12 hour IC Characterization with a PXIe-2738 Matrix Switch Card

Matthew Beach
Texas Instruments
m-beach@ti.com
Outline

- Introduction
- Hardware
- Software
- Data Analysis
- Conclusion
- Acknowledgements
- Questions
Problem Statement / Introduction

- Validation of new silicon takes too long!

- Automation speeds up the measurements
  - Allows for many more conditions
  - Does not help speed up setup

- Need to automate the setup!
  - Relay matrix card allows the setup to change programmatically
  - Can connect any instrument to any DUT pin
  - Allows for consistent and repeatable measurements
  - Eliminates incorrect setups
PGA460 Ultrasonic Sensor Signal Conditioner

- **Application**
  - Ultrasonic Radar
  - Automotive Park Assist
  - Lane Departure and Collision Warning
  - Object distance and position
  - Presence and proximity Detection

- **Features**
  - Single Transceiver or Transmitter/Receiver pair operation
  - Dual NMOS Low side Drivers with Configurable Current Limit
  - Differential Low noise Echo Amplifier provides programmable gain up to 90dB
  - 12-bit Analog to Digital Converter
  - System Diagnostics Input
  - Integrated State Machine with EEPROM
  - Programmable Threshold / Time settings
  - Integrated Temperature sense
  - One Wire Time Command Interface
  - One Wire UART Interface
  - Fast TTL Level USART Interface
  - AEC-Q100 Qualified
Solution

- PXIe-2738 Matrix Switch card
  - 8x32 (2-wire) matrix configuration with Kelvin connections
  - Up to 100V and 2A
  - Allows any instrument to connect to any DUT pin
- Other matrix configurations available
  - 4x64, 16x16, 4x136, etc.
  - Can combine multiple cards to create custom configurations
- Multiple cabling options
  - 160 pin DIN connector
  - 4 D_SUB connectors
  - Bare wire connector
Connect any DUT pin to any instrument

- 8x32 card allows for 8 buses and 32 DUT pins/instruments
PGA460 Evaluation board

- Board can be used for automation or not
  - Has banana jacks to connect all instruments to relay matrix
  - All DUT pins are hard wired into matrix
    - DUT pins also have banana jacks and test points for non-automated setups
Software Implementation

- Code runs on National Instruments TestStand
  - Ability to loop parameters
    - VPWR levels
    - Temperatures
    - Which DUT blocks are tested (output drivers, ADC, temp sensor, etc.)
    - Additional “Quick_Run” setting for debug
      - Skips long loops for quicker debugging
    - Different parameters inside some blocks
      - Extra temperatures for Temp Sensor
      - Load conditions for LDO’s
      - Voltage settings for IOREG block
      - etc.
Switch control

- Simple VI’s were written to control matrix
  - Three different VI’s are called in TestStand
    - Open all relays
    - Connect an array of pins/instruments to any row
    - Disconnect an array of pins/instruments to any row
      - Checks to make sure switch not already open/closed
  - ENUM is used to name the DUT pins and instruments
Analysis of data

- Data logging stores data in database
  - Save data in csv file and import into analysis template
    - Can quickly review data
  - Data is also imported into spec database for compliance
Switch control Update

- Relays are not evenly used
  - Vary from <100 to >5000 uses
    - 100M cycles mechanical
    - 500k cycles at 30V/1A
    - Still well below expected end of life

Expected mechanical relay life.......................... $1 \times 10^8$ cycles

Expected electrical relay life
- $\leq 30 \text{ mV, } \leq 10 \text{ mA}$ resistive.......................... $2.5 \times 10^6$ cycles
- 30 V, 1 A..................................................... $5 \times 10^5$ cycles
- 30 V, 2 A..................................................... $1 \times 10^5$ cycles
- 60 VDC, 1 ADC resistive................................. $1 \times 10^5$ cycles

Note Relays are field replaceable. Refer to the NI Switches Help at ni.com/manuals for more information about replacing a failed relay.
Random variable from 0 to 7 created at beginning of each test execution
- Variable added to existing row choice
- Will make sure each column now has even number of uses across each row
- To even out column use will need to be done through different projects

Row variable is a random integer from 0 to 7. A new value is assigned at the beginning of each test execution.

Instrument handle

Column

Relay needs to be closed
Conclusion

- 94% of planned tests completed with full automation
  - Coverage in still increasing
  - Latest silicon evaluation completed in <24 hours
    - Tested across three VPWR levels and three temperature settings
- Reduces cost
  - Eliminates purchasing of additional equipment
  - Can now mux the same piece of equipment to multiple pins
- Reduces time to evaluate new parts
  - Do not have to manually move instruments to different pins
  - Testing continues to run at night
- Allows for remote debug and development
  - Can modify the setup programmatically
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Before you go, take the survey.
Questions?

Matt Beach
Texas Instruments
m-beach@ti.com