Automated Measurement with IC-CAP

Application Note

A seamless solution for automated measurement and parameter extraction with Agilent IC-CAP

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Abstract

Cascade Microtech, Inc., a leading company in high-frequency, wafer-level measurement systems and equipment, provides a unique solution for measurement system integration. Due to the special combination of hardware and software solutions, original architecture and flexibility of Cascade Microtech products, it is possible to combine complete measurement and parameter extraction systems on a single PC. This document describes such a system based on a Cascade Microtech's ProberBench™. High-frequency calibration and automation tasks are provided by SussCal® and ProberBench software from Cascade Microtech, while measurement, data analysis as well as system management tasks are managed by the IC-CAP software from Agilent Technologies. This combined solution provides a highly-efficient, reliable and fully-integrated measurement system for testing several different semiconductor components.

IC-CAP

The Integrated Circuits Characterization and Analysis Program (IC-CAP) is an interface between measurements and simulations of electronic devices. After a device has been measured from typically DC to high frequencies, a device model or a sub-circuit is selected for the requested simulator, and the model parameters are extracted and optimized until the simulated data match the measured data. IC-CAP offers very flexible and easily customizable capabilities for the user to communicate with the wafer prober. This is based on the implemented programming language PEL, which – besides providing custom implementation of parameter extraction strategies – enables communication with other programs and set up of automation macros.

System Description

Cascade Microtech's software package is responsible for low-level management automation of hardware and service functions (Figure 1). The main tasks of the Cascade Microtech software are:

- Highly-accurate calibration of the VNA
- Thermal systems management
- Wafer management, such as stepping, binning, sub-die probing, etc.
- Automated management and profiling of the chuck height for calibration/measurement tasks

IC-CAP is responsible for the whole system management, data acquisition and parameter extraction. IC-CAP controls the measurement instrument via the GPIB instrument interface, while communicating directly to Cascade Microtech software, using appropriate commands.
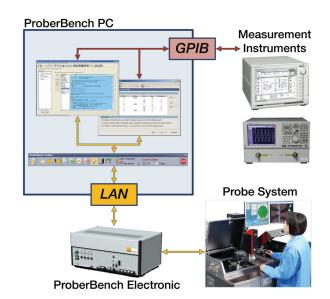

Figure 1. Architecture of an automated measurement and modelling system

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ProberBench and IC-CAP Integration Solution

The solution for integrating Cascade Microtech ProberBench and Agilent IC-CAP on a single PC does not require additional hardware parts, like a secondary GPIB interface. The link between the two software packages is organized over the software utility 'ProberBench-IC-CAP Translator'. This is a special program available from the ProberBench software package, provided by Cascade Microtech*. All commands and requests generated by IC-CAP are transferred to the target application (like SussCal, WaferMap, etc.) over the ProberBench message server. The probe system responses are captured by the 'ProberBench-IC-CAP Translator' and transferred to IC-CAP for further analysis. As a result, the IC-CAP software has full control over the entire system.

*The ProbeBench-IC-CAP Translator utility can also be found in IC-CAP demo features package:
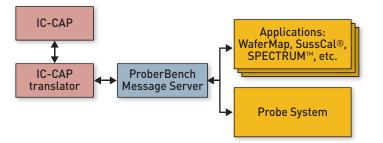 demo_features\2_LINKING_TO_MEAS_INSTRUMENTS\3_PROBER_MATRIX_THERMOCHUCK\2_Prober\ CascadeMicrotech_Suss.

Figure 2. Software architecture of the automated measurement and modelling system

Configuring the System for the First Run

Cascade Microtech ProberBench and Agilent IC-CAP should be installed on the system PC. Cascade Microtech WaferMap application will be used for a simple test of the system configuration.

Download the latest version of the IC-CAP demo_features directory from:

http://edocs.soco.agilent.com/display/eesofkc/demo_features+directory+ICCAP+%28latest+version%29
under **Examples/SupportExamples** and then further under section IC-CAP.

See the item Latest demo_features directory directory for IC-CAP.

Start IC-CAP, hit the blue examples icon and load the ModelFile:

PAxxx_ProberBench.mdl

from:

demo_features\2_LINKING_TO_MEAS_INSTRUMENTS\3_PROBER_MATRIX_THERMOCHUCK\2_PROBER\ CascadeMicrotech_Suss\CascadeMicrotech_Suss.

Refer to the Macro README for details about this ModelFile.

This program is preconfigured to be run in demo mode (without ProberBench). To switch the demo mode off, change the **IC-CAP SetupVariable DEMO=1** to **DEMO=0**.

Make sure that the ProberBench-IC-CAP Translator (**ProberBench_ICCAP_Translator.exe**)* is located in the directory **C:\PBench** (predefined ProberBench directory).

*A copy is available in the same directory as the IC-CAP ModelFile.

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Please note that the IC-CAP SETUPVARIABLE DIRNAME stores the path to the ProberBench-IC-CAP Translator. Its predefined value is C:\PBench. You can modify it, if you install the interface file ProberBench_ICCAP_Translator.exe elsewhere on your system.

To assist with testing this link, the IC-CAP program **test_conn2prober** is provided in the ModelFile (Figure 3). When you execute it, it will ask for the settings of the above mentioned **SetupVariables**.

Figure 3. The block diagram of IC-CAP model file

IC-CAP Model File in Detail

The **PAxxx_ProberBench.mdl** IC-CAP ModelFile contains the basic set of elementary function examples (PEL Programs) demonstrating the communication principle between IC-CAP and the ProberBench package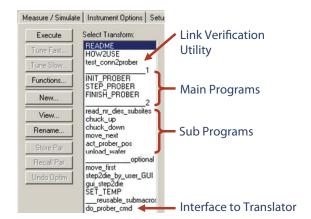. The PEL program **do_prober_cmd** is the central interface program. It takes a ProberBench command string and sends it to the Cascade Microtech Message Server over the ProberBench-IC-CAP Translator. The result of the program execution is the Message Server's feedback to the IC-CAP Program **do_prober_cmd**, and will be stored in the IC-CAP SetupVariable **PBresult**.

No additional configuration steps are required. The communication functionality can be tested using elementary subprograms that are available in the IC-CAP ModelFile. For example, the functions '**chuck_up**' and '**chuck_down**' move the chuck to the contact and separation heights respectively.*

*Please note that the contact height should be set before using these functions.

Measurement and Automated RF Calibration with SussCal Professional

Another example is the program SussCal_n_ProberBench_Demo, available from Cascade Microtech or Agilent-EEsof. This is an example of a main measurement program for S-Parameters. It provides the automated test of all dies on the wafer, controlled by ProberBench and WaferMap, as well as the VNA RF calibration using SussCal Professional. To use this example, SussCal and WaferMap should be started on the PC and configured properly. SussCal should have an active calibration project. It is also required to switch SussCal remote mode operation. This will allow IC-CAP to initiate the calibration process and its progress control. To switch SussCal to remote operation mode, select Remote Control from the system menu, or use the Remote Control button from the tool bar (Figure 4 and 5).
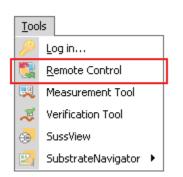

Figure 4. Activation of the remote control mode from SussCal Professional system menu

Figure 5. Configured SussCal Professional calibration project. SussCal is switched to the remote control mode to interact with IC-CAP

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For demo purposes, this example is configured for the automated VNA calibration at the start and after every five dies being measured. If required, this definition can be easily modified and any alternative condition can be defined.
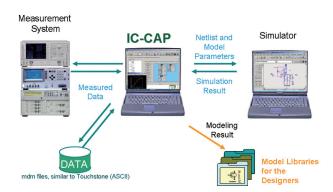
Conclusion

The unique system for automated RF calibration, measurement and unattended DC and RF parameter extraction was presented. In contrast to conventional solutions, this system provides test and modeling engineers with the following significant advantages:

1. The flexibility and the unique concept of IC-CAP from Agilent technologies and ProberBench from Cascade Microtech allow for a seamless integration of these products into a complete measurement and modeling system.
2. No additional hardware components like a second GPIB bus and PC are required.
3. Since the software packages are directly linked to each other, the communication stability and speed are significantly increased.

Several IC-CAP PEL examples are provided: from elementary functions supporting the automated wafer-level probe system to complete, complex test programs, including RF VNA calibration with SussCal.
The system discussed here sets a new standard for automated wafer-level measurement and modelling for current and next-generation semiconductor devices.

About IC-CAP from Agilent Technologies:

The device modeling software IC-CAP (Integrated Circuit Characterization and Analysis Program) provides powerful characterization and analysis capabilities for today's semiconductor modeling. IC-CAP offers device engineers and designers a state-of-the-art modeling tool that fills numerous modeling needs, including instrument control, data acquisition, parameter extraction, graphical analysis, simulation, optimization, and statistical analysis (Figure 6 and 7).
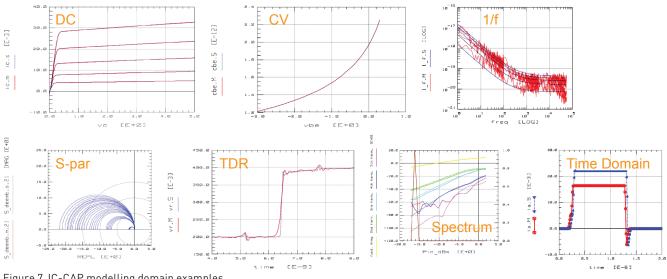

Figure 6. IC-CAP interface between measurements and simulations

Figure 7. IC-CAP modelling domain examples

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All of these capabilities are combined in a flexible, automated, and intuitive software environment for efficient and accurate extraction of active devices and circuit model parameters. IC-CAP provides the power to build model libraries for Advanced Design System (ADS) or other commercial simulators like Spectre, Eldo, Hspice and Saber.

IC-CAP represents an open and flexible software architecture. All setups and macros are open for user modifications. Using parameter extraction language (PEL), custom extraction methodologies can easily be implemented directly into IC-CAP, related to the selected model or sub-circuit. The IC-CAP open interface also permits to write customized measurement instrument drivers.

Within a single environment, IC-CAP can be used to automate measurements, simulate device performance, extract and optimize model parameters.

IC-CAP Website:
http://eesof.tm.agilent.com/applications/device_modeling-b.html