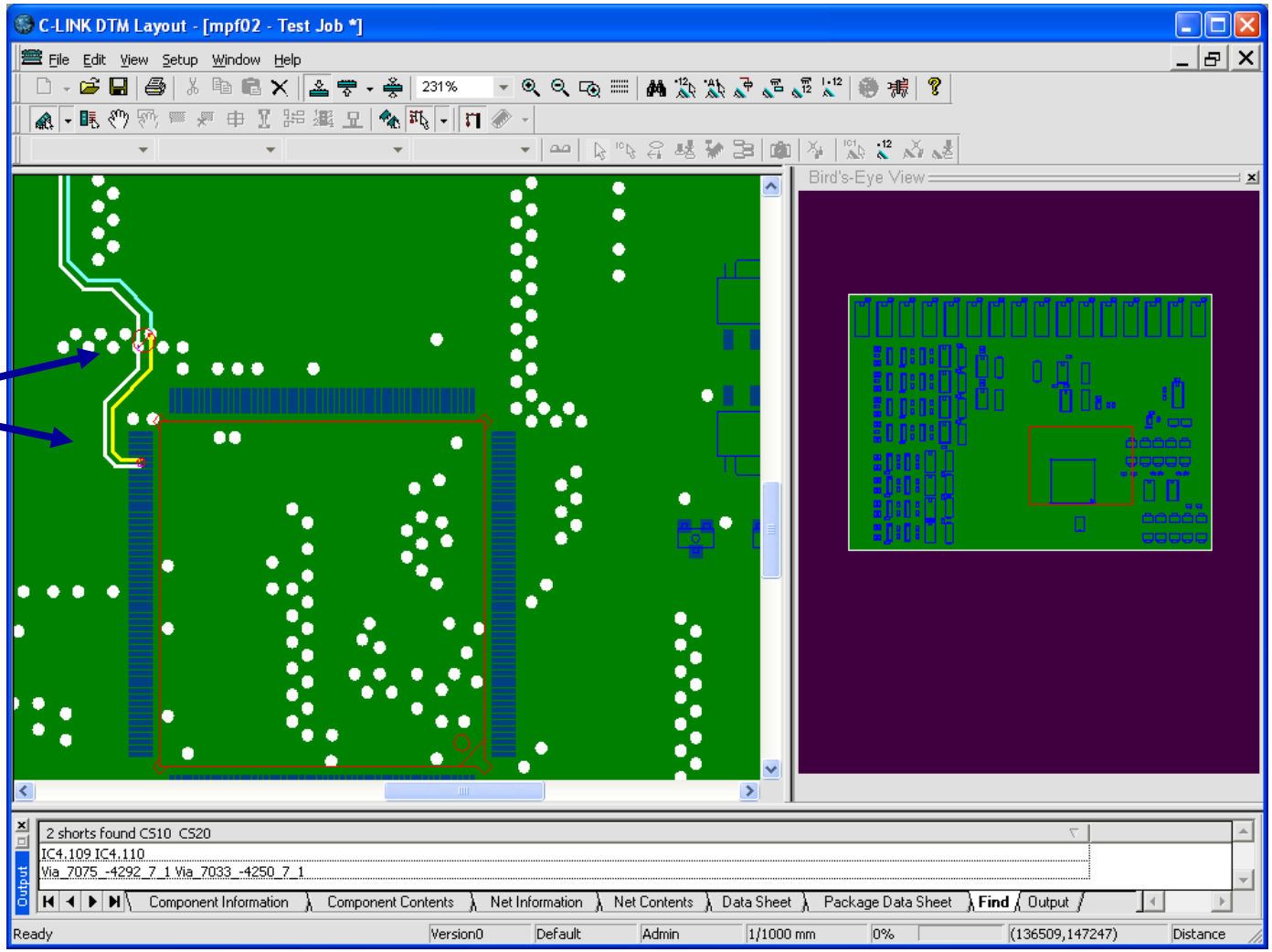
Easy diagnosis and therefore fast and cost efficient repair. Collected data can be used for fast optimization of the process. Test results point directly to defective structures, so that all graphical help functions can be used.

Layout-display directly points to possible locations of shorts and offers fast diagnosis.



Example ICT (2)

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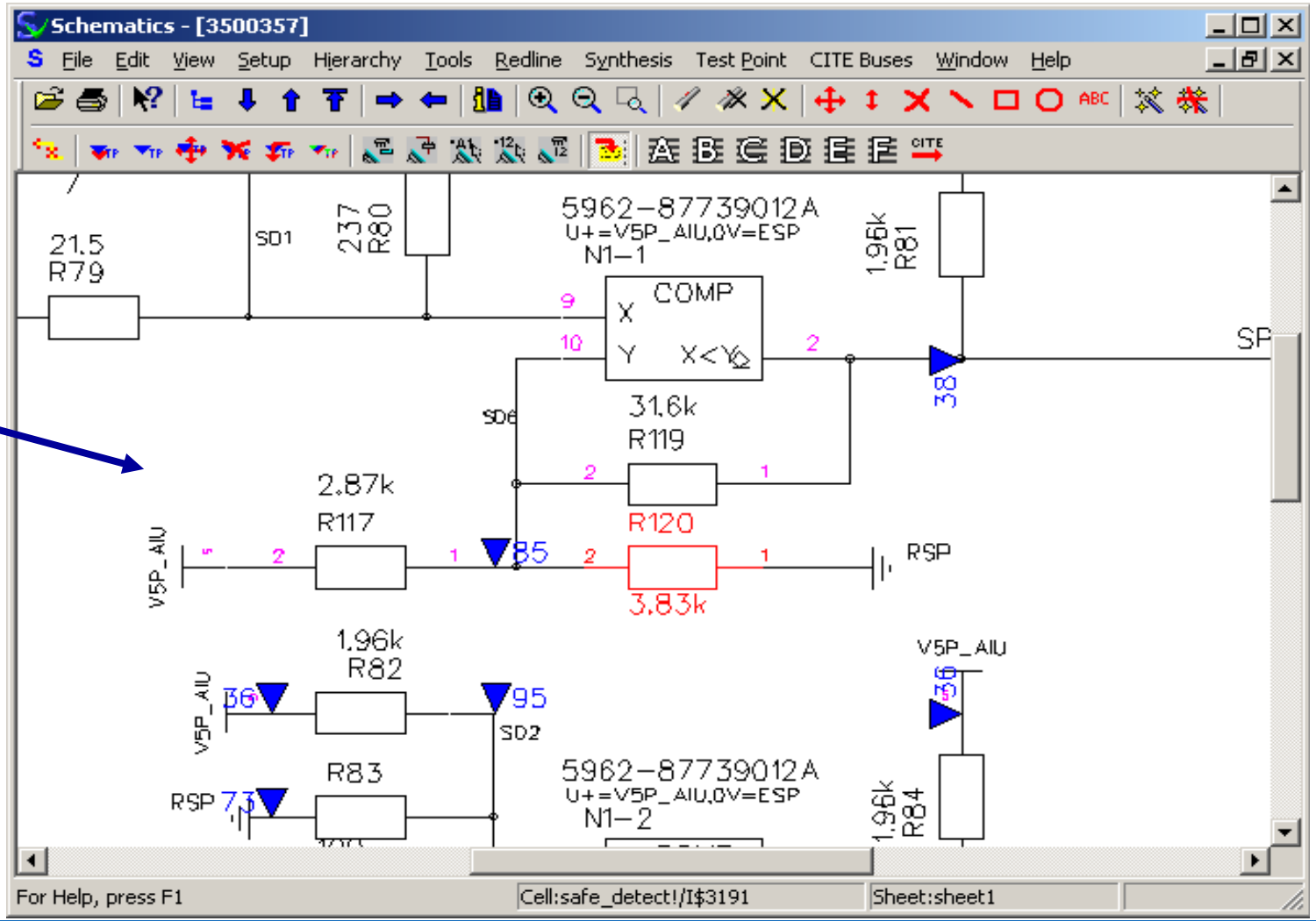
Easy diagnosis and therefore fast and cost efficient repair. Collected data can be used for fast optimization of the process. Test results point directly to failing components, so that all graphical help functions can be used.

Directly linked Schematics-display showing the faulty component and its environment. (incl. Interactive debugging)



Example ICT (3)

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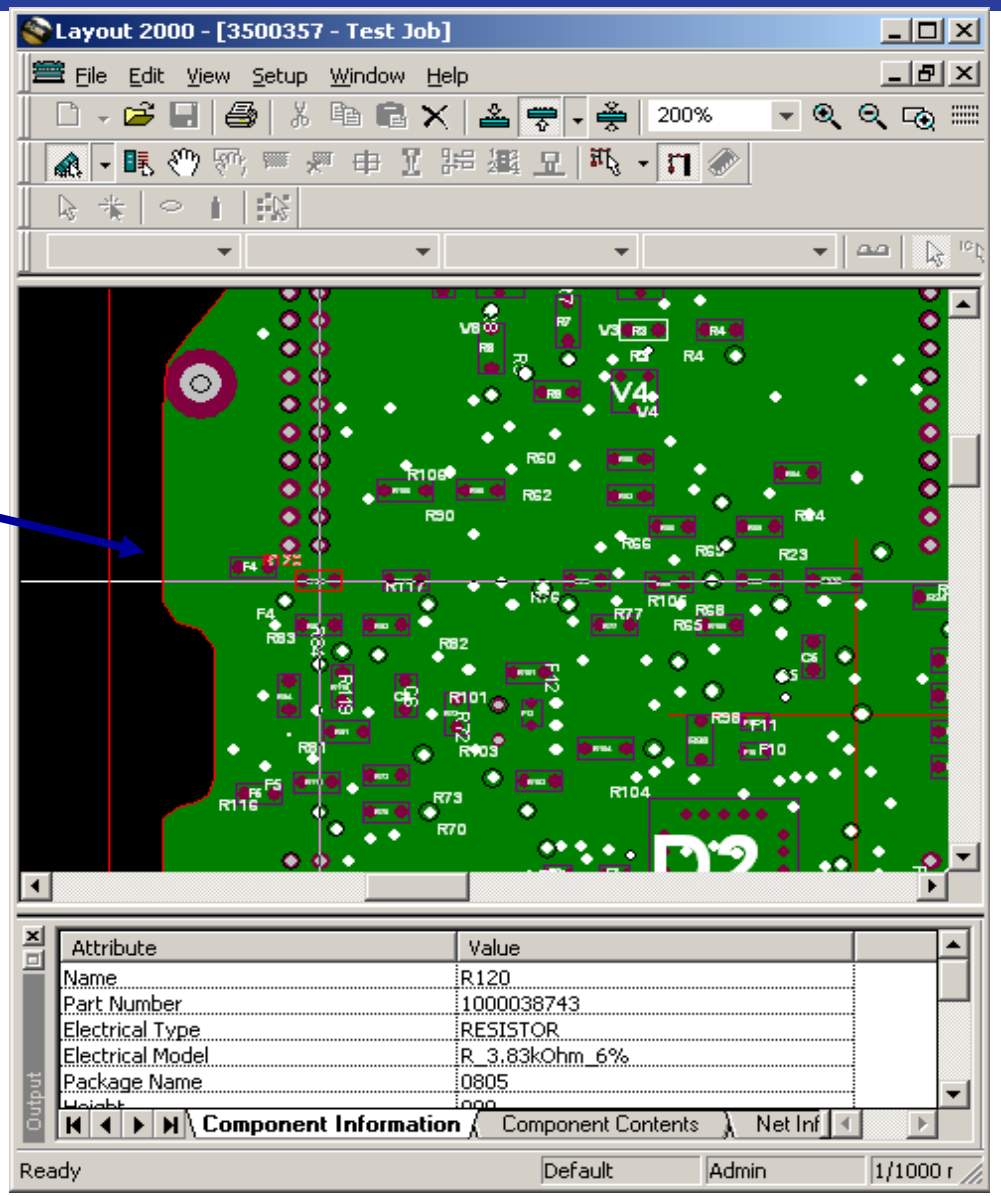
Easy diagnosis and therefore fast and cost efficient repair. Collected data can be used for fast optimization of the process. Test results point directly to failing components, so that all graphical help functions can be used.

Layout-display directly points to faulty components and offers fast localization.



Example ICT (4)

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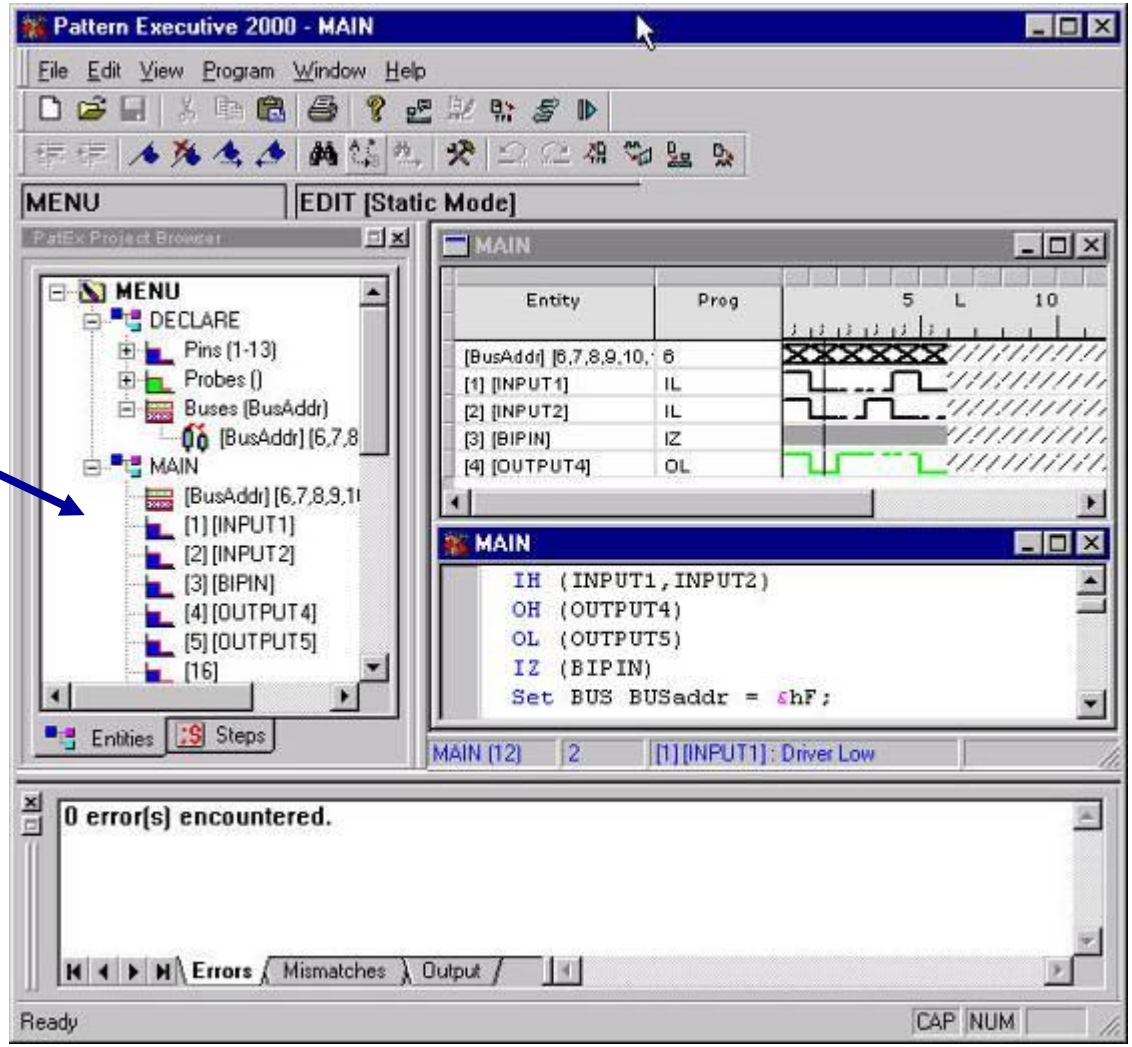
Easy diagnosis and therefore fast and cost efficient repair. Collected data can be used for fast optimization of the process. Test results point directly to failing components, so that all graphical help functions can be used.

Digital-Display shows the state of involved driver/sensors and supports diagnosis of digital failures. (incl. Interactive debugging)



Example FCT (1)

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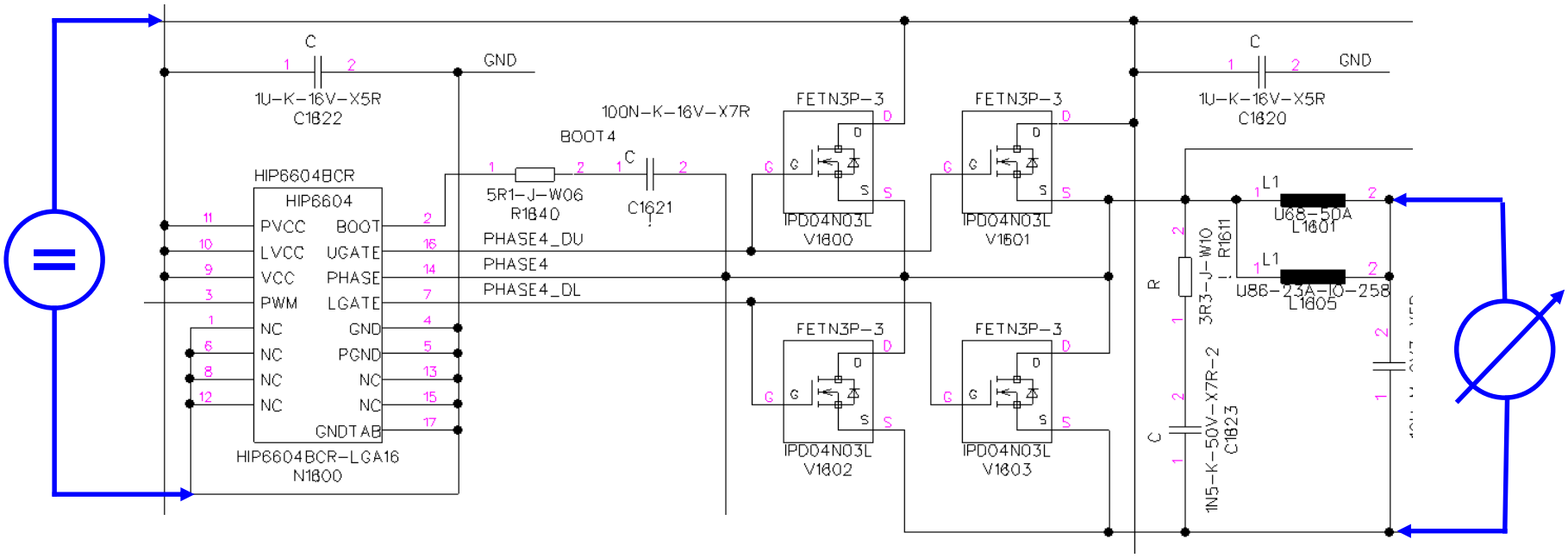
Verification of UUT function (or parts) with real voltage- and load conditions:

Safe function of switching regulator also with:

✓ - min/typ/max load
- Under-/Over- voltage



Example FCT (2)

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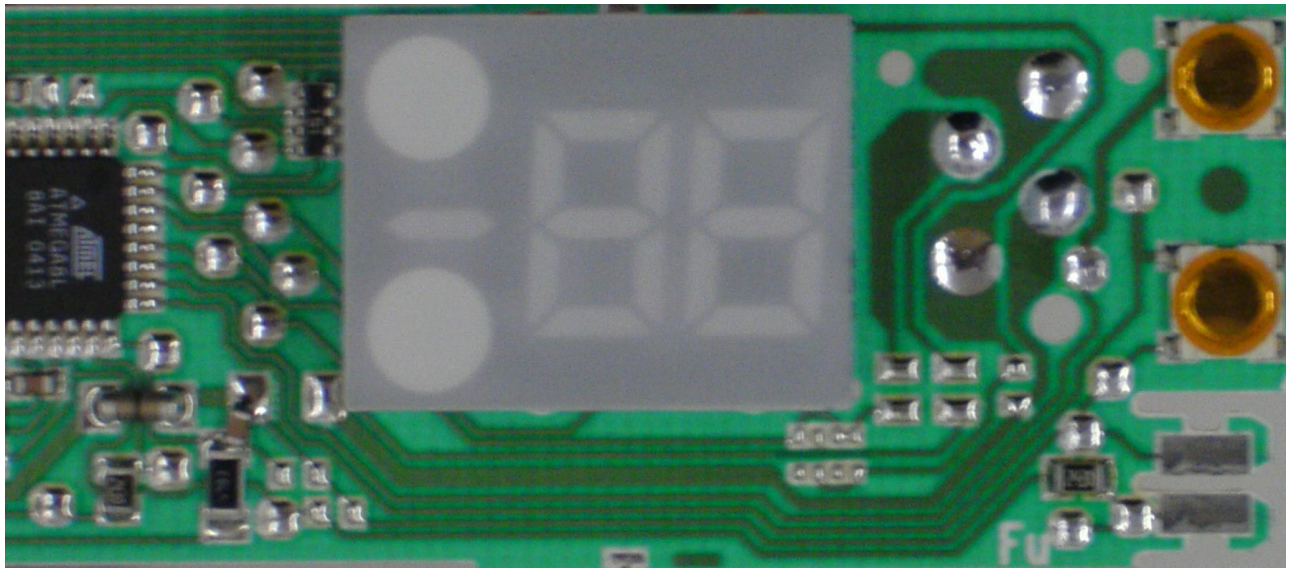
All segments enlightened with same intensity and color?:

✔ Automatic optical evaluation of color and brightness, actuation of controls (switches, trimmers,..)



Example FCT (3)

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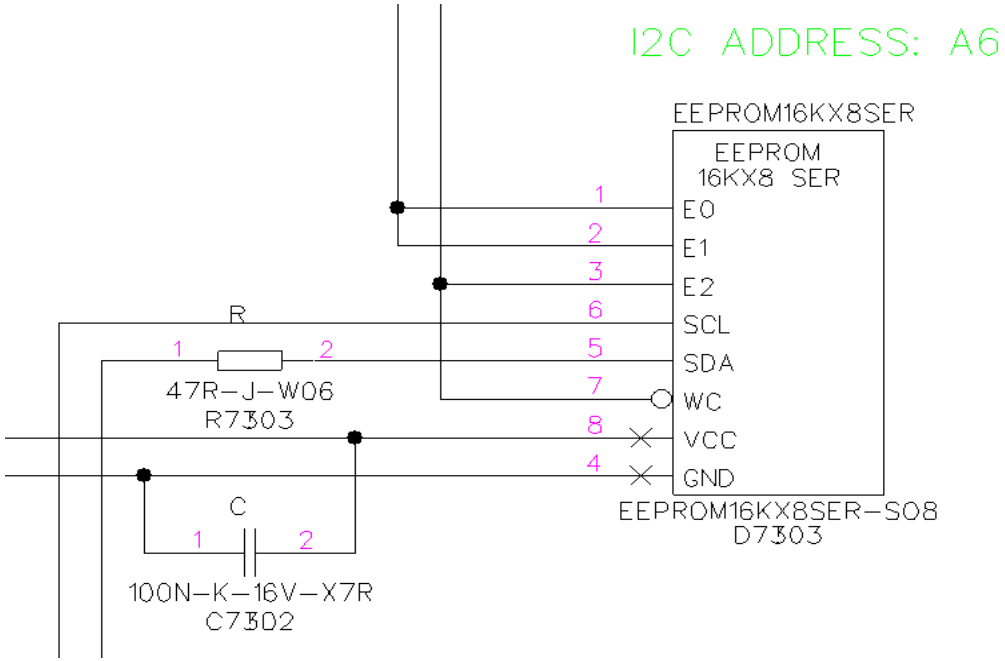
Calculation and programming of configuration data:

✓ - adjust UUT adjustment & determine configuration data
- program to UUT memory and verify



Example FCT (4)

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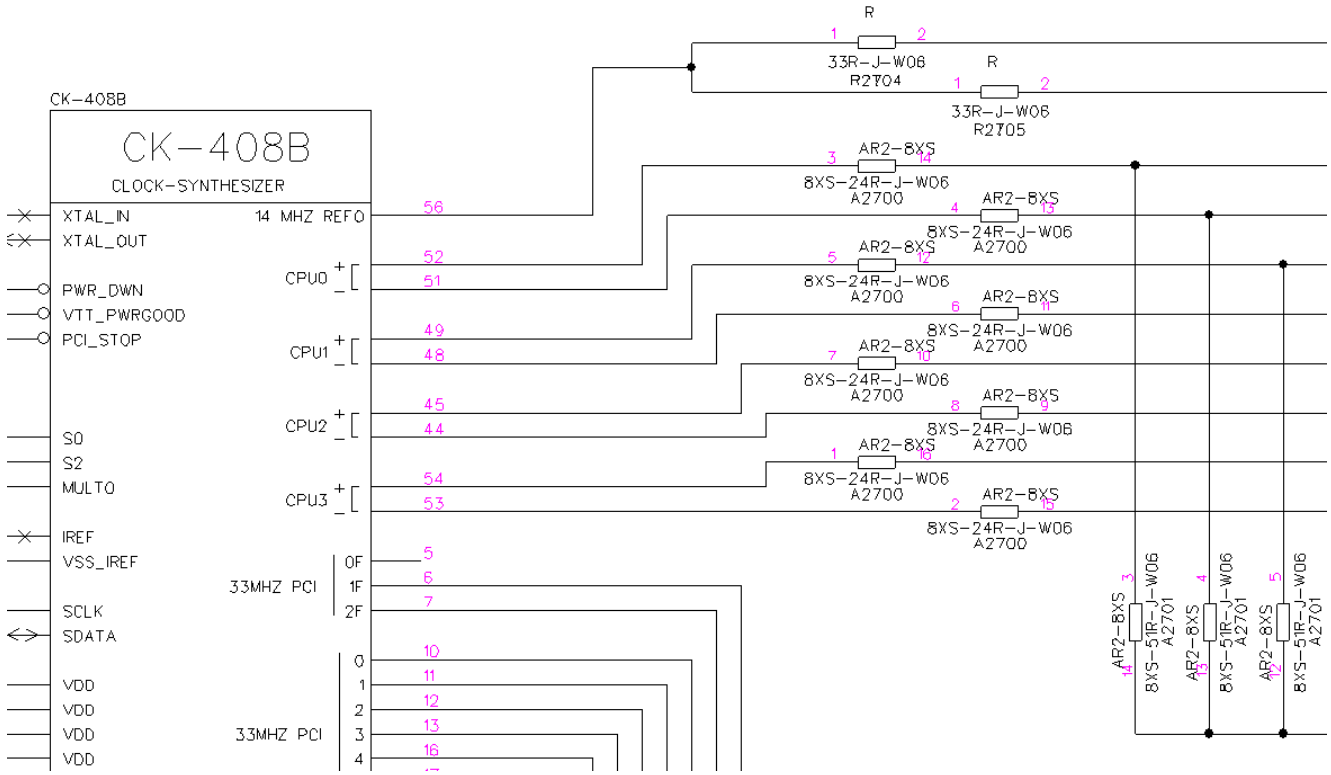
Verify UUT (or parts of UUT) under real time conditions:

Missing / wrong signal-termination:

✓ / ? Failure-detection: "Pcb does not start up (always?)"

? Diagnosis / Failure localization



Example FCT (5)

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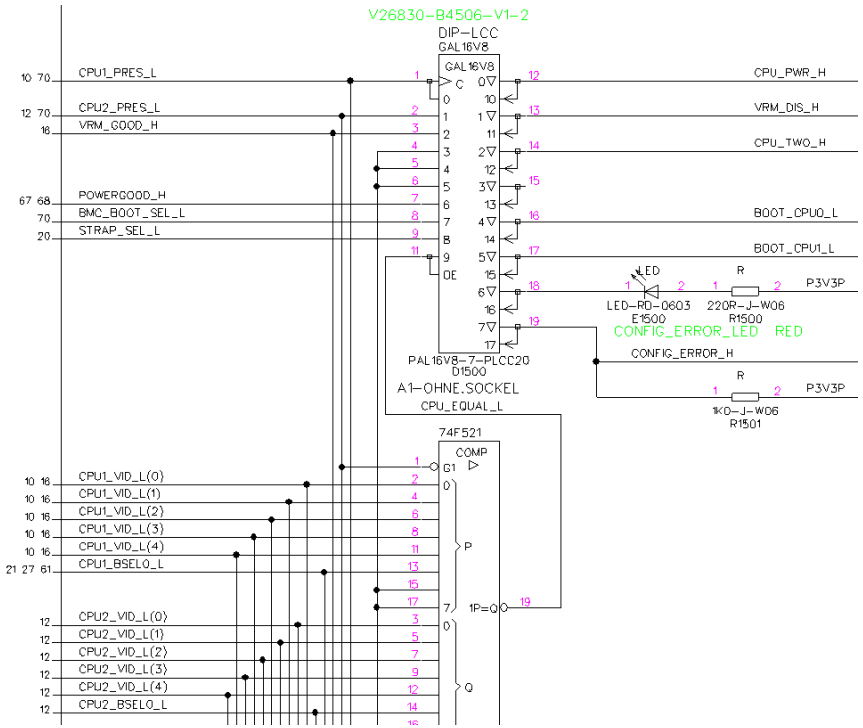
PCB powered up and Start_Up-Test says "Pass",
but in normal operation random failures (or not…)

? - what is really tested/used during Start_Up & FCT
- all Opens / Shorts detected during these tests



Combination (1)

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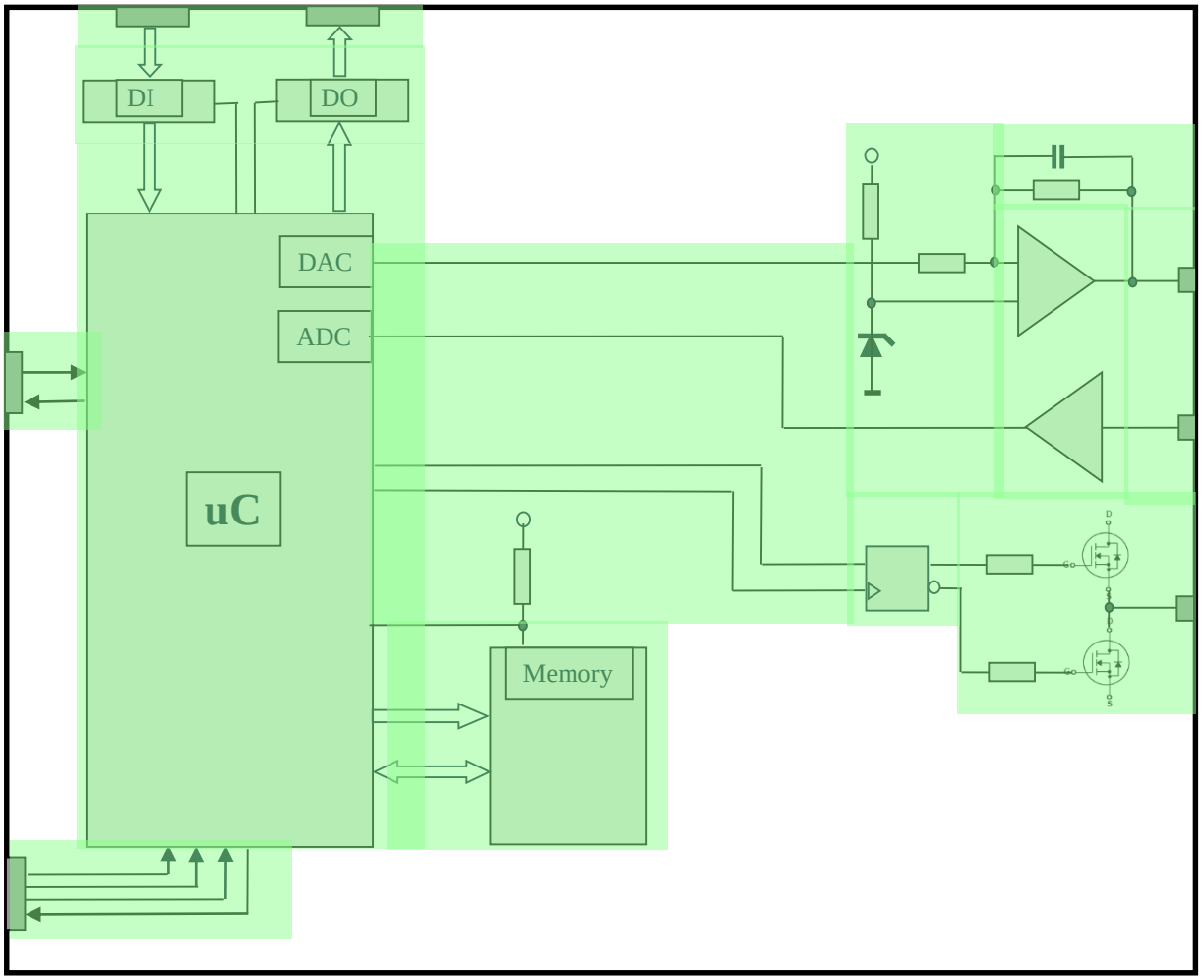
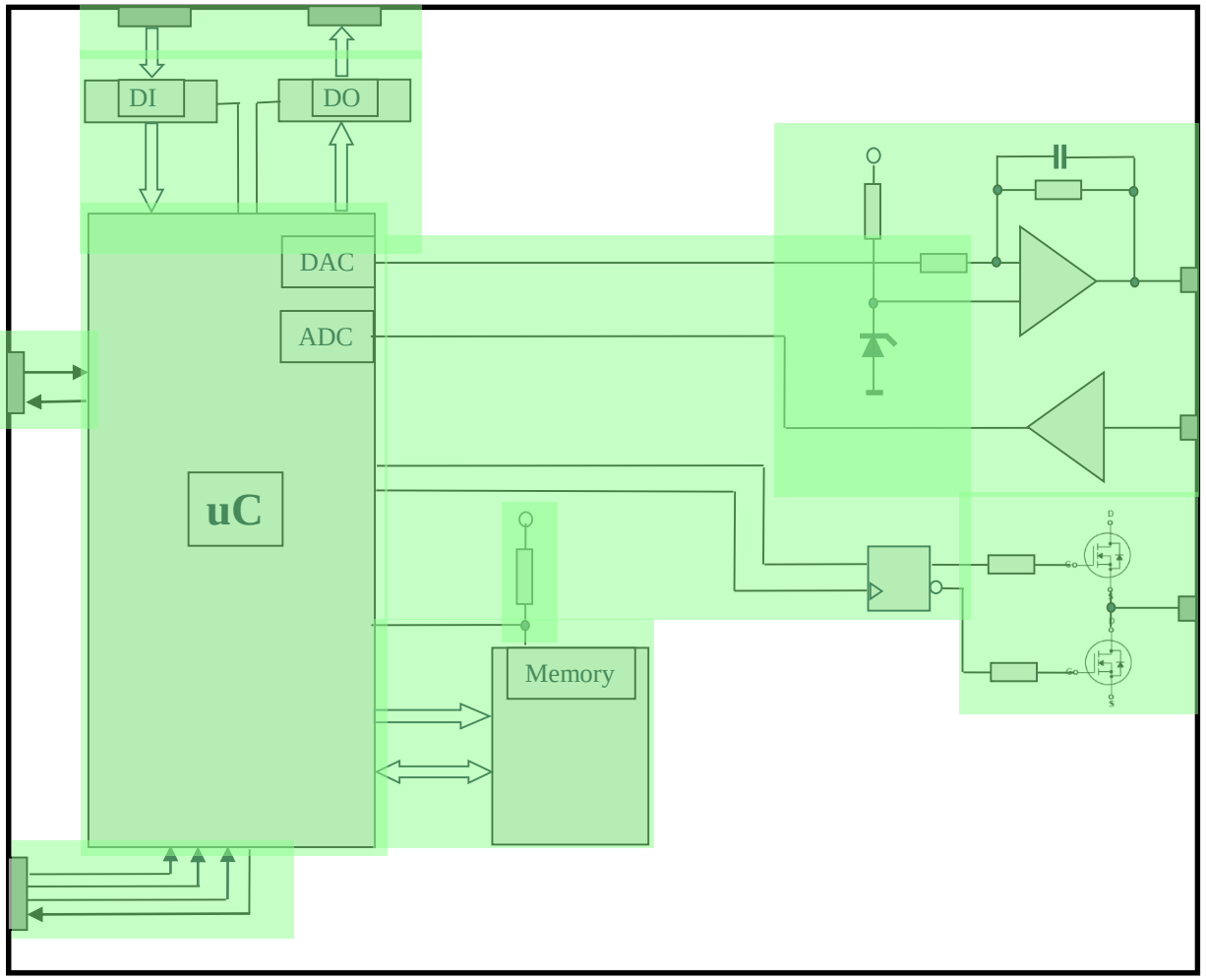


- ➢ **aICT**
- **+ Power & aFCT**
- **+ dICT**
- **+ Programming**
- **+ BIST & Communication**

- 100% adaptation
- Overlapping tests / redundancies

→ **HIGH COSTS**

Combination (2)



- ➢ **partial aICT (active)**
- **+ Bscan & Programming**
- **+ BIST & Communication**

↓ Adaptation
↓ Redundancies
↓ TP-Development
↓ Test time
→ **LESS COST**

Mix of Methods

- **Minimize costs**
- **Adjust the strategy to every single product**
- **Avoid redundancies**
  → accurate analysis, what is tested where
  complimentary tests, not overlapping tests

- **Reduce costs for adaptation**
  → f.e. ICT only where really necessary
  (only to ensure correct start_up of pcb under power)
  Integrate BoundaryScan

- **Minimize handling**
  → Integration of various methods on a single test station
  (f.e. with HV-Matrix also 230V-Test on a combinational tester)

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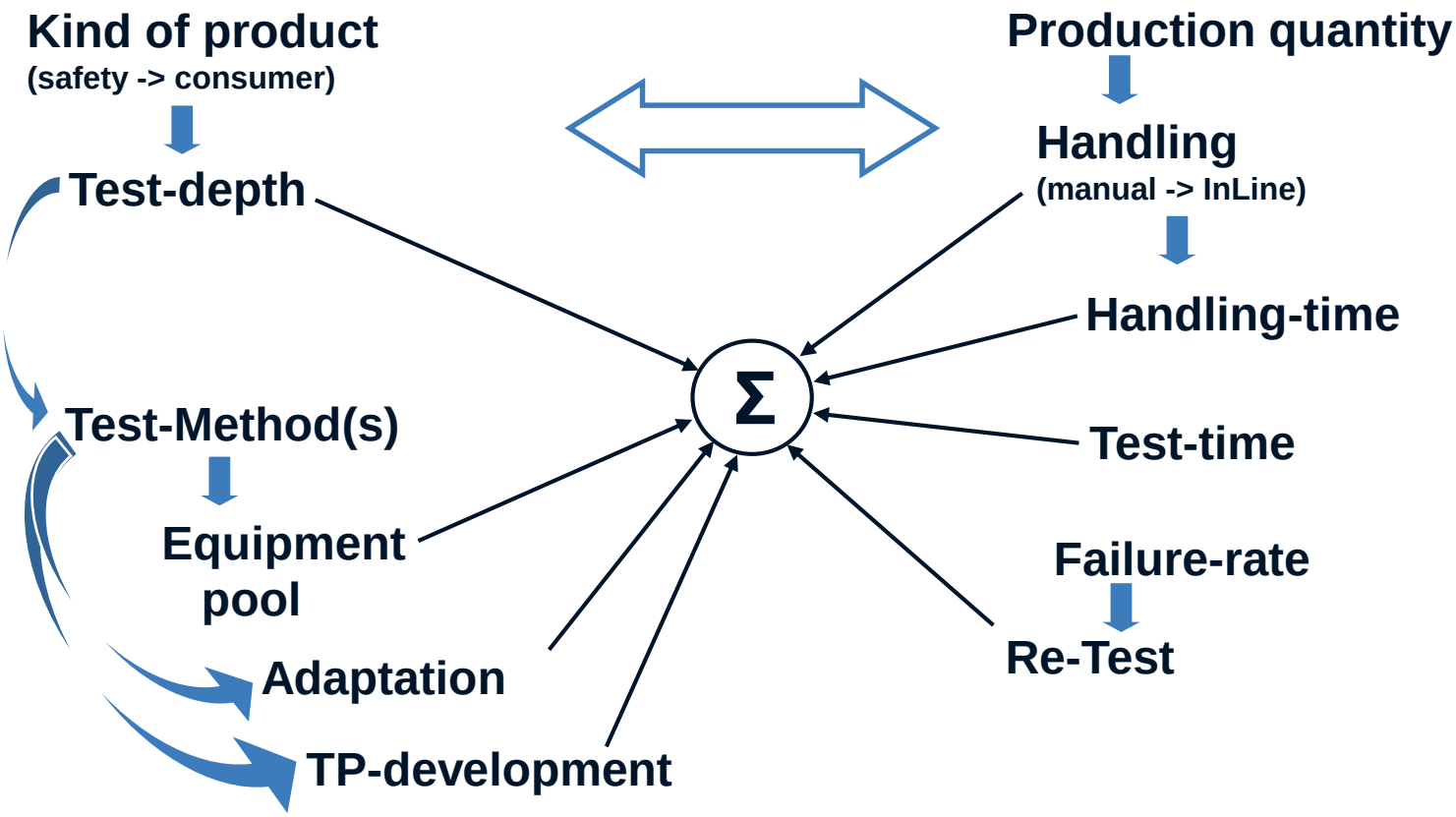
Cost influencing factors



How to test which product?

- **Analysis of the single product:**
  Structure, industrial segment of usage, fault spectrum, adaptability, production quantity, costs, ...

- **Flexible decision for a product specific strategy**

- **needs:**
  → flexible test system (Combinational Test System, maybe Flying Prober)
  → flexible tester-pool with:
  common HW-platform (maintenance, spare parts,...)
  consistent SW-platform (Know-How, programming, operation,...)

→ optimal cost-benefit ratio for all cases

Thank you for your interest!

For further information:

info@digitaltest.de

or Tel. +49(0)7244-9640-0 (Europe)

+01 (0) 9256038650 (USA)

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