

Test Coverage Matrix

- ✿ Perhaps the best means of determining whether the test equipment can detect the manufacturing defects of a board is the Test Coverage Matrix (TCM).
 - ICT has very effective tools to generate its test coverage portion of the report.
 - FCT and Systems testers usually have to use fault injection to find the faults.
- ✿ The report has these sections:
 - Summary of test coverage, including a listing of devices not tested.
 - Listing of all devices on the board (usually in alphabetical order) to document whether they're tested or not (or partially tested).
 - Listing of the shorts on a board that cannot be tested (usually because of nodal access problems at ICT).
 - Listing of the device pins on devices with > 2 pins to document whether all open pin fault are detected.

Test Coverage Matrix, Slide 1 of 7

Test Coverage Matrix for "XYZ" (sample) Board

NOTE: This board was not designed for testability.

Summary of Untested Devices and Untested Faults in Test Process:

Device	Value	Fault	Comments
C10 Reverse	33uF_20%	Orientation	Cannot test C10 to be installed backwards. (This cap may be detected by exploding at later tests.)
C19	1nF_10%	Value	Untested due to impedance of R8 and R18.
C81	3.3nF_20%	Value	Untested due to guard ratio with C10.
D26 Zener	Z9P1V	Value	Tested for forward drop, but value of Zener Clamp not tested.
U2.6	Adj. Short	U2.5 to U2.6	ICT cannot test this pin-to-pin adjacent short due to design access; other test cannot detect this fault.
U2.6	Adj. Short	U2.6 to U2.7	ICT cannot test this pin-to-pin adjacent short due to design access; other test cannot detect this fault.
U2.13	Adj. Short	U2.12 to U2.13	ICT cannot test this pin-to-pin adjacent short due to design access; other test cannot detect this fault.
U2.13	Adj. Short	U2.13 to U2.14	ICT cannot test this pin-to-pin adjacent short due to design access; other test cannot detect this fault.
U2 Pin 7	L6574	Pin Lifted Fault	Not test in process can detect this pin fault.

Statistical Summary of ICT:

Summary of Component Test Coverage: ICT Coverage is 136 of 141 devices = 96.5% Coverage.

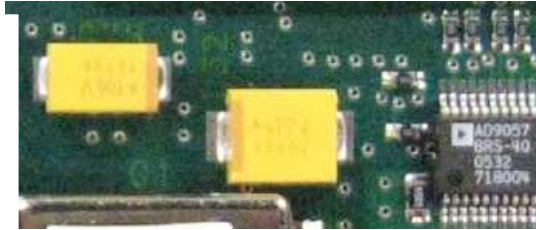
Summary of Shorts Test Coverage: ICT Tests 7,017 of 7,021 possible shorts = 99.943% Coverage.

Summary of Pin Fault Test Coverage: ICT Tests 288 of a possible 311 pin faults = 92.6% Coverage.

Design-For-Testability for Nodal Access: ICT access to 51 of the 120 Networks for a 42.5% Nodal Design-For-Testability Compliance.

Reminder: This board was not designed for testability, so the ICT coverage is lower than cases where DFT Compliance is used.

Orientation of Polarized Capacitors



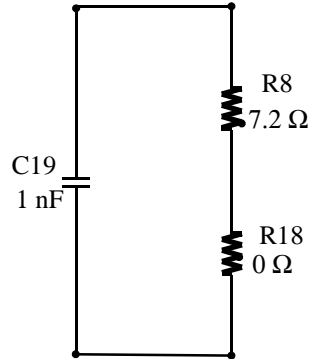
- The brown stripe shows the Anode (“+ Side”) of these polarized ceramic capacitors.
- AOI and FPT systems can detect when they’re reversed by using their cameras to ensure the brown stripe is on the correct end.
- Techniques for testing for the orientation of polarized capacitors are fully covered in the ICT (Section III) segment of this course.

Test Coverage Matrix, Slide 2 of 7

Section I: Component Test Coverage

		Test Coverage Report For Each Level of Testing				
Device	Value	In-Circuit Test	Functional Test	Unit Test	Burn-In	Overall
C1	220nF_10%	Tested	N/A	N/A	N/A	Tested
C2	2.2nF_20%	Tested	N/A	N/A	N/A	Tested
C3	1uF_10%	Tested	N/A	N/A	N/A	Tested
C5	150nF_10%	Tested	N/A	N/A	N/A	Tested
C6	2.2nF_10%	Tested	N/A	N/A	N/A	Tested
C7	100nF_10%	Tested	N/A	N/A	N/A	Tested
C9	2.2nF_20%	Tested	N/A	N/A	N/A	Tested
C10 Value	33uF_20%	Tested	N/A	N/A	N/A	Tested
C10 Reverse	33uF_20%	Untested	Untested	Untested	Untested	Untested
C18	1uF_10%	Tested	N/A	N/A	N/A	Tested
C19	1nF_10%	Untested due to R8 and R18.	Untested	Untested	Untested	Untested
C22	100nF_10%	Tested	N/A	N/A	N/A	Tested
C24	470pF_10%	Tested	N/A	N/A	N/A	Tested
C25	680nF_10%	Tested	N/A	N/A	N/A	Tested
C26	1nF_10%	Tested	N/A	N/A	N/A	Tested
C27	1nF_10%	Untested due to C31 in parallel.	Untested	Tested	N/A	Tested
C28	470pF_10%	Tested	N/A	N/A	N/A	Tested
C29	100nF_10%	Tested	N/A	N/A	N/A	Tested
C30	47pF_5%	Tested	N/A	N/A	N/A	Tested
C31	100nF_10%	Tested	N/A	N/A	N/A	Tested
C35	22pF_5%	Tested	N/A	N/A	N/A	Tested
C36	150nF_5%	Tested	N/A	N/A	N/A	Tested
C37	220nF_5%	Tested	N/A	N/A	N/A	Tested
C37A	47nF_5%	Tested	N/A	N/A	N/A	Tested
C38	150nF_5%	Tested	N/A	N/A	N/A	Tested

Example of an Untestable Capacitor



Untestable C19.

Test Coverage Matrix, Slide 3 of 7

C93	2.2uF_10%			Tested	N/A	N/A	N/A	Tested
D1	DIODE			Tested	N/A	N/A	N/A	Tested
D2	DIODE			Tested	N/A	N/A	N/A	Tested
D3	DIODE			Tested	N/A	N/A	N/A	Tested
D4	DIODE			Tested	N/A	N/A	N/A	Tested
D7	DIODE			Tested	N/A	N/A	N/A	Tested
D8	DIODE			Tested	N/A	N/A	N/A	Tested
D17 Forward	Z14V			Tested	N/A	N/A	N/A	Tested
D17 Zener	Z14V			Tested	N/A	N/A	N/A	Tested
D18	DIODE			Tested	N/A	N/A	N/A	Tested
D22 Forward	Z8P2V			Tested	N/A	N/A	N/A	Tested
D22 Zener	Z8P2V			Tested	N/A	N/A	N/A	Tested
D23 Forward	Z3P6V			Tested	N/A	N/A	N/A	Tested
D23 Zener	Z3P6V			Tested	N/A	N/A	N/A	Tested
D24	DIODE			Tested	N/A	N/A	N/A	Tested
D25	DIODE			Tested	N/A	N/A	N/A	Tested
D26 Forward	Z9P1V			Tested	N/A	N/A	N/A	Tested
D26 Zener	Z9P1V			Zener clamp not testable.	Untested	Untested	Untested	Untested
D61	DIODE			Tested	N/A	N/A	N/A	Tested
D68	DIODE			Tested	N/A	N/A	N/A	Tested
F1	FUSE			Tested	N/A	N/A	N/A	Tested
JR1	0o			Tested	N/A	N/A	N/A	Tested
JR2	0o			Tested	N/A	N/A	N/A	Tested
JR3	0o			Tested	N/A	N/A	N/A	Tested
JR4	0o			Tested	N/A	N/A	N/A	Tested
JR5	0o			Tested	N/A	N/A	N/A	Tested
L1	Transformer			Tested	N/A	N/A	N/A	Tested

Test Coverage Matrix, Slide 4 of 7

Q1	NFET			Tested	N/A	N/A	N/A	Tested
Q5	NFET			Tested	N/A	N/A	N/A	Tested
Q6	NFET			Tested	N/A	N/A	N/A	Tested
R1	332Ko_1%			Tested	N/A	N/A	N/A	Tested
R2	21.5Ko_1%			Tested	N/A	N/A	N/A	Tested
R3	0o			Tested	N/A	N/A	N/A	Tested
R4	5.11Ko_1%			Tested	N/A	N/A	N/A	Tested
R5	49.9Ko_1%			Tested	N/A	N/A	N/A	Tested
R6	86.6o_1%			Tested	N/A	N/A	N/A	Tested
R7	22.1o_1%			Tested	N/A	N/A	N/A	Tested
R8A	2.4o_5%			Tested	N/A	N/A	N/A	Tested
R8B	2.4o_5%			Tested	N/A	N/A	N/A	Tested
R8C	2.4o_5%			Tested	N/A	N/A	N/A	Tested
R9A	499Ko_1%			Tested	N/A	N/A	N/A	Tested
R9B	499Ko_1%			Tested	N/A	N/A	N/A	Tested
R9C	499Ko_1%			Tested	N/A	N/A	N/A	Tested
R10	8.06Ko_1%			Tested	N/A	N/A	N/A	Tested
R11	0o			Tested	N/A	N/A	N/A	Tested
R15	1Mo_1%			Tested	N/A	N/A	N/A	Tested
R18	0o			Tested	N/A	N/A	N/A	Tested
R19	100Ko_1%			Tested	N/A	N/A	N/A	Tested
R20	46.4Ko_1%			Tested	N/A	N/A	N/A	Tested
R22	499Ko_1%			Tested	N/A	N/A	N/A	Tested
R26	10o_1%			Tested	N/A	N/A	N/A	Tested
R27	10o_1%			Tested	N/A	N/A	N/A	Tested
R28	0o			Tested	N/A	N/A	N/A	Tested
R30A	1.5o_5%			Tested	N/A	N/A	N/A	Tested
R30B	1.5o_5%			Tested	N/A	N/A	N/A	Tested
R32A	10Ko_1%			Tested	N/A	N/A	N/A	Tested

Mastering Test Engineering
Section VII: Manager's Summary
Slide 27

Test Coverage Matrix, Slide 5 of 7

R47A	182Ko_1%			Tested	N/A	N/A	N/A	Tested
R47B	182Ko_1%			Tested	N/A	N/A	N/A	Tested
R47C	332Ko_1%			Tested	N/A	N/A	N/A	Tested
R47D	182Ko_1%			Tested	N/A	N/A	N/A	Tested
R48	2.15Mo_1%			Tested	N/A	N/A	N/A	Tested
R49	49.9Ko_1%			Tested	N/A	N/A	N/A	Tested
R50	0o			Tested	N/A	N/A	N/A	Tested
R61	22.1Ko_1%			Tested	N/A	N/A	N/A	Tested
R63	110Ko_1%			Tested	N/A	N/A	N/A	Tested
R65	100o_5%			Tested	N/A	N/A	N/A	Tested
R69	332Ko_1%			Tested	N/A	N/A	N/A	Tested
R152	1Mo_1%			Tested	N/A	N/A	N/A	Tested
R153	18.2Ko_1%			Tested	N/A	N/A	N/A	Tested
R161	30.1Ko_1%			Tested	N/A	N/A	N/A	Tested
R162	30.1Ko_1%			Tested	N/A	N/A	N/A	Tested
R163	30.1Ko_1%			Tested	N/A	N/A	N/A	Tested
R174	78.7Ko_1%			Tested	N/A	N/A	N/A	Tested
R175	5.11Ko_1%			Tested	N/A	N/A	N/A	Tested
RV1	MOV-420V			Tested	N/A	N/A	N/A	Tested
U1	NS9544			Tested	N/A	N/A	N/A	Tested
U2	iT4545			Tested	N/A	N/A	N/A	Tested
W1	JUMPER			Tested	N/A	N/A	N/A	Tested
W2	JUMPER			Tested	N/A	N/A	N/A	Tested
W3	JUMPER			Tested	N/A	N/A	N/A	Tested
W4	JUMPER			Tested	N/A	N/A	N/A	Tested
W5	JUMPER			Tested	N/A	N/A	N/A	Tested

Mastering Test Engineering
Section VII: Manager's Summary
Slide 28

Test Coverage Matrix, Slide 6 of 7

Section II: Shorts Test Coverage

CT detects all shorts on this product except for these isolated (and Unused) networks.

U2.5	Adj. Short	U2.4 to U2.5	Untested	Tested	N/A	N/A	Tested
U2.6	Adj. Short	U2.5 to U2.6	Untested	Untested	Untested	Untested	Untested
U2.6	Adj. Short	U2.6 to U2.7	Untested	Untested	Untested	Untested	Untested
U2.13	Adj. Short	U2.12 to U2.13	Untested	Untested	Untested	Untested	Untested
U2.13	Adj. Short	U2.13 to U2.14	Untested	Untested	Untested	Untested	Untested

Section III: Pin Faults (for devices with > 2 pins)

D18 Pin 1	DIODE		Tested	N/A	N/A	N/A	Tested
D18 Pin 2	DIODE		Tested	N/A	N/A	N/A	Tested
D18 Pin 3	DIODE		Tested	N/A	N/A	N/A	Tested
D24 Pin 1	DIODE		Tested	N/A	N/A	N/A	Tested
D24 Pin 2	DIODE		Tested	N/A	N/A	N/A	Tested
D24 Pin 3	DIODE		Tested	N/A	N/A	N/A	Tested
D25 Pin 1	DIODE		Tested	N/A	N/A	N/A	Tested
D25 Pin 2	DIODE		Tested	N/A	N/A	N/A	Tested
D25 Pin 3	DIODE		Tested	N/A	N/A	N/A	Tested
D68 Pin 1	DIODE		Tested	N/A	N/A	N/A	Tested
D68 Pin 2	DIODE		Tested	N/A	N/A	N/A	Tested
D68 Pin 3	DIODE		Tested	N/A	N/A	N/A	Tested
L1 Pin 2	Transformer		Tested	N/A	N/A	N/A	Tested
L1 Pin 4	Transformer		Tested	N/A	N/A	N/A	Tested
L1 Pin 7	Transformer		Tested	N/A	N/A	N/A	Tested
L1 Pin 9	Transformer		Tested	N/A	N/A	N/A	Tested

Test Coverage Matrix, Slide 7 of 7

Q5 Pin Gate	NFET		Tested	N/A	N/A	N/A	Tested
Q5 Pin Source	NFET		Tested	N/A	N/A	N/A	Tested
Q5 Pin Drain	NFET		Tested	N/A	N/A	N/A	Tested
Q6 Pin Gate	NFET		Tested	N/A	N/A	N/A	Tested
Q6 Pin Source	NFET		Tested	N/A	N/A	N/A	Tested
Q6 Pin Drain	NFET		Tested	N/A	N/A	N/A	Tested
U1 Pin 1	NS9544		Tested	N/A	N/A	N/A	Tested
U1 Pin 2	NS9544		Tested	N/A	N/A	N/A	Tested
U1 Pin 3	NS9544		Tested	N/A	N/A	N/A	Tested
U1 Pin 4	NS9544		Untested	Tested	N/A	N/A	Tested
U1 Pin 5	NS9544		Tested	N/A	N/A	N/A	Tested
U1 Pin 6	NS9544		Tested	N/A	N/A	N/A	Tested
U1 Pin 7	NS9544		Tested	N/A	N/A	N/A	Tested
U1 Pin 8	NS9544		Tested	N/A	N/A	N/A	Tested
U2 Pin 1	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 2	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 3	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 4	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 5	iT4545		Untested (No Access)	Untested	Untested	Untested	Non-Essential
U2 Pin 6	iT4545		Untested (No Access)	Untested	Untested	Untested	Non-Essential
U2 Pin 7	iT4545		Untested	Untested	Untested	Untested	Untested
U2 Pin 8	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 9	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 10	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 11	iT4545		Untested	Tested	N/A	N/A	Tested
U2 Pin 12	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 13	iT4545		Untested (No Access)	Untested	Untested	Untested	Non-Essential
U2 Pin 14	iT4545		Tested	N/A	N/A	N/A	Tested
U2 Pin 15	iT4545		Untested	Tested	N/A	N/A	Tested
U2 Pin 16	iT4545		Untested	Tested	N/A	N/A	Tested

Test Coverage Matrix Summary Comments

- ✿ The key is to formulate a way to detect with other means the faults that the test equipment cannot cover. Options are:
 - Enhanced test at ICT, Functional, or Unit testing.
 - AOI.
 - Visual Inspection.
- ✿ Understand that, even if you have 100% test coverage, you will probably still have field failures, mostly because:
 - Customer mistakes in the field (such as ESD damage, putting connectors into wrong slots, or defective units in the field making a PC Board seem defective).
 - Infant mortality in the field.
 - Design errors.