

HC-20 Series

Hot Carrier Package Level Test System

- CMOS and Bipolar Transistors
- 10 μ V to 200 V (300 V), 1 pA to 400 mA (1 A)
- Very Flexible Configuration: 2 to 5 Terminal Devices
- High Capacity: 256 DUTs, 16 Groups
- High Speed: 100 Measurements/s
- High Accuracy: 0.05% Base Accuracy
- Various Temperature Options



Introducing the HC-20 Series Test System

The mb-Technologies HC-20 series test system is a complete measurement solution designed for package level testing of CMOS and bipolar transistors and other semiconductor devices.

This includes standards like hot-carrier (HC) testing, bipolar forward and reverse stress, diode testing and many other characterization methods. The software comes with a large library of industry-proven tests plans, a build-in programming language, statistical functions and analysis tools.

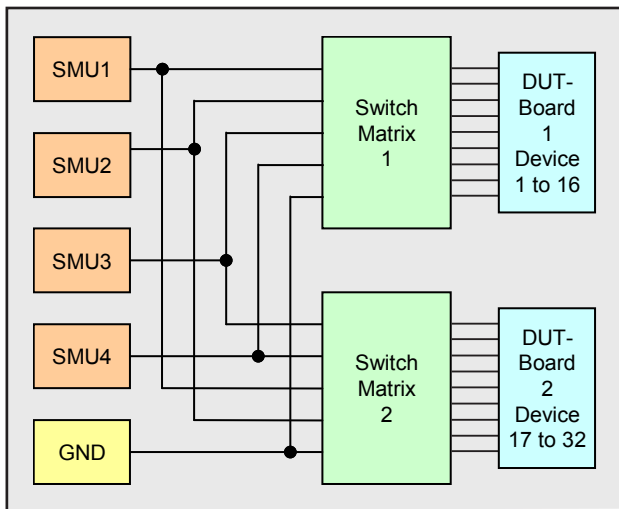
Perfectly suited for the characterization of advanced semiconductor technologies, the high voltage and current capabilities

makes this test system especially useful for integrated high voltage transistors, e.g. used in automotive applications.

The flexible configuration allows characterization of complex devices like fully isolated high voltage transistors with up to five terminals using all different voltages.

The combination of precise and fast measurement electronics along with the use of Kelvin-guarded connection technique throughout the whole test system gives excellent measurements results. The high accuracy and repeatability allows to resolve low degradation effects in the sub-percent range.

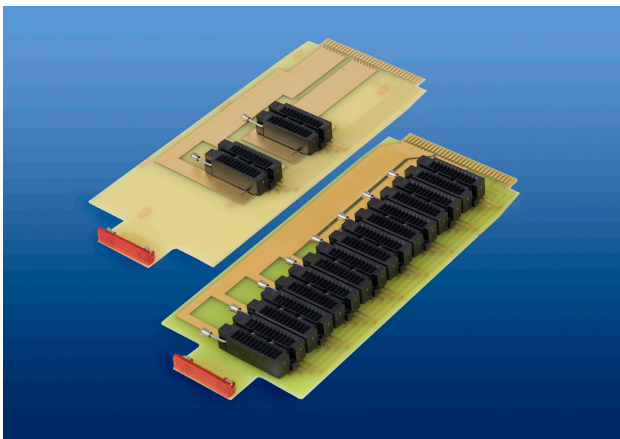
Features



HC-20 module using 4 SMUs for one DUT-board or 2 SMUs for both DUT-board (split mode)



Source-Measure-Unit SMU1022 (200 V, 400 mA, 20 W)



Standard DUT-boards

Compact and Versatile

The basic building block of the HC-20 series test system is a module with 4 Source-Measure-Units (SMUs), 2 switch matrix boards and 2 DUT-board chambers. Up to 8 modules fit into one test system, each of them can run one or two independent experiments.

A module can either be used with all 4 SMUs or can be split any time into 2 modules with 2 SMUs each.

Using 4 SMUs complex devices with up to 5 terminals (like isolated high voltages transistors with multiple bias voltages) can be characterized. In this case only one DUT-board (16 devices) is used at a time.

The split-mode allows 2 independent experiments using 2 DUT-boards, i.e. 32 DUTs per module.

Measurement Electronics

The HC-20 series test system uses high performance Source-Measure-Units from mb-Technologies. These units can source and measure voltages from 10 μ V to 200 V and currents from 1 pA to 400 mA. They can also be used as voltage meter, current meter or capacitance meter.

Optionally the test system can be equipped with high-power SMUs providing up to 300 V or 1 A.

The switch matrix is optimized for maximum flexibility and high measurement capacity. It provides low leakage and neglectable channel-channel crosstalk. The modules are designed without any cabling and use Kelvin-guarding on all package pins for best measurement accuracy, lowest leakage and highest reliability.

All units within one module are synchronized with a high-speed bus. Test execution is done locally at full speed with up to 100 measurements per second (including force change).

DUT-Boards

16 devices can be measured on each DUT-board. Any customized socket and pin configuration is possible and can be delivered shortly.

We also provide standard DUT-boards providing 2 DIL24 sockets with 8 CMOS transistors each or 8 sockets with 2 transistors (common Gate). A standard board is available for characterization of bipolar transistors.

DUT-boards use zero-force sockets and are indented for room temperature measurements.

Temperature Options

Temperature control is a major key for accurate measurements and repeatability. In reliability testing this is even more important. Even a temperature change of a few tenths of degrees can result in a significant shift of some transistors key parameters which can be larger than the change due to degradation.

In the standard HC-20 series test system the measurement is done at room temperature. The DUT chamber is thermally decoupled from the measurement electronics and ventilated. The air flow can be heated or cooled by a few degrees allowing to compensate the room temperature variation. This unique features stabilizes the DUT chamber temperature to better than 0.1 K. A version without temperature stabilization is also available for applications where the room temperature is stable enough.

For customers requiring lower or higher temperatures the test system can be equipped with temperature chambers. Various models are available covering the temperature range from -65°C to +250°C. The test system can also be connected to a customer supplied temperature chamber.

Exact Timing

A unique feature of mb-Technologies Source Measure Units: Time accurate voltage or current ramps or a series of ramp steps with a predefined measurement rate. Slow rate is 50 nV/s to 10000 V/s! This also works with multiple SMUs, executing the same or different patterns, but fully synchronized.

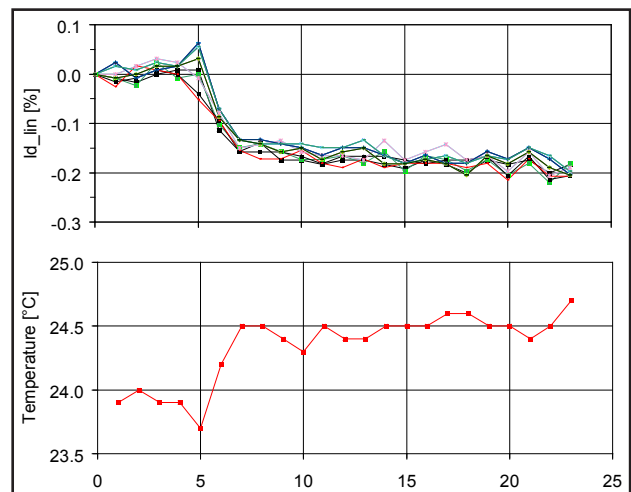
A Source Measure Unit can handle complex voltage patterns of up to 1000 steps. For each step individual measurement rates, ranges and shutdown parameters can be defined. Any sub-series of steps can be repeated up to 1 million times.

This feature allows an exact definition of stress voltages with defined slopes, slow voltage ramps, AC stress, EEPROM endurance cycles, arbitrary function generators and many more.

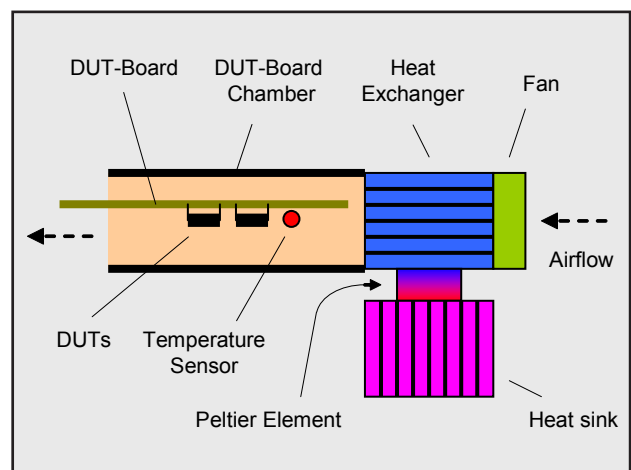
Wafer-Level-Reliability

The HC-20 series is fully compatible to mb-Technologies series of parameter testers and WLR test stations. Test plans and measurement algorithms developed on one of those systems can easily be transferred to the HC-20 series of package level testers and vice versa.

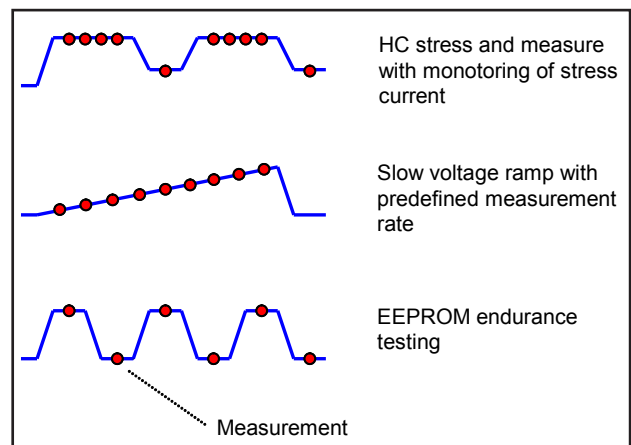
By using an adapter cable the HC-20 tester can even be connected to a wafer handler or micro manipulator.



Parameter shift due to temperature variations



Stabilized room temperature



Voltage ramp examples

Connection Options

The switch matrix allows various semiconductor devices to be measured. The Bulk and Extra pins are typically used for Well or Substrate bias voltages and are available in non-split mode. In many cases however these pins are not required. This allows using the split mode and doubles the measurement capacity while the Bulk and Extra pins can still be connected to common ground or another SMU.

SMU	1	2	3	4	Gnd
Source					✓
Drain 1 to 16	✓				
Gate		✓			✓
Bulk			✓		✓
Extra	✓	✓		✓	✓

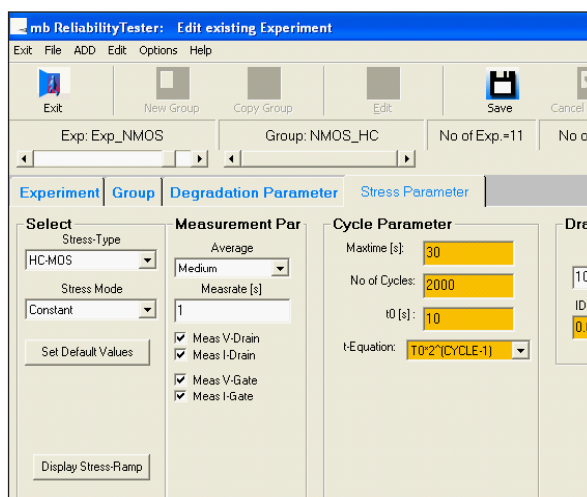
CMOS connection options
(Common Gate)

SMU	1	2	3	4	Gnd
Source					✓
Drain 1 to 8	✓				
Gate 1 to 8		✓			✓
Bulk			✓		✓
Extra	✓	✓		✓	✓

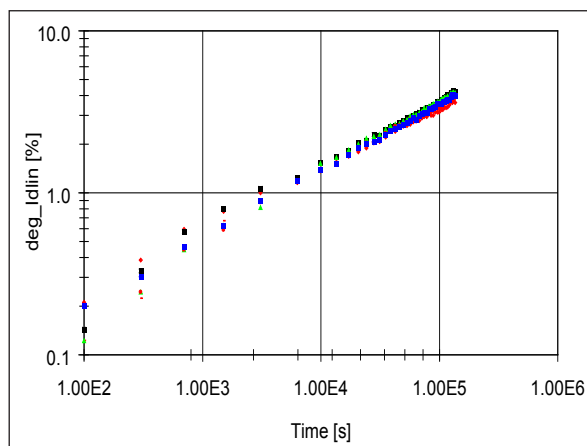
CMOS connection options
(Split Gate)

SMU	1	2	3	4	Gnd
Collector					✓
Emitter 1 to 8	✓				
Base 1 to 8		✓			✓
Bulk			✓		✓
Extra	✓	✓		✓	✓

Bipolar connection options
(Swap Collector and Emitter for
common Emitter option)



Easy and flexible experimental setup



Measurement results can also be exported in various
formats

Software

Included with all mb-Technologies test systems is **mbTester**: The all-in-one software package for characterization, setup and control of experiments, test program development and data analysis. Easy-to-use and powerful!

The software supports interactive characterization and data analysis as well as fully automated production testing in engineering and operator modes. Support of external equipment like wafer handlers and temperature chambers is provided.

A huge library of test plans covering typical measurements for many semiconductor devices, characteristic curves, parameter extraction, reliability algorithms and data analysis is included. Most of these test plans are used in the semiconductor industry for years and come with various configuration options.

Developing and debugging of test algorithms is easy by using the build-in programming language **mbScript** with features like context sensitive help, code completion and single stepping. The source code of all test plans and library functions is included and can be modified for special requirements or can be used as a starting point for new applications.

Depending on the hardware resources available any number of experiments and measurements can be executed in parallel. While test setup, control and data analysis is done on the PC the test execution takes place in the hardware so the measurement speed does not depend on the number of experiments running.

For customers using their own measurement environment a software interface for LabView® and other programming languages like C++ and Basic is included.

Specifications

SMU models

Model	Power	Output Voltage / Current	
SMU1012	15 W	< 100V: 150 mA	100 to 300V: 50 mA
SMU1022	20 W	< 50V: 400 mA	50 to 200V: 100 mA
SMU1032	30 W	< 100V: 300 mA	100 to 300V: 100 mA
SMU1052	50 W	< 50V: 1 A	50 to 200V: 250 mA

Voltage Ranges

Range	Resolution*		Accuracy
300 V	1 mV	10 mV	0.05% + 100 mV
20 V	100 µV	1 mV	0.05% + 10 mV
2 V	10 µV	100 µV	0.05% + 1 mV
200 mV	1 µV	10 µV	0.20% + 400 µV

Current Ranges

Range	Resolution*		Accuracy
1 A	5 µA	50 µA	0.05% + 1 mA
100 mA	500 nA	5 µA	0.05% + 50 µA
10 mA	50 nA	500 nA	0.05% + 5 µA
1 mA	5 nA	50 nA	0.05% + 500 nA
100 µA	500 pA	5 nA	0.05% + 50 nA
10 µA	50 pA	500 pA	0.05% + 5 nA
1 µA	5 pA	50 pA	0.05% + 500 pA
100 nA	500 fA	5 pA	0.10% + 100 pA
10 nA	50 fA	500 fA	0.20% + 20 pA
1 nA	5 fA	50 fA	0.50% + 5 pA

* Measure / Force Resolution

Switch Matrix, DUT-Boards

Isolation channel/channel	> 10 ¹² Ohms
Isolation channel/ground	> 10 ¹² Ohms
Thermal EMF	< 20 µV
Switching time	< 2 ms
Life expectancy	> 5 x 10 ⁸ cycles

Additional Parameters

Measurements (1/s)	> 300 typ. (measure only) > 100 typ. (including force change)
Timing accuracy	0.01% + 1 ms
Noise	0.01% (range) + 5 mV
SMU program buffer size	40000 operations
SMU data buffer size	10000 results

Specifications conditions:

- 23°C ± 5°C and RH < 60%
- 30 minutes warm-up after power-on
- Integration: LONG, accuracy NORMAL: 2x, FAST: 5x
- Calibration interval : 1 year

Stress

- Voltage or current stress possible
- Stress time 0.1 s to 106 s
- Stress time increments linearly, logarithmic or user defined
- Accurate stress times and slew rates
- Multiple stress voltages or arbitrary functions to simulate real applications
- Support of external stress other than electrical (e.g. temperature treatment, ionizing radiation)
- NBTI and BTS measurement w/o interruption of stress voltage
- Monitoring of stress voltages and currents and elimination of defective devices
- Delay time between stress and measurement allowing cool-down of devices

Measurement

- Any number of degradation parameters
- Curve measurements possible after every stress cycle
- Plausibility limits for degradation parameters
- Repeatability checking, e.g. double initial measurement
- Definition of reference devices which are measured but not stressed
- Elimination of devices if maximum degradation is reached
- Temperature correlation

Data Analysis

- Large data base for measurement results and conditions
- Extensive data analysis functions including various search options, charting and comparison with previous experiments
- Generation of Weibull plots and lifetime calculation
- Automation of data analysis and report writing
- Data export into customers engineering database



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