Overview

• Review
  – Motivation
  – System Specification & Features
  – System Hardware
• Current Status
• Challenges & Solutions
• Future Work
# Motivation

<table>
<thead>
<tr>
<th></th>
<th>Turnkey</th>
<th>In-house</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timeline</strong></td>
<td>Purchase lead time</td>
<td>On-going</td>
</tr>
<tr>
<td><strong>System</strong></td>
<td>Proven/Widely-used</td>
<td>Custom design</td>
</tr>
</tbody>
</table>
| **Objective**  | Predict life expectancy          | Research
determine failure mechanisms |
| **Test Types** | Life Test/Burn-in                | Flexible                            |
| DC Drain Gate  | 0-100V, up to 4A, 400W max       | 0-60V, up to 6A, 300W max           |
|                | ±18.5V, up to 200mA              | ±10V, up to 20mA                    |
| RF             | 600MHz-3 GHz                      | 900MHz-10GHz                        |
|                | 2-18 GHz                          | 36-40 GHz                           |
|                | 58-60 GHz                         | 76-78 GHz                           |
| Temperature    | 50º to 250º C                     | 25º to 150º C                       |
| Optical        | NA                               | Research with wavelength and intensity |
| Thermal Imaging| NA                               | IR, Micro Raman additional hardware |
| Pulse          | 1-100kHz                         | 1-100kHz+                           |
| Data Storage   | Independent test files           | SQL database                        |
Review

System Specifications & Features

- 16 Device Capacity
  - Individual device control
    - Gate bias
      - ±10Vdc up to 20mA
      - 0-60Vdc, 6A max, 300W max
    - Drain bias
      - 0-60Vdc, 6A max, 300W max
      - Over-current & over-voltage protection
    - Temperature
      - 25-150° C Peltier heating
      - PID control
  - Controlled in groups of 4
Review

System Specifications & Features

- Long-term DC Stress
  - Types
    - Stress-recovery
    - Step-stress-recovery
    - Step-stress
  - Device Characteristics
    - IV curve
    - Transfer curve, $V_T$
- Gate Pulse Test (Gate Lag)
- RF Stress
  - 2 GHz
System Hardware

Gate Bias
NI 9224 analog output
±10 Vdc @ 20 mA

Source Drain Bias
Programmable DC Power Supply
60Vdc @ 3.5A

RF
Bias & Control

Z_load
Review

System Hardware

Gate $V_G$ & $I_G$
NI 9205 Analog Input
16 bit ±10V

Coupler diode detector

Power In
NI 9205 Analog Input
16 bit ±10V

Data Acquisition

$P_{\text{rev}}$ 0-5Vdc
$P_{\text{forward}}$ 0-5Vdc

Drain $V_D$
NI 9401 Analog Input
12 bit ±60V

Drain $I_D$
Current Shunt Monitor 20V/V
NI 9205 Analog Input
16 bit ±10V

Attenuator (30 dBm)

Z$_{\text{load}}$

Power Out
NI 9205 Analog Input
16 bit ±10V

$P_{\text{out}}$ 0-5Vdc
Review

System Hardware

Temperature Measurement and Control

http://www.ovenind.com
Current Status

- 8 functional channels
  - Control application is scalable by groups of four
    - Multiple instances of application to control four channels
    - Allows for independent testing
  - Assemble boards to reach full capacity
- DC test
  - Step/Stress/Recovery
  - IV & Transfer characterization
- Sequencing
  - Hardcoded 5 levels
Challenges & Solutions

Oscillations

Dev119
Reticle C
Vg=2

Gate
2.4V_{pp}
5V_{rms}

Drain
6.9V_{pp}

Id
Vd

A 21st Century Approach to Reliability
Challenges & Solutions

**CLEAN DC**

- R = 100
- C = 0.011111 μF
- f = 143 kHz

Vg: -3 to -2
Future Work

Gate Stress Bias & Control

http://www.testequipmentdepot.com/instek/powersupplies/PSMSeries.htm

A 21st Century Approach to Reliability
## Future Work

### Specialized Channels

<table>
<thead>
<tr>
<th>Control Software</th>
<th>Channels</th>
<th>Features</th>
</tr>
</thead>
</table>
| 1                | 1-4      | $V_D$: 0 to 60V  
                |          |  
                |          | $V_G$: ±10V  
                |          |  
                |          | Pulse: 1kHz |
| 2                | 5-8      | $V_D$: 0 to 60V  
                |          |  
                |          | $V_G$: ±10V  
                |          |  
                |          | Pulse: 1kHz |
| 3                | 9-10     | $V_D$: 0 to 60V  
                |          |  
                |          | $V_G$: -60 to 0V  
                |          |  
                |          | Pulse: 1MHz  
                |          |  
                |          | Precision measurement |
| 4                | 13-16    | $V_D$: 0 to 60V  
                |          |  
                |          | $V_G$: ±10V  
                |          |  
                |          | Pulse: 1kHz  
                |          |  
                |          | Precision measurement |
Future Work

• Gate Control with a second power supply
  – Precise multi-range gate current measurement

• Constant drain current testing
  – Feedback on bias voltages
  – Feedback loop Temperature & Power
  – Feedback loop $I_D$ to $V_G$

• Measure $R_D$, $R_S$

• Sequencing