Rambus

Silicon Valley TEST Conference & Expo San Jose Nov. 8-9, 2010 www.svtest.com

LabStation™: A Low Cost, Scalable, High Throughput Characterization Environment

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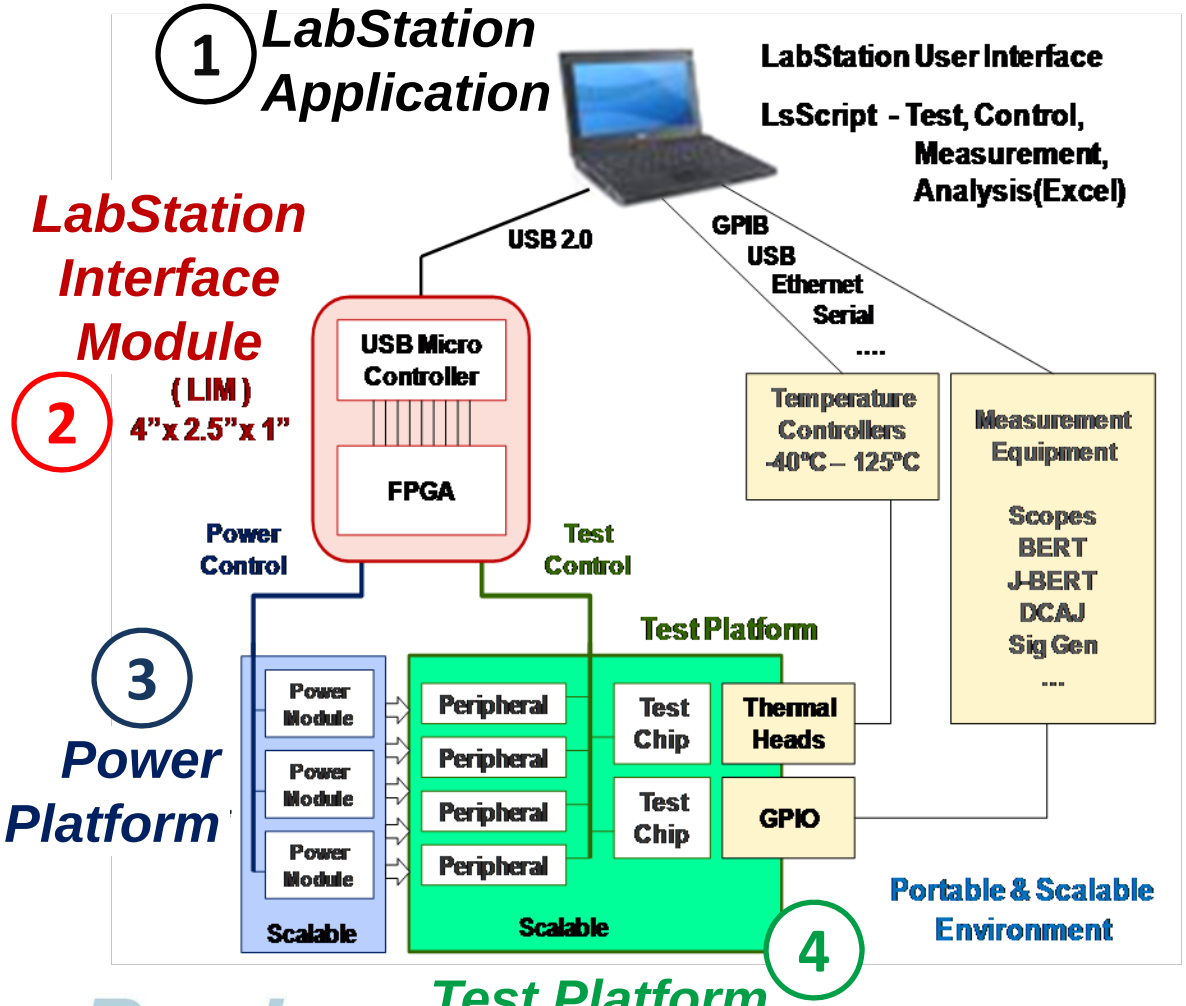
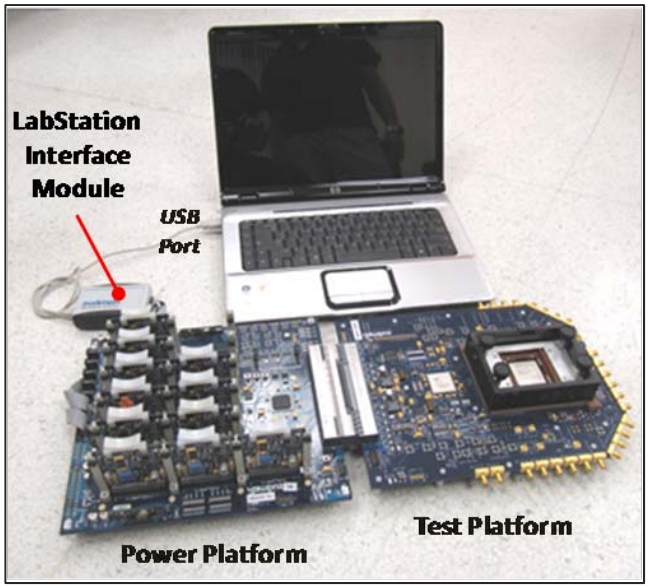
Outline of Presentation

- Overview of LabStation environment
- Architecture of the interfaces for controlling test chip and system-under-test
- Architecture of LabStation software
- Flexibility and configurability of hardware
- Illustrations of high throughput capability

LabStation Characterization Environment



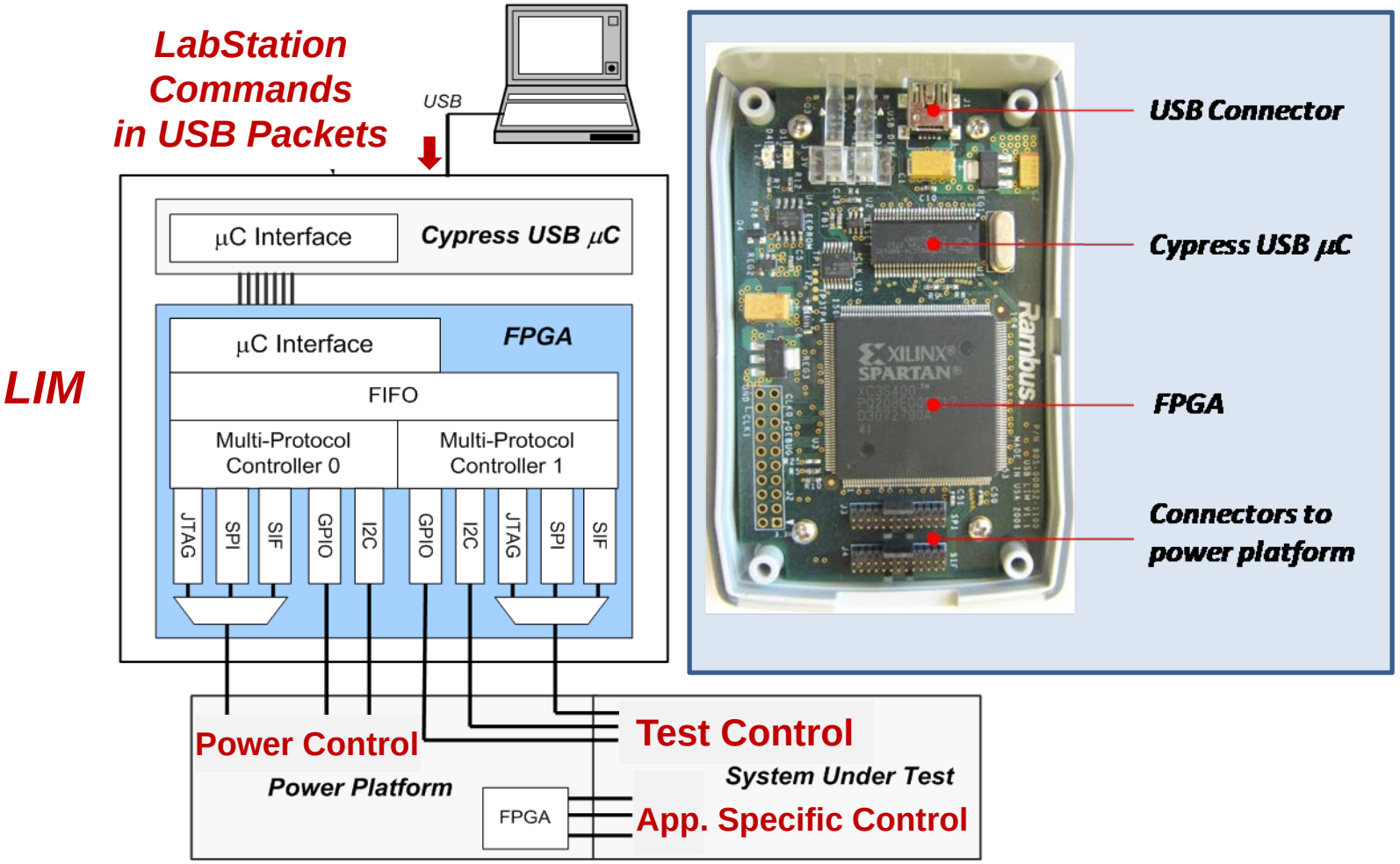


LabStation Characterization Environment

- Common environment for ***testing systems with different IO cells*** (e.g. DDR2, DDR3, XDR™, Mobile XDR™ & SERDES)
- Adaptation through software update without redesign
- Flexible and reusable hardware
- Ease of transport for worldwide deployment
- Supports development, characterization & production
- Shorten time-to-market
- Proven successful (PS3, HDTV, Projector)

LabStation Interface Module

Test Command Translator



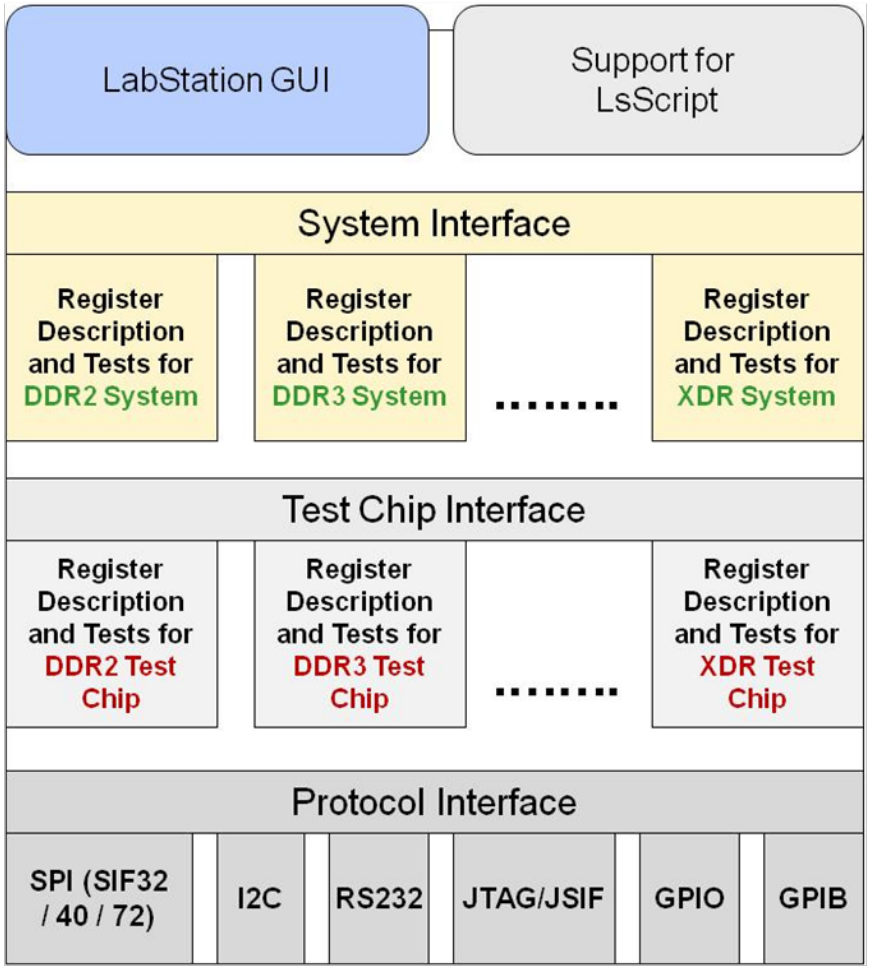
Architecture of LabStation Application Software

LabStation Software Runs On Host Computer

Updated to include new test board

Updated to include new test chips

Updated to include new HW protocol



All layers of LabStation software are flexible and configurable

Characterization Environment highly adaptable for testing different IO cell technologies

Examples of Components Supported by LabStation

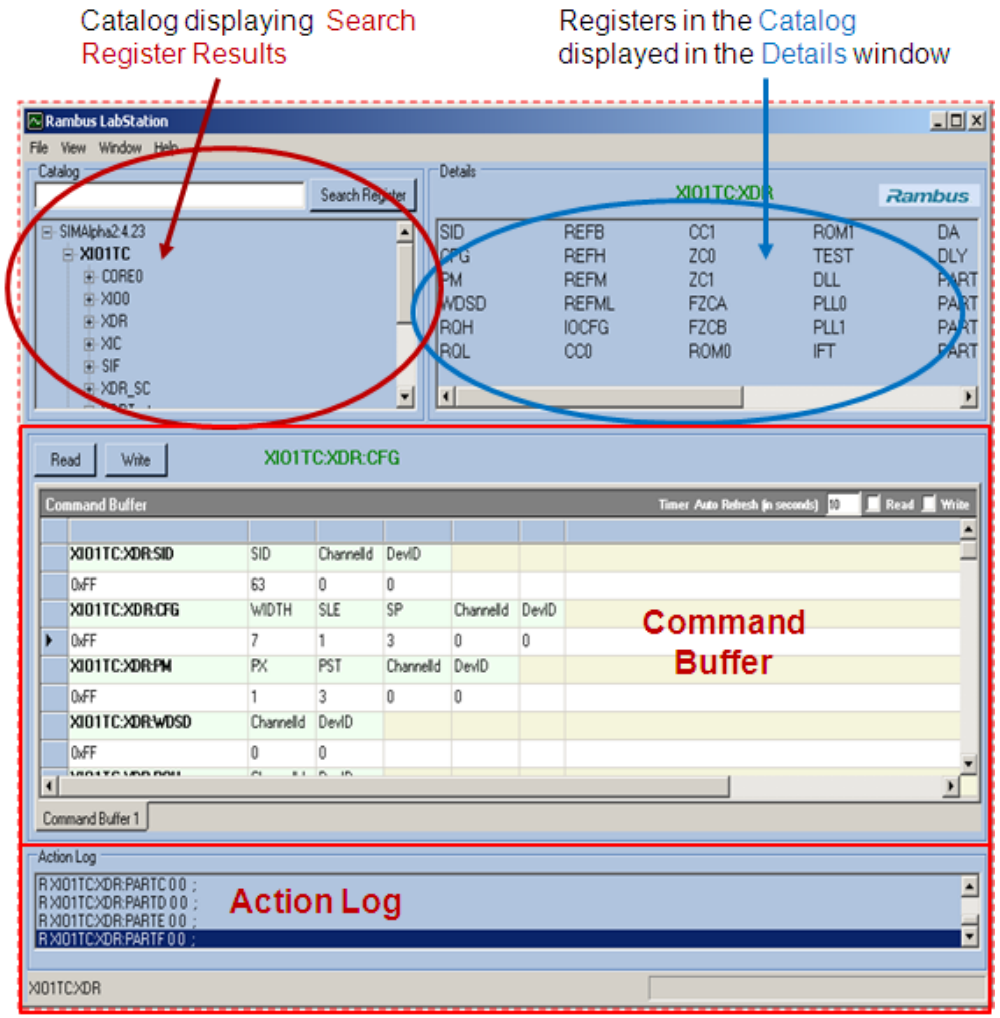
ADCs
DACs
Temperature Sensors
Clock Generators
Digital Pots
EEPROMs
Real Time Clocks
..
..

ADT7301	Temp Sensor	Analog Devices	MAX1153	Temp Sensor	MAXIM
AD5231	Digital Pot	Analog Devices	MAX1240	ADC	MAXIM
AD5235	Digital Pot	Analog Devices	MAX1286	ADC	MAXIM
Ad7416-18	Temp Sensor	Analog Devices	MAX4691	MUX	MAXIM
AD7814	Temp Sensor	Analog Devices	MAX5122	DAC	MAXIM
ADS7817	ADC	Texas Instrument	MAX5171	DAC	MAXIM
ADT7461	Temp Sensor	Analog Devices	MAX6642	Temp Sensor	MAXIM
ADT7467	Temp Sensor	Analog Devices	MAX6957	LED Display	MAXIM
AT34C02B	EEPROM	ATMEL	MCP23008	IO Expander	MicroChip
AT25128	EEPROM	ATMEL	MCP23016	IO Expander	MicroChip
BR24L04-W	EEPROM	ROHM	MK1493	Clock Generator	ICS
CDCDLP223	Clock Synthesier	Texas Instrument	MPC9230	Clock Synthesier	IDT
CDCE706	Clock Synthesier	Texas Instrument	PCA9540	I2c Mux	Philips
CY22150	Clock Generator	Cypress	PCA9546A	I2c Switch	Philips
GLK12232	Matrix Display	Matrix Orbital	PCA9547	I2c Mux	Philips
PCA9548	I2c Switch	Philips	PCA9556	I2c GPIO	Philips
ICS9FG104	Clock Generator	ICS	RPS-10	Remote Power Swit	WTI
ICS9249	XDR clock Generato	ICS	RTC-8564	Real Timme Clock	EPSON
ICS954309	Timing control hub	ICS	S75100	Temp Controller	TTC
ICS954321	Timing control hub	ICS	SLG505YC264(	Clock Synthesier	SILEGO
MA24AA64	EEPROM	MicroChip	SLG63103	Clock Generator	SILEGO

LabStation User Interface

Hierarchy of Test Platform: Test Chip, Peripherals

Customized View of Commands & Registers within the Hierarchy of Test Platform



LsScript Language in a Sample Test Script

```
; script to run a test across vdd of 900mv to 1250mv and measuring current

local QW qw_vdd_val 900 ;
for($qw_vdd_val = 900 ; ($qw_vdd_val <= 1250) ; $qw_vdd_val = ($qw_vdd_val + 50))

{
 W ECMB:vdd:voltage ($qw_vdd_val)                    ; change vdd voltage
 wait 100                                            ; wait 100 ms to let voltage settle
  run testchip:noisetest:start call                  ; run the be noise test
  print ELFCON "Current = " %( ECMB:Vdd:Current ) \n ; print the current in log file
                                                        and on console
 run testchip:noisetest:stop call                    ; stop the noise test
}
```

- ***LsScript uses a C like syntax***
- ***Supports all logic & math operators, for loops, variables, and procedures***

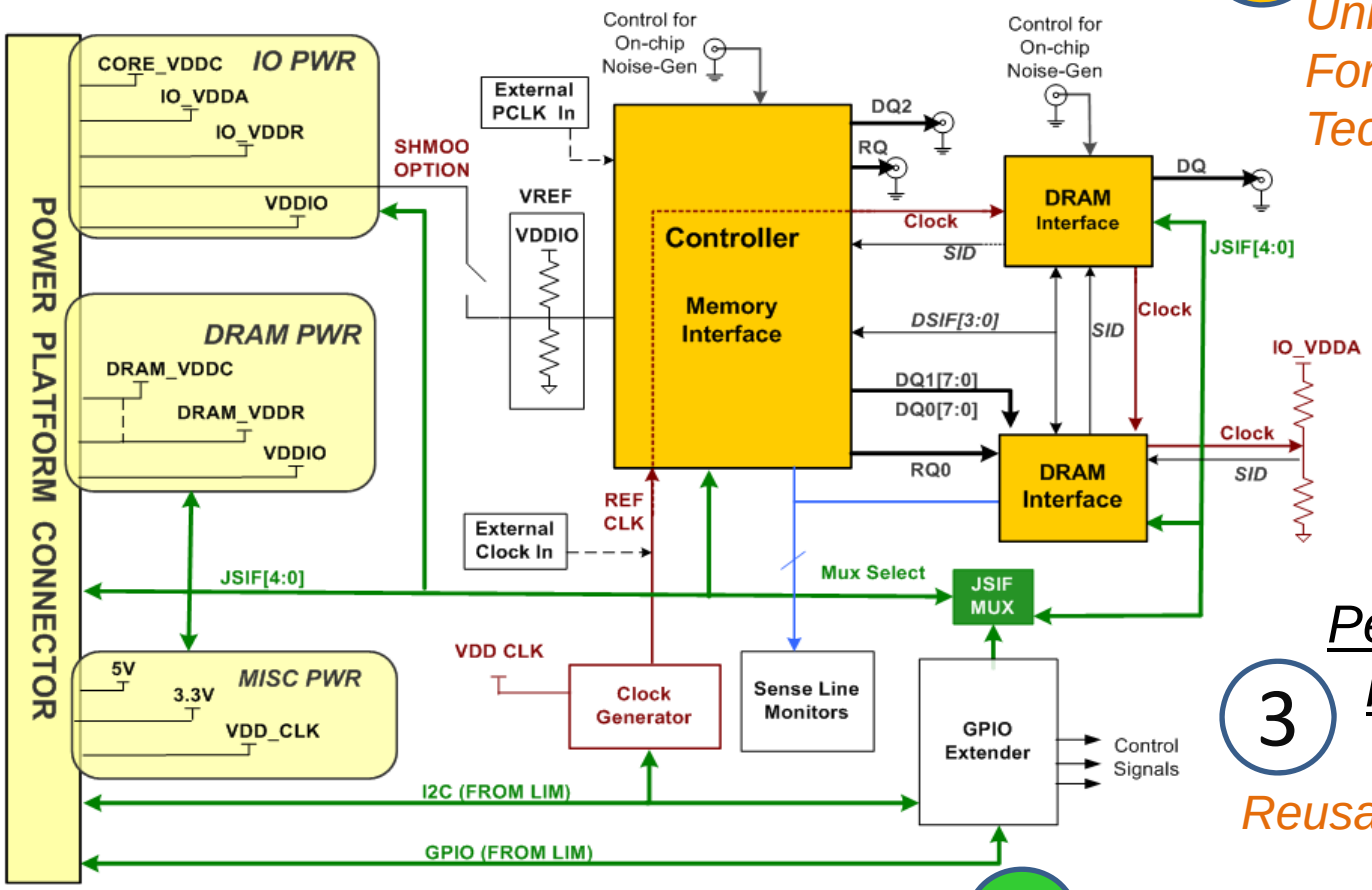
Four Parts of a Test Board

1 *Power in Yellow*

Reusable Design

System-under-test in Gold 2

Unique Design For IO Cell Technology



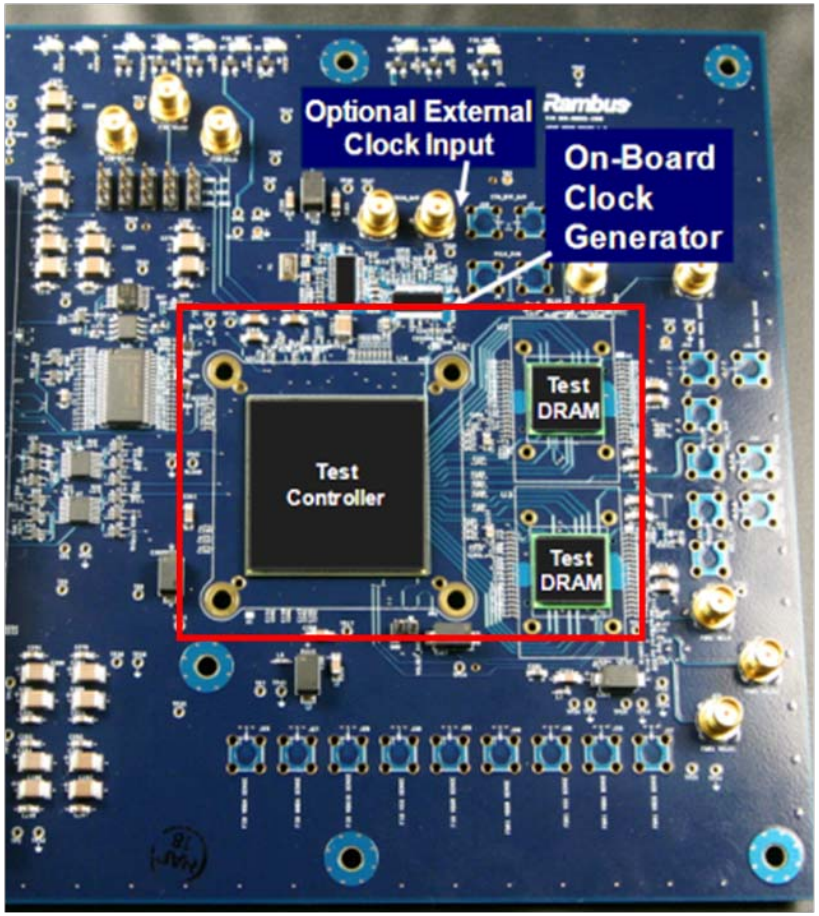
Peripherals in White 3

Reusable Design

Control in Green 4

Reusable Design

Design of System-under-test

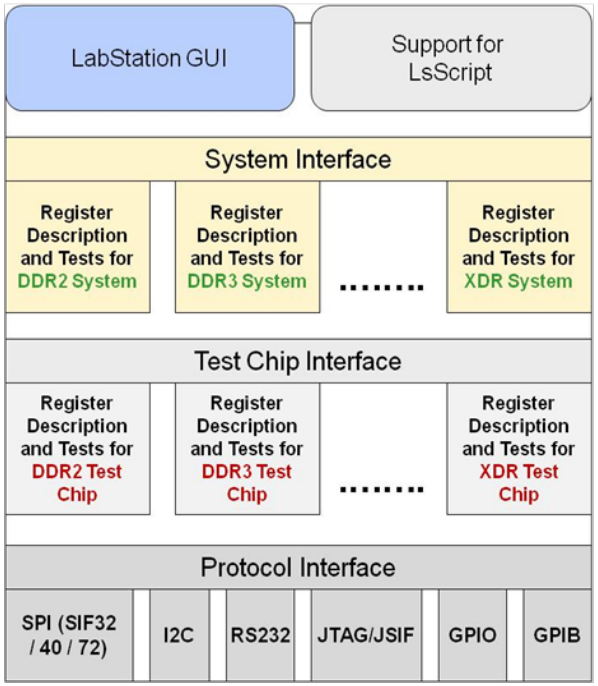


To reduce time-to-market

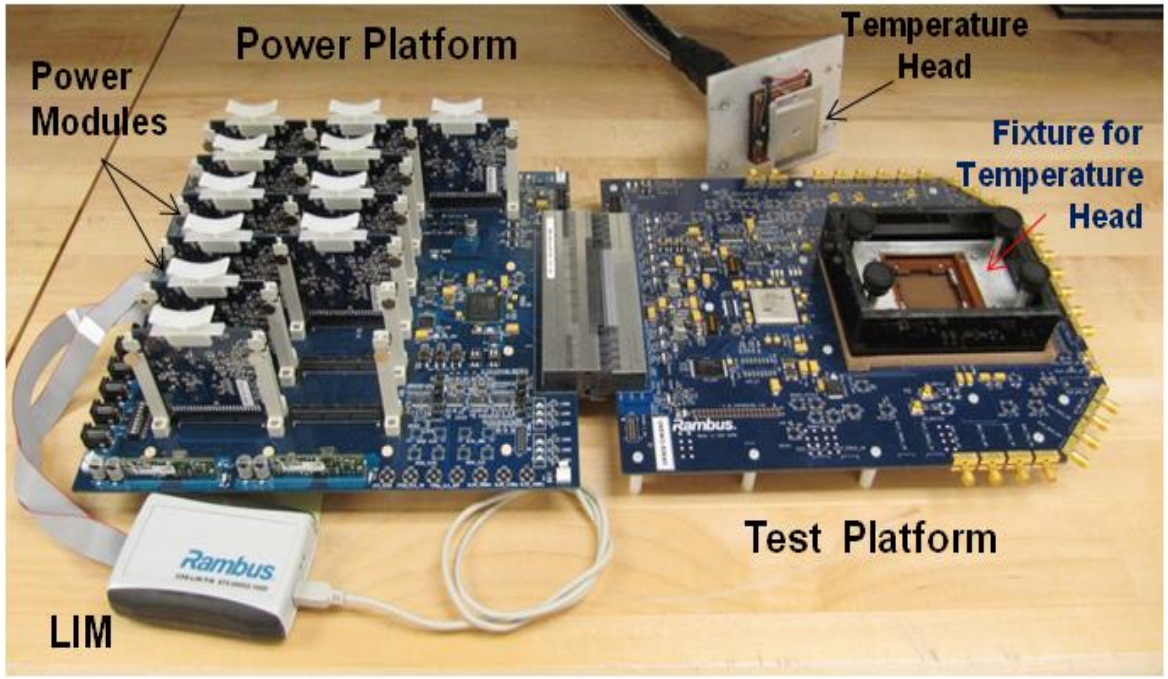
System-under-test in red box mimics a production system, i.e. one design for validation of circuits and system

The design is transferable to production system, including packaging and PCB layout

Reusable and Reconfigurable Test Environment

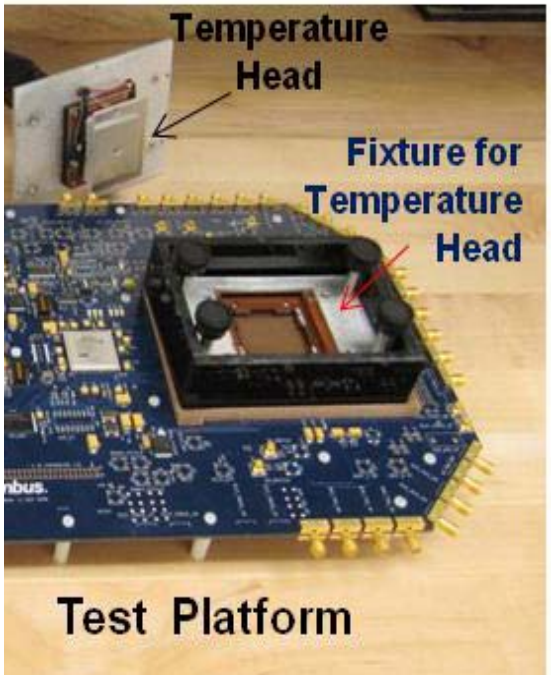


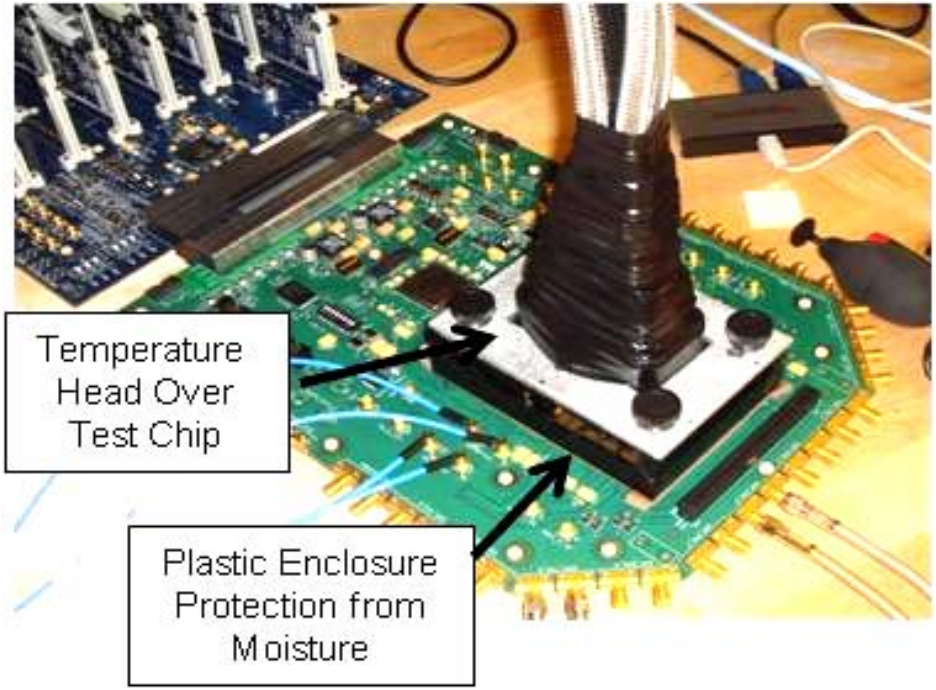
All layers of LabStation software are flexible & configurable for testing different IO cell tech.



Power Platform, LIM And Temperature Control

Temperature Head with Enclosure Over DUT





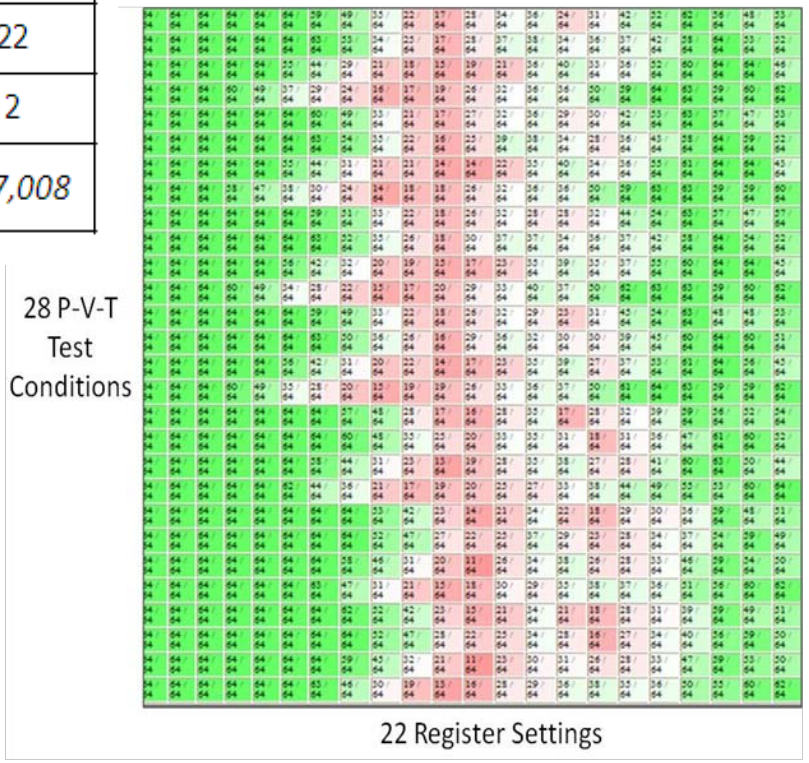
Maintain test chip at a desired temperature between - 40°C and 125°C

High Throughput Testing & Visual Presentation of Data

Process Splits	FF, FS, SF, SS
Temperature	0C – 95C
VDDR	0.900V – 1.100V
VDDA	1.455V – 1.545V
VTT	1.140V – 1.260V
Operations	READ, WRITE

Number of Devices (Processes)	4
Voltage-Temperature Combination	19
Data Pins per Device	32
Register Settings	22
Operations per Data Pin	2
Total Number of Tests	*107,008*

Pass/fail range for register settings of XDR memory interface



Automation resulted from skillful hardware and software integration

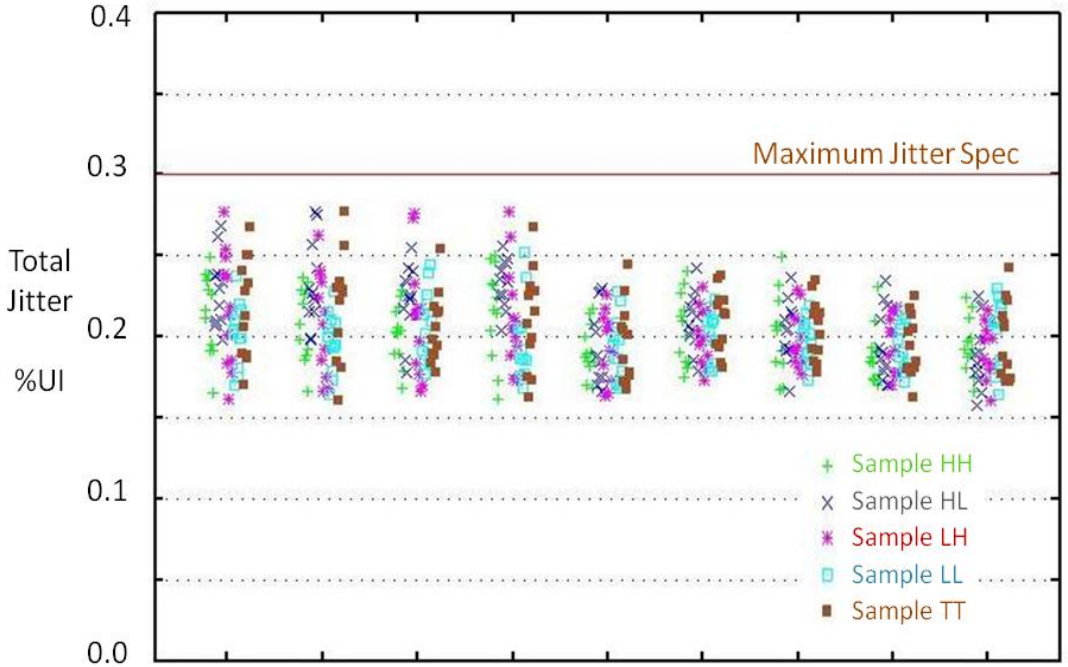
Enables very high throughput characterization at a low cost

Testing of Multi-protocol Serial Link at Extreme Conditions

For Total Jitter Shown:

CEI6 mode @ 6.375 Gbps
15 samples total
4 data lanes tested
9 voltage conditions
3 test temperatures

Total Test Time: 1 Day



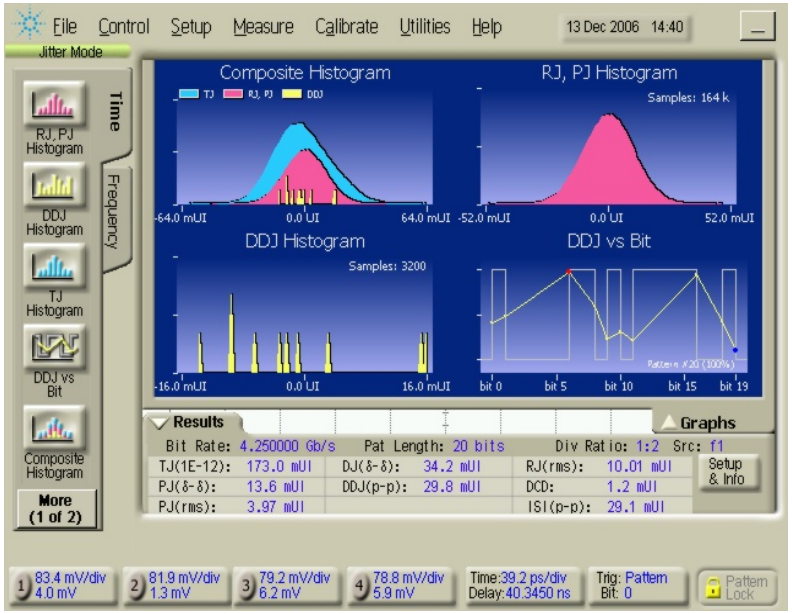
V_{TT}	(V)	1.128	1.172	1.410	1.590	1.500	1.128	1.272	1.410	1.590
V_{DDR}	(V)	0.828	0.828	0.828	0.828	0.828	0.828	0.828	0.828	0.828
V_{DDA}	(V)	1.410	1.410	1.908	1.908	1.500	1.410	1.410	1.908	1.908
T	(°C)	-40	-40	-40	-40	65	125	125	125	125

3 Supply Voltages
9 Combinations

- 40°C to 125°C

Extra Data For Debugging

temp (C)	vdd (V)	lane	RJ (rmsUI)	ISI (UI)	DJ (UI)	TJ (UI)	eye_image	image
25	1.20	4	0.0100	0.029	0.034	0.173		
0	1.26	4	0.0100	0.029	0.035	0.174		
125	1.08	4	0.0100	0.033	0.038	0.176		
125	1.26	4	0.0098	0.035	0.042	0.178		
0	1.08	4	0.0101	0.031	0.039	0.179		
0	1.26	0	0.0098	0.040	0.044	0.181		
25	1.20	0	0.0100	0.040	0.043	0.182		
0	1.08	0	0.0101	0.038	0.044	0.184		
125	1.26	0	0.0097	0.049	0.053	0.188		
125	1.08	0	0.0101	0.049	0.049	0.189		



High throughput makes it easy to collect extra data to support debugging when problems arise in production phase

Conclusion

- LabStation Characterization Environment
  - Offers a set of cost effective test tools
  - Ease of transport for worldwide deployment
  - Validates designs of memory subsystems & SERDES
  - Easy to add features for new IO cell technologies
  - Useful for circuit validation, system development and debugging of production system
- Shorten time-to-market of new consumer electronic systems