APPLICATION NOTE

Automated Wafer-level Testing with Keysight WaferPro and FormFactor Velox

KEYSIGHT

Automated Wafer-Level Testing

With advancing technology nodes, modern characterization labs rely on advanced measurement drivers and sophisticated routines to carry out full wafer-level testing. Keysight Device Modeling WaferPro offers a unified platform for automated wafer-level testing, seamlessly integrating prober control, measurement execution, and data collection ready for device modeling and characterization tasks. A typical wafer may contain devices with multiple pad layouts. With fixed probe positioners, only devices sharing the same layout can be measured in the same automated test plan, resulting in manual adjusting prior to each automated test. Motorized Positioners (MP) eliminates the need to manually adjust the prober configuration and can also be used to correct for temperature adjustments. Even though motorized positioners offered in modern probe stations help eliminate the need to manually change probe configuration for different device layouts, they must also be software controlled as part of prober control software such as FormFactor Velox and device characterization software such as WaferPro. Velox™ is the FormFactor's industry-standard software suite enabling seamless operation of semi- and fully-automated 200 mm and 300 mm wafer probe stations.
It works seamlessly with VueTrack alignment technology for positioners and eVue Pro digital microscope.

This application note demonstrates automated DC characterization of multiple MOSFET devices with varying layouts using a single, unified test plan executed via the VeloxMP driver in WaferPro, as shown in Fig. 1.

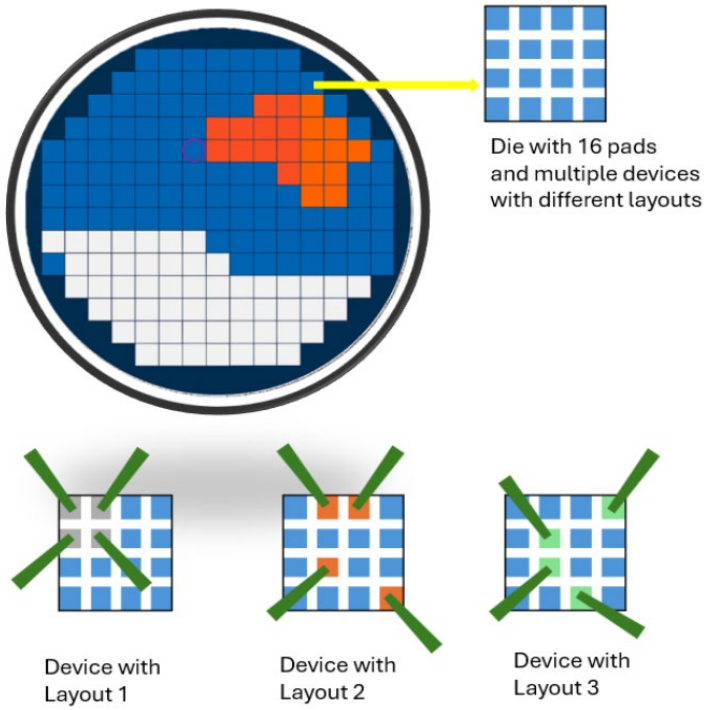


Figure 1. Typical wafer with each die containing multiple devices with different pad layouts

VeloxMP Driver

This feature allows test engineer to automatically take wafer-level measurements using a single test plan for multiple device layouts with the use of motorized positioners in Velox. Upon initializing the prober setup, VeloxMP driver reads the motorized positioners definitions and the subsite table defined in Velox software and makes those available in WaferPro as shown in Fig. 2(a). WaferPro can also execute other options listed as needed. Similarly, initializing setup for thermal chuck allows WaferPro to read and set chuck temperature as shown in Fig. 2(b). Currently, this feature is enabled through WaferSync only. WaferSync is WaferPro's exclusive interface to Velox, enabling seamless synchronization of wafer maps and critical notifications throughout test plan execution.

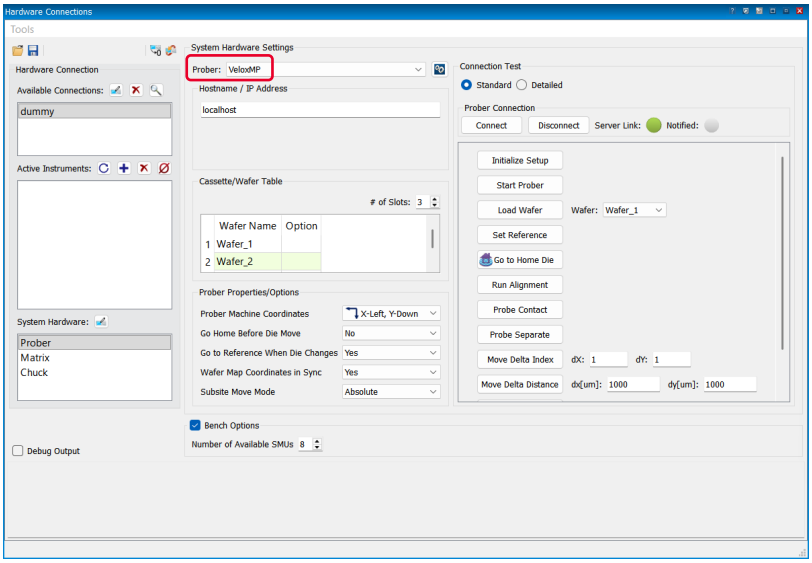


Figure 2(a). Prober driver selection in Hardware connections window

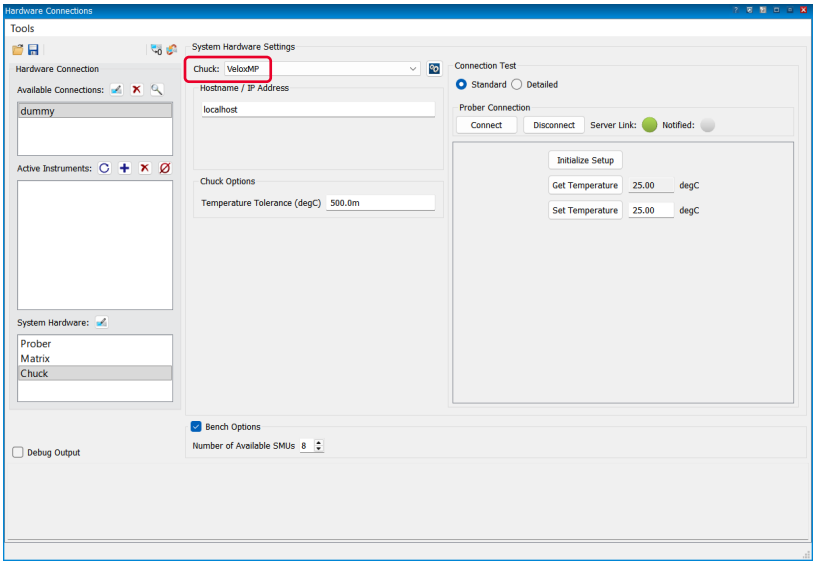


Figure 2(b). Thermal chuck driver selection in Hardware connections window

Configuring Velox Software

First, the test engineer configures the probe station related settings in the Velox software. Key steps include defining the home die position on the wafer map, specifying the die size, and then creating sub-die definitions for devices with multiple layouts. When defining sub-dies, the “Use Motorized Positioners” option must be enabled so that Velox can correctly interpret and navigate between different layouts, as illustrated in Fig. 3.

Next, the WaferSync interface is enabled from the Velox main menu before launching WaferPro.

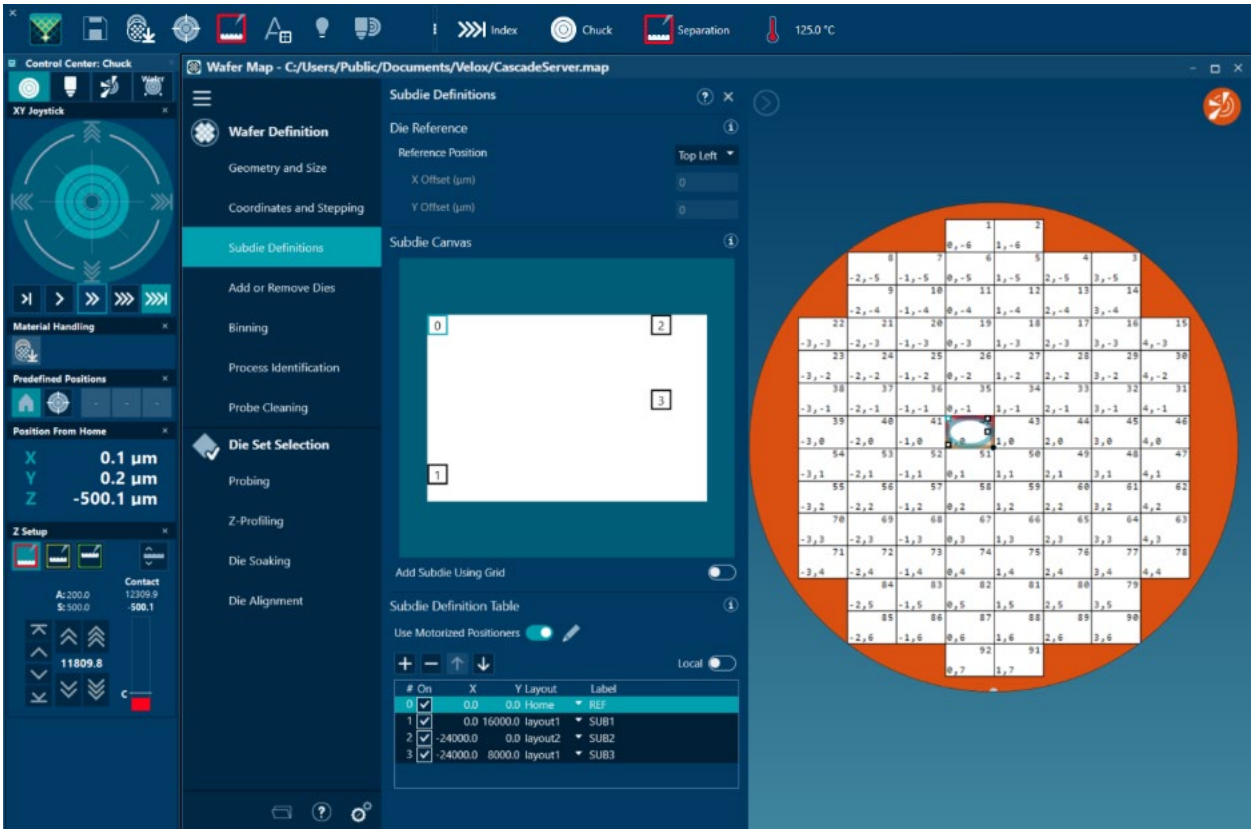


Figure 3. Defining subdies in Velox software

Setting System Variables

Under Edit -> System Variables, test engineer must set the following system variable flag to enable this feature as shown in Fig. 4. Once set to Yes|TRUE|1, prober-side configuration must be complete. See " Configuring FormFactor Velox Probe Station Control Software “ section of user manual for additional details.

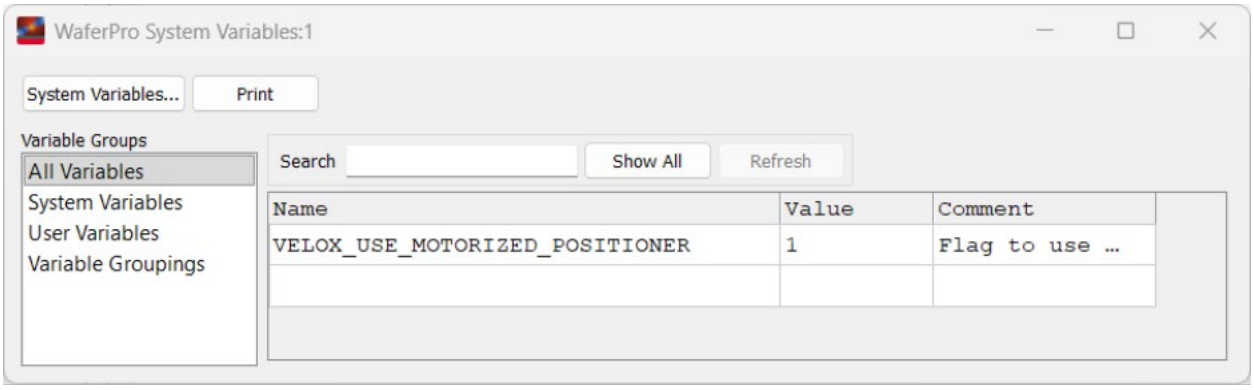


Figure 4. System variable setting in WaferPro to enable MP in Velox

Syncing Wafer Map between Velox and WaferPro

By launching the Wafer Map window within WaferPro, test engineer must click on “Get Wafer Map” to synchronize the wafermap loaded on probe station as shown in Fig. 5. This step ensures correct home die position, die size etc. are loaded from Velox to WaferPro.

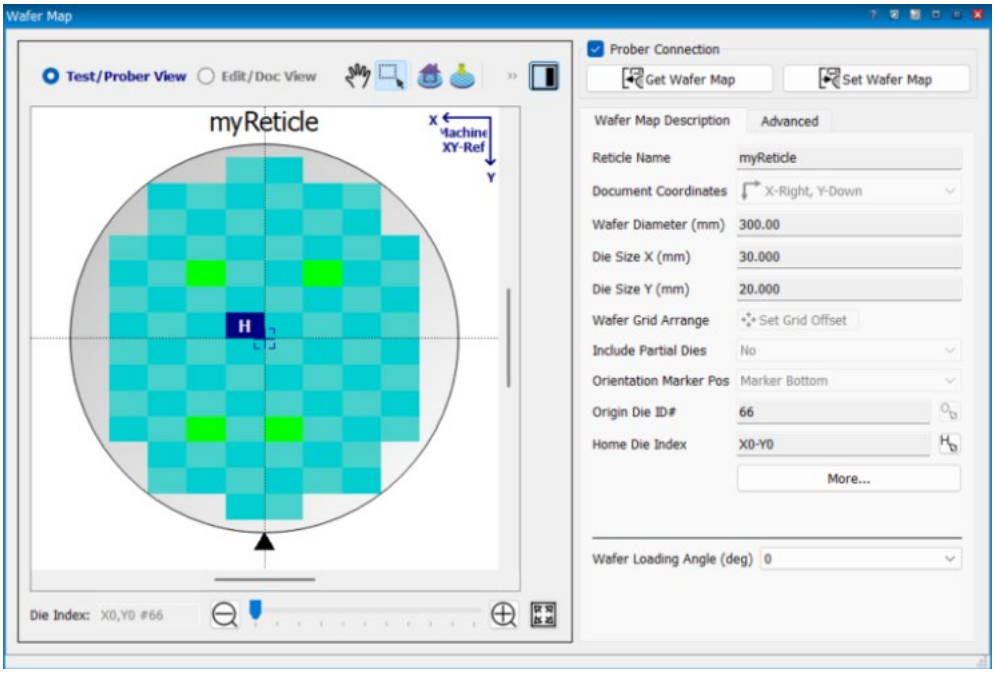


Figure 5. System variable setting in WaferPro to enable MP in Velox

Getting Subsite Table from Velox in WaferPro

Once subdies with same or different layouts have been defined on Velox, they must be loaded inside WaferPro by clicking the “Get Subsite Table” as shown in Fig. 6. WaferPro supports loading the subsite name as it is defined on Velox, X & Y coordinates and corresponding pad layout information.

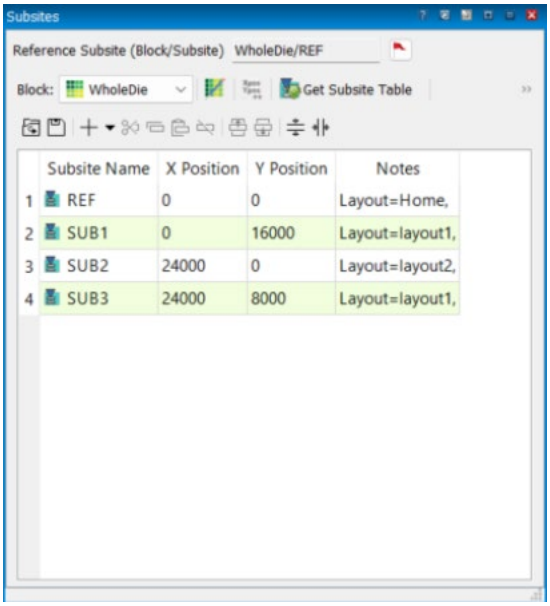


Figure 6. Getting subsite table along with coordinates from Velox

Test Plan Execution

Before starting the test plan, the test executive must ensure that the wafer map has been synchronized and that the correct subsite data has been loaded into WaferPro as discussed in previous steps. Note the test plan shown in this application note is a simple plan measuring only three devices per die at two temperatures for demonstration only. In practice, a test plan may include hundreds of devices per die, tens of dies and multiple temperatures. Test plan execution begins by clicking “Start/Resume Test Plan”. Then, WaferPro initiates the specified test sequence by setting the chuck temperature to 27 °C, loading Wafer_1, and moving to the center die (X1-Y1) and REF subsite, as shown in Fig. 7. Measurements are then executed by stepping through each subsite for the given die before proceeding to the next die.

After measurements are completed for all four dies at 27 °C in this test plan sequence, Velox raises the thermal chuck temperature to 125 °C, performs thermal stabilization and re-alignment, and then repeats the measurements for the entire wafer.

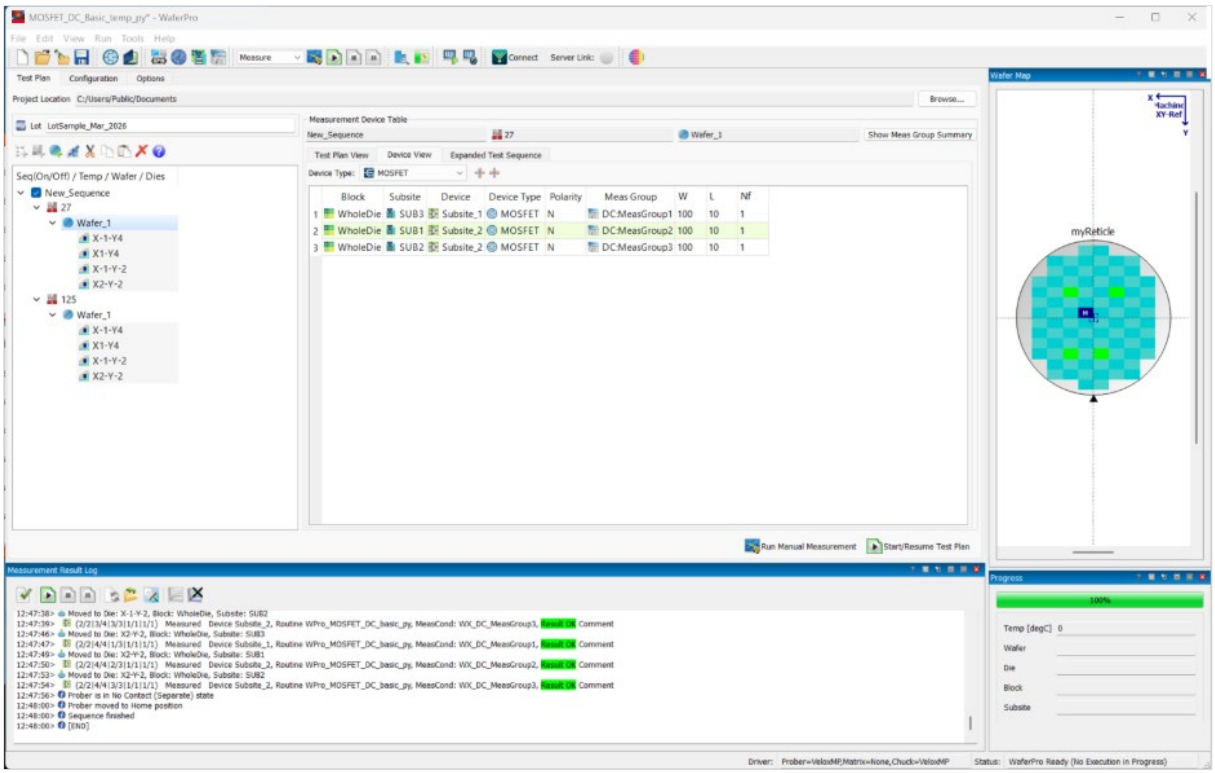


Figure 7. WaferPro window shows the execution of full test plan.

Data Analysis and Visualization

Test engineer can visualize measured data by highlighting the desired test then clicking “Display results” as shown in Fig. 8 below

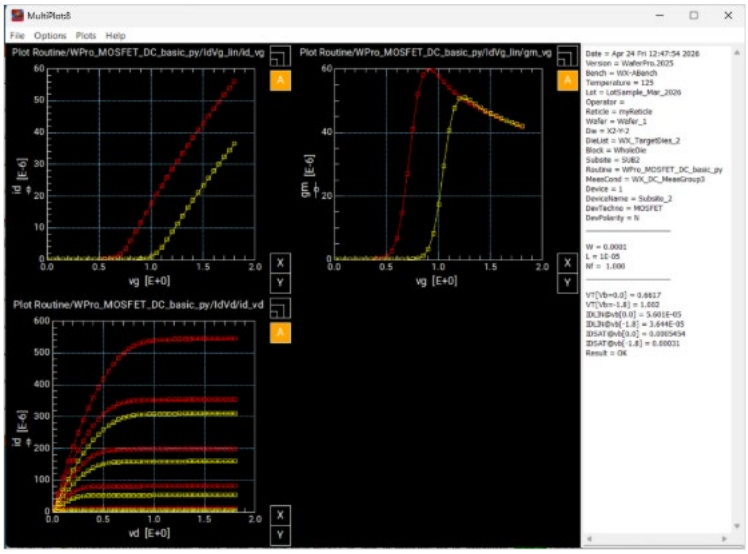


Figure 8. Measurement results

Conclusion

The new VeloxMP driver, used with the WaferSync interface in WaferPro, enables fully automated wafer-level testing of multiple devices with different pad layouts without manual repositioning of the probe positioners. Seamlessly integrated with the Velox VueTrack system, it supports accurate probe-to-pad alignment throughout the measurement process.
As demonstrated in this application note, the driver improves test efficiency by executing a single-pass test plan that measures four dies, with three devices per die across two layouts, at two temperatures. During the sequence, Velox software automatically manages thermal stabilization and re-alignment.

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