DC Parametric Semiconductor Validation: Hardware Components Instrument

COURTESY: NATIONAL INSTRUMENTS

Semiconductor validation is generally segmented in two parts, structural and functional. Structural tests ensure that the chip has been built correctly. Functional tests determine whether the chip meets design specifications and performs as intended in its final environment. The hardware components listed in this document can be used to conduct a host of structural tests to determine the DC parameters on a CMOS chip. The reference designs listed below include detailed descriptions of the test setup as well as example code for performing the test.

1. Open and Short Circuit Test
2. Power Consumption Tests (IDD, IDDQ)
3. Input Voltage Threshold Test (VIL, VIH)
4. Input Leakage Test (IIL, IIH)
5. Output Voltage Level Test (VOL, VOH)
6. Output Short Circuit Test (IOS)

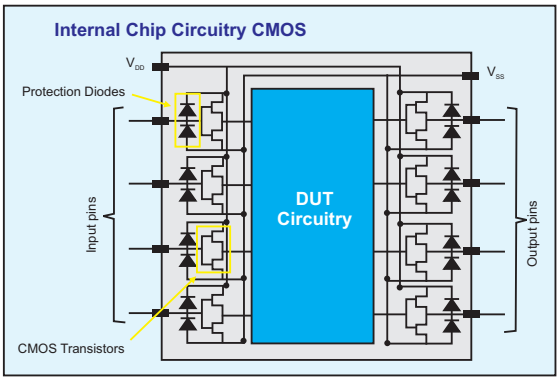

Fig. 1.Internal Circuitry of a CMOS Chip

These tests are performed through knowledge of the internal circuitry of the chip under test. The set of reference designs in this architecture have been written for a standard CMOS chip as shown below. The opens and shorts test, which is usually the first test performed, tests for continuity by biasing the protection diodes on the chip. The power consumption tests check for current draw by the internal chip circuitry in a variety of logic states. Finally, voltage threshold and leakage tests characterize the performance of the input and output transistors of the chip as shown below.

Required Hardware

This implementation of Opens/Shorts Semiconductor Test requires the following hardware:

Description	Model Name	Component
PXI Chassis:	PXI-1045	18-Slot 3U PXI Chassis with Universal AC Power Supply
PXI Controller:	PXI-8105	2.0 GHz Dual-Core PXI Embedded Controller
SMU:	PXI-4130	Source Measure Unit
Switch:	PXI-2535	544-crosspoint FET Matrix Switch
High-Speed Digital:	PXI-6552	100 MHz Digital Waveform Generator/Analyzer
Switch Cable:	SHC68-68	68-pin VHDCI to SCSI cable
Switch Terminal Block:	TBX-68	68-pin external screw-terminal block

Table 1: Required hardware components for Opens and shorts test in PXI

The PXI platform is inherently suited for DC Parametric Semiconductor Validation. Its broad product offering (over 1500 products) and modular architecture add scalability and flexibility in to the system. Incorporating additional test points is as easy as adding a switch module in an available slot. Reducing test time is also possible by simply adding additional instrumentation (e.g. SMU or high-speed digital device) and conducting parallel measurements. This DC Semiconductor Validation test system is architected in PXI using the PXI-1045 18-slot chassis and the PXI-8105 2.0 GHz Dual-core embedded controller. The 18-slot chassis is particularly useful for building a comprehensive semiconductor validation test system which may require the use of RF instruments, digitizers, arbitrary waveform generators, and high-speed digital products, which are also available in PXI form factor.

This DC Semiconductor Validation test system, which is designed to test DC parametrics on 128 pins of a single chip, uses three main components, the PXI-4130 Source Measure Unit, the PXI-6552 100 MHz Digital Waveform Analyzer/Generator and the PXI-2535 544-crosspoint FET switch matrix. The National Instruments PXI-4130 is a programmable, high-power Source-Measure Unit in a single-slot, 3U PXI module. The NI PXI-4130 has a single isolated SMU channel that offers a 4-quadrant ±20 V output that

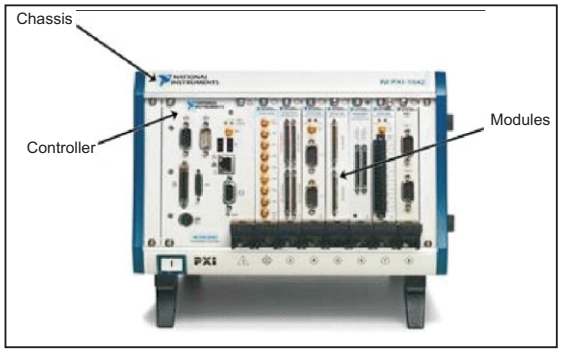

Fig. 2. The PXI platform has a modular and scalable architecture

Fig. 3. The PXI-4130 Source Measure Unit

incorporates remote (4-wire) sense. This channel is capable of sourcing up to 40W in quadrants I and III, and sinking up to 3W in quadrants II and IV. With 5 available current ranges offering measurement resolution down to 1nA, this precision source is ideal for applications that require programmatic sourcing and sweeping as well as high accuracy measurements such as those required by semiconductor validation tests.

The National Instruments PXI-6552 is a 100 MHz digital waveform generator/analyzer. It features 20 channels with programmable voltage levels and per-clock cycle, per-channel direction control. The module contains deep onboard memory with triggering and pattern sequencing. It is used to program the CMOS chip in to a known state.

The National Instruments PXI-2535 high-density FET switch matrix features 544 crosspoints in a compact,

Fig. 4. The PXI-6552 100 MHz Digital Waveform Generator/Analyzer

Fig. 5. The PXI-2535 544-crosspoint FET Matrix Switch

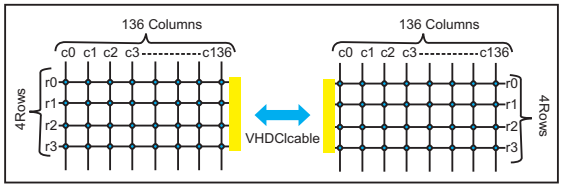

Fig. 7. Building a 4x272 Matrix using two PXI-2535 FET matrix modules

single-slot, 3U PXI form factor. It is configured as a 4x136 1-wire matrix. Because the PXI-2535 uses field effect transistor (FET) switch technology, it offers unique benefits such as unlimited mechanical lifetime, unlimited simultaneous crosspoint connections, and switching speeds as high as 50,000 crosspoints per second. These features make this switch ideal for testing mass produced devices such as semiconductor chips. In this system, the PXI-2535 acts as a front-end for the PXI-4130 Source Measure Unit.

Other important components of this test system include cables and connector blocks which facilitate signal connections to the switch. Connections to the PXI-2535 can be made using an external connector block and VHDCI cables. The top two connectors on the PXI-2535 4x136 switch matrix are used for the 136 column connections. You will need 2 VHDCI cables and 2 TBX-68 terminal blocks to be able to connect to all 136 columns. The bottom left connector can be used to connect signals to rows. You will need 1 VHDCI cable and 1 TBX-68 terminal block to connect signals to rows.

The bottom right connector also provides access to the rows of the matrix module and facilitates matrix expansion. Building large matrices with the PXI-2535 is very simple and can be done by connecting the bottom right connectors of two modules using a VHDCI cable.