REEDHOLM

DATA SHEET

DS-10000

DC Parametric Analyzers

- **Five Platforms**
- **Expandable and Customizable**
- **Special Function Instruments**
- **Precision at Production Speeds**
- **Test & Characterization Software**
- **MS-DOS or Windows Interfaces**
- **Integrated Control of Prober or Handler**
- **Thermal Chuck Control**

Each model in table 1 can be built to address today's needs, yet be expanded in the field with optional instruments and software for tomorrow's needs.

- Four bias supplies and one digital multimeter.
- 8-pin switching matrix (96 for RI-70) and cabling.
- Test controller w/IEEE-488 interface.
- Monitor, keyboard, and printer.

Instrumentation Architecture

Modular instruments plug into a proprietary back plane with five active, and one ground, nodes. Figure 1 shows how any resource (bias or meter) can be connected to any pin. Instruments are shared among the various analyzers, so one set of spares can be used to support multiple platforms.

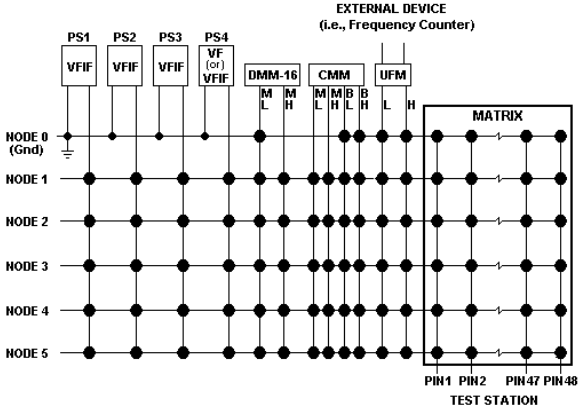

Figure 1 – Node Structure of CPM-Based System

Model	Description
RI-EG 	Instruments rack mounted in left bay of an Electroglas 2000 series high table. Has minimum footprint and simplest probe card cabling. Expandable to 64 PAM or 72 CPM pins.
RI-40 	Instruments placed in modular units nested vertically to provide smallest industry footprint. Has highest instrument capacity of all Reedholm systems. Expandable to 64 PAM or 96 CPM pins.
RI-70 	High pin count dc test system providing parametric capabilities to all pins. Expandable from 96 to 576 CPM pins plus can have 24 PAM pins installed bringing the total to 600 pins.
RI-75 	Test controller and instruments are mounted in 5' tall cabinet with internal room for rack-mounted expansions such as capacitance meters and high current supplies. Expandable to 64 PAM or 72 CPM pins.

Table 1 – Reedholm dc Parametric Analyzers

Switching Sub-System

The basic element in connecting to a device under test (DUT) is a Kelvin guarded switching module providing access to 8 DUT pins. For very low current measurements, a picoammeter matrix module (PAM) is used instead of the standard cross-point matrix module (CPM). Each PAM has a very low current node that increases sensitivity by 3 decades. The RI-70 is CPM based with possible PAM expansion. Other testers require CPM or PAM matrix selection at time of order.

Instrument Spans

Standard instruments provide up to ±200V and ±550mA augmented by the rich set of capabilities listed in table 2. Additionally, IEEE-488 controlled instruments can be added to further extend test capabilities.

Option	Description
CMM	One capacitance meter can be installed to provide measurements with ±100V dc bias. Excitation can be 15mV at 100kHz, 15mV at 1MHz, or 100mV at 1MHz.
2000V 4 Pins	One of these supplies can be installed to provide +2000V at 1mA for corona-free device and oxide breakdowns on 4 pins.
HVSMU	Two high voltage source-measure units can be installed to extend bias and measurement span to ±250V at 10mA. With -100V bias on low leg, a single HVSMU provides +350V DUT bias.
HISMU	One high current source-measure unit can be installed to provide pulsing and measurements up to ±5A at ±10V.
PPG	Two single channel programmable pulse generators can be installed to provide single or multiple pulses up to +30V at 300 or 1500Ω source resistance. Width can be 1µs to 65,534µs.
PPG-4	One four-channel programmable pulse generator can be installed. Each channel can output single or multiple pulses up to ±10.2V at ±50mA. Width can be 200ns to 200s.
SCM	A single self-calibration module provides dc voltage and dc current traceability to NIST standards.
UFM	Up to four user function modules can be installed to connect external instrumentation to the back plane and system matrix.

Table 2 – Instrumentation Extensions

Cabling and Probe Cards

Any type of probe card interface can be connected. Analog cabling provides guarded, Kelvin sensed connections to the probe card connector. The simplest standard interface has a 48-pin card edge connector for currents down to 100pA. An optional low current interface for currents <1pA has up to 24-pins for 100, 150, and 200mm wafers. Alternatively, the probe card interface assembly (PCIA) provides sub-pA measurements for all size wafers including 300mm.

Figure 2 – Probe Card Interface Assembly (PCIA)

PC-Based Control

Systems are memory mapped to a test controller running MS-DOS®. Data exchange with instruments is <2µsec/byte. The controller has networking software for easy connectivity to any Windows test client.

Modularization isn't limited to the instrumentation. Generally, test plans created on one platform can be used on other platforms. There are some exceptions; e.g., test plans with capacitance measurements cannot run on a system that doesn't have a capacitance meter.

When running the Reedholm Windows-based software, the controller is a slave to the test client.

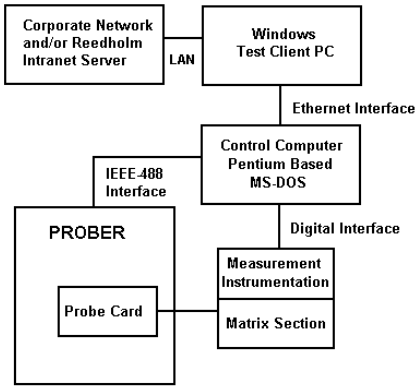

Figure 3 – RDS Intranet System Block Diagram

By using a real-time OS for testing, Reedholm test systems have the highest throughput plus accurate timing. That timing control is crucial when performing fast WLR and other time-based measurements.

Standard Software for Each System

- Pascal compiler for writing user test functions.
- Low-level instrumentation drivers.
- Acquire, EMAGE, EMPAC, and GrafPAC.
- Diagnostic and maintenance tools.

Automatic Prober Integration

Most IEEE-488 controlled automatic probers can be, or have already been, integrated with Reedholm application software. Control features include:

- Die (site) coordinate movement.
- Intradie (module or sub-die) movement.
- Multiple inkers with delayed inking.
- Off-line inking.
- Error detection and recovery.
- Material handling for wafer lot testing.
- Support of OCR and bar code readers.

Scope of Specifications

Unless Reedholm probe cards are used, instrument specifications apply to the end of a 41" prober analog cable (PAC) with no probe card attached.

Facility Requirements

Nominal system power is 117V±10% at 50 or 60Hz and 15A for the instrumentation cabinet, test controller, and test station monitor. Regulated system supplies isolate instrumentation from power line variations. Operation at other voltages requires external power transformers. For instance, step-up transformers are typically used in Japan, and step-down ones in Europe.

Additional computers and peripherals generally have built-in ±10% tolerance for power line variation, and can operate at 50 or 60Hz.

Environmental Conditions

Warranty only applies for these conditions:

- Temperature: 18°–28°C.
- Humidity: 10%–50% R.H. non-condensing.

Switching System Specifications

The switching sub-system is a critical element in dc parametric testing. Reedholm has developed well-guarded, low noise, low thermal crosspoint switching modules using dry reed relays.

Inherent long relay lifetimes are assured by elimination of hot switching (i.e., opening or closing relays when there is enough energy available to cause material transfer between switch contacts).

Specifications apply to the user function interface (UFM) as well as the CPM, PAM, and node switches on function modules.

Specification	Limit
Maximum stand-off voltage	±600V
Maximum carrying current	±2A
Pin leakage with ±100V on all other pins	<±10pA*(# of pins)
Pin-to-pin thermal emf	<±100µV
Shorted pin-to-pin resistance	<500mΩ
Switching speed including software delays	1ms

PAM-16 Specifications

Mode	Range	Measure Error		Resolution
		Offset	% of Value	
Current	100pA	250fA	0.2	6.25fA
	1nA	250fA	0.2	62.5fA
	10nA	2.5pA	0.2	625fA
	100nA	25pA	0.2	6.25pA

Comments:

1. Current noise is 7fA rms at a bandwidth of 20Hz. Averaging multiple readings reduces noise by the square root of the number of readings.
2. Settling time is <35ms to within 0.1% of the final value above 1nA and <50ms for the lower two ranges.
3. A/D conversion time is 50ms.

VFIF-16 Specifications

Mode	Range	Source Error		Resolution
		Offset	% of Value	
Voltage	2.5V	500µV [100µV]	0.05	78.125µV
	5V	1mV [200µV]	0.05	156.25µV
	10V	2mV [400µV]	0.05	312.5µV
	25V	5mV [1mV]	0.05	781.25µV
	50V	10mV [2mV]	0.05	1.5625mV
	100V	20mV [4mV]	0.05	3.125mV
Current	100nA	200pA	0.20	1.5625pA
	1µA	700pA	0.15	15.625pA
	10µA	2nA [700pA]	0.05	156.25pA
	100µA	20nA [6nA]	0.05	1.5625nA
	1mA	200nA [60nA]	0.05	15.625nA
	10mA	2µA [600nA]	0.05	156.25nA
	100mA	20µA [6µA]	0.05	1.5625µA
	1A	200µA [60µA]	0.10	15.625µA

Comments:

1. Maximum output current is 200mA on the 1A range.
2. Accuracy on lowest two current ranges requires line cycle integration.
3. Offset errors shown in brackets [ ] are for 8-hour period and ±1C°.

DMM-16 Specifications

Mode	Range	Measure Error		Resolution
		Offset	% of Value	
Voltage	250mV	250µV [50µV]	0.05	7.8125µV
	500mV	250µV [50µV]	0.05	15.625µV
	1V	300µV [75µV]	0.05	31.25µV
	2.5V	500µV [100µV]	0.05	78.125µV
	5V	1mV [200µV]	0.05	156.25µV
	10V	2mV [400µV]	0.05	312.5µV
	25V	5mV [1mV]	0.05	781.25µV
	50V	10mV [2mV]	0.05	1.5625mV
	100V	20mV [4mV]	0.05	3.125mV
Current	100nA	100pA*	0.20	3.125pA
	1µA	300pA*	0.15	31.25pA
	10µA	2nA*	0.05	312.5pA
	100µA	20nA	0.05	3.125nA
	1mA	200nA	0.05	31.25nA
	10mA	2µA	0.05	312.5nA
	100mA	20µA	0.05	3.125µA
	1A	200µA	0.10	31.25µA

Comments:

1. Settling time to 0.01%:
   4.0ms, 100nA Range
   2.3ms, 1µA Range
   1.7ms, 10µA-1A Ranges
   1.6ms, 250mV-100V Ranges
2. Accuracy is determined with digital averaging approximating a.c. power line cycle integration.
3. Range Error shown in parentheses [ ] applies for an 8-hour period after auto zero, and for ±1C°.
4. When measuring current from sources with non-zero output conductance, add the following amounts to the error specification: ±(830ppm of value + 151pA)/mho.

RDS Intranet Software

Windows-based RDS Intranet provides a complete solution for automated dc parametric test. The major difference is that the Intranet application runs as an intranet website for the entire facility. As a result, duplicate copies of test plans are no longer an issue. Everything is stored in a single database hosted on Microsoft SQL Server. Also, when the RDS Intranet application was written, numerous changes and enhancements were made:

- EMPAC and EMAGE were merged into Build, an integrated test plan editor.
- Acquire was simplified to only provide automated testing. Probe pattern creation was moved to Build.
- Acquire, GrafPAC, and EMAGE reports/plots were moved into one application: Examine.
- Support was added for more programming languages: Pascal for the test controller and Visual Basic, C++, etc. for the Windows computers.
- Lot data reports were written using MS SQL Reporting Services so that customers could change and expand reports as desired.
- The IE browser was used for the RDS Intranet GUI so that the latest interface technology (mouse, hyperlinks, multiple windows and frames, etc.) would be inherently available.

Migrating to Intranet from RDS DOS

To facilitate upgrading to the Intranet version, RDS DOS test plans, probe patterns, devices, and test data can be imported. Thus, previous investments in Reedholm software are not lost.

Database-Driven Testing and Probing

Reedholm testing remains data-driven under the Intranet code with data stored in an SQL Server database. Test data is downloaded over an Ethernet connection from the test client to the test controller. Having all tests in a database makes it easier to develop, maintain, and control test plan development.

Build (Test Plan Developer)

In addition to having the combined capabilities of EMPAC and EMAGE, Build has many enhancements:

- Execution of test lists as well as single tests.
- Separate test limits within a process definition.
- Version control & locking of test plans and limits.
- Up to twelve pins per device leg.
- More bias options for each device leg.
- Graphical editing of die and intradie patterns.

For example, Build provides the ability to change test types without having to re-enter pin and bias information. As shown in Figure 7, the test can be changed from "Beta at an I_c" to "Beta at an I_e" to "Beta at an I_b" with single mouse clicks.

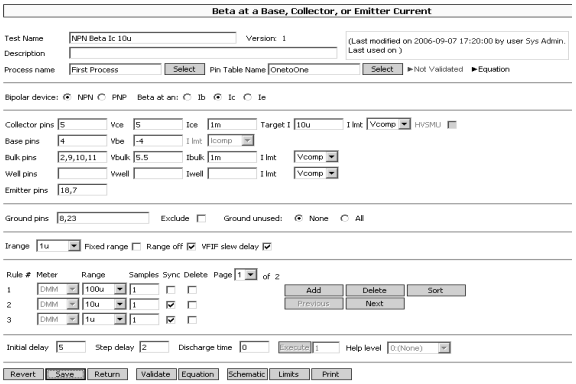

Figure 7 – Build Beta Test Input Screen

Acquire (Production Test Environment)

Acquire was simplified in RDS Intranet to handle only automated testing. Probe pattern and report configuration editing were moved to Build and Examine respectively. New Acquire features include:

- Display of test results without pausing.
- Validation of probe patterns and test plans required before lot testing begins.
- Devices and/or lots to be tested must match a user input list or one loaded from the network.
- A separate interface for packaged parts.

Examine (Analysis Tool)

Very few analysis or plotting features were added to Examine that didn't already exist in GrafPAC and EMAGE. Those provide more than enough capability to perform basic process evaluation and monitoring. To provide compatibility with 3rd party software and user enhancements, Examine can:

- Save plots to Windows clipboard or as JPEG, BMP, or PNG files.
- Apply equations to wafer maps, e.g. create wafer map of summed resistance measurements.
- Use equations and VB scripts on most plots.

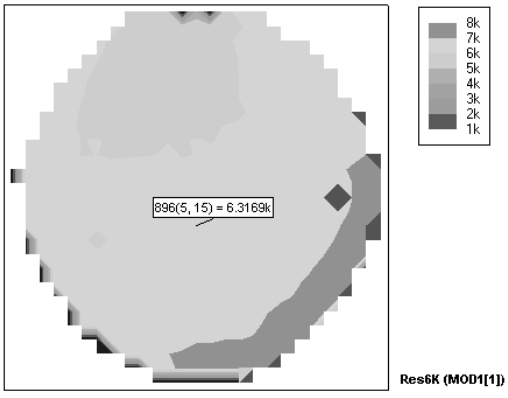

Figure 8 – Examine Contour Wafer Map

Maintenance Tools

A range of software tools ensures that the software, computer hardware, and instrumentation are running within specification. These tools provide troubleshooting to the module level, allowing maintenance personnel to quickly replace faulty elements with spares and get the system operational in minimum time.

Diagnostics

All of the instrumentation and analog cabling is confirmed for accuracy, connectivity, span, and power related specifications by self-test diagnostic programs. That includes:

- Leakage in matrix, back plane, cabling.
- Opens and shorts in matrix, back plane, cabling.
- Voltage and current forcing and limiting.
- Voltage, current, & capacitance accuracy.

A separate PAM diagnostic confirms not only operation of the PAM, but low leakage cabling and probe cards. Similarly, the CMM diagnostic assures capacitance performance and stability on a probe card.

Troubleshooting

Table 3 lists some of the additional software tools for system troubleshooting.

Tool	Description
HWPAS	Displays instrumentation memory registers and provides direct register control. Used to troubleshoot at the lowest level.
HOOKUP	Provides manual control of instrumentation from the test controller keyboard.
MODULE TESTS	Exhaustive test routines for each module provide in-depth information on instrument performance. These are used in Reedholm production test.
RISPEED	Provides operational speed of many low level routines. Is used to confirm timing control of the test controller.

Table 3 – Troubleshooting Tools

Calibration Tools

Each module can be calibrated using a pull-down menu and bench instrumentation. Additionally, the SCM and its SCAL and SELFCAL software provide calibration traceable to NIST through a customer-supplied high accuracy digital multimeter.

Running SELFCAL assures that accurate measurements are made with the standard instrumentation, even when calibration has not been performed. Thus, SELFCAL extends the time between module calibrations, and can actually eliminate them.

Warranty

Warranty is 12 months for defective parts and labor with work performed at the Reedholm Texas facility.

For remote facilities that cannot use overnight shipping effectively, a set of spares is an economical solution to minimizing downtime. Spares also reduce downtime that occurs when customs agents get involved.

Extended warranty and service contracts are available. However, service contracts are seldom justified for systems with demonstrated MTTF >36 months.

Open service purchase orders are an alternative to service contracts. With them, the engineer responsible for the test system can get someone from Reedholm involved without having to wade through lengthy approval delays.

User Training

While system training can occur at Reedholm or onsite during installation, training is best done at Reedholm. Doing so minimizes interruptions and maximizes learning. Onsite training must be ordered separately. The standard user training class covers:

- Building test plans and probe patterns.
- Device characterization and test optimization.
- Data analysis.
- Basic system maintenance.
- Importing DOS test plans if upgrading.

Other types of training classes such as in-depth maintenance, user function training, etc. are available.

Documentation

Documentation includes comprehensive user manuals that describe hardware and software operation down to the bit level. With RDS Intranet, all manuals are online except for the Getting Started one that also provides guidance in the remote chance that the Windows software is corrupted.

Support

Technical phone, fax, and e-mail support is available from the USA Monday through Friday excluding holidays. Local support is available from Reedholm distributors in many parts of the world.

With RDS Intranet, support is available via the GoToMeeting product. Via the Internet, this program allows Reedholm to take control of a test system for:

- Running maintenance programs.
- Troubleshooting device test issues.
- Applying software patches.