WP 14013

ICT Vs FCT Test : case studies

Abstract: Functional test is not enough for reliably testing a PCB. This White Paper describes some of the most common cases, where only accurate In Circuit test can guarantee the full coverage and reliability of electronic boards.

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SPEA

Benefits of the In Circuit test

In the present document, the techniques specific to the In Circuit test are compared to those of the Functional test with regard to the following aspects:

- Board coverage
- Diagnostic level
- Test reliability
- Speed

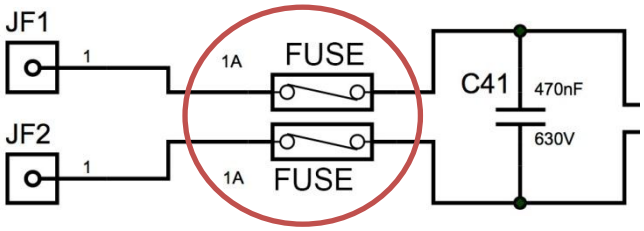
Board coverage

Generally speaking, the functional test covers all the components involved in the actual working of the board itself.

Typically, the functional test is not able to verify all the other components (filter and protection elements) of the board, used to ensure its life expectancy and reliability over time.

The following examples constitute a series of cases where components with errors in their most relevant parameters, or even unmounted components, cannot be identified by the functional test.

1) *Wrong Fuse value*

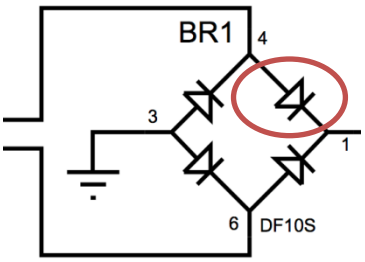


The functional test and most of the ICT testers on the market can only verify the presence of the fuse and check that it doesn't go off during the execution of the test.

In case the value of the mounted fuse is higher than the current absorbed by the board under test (for instance if a 10A fuse is mounted instead of a 1A fuse), the functional test will not be able to detect this defect and the board will exit the production line basically without protection from input overcurrent.

By measuring the resistance of the fuse with a very accurate In Circuit test, it is possible to identify the range of the mounted fuse and the big differences in the characteristics of the mounted components that could damage the board.

2) Missing diode on rectifier Bridge



If one of the 4 diodes present on a rectifier bridge is missing, this defect will not be detected by the functional test. When the board works for brief periods of time, in fact, this kind of defect bear no consequences on it.

Therefore, with the functional test, the board will exit the production line without this component, thus compromising the reliability of the board over time (the current flowing inside the mounted diode will be double than expected).

With the In Circuit test, it is possible to verify the presence, the correct mounting and the electrical characteristics of the diodes that will be mounted, ensuring the reliability of the product over time.

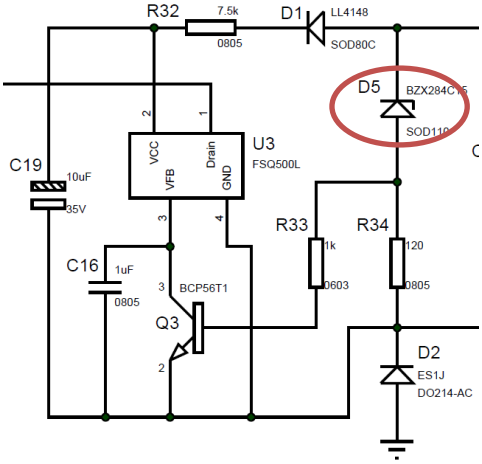
3) Missing Zener diode

The electrical diagram on the side pictures a typical case where a zener diode is used as a protection device.

In case the Zener diode is not mounted, the functional test will not be able to detect that it's missing.

Therefore, the board will exit the production line without this component and, as a result, it will be more vulnerable towards external voltages that could damage it.

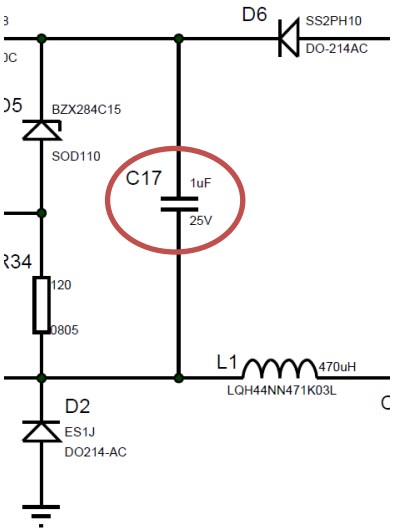
With the In Circuit test, it is possible to verify the presence, the correct mounting and the electrical characteristics (in particular the zener voltage) of these diodes.



4) Missing capacitor

The electrical diagram on the side pictures a typical case where a missing components can't be detected by the functional test: filter capacitors.

The functional test, in fact, is not able to establish if one of the filter capacitors has not been mounted.
Therefore, the board will exit the production line without this component and its output voltage will probably be less stable than planned during development.



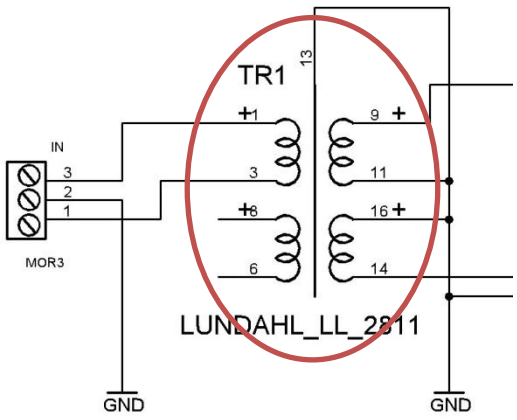
Diagnostics

5) Wrong transformer winding

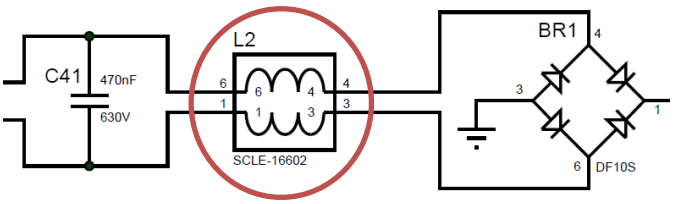
The electrical diagram on the side pictures a typical case where a component mounted backwards can't be detected by the functional test.

In this case, the In Circuit test is able to verify the correct mounting of the transformer and its correct turns ratio.

In other cases (for instance in switching stages), inverting the phase of the transformer prevents the stage from working. In this cases, the defect is detected by the functional test (since the switching stage does not work), but it becomes difficult to diagnose, and this increases the time needed to repair the board itself.
With the In Circuit test, it is possible to univocally identify the component and the defect to repair.



6) Filter



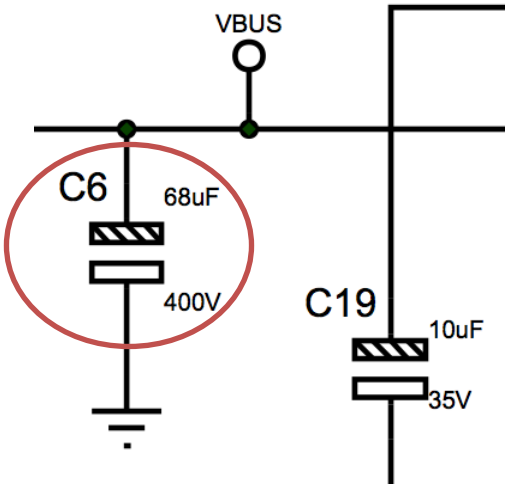
The electrical diagram on the side pictures a filter with wrong value. Functional test cannot detect this defect. This will result in two negative effects:

- Malfunctioning of the PCBA
- Wrong value component may cause interference on the power supply net of the PCBA

In addition to verify the filter value, the In Circuit test is able to detect if the filter is correctly oriented; in this way it is also able to test its behavior as a transformer, polarity included (in this case the turns ratio will always be 100%).

Test reliability

7) Reversed capacitor



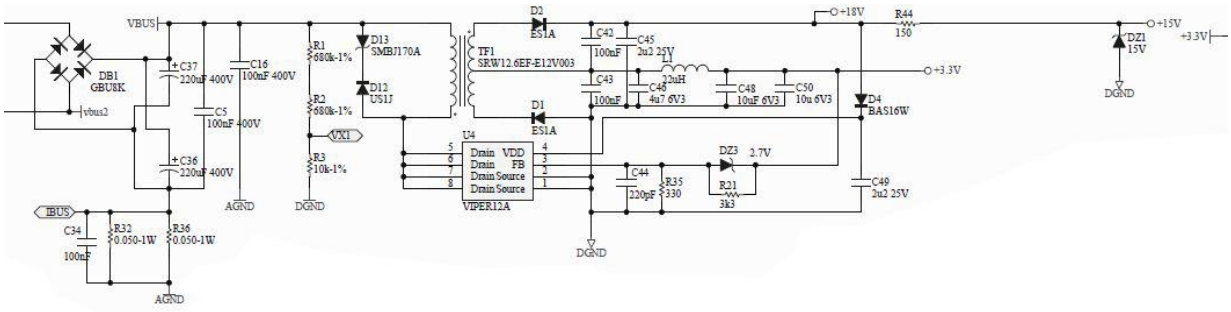
The electrical diagram on the side pictures a typical case where an incorrectly mounted component can be detected by the functional test, but this method could be dangerous for the board or for the operator executing the test.

Let's examine an incorrectly mounted polarized capacitor: it will blow up the first time it gets powered. This could cause unrepairable damage to the board under test (for instance ruining the PCB).
It could damage the repair station or harm the operator (particularly if the test is executed on an open board.

The In Circuit test is able to identify the wrong mounting of the component before this gets powered at mail voltage, avoiding turning on the board under dangerous conditions.

Speed

8) Switching Power Supply



Typically, as far as test execution speed is concerned, the In Circuit test has a 10:1 ratio compared to the functional test.
This happens because the functional test time is related to the timing of the actual working of the board, including the timespan needed for turning it on or off etc.

Supposing we want to test the circuit highlighted in figure, we can hypothesize the following times for the execution of the functional test:

1. Board power on: 1 sec
2. Output voltage check: 0.1 sec
3. Board power off: 0.5 sec
4. High voltage capacitors discharge: 0.5
5. TOTAL: 2.1 sec

The In Circuit test typically needs few ms to test a single component.
If the average test time for one component is 10ms, the circuit under analysis can be tested in 225 ms (30 components are present on board).
In this case, the ratio between the time needed for the executions of the In Circuit test and the functional test is much higher than the expected 10:1.

WARNING

In all cases described in this White Paper, executing only the functional test is not enough to ensure a stable and reliable testing.