Probe Card Metrology For Mixed Signal Probe Cards

How do I test this probe card with all these #@! relays and components?

By
Rod Schwartz, Daniel Kosecki & Russ Allred
Integrated Technology Corporation
Introduction

- Testing Mixed Signal & Other Types of Cards
- Any Card with Components or Relays
- Definitions & Examples
- Test Methods & Techniques Available Now
- Work-Arounds for Untestable Circuits
- Futures
Definition of Mixed Signal

- Multiple Technologies on One Card
- Many & Varied Components on Card
- May Have Linear, RF, Digital, Etc.
- R, C, L, Networks, Diodes, Active Circuits
- Relays
RF Probe Card – Courtesy Artest
RF Probe Card – Courtesy Artest
Memory Card – Courtesy Agilent
Reasons for Testing Components

- Presence/Absence of Component
- Value of Component
- Circuit may work without it
  - May not work correctly
- Performance may degrade
  - Oscillator at wrong frequency
  - Binning to wrong speed category
  - Filters at wrong frequency
  - Rise time control wrong
Resistor Test

- Series – In series with probe
- Parallel – Between probes (Edges/Pogo’s)
- Value - +/- tolerance
Capacitance Test

- **Parallel** – Between Probes (Edges/Pogo’s)
- **Series** – In series with probe
  - Requires AC measurement techniques
- **Polar** – Applied voltage polarity specified
- **Non-Polar** – Polarity not critical
- **Value** - +/- Tolerance
- **Leakage** – Maximum Limit
- Important to Test Each Component not Equivalent
Relay Functional Test

- Basic operation
- Contacts Open/Close
- Function of associated Components
  - Type
    - Form A N/O
    - Form B N/C
    - Form C
- Flyback Diodes
Relay Parametric Test

- Pull-In/Drop Out Voltage
- Coil Current
- Turn On/Off Times
- Closed Contact Resistance
- Open Contact Leakage
- Intermittent Operation
More Complex Tests

- Resistor Networks
- RC Networks
- Inductors
- Diodes
- Crystals
- Active Devices
  - Digital
  - Linear
Basic Electronic Measurement System
RESISTORS

- Wide range of values
- Milliohms to Megohms
- Kelvin measurements required
- Low values
- Integrity check
- Series & Parallel cases
- Probe to Probe
- Series with probe
- Networks
RESISTOR TEST METHODS

- Low Values
  - FI/MV
  - Kelvin required
- High Values
  - FV/MI
  - Low current measurements
Series Resistor Test
Resistor Network

Primary Test Path

Input Channel 1

Primary Test Path 1

Input Channel 2

R2  4.7K ohm

Input Channel 3

R2  2.0K ohm

Input Channel 4

R4  2.0K ohm

Input Channel 5

R5  4.7K ohm

Input Channel 6

R6  100 ohm

Pad 100

Pad 10

Primary Test Path 2
Resistor Voltage Divider Network

Source Voltage 1

Source Voltage 2

Source Voltage 3

Pad 10

Pad 50

Pad 100

Pad 150

Pad 200

Pad 250

Source GND
CAPACITOR TEST METHODS

- **Charge/Slope Method**
  - Works well for large capacitors
  - Limitations at low values
  - Finds some problems AC will not

- **AC Impedance Method**
  - Works better on small capacitors
  - Easier to compensate for stray capacitance
  - Limitations at high values
  - Correlates with Capacitance Meter
Capacitance Measurement System
Capacitor Calculations

\[ C = \frac{I}{(\Delta V/\Delta T)} \]

Southwest Test Workshop
June 2001

Integrated Technology Corporation
Productivity Solutions For Probe

www.IntTechCorp.com
Capacitance Error Sources

- **Stray Capacitance**
  - Adds to Capacitor Value
  - Multiplexer (Fixed)
  - Wiring (Variable)

- **Leakage**
  - Makes Capacitor Look Larger

- **Series Resistance**
  - Makes Capacitor Look Smaller
  - Kelvin Connection Critical
Cap Measurement Errors

Graph showing voltage over time with different markers:
- START
- STOP
- CHARGE RAMP
- LEAKAGE EFFECT
- Series Resistor
Capacitor Leakage

- Critical parameter
- DC Test
- Makes Capacitor Value Look Higher
- Dielectric Absorption
  - Makes Leakage Hard to Measure
  - Increases Settling Time Considerably
  - Causes Problems with Discharging
Dielectric Absorption

- A measure of the reluctance of a capacitor’s dielectric to discharge completely – usually measured in percent of original charge.
  - Def. – Illinois Capacitor, Inc.
Leakage Test

**Leakage Current:** Capacitors shall be stabilized at the rated temperature for 30 minutes. Rated voltage shall be applied to capacitors for 5 minutes using a steady source of power (such as a regulated power supply) with 1000 ohm resistor connected in series with the capacitor under test to limit the charging current. Leakage current shall then be measured.

At $+25^\circ$C, the leakage current shall not exceed the value listed in the Standard Ratings Table.

At $+85^\circ$C, the leakage current shall not exceed 10 times the value listed in the Standard Ratings Table.

Source: Vishay Sprague Tantalum Capacitors Data Book Pg 23.
CAPACITOR TEST LIMITATIONS

- Background Capacitance
  - Limits low end accuracy

- Leakage
  - Causes errors in value
  - Test Times are Long

- Polar Capacitors
  - Must be properly biased

- Dielectric Absorption
  - Capacitor Exhibits “Memory”
  - Makes Complete Discharging Difficult
  - Looks like leakage
Discharging Capacitors

- Must discharge for other tests
  - Prevent “Pumped-Up” Voltages
  - May Cause Errors in Wire Check
- Damage to probes or tester
  - Arcing at Probe Tips
- Dielectric Absorption
  - May retain residual charge
  - Increases required discharge time
Leakage Versus Time

Cap Leakage in Nano Amps

- **1 mf Cap**
- **1000 mf Cap**

Time in Miliseconds

Leakage in Nano Amps

- **1 mf Capacitor**
- **1000 mf Capacitor**

Southwest Test Workshop  
June 2001
RELAYS

- Connect alternate components
- Change test path
- May be higher voltage than circuit
- Coil shorts to test circuit are BAD!
- Catch diodes required
- Performance may be critical to test
- Functional test mandatory
- Parametric test desirable
- Intermittent function test desirable & Useful
- Relays added to prevent probe damage
RELAY TEST METHODS

- Test associated components or paths
- Test open/closed cases
- Functional test
- Test relay function directly
- Contacts
- Parametric Test
Relay Parametric Tests

- Coil resistance
- Coil current
- Catch diode presence
- Pull-In/Drop-Out Voltage
- Contact resistance
- Turn-On/Turn-Off Times
Relay MUX - One Channel
Relay MUX
Relay MUX - Logic Driver
Logic Drive - Probilt™ MUX
Logic Drive - Probilt™ MUX
Futures

- More Complex Component Networks
  - New Programming Techniques
- Logic & Linear IC’s on Probe Card
  - New Programming Techniques
  - Multiple Supply Voltages
  - “Full” Logic Testing
- Ultra Low Leakage
Acknowledgements

- Rex Lewis, TI
- Ali Jafari, Agilent
- Jerry Pilkay, Artest
- Nick Sporck, Form Factor