Probe Card Metrology For Mixed Signal Probe Cards

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

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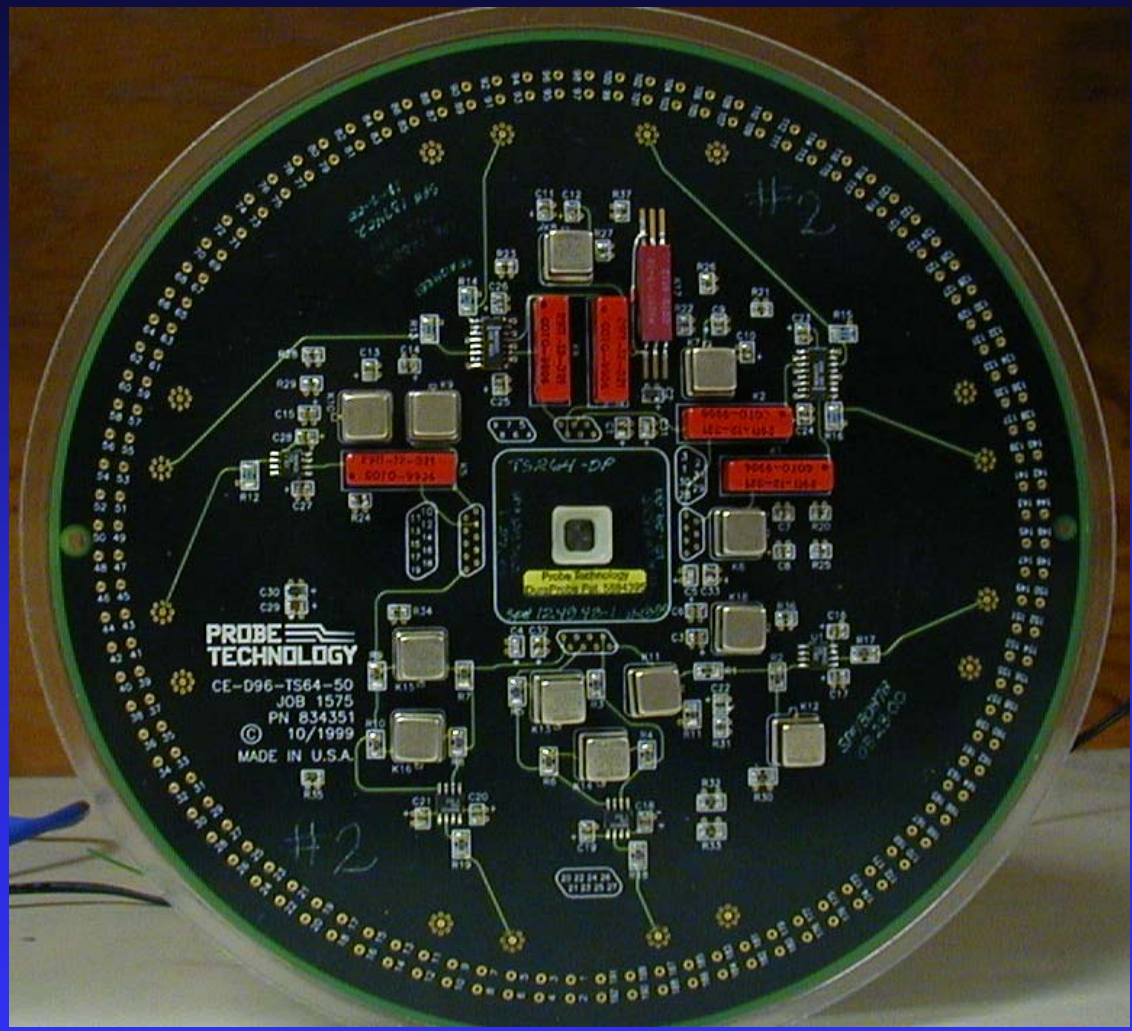
Introduction

- 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

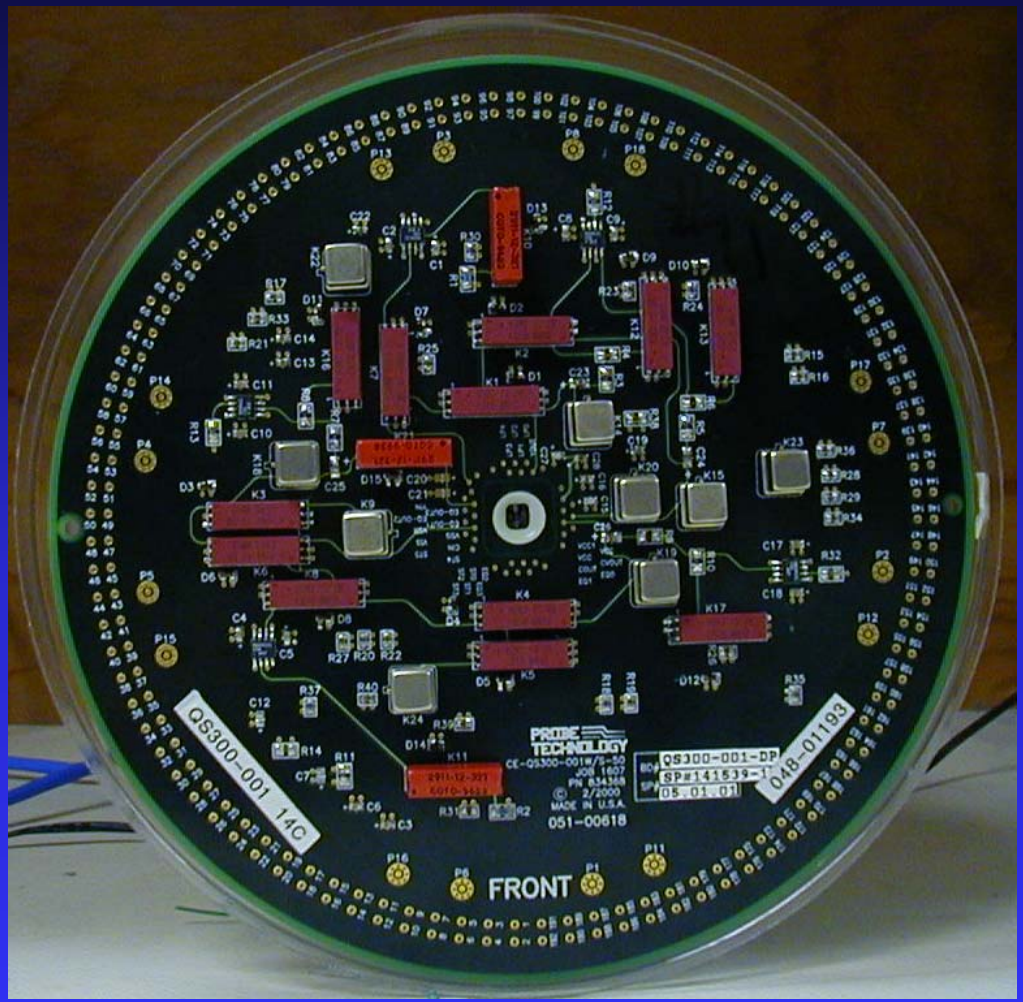
Definition of Mixed Signal

- Multiple Technologies on One Card
- Many & Varied Components on Card
- May Have Linear, RF, Digital, Etc.
- R, C, L, Networks, Diodes, Active Circuits
- Relays

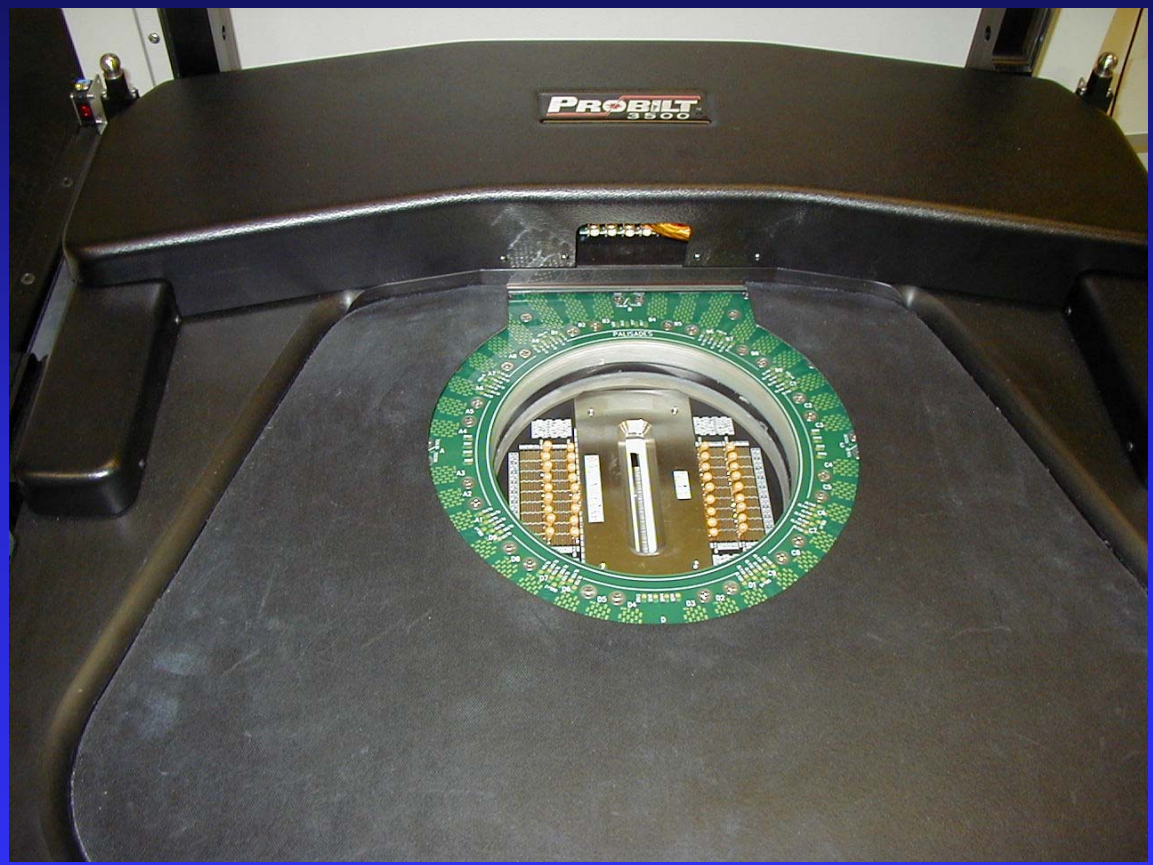
RF Probe Card – Courtesy Artest



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

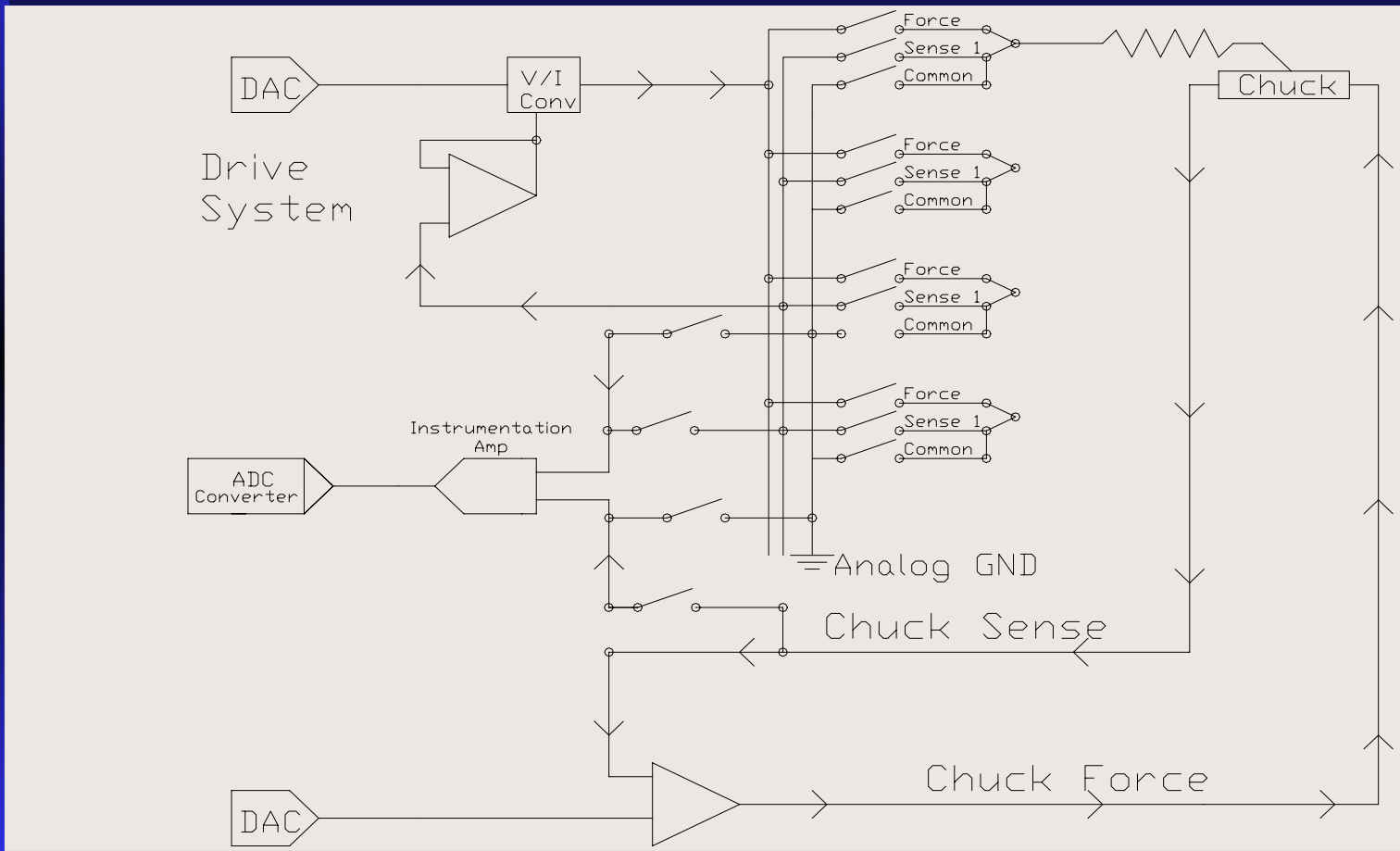
Relay Parametric Test

- 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



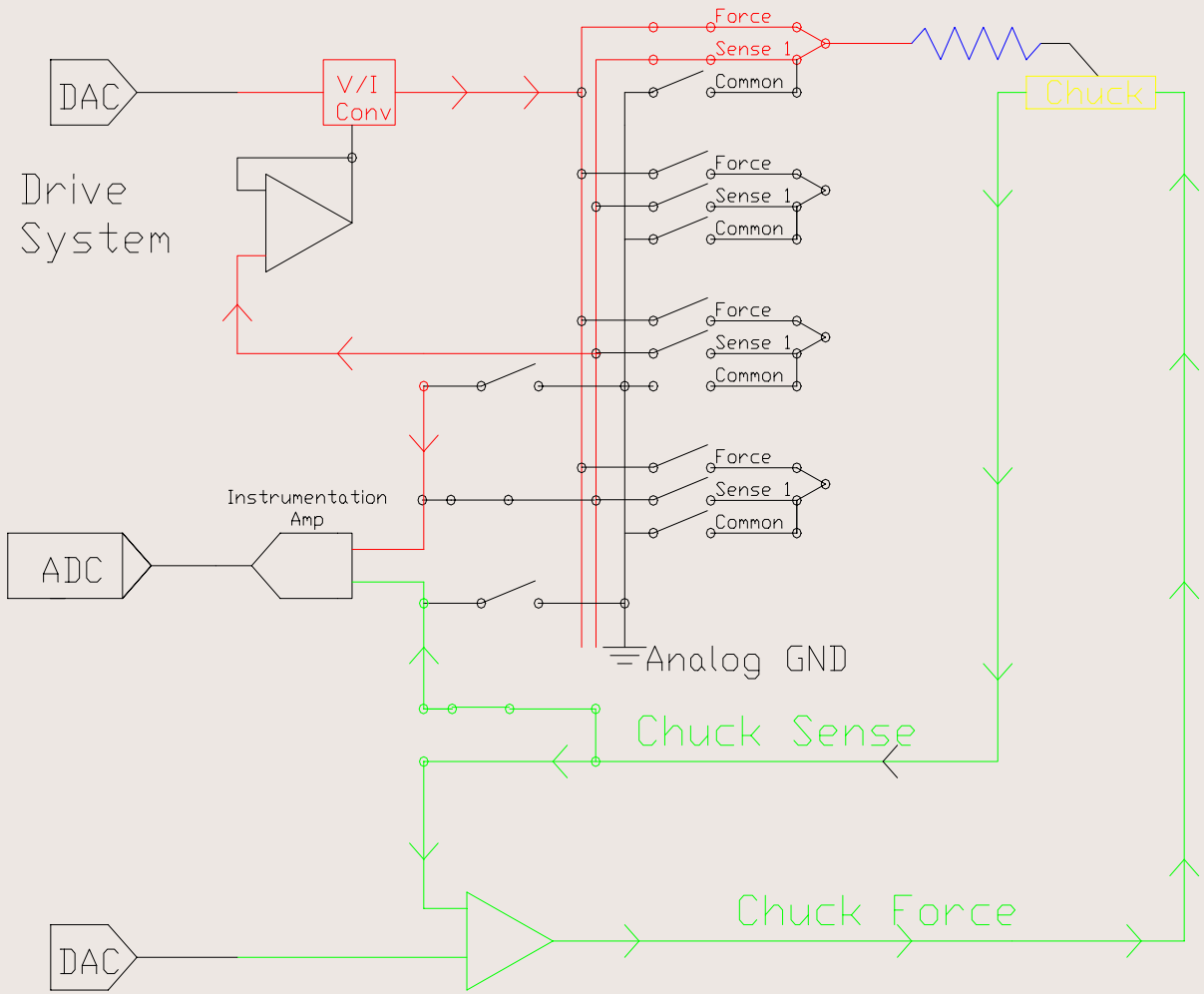
RESISTORS

- 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

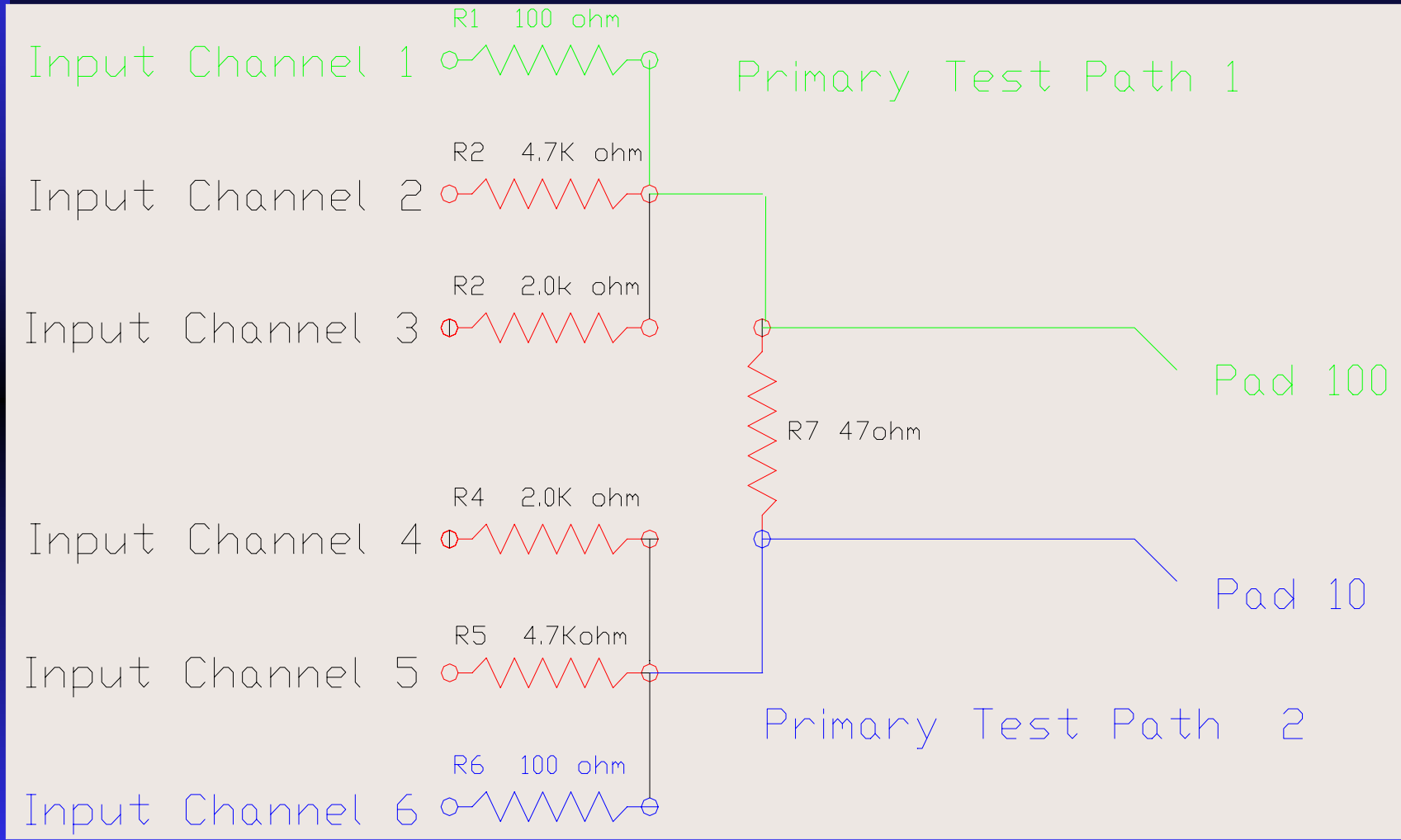
- Low Values
  - FI/MV
  - Kelvin required
- High Values
  - FV/MI
  - Low current measurements

Series Resistor Test

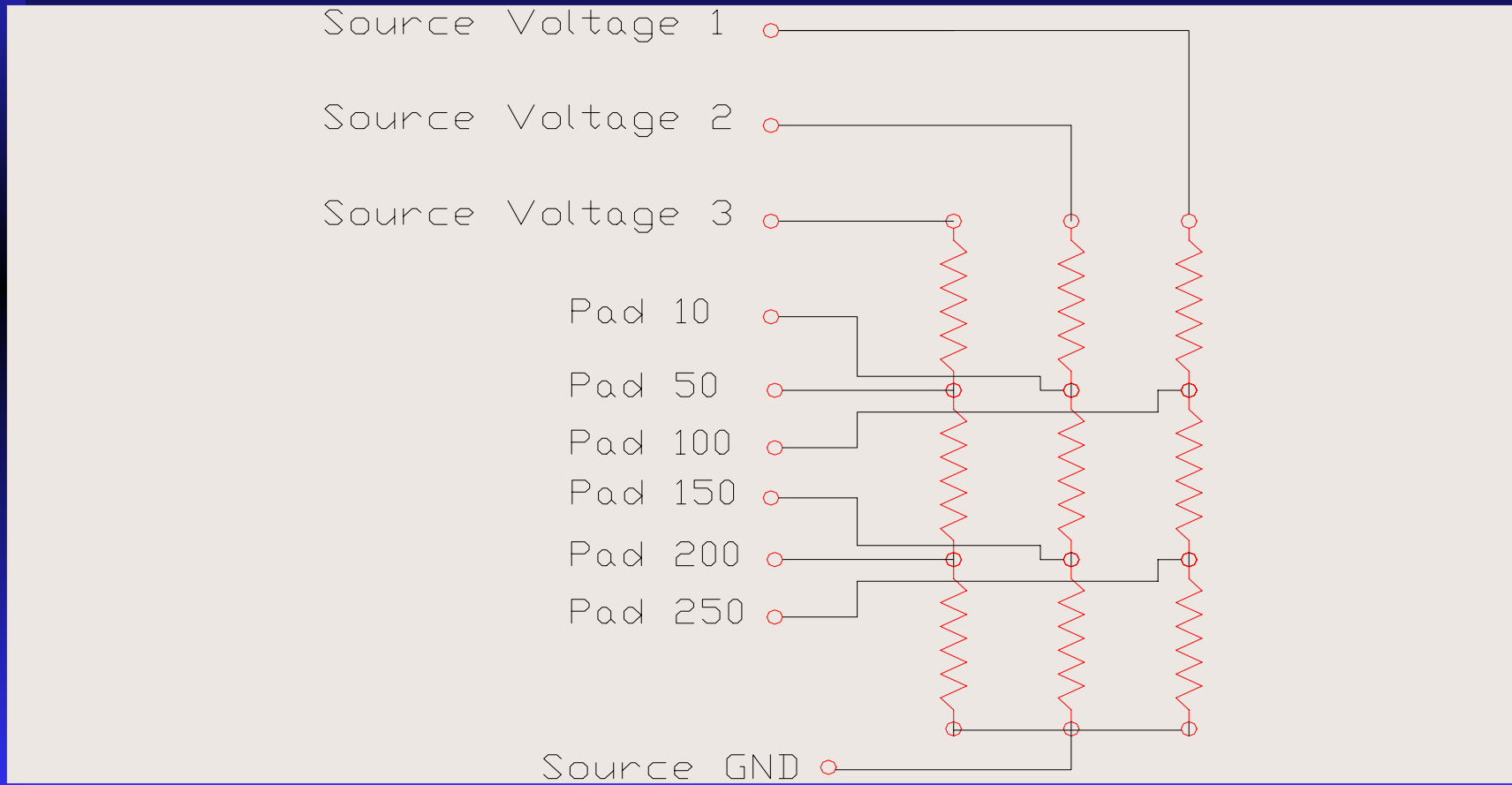


Resistor Network

Primary Test Path



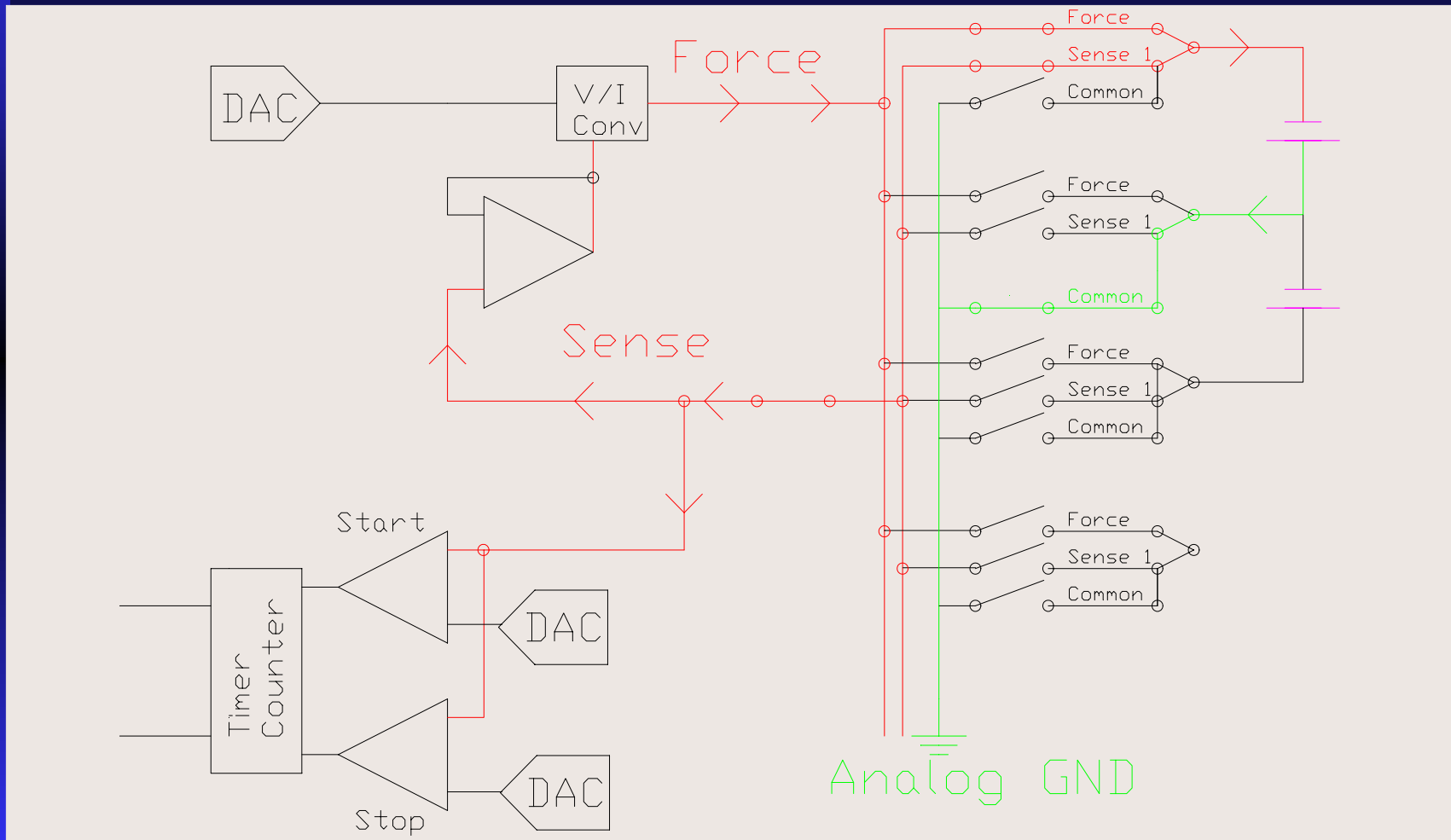
Resistor Voltage Divider Network



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



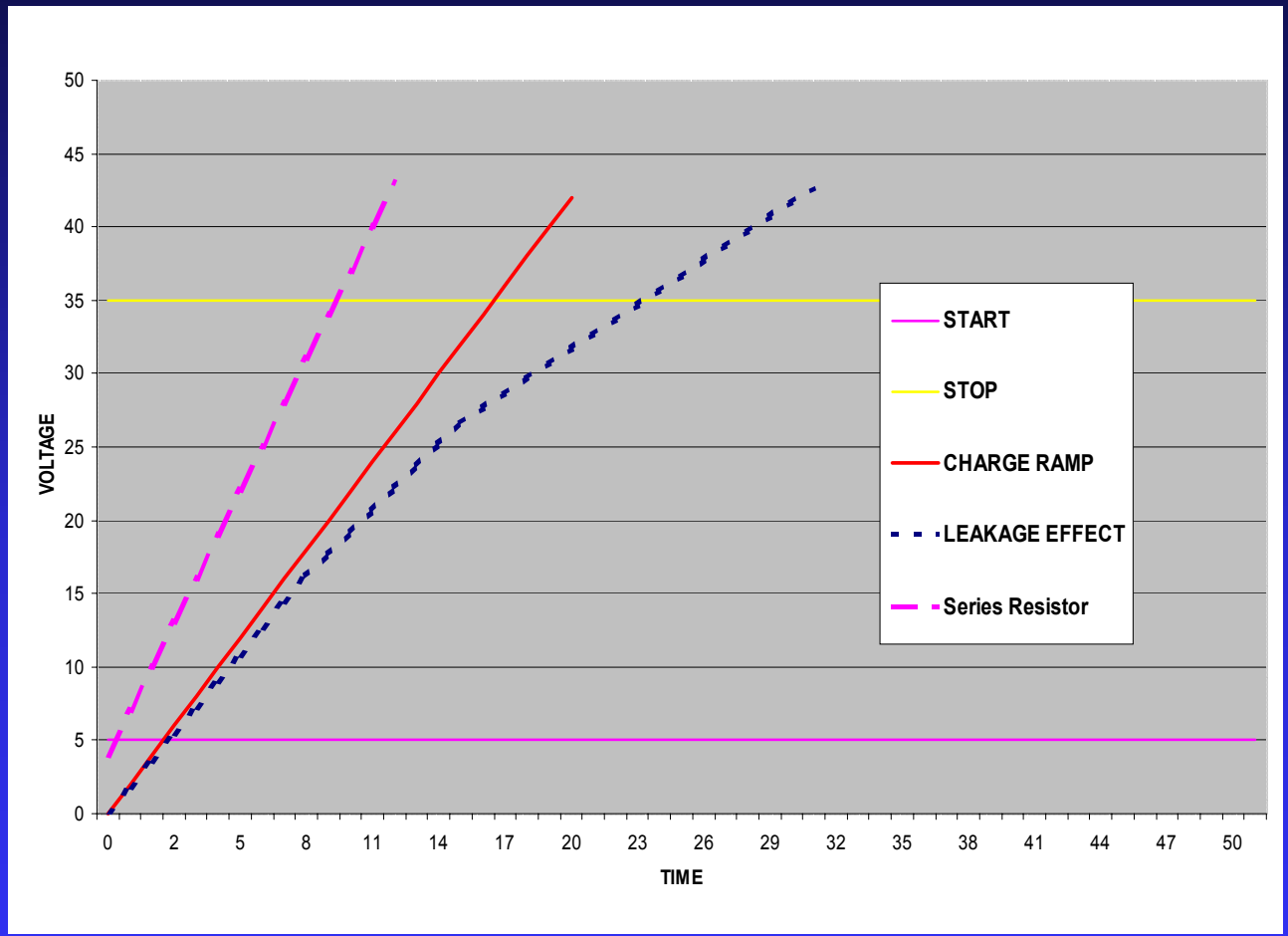
Capacitor Calculations

$$C = I / (\Delta V / \Delta T)$$

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



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 Absoption

- 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°C, the leakage current shall not exceed the value listed in the Standard Ratings Table.

At + 85°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.

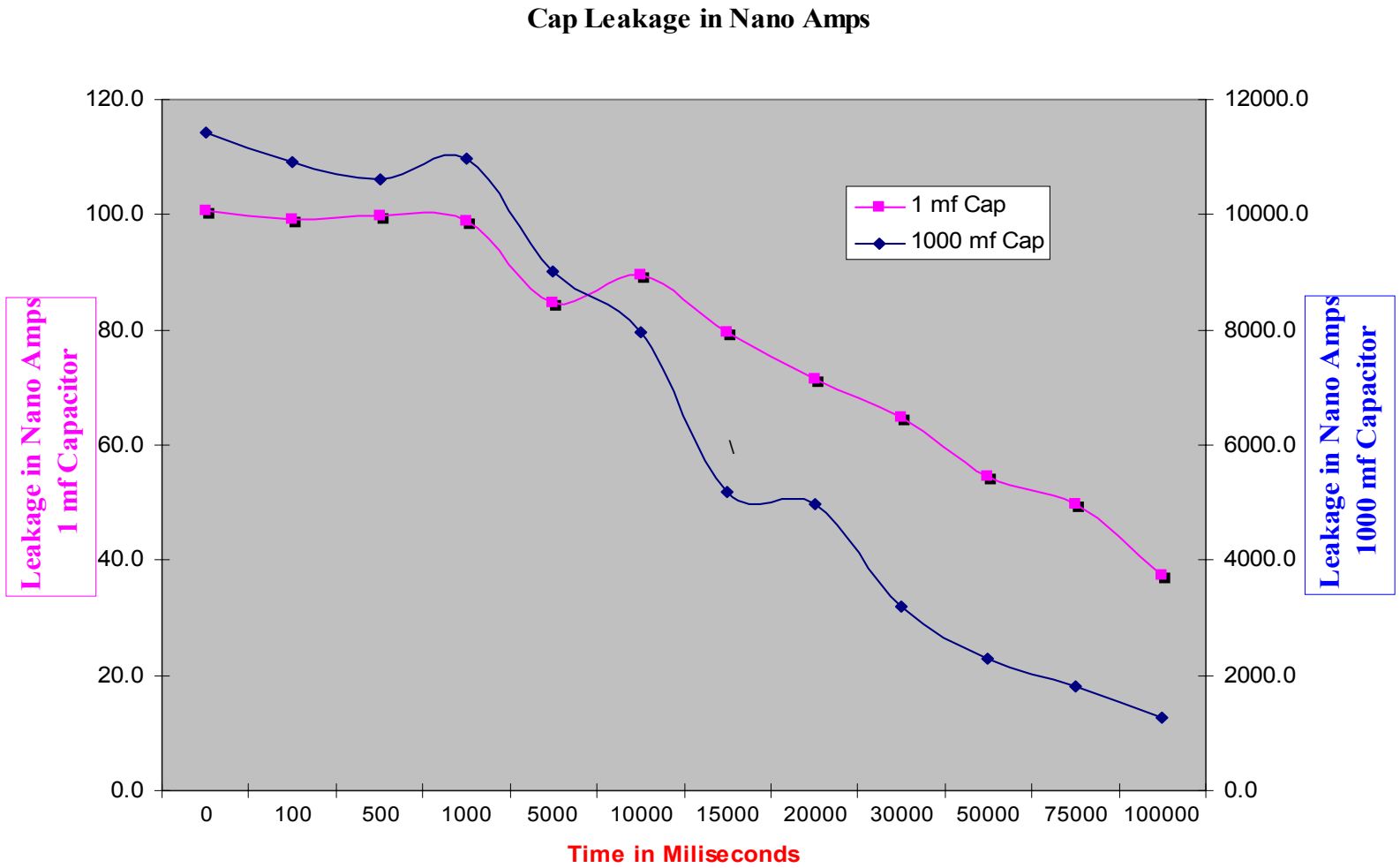
CAPACITOR TEST LIMITATIONS

- 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



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

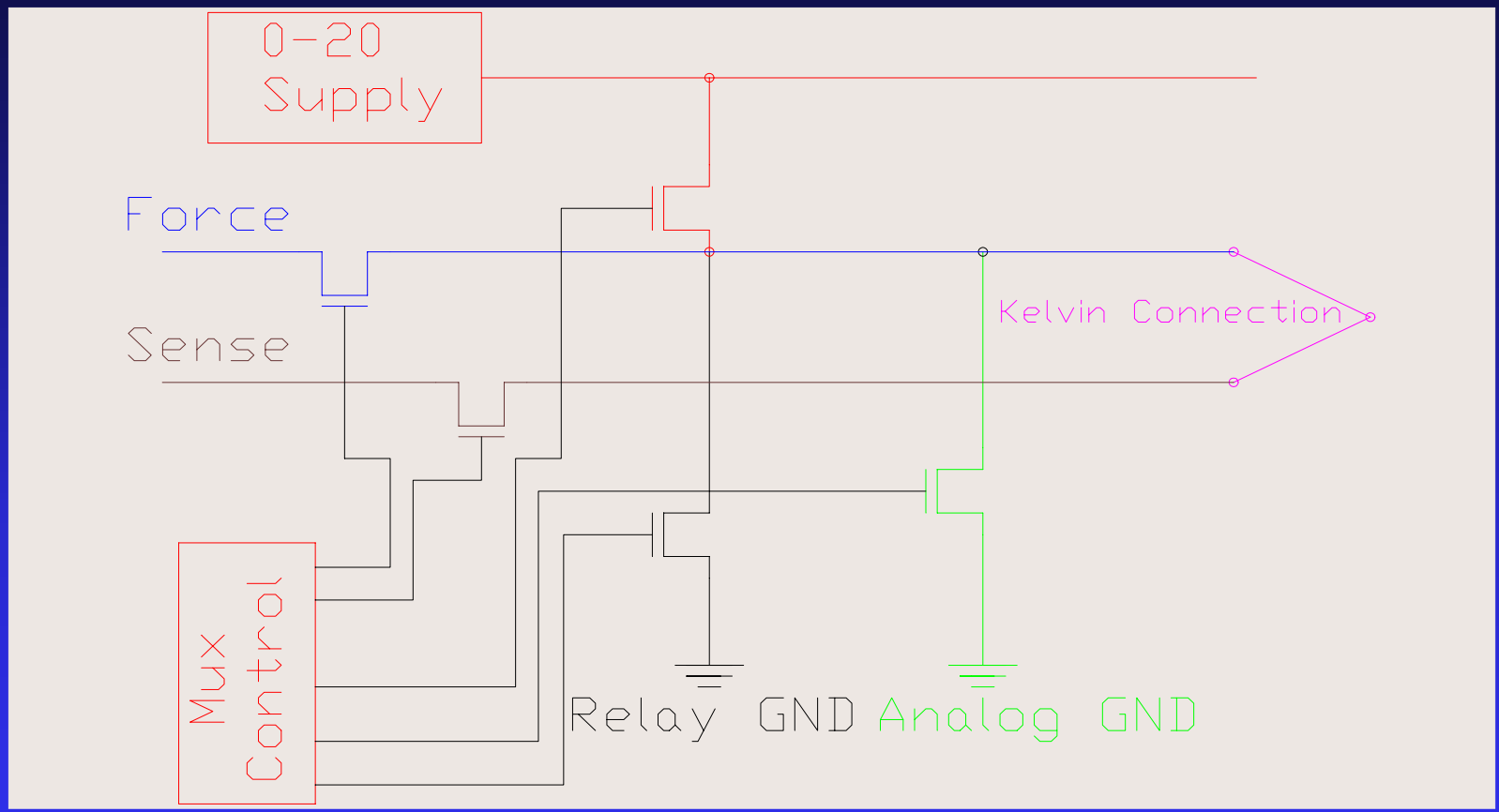
RELAY TEST METHODS

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

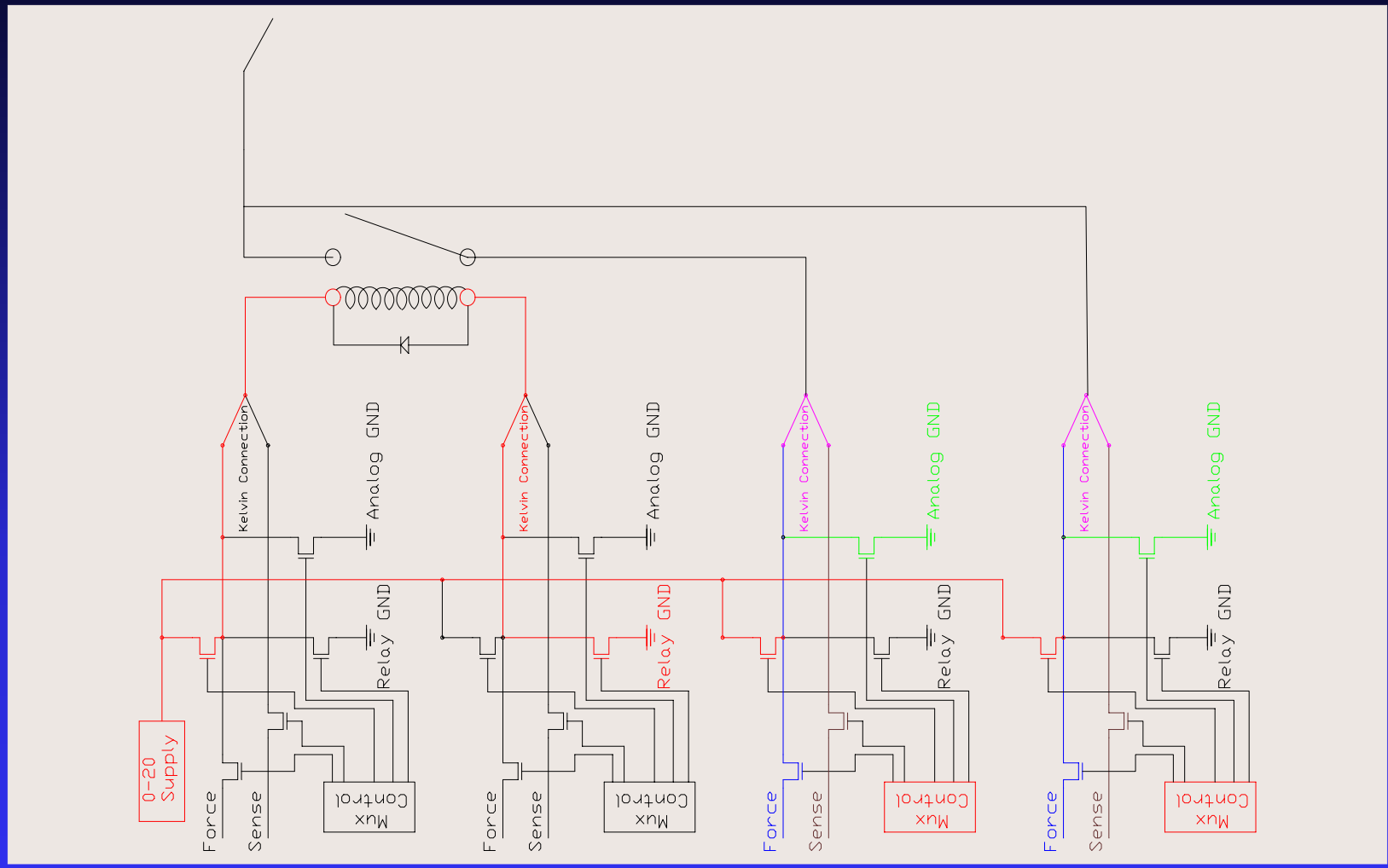
Relay Parametric Tests

- Coil resistance
- Coil current
- Catch diode presence
- Pull-In/Drop-Out Voltage
- Contact resistance
- Turn-On/Turn-Off Times

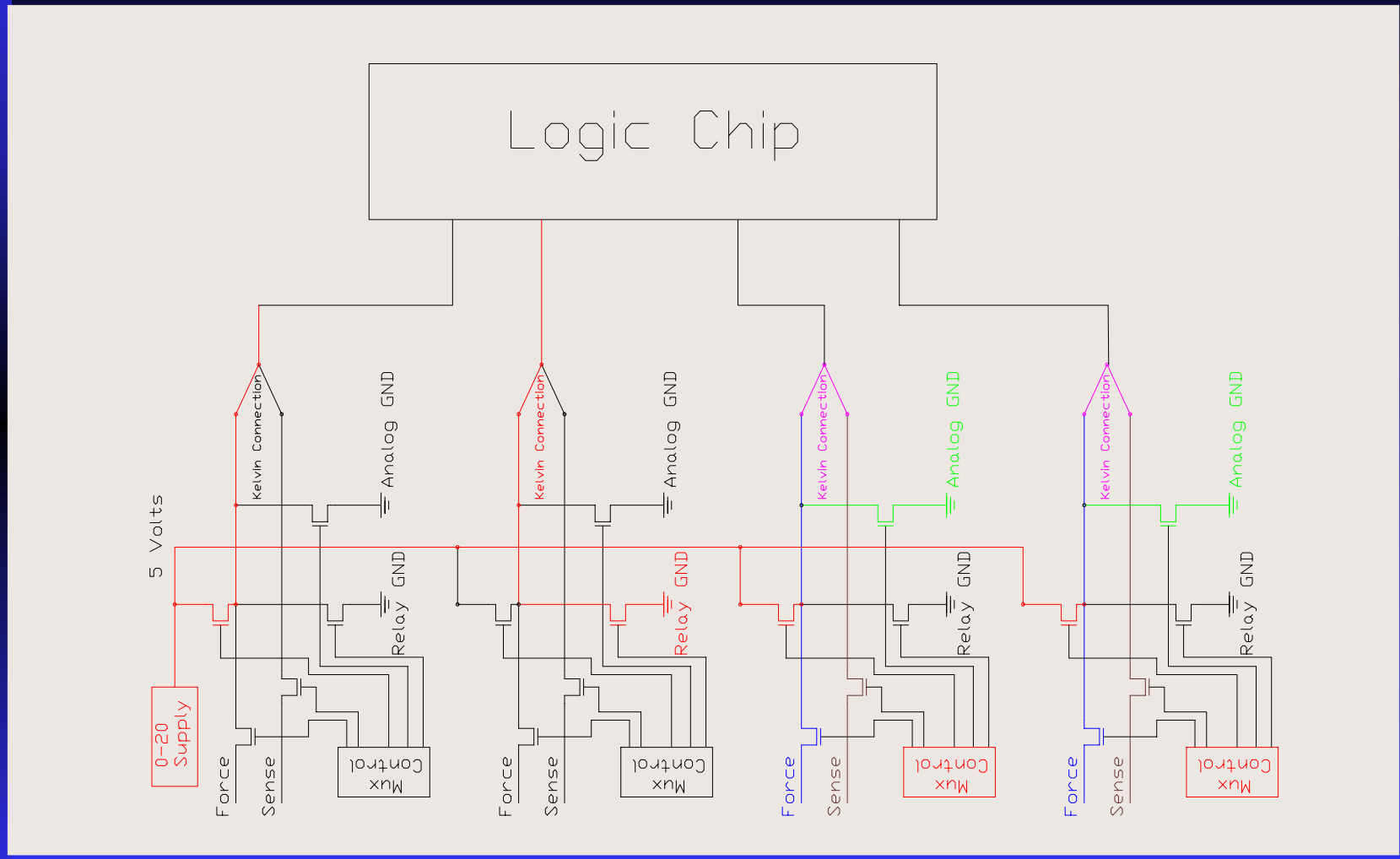
Relay MUX - One Channel



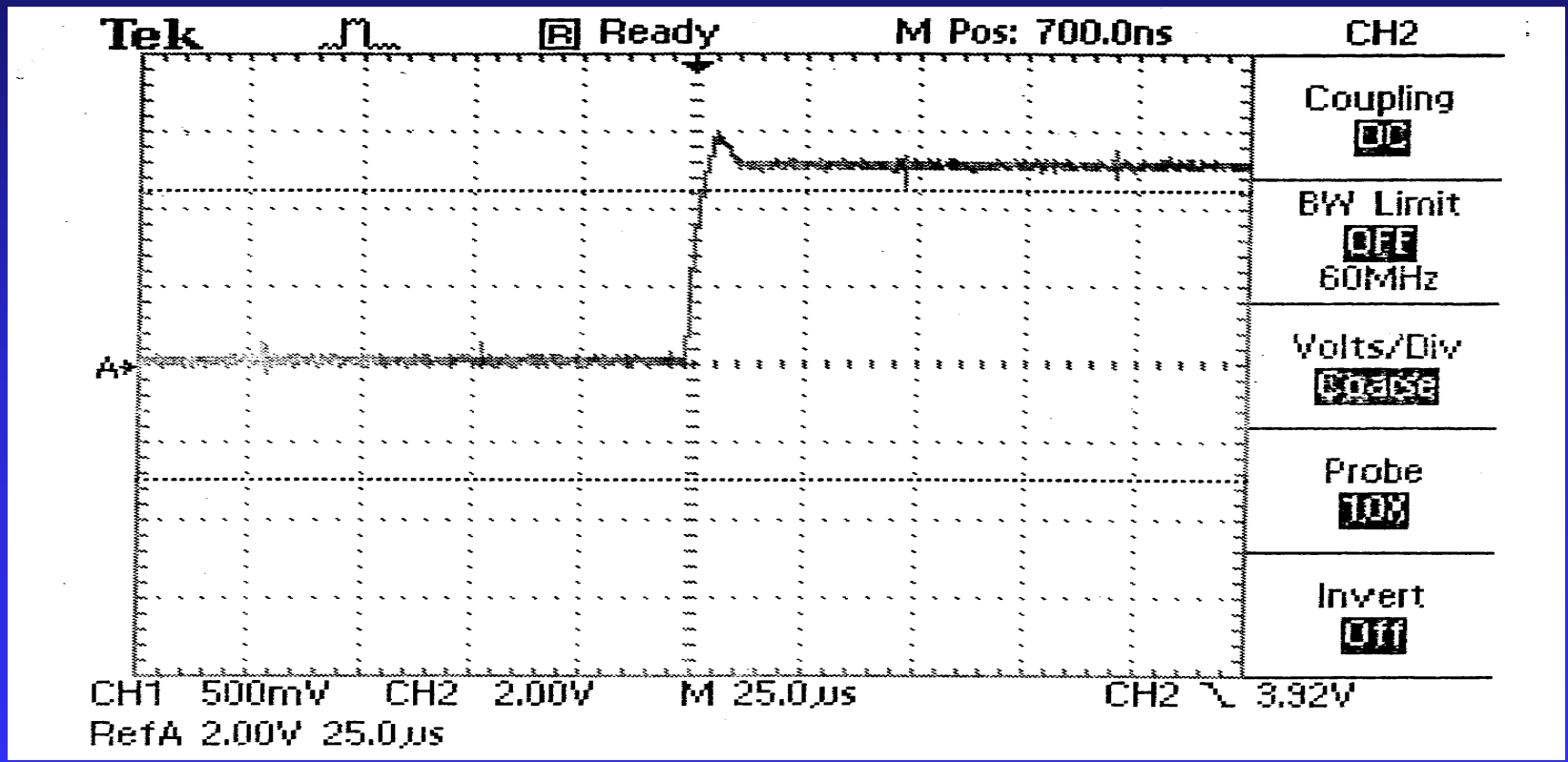
Relay MUX


Kelvin Connection
Analog GND
Relay GND
0-20 Supply
Force
Sense
Mux Control

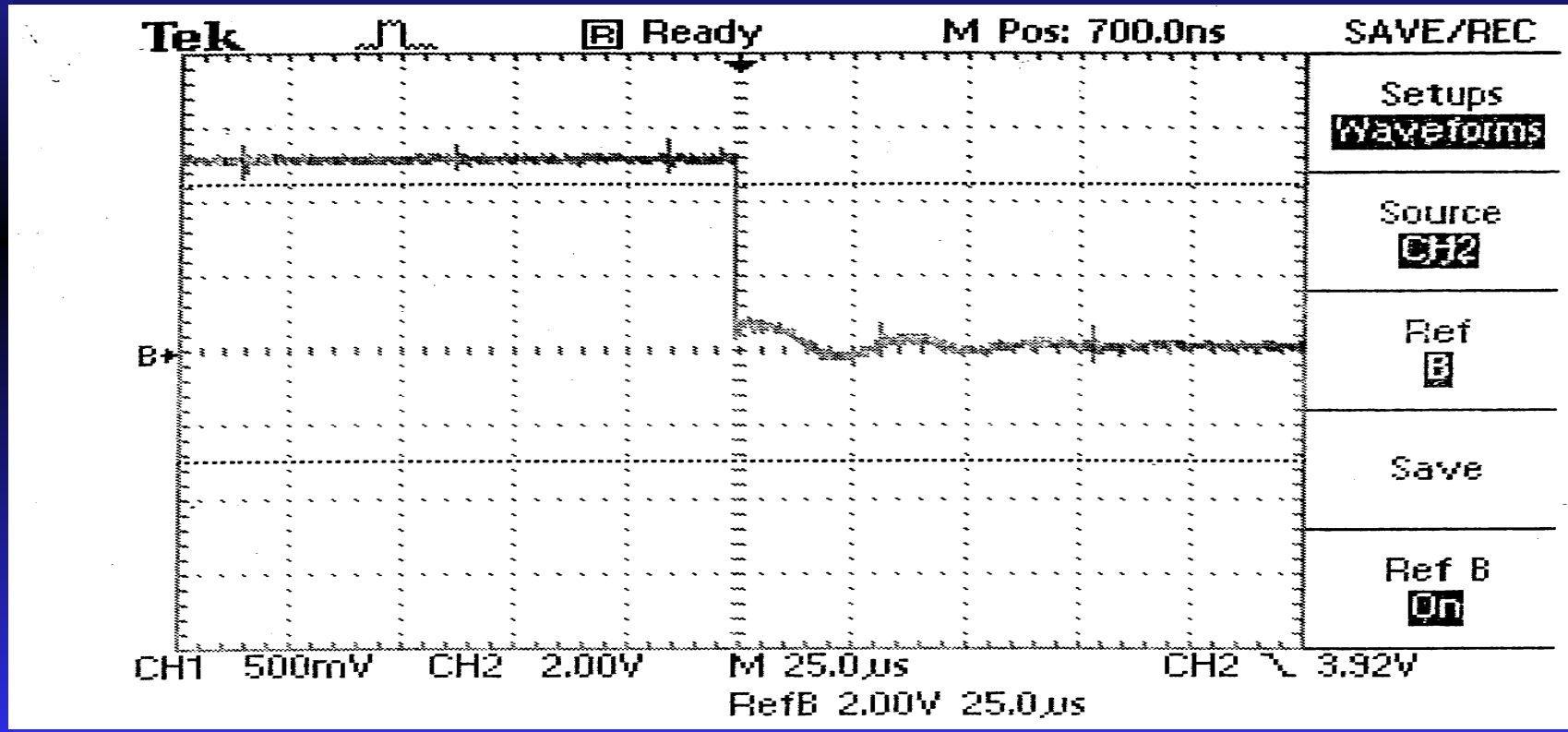
Relay MUX - Logic Driver



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

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