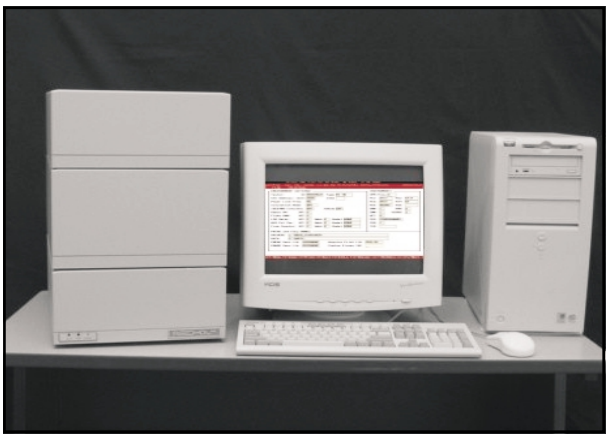
# DC Parametric Analyzer

## Model RI-40

- **Proven Speed Advantage**
- **Automatic Data Acquisition**
- **Kelvin Sensing to Probes**
- **Prober Control (IEEE-488)**
- **Full Screen Graphical Editor**
- **Variable Integration Times**
- **Powerful Parameter Extraction**
- **Sub-pA Measurements**
- **Network Compatible**



Delivering precision measurements at production speeds, the RI-40 modular dc parametric test system is the smallest footprint full-featured tester on the market. It contains a minimum of three sections: matrix, instruments, and power supplies. Additional sections can be added, allowing the system to be as flexible as possible to meet today's and tomorrow's test/measurement needs.

### PC-Based Control

The entire system is controlled by a Pentium-based computer with a memory mapped interface that enables communication between the computer and instruments in less than 10µs. Connecting the controlling MS-DOS® computer to widely used networks and other computers (from PC's to mainframes) for use with data bases is easy. Reedholm software license policy enables a distributed parametric test environment, which provides:

- Minimized test time.
- Desktop test plan development and analysis.
- Data uploading to other computers and servers.

Compared to slower UNIX® and other multi-tasking OS-based alternatives, the RI-40 has profound performance advantages in the areas of speed, low current measurements, ease of use, and Wafer Level Reliability (WLR) requirements. Leading semiconductor companies are finding these advantages justify a change from the old standard for next-generation process development and control verification.

### System Flexibility

Standard systems are capable of making parametric tests using up to 200V and 550mA. The self-calibration module provides conformance to ISO9000 for many customers.

Instruments are available to extend measurement capability from 200V to 1500V, and current capability from 550mA to 5A.

Other options include single- and four-channel programmable pulse generators. In addition, virtually any IEEE-488 controlled instrument can be added to the system to further extend measurement capability.

# Software

## EMPAC (Test Plan Development)

EMPAC (Electrical Measurements for Process Analysis and Control) is an editor for test plan development and maintenance. It is designed so an engineer can create a test, acquire data, and verify results in just a few minutes. Each parameter can be retested several times in order to optimize each test in the plan. This ensures accuracy, repeatability, and speed for each parametric test. All test results and conditions (pin assignments, forcing conditions, pass/fail limits) are stored as a record in an ASCII data file. Test plans can be added, deleted, or modified as necessary to maintain a modern dc parametric test system.

Password control helps maintain a secure environment. EMPAC's flexibility, completeness, and reliability are attractive to new dc test engineers and test veterans. Customers use EMPAC to generate test plans consisting of a few parameters to over 10,000 parameters. The test library is also expandable by the user.

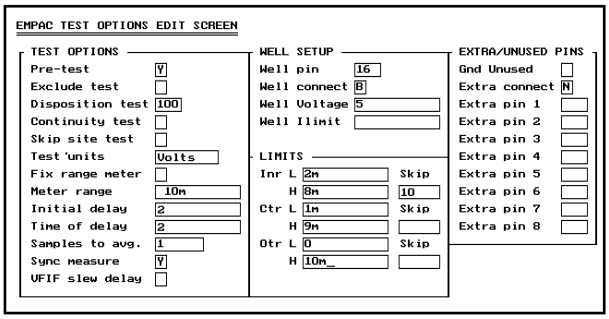



Figure 1 - EMPAC Edit Options Screen

## EMAGE (Structure Evaluation Tool)

EMAGE (Electrical Measurements for Analysis and Graphical Evaluation) is an automated digital curve tracer package. It is used for parameter extraction or device and material characterization. It can acquire this kind of data at the same time it is making standard parametric measurements.

All results are output in a flat ASCII format, which can be made compatible with commercial SPICE packages.

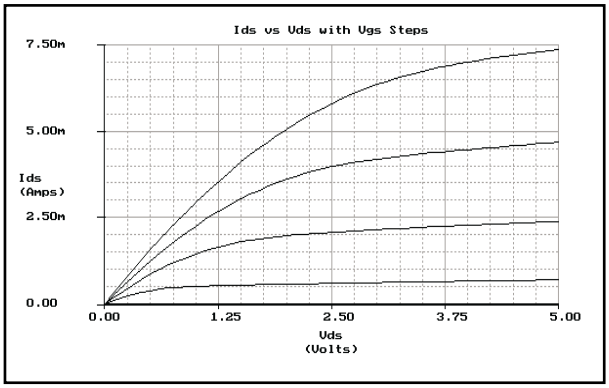



Figure 2 - EMAGE Drain Characteristics Curves

## Acquire (Test Plan Manager)

Acquire controls an automatic prober while coordinating execution of EMPAC and/or EMAGE test plans. Extremely large test suites can be built up for simple module or sub-die test structures. Acquire execution can be initiated using command line parameter passing, allowing the user to execute production from a shell program.

Acquire is used for the most demanding technology development applications as well as for WLR and E-Test production. Four reports (raw data, lot summary, wafer summary, and limit summary) are provided.

Export utilities exist for converting Acquire and EMAGE data files into the popular dBase IV format that is supported by most databases and spreadsheets, including: MS-EXCEL, MS-SQL Server, and Lotus 1-2-3.

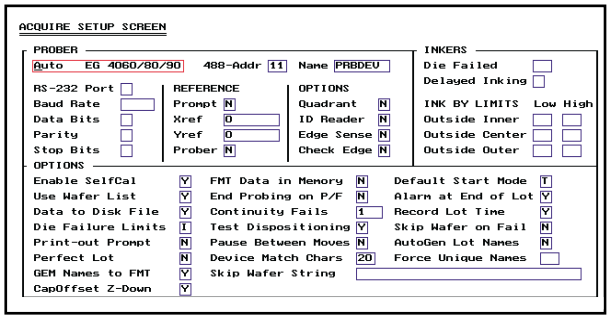



Figure 3 - Acquire Setup Screen

## GrafPAC (Analysis Tool)

GrafPAC gives users an interactive tool that can automatically take raw data generated by Acquire and turn it into information. Graphing capability includes:

- Trend charts
- Histograms
- Normal plots
- Scatter plots
- Wafers maps
- CDF plots

Selection of data to graph is provided by filters and lists. Features can be accessed with command line parameter passing. Standardized reports can be produced automatically.

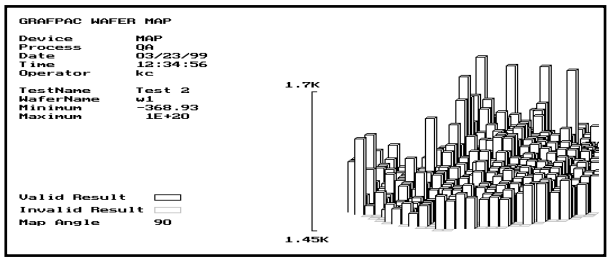



Figure 4 - GrafPAC Wafer Map

## Diagnostics

A range of tools is available to assure that all elements of a system are performing reliably and accurately.

- DIAG -Tests instrumentation and identifies failures
- HWPAS - Inspects instrumentation registers
- HOOKUP - Uses instrumentation in manual mode
- SELFCAL - Provides calibration traceable to NIST

# System Configuration

The base configuration includes one 8–pin crosspoint matrix module or a picoammeter matrix module, depending on current resolution required.

## Instrumentation Cabinet

Three Modular Chassis, Stacked Dimensions:
- CPM Configuration—L21" x W13" x H18.75"
  L533mm x W330mm x H476mm
- PAM Configuration—L21" x W13" x H20.75"
  L533mm x W330mm x H527mm

Switching Instrument Supplies

## Tester Computer

Check with factory for present model.

## Color Printer

Check with factory for present model.

## Matrix

DUT Interface—choice of:

- 8-pin Crosspoint Matrix Module (CPM) with 3–foot Prober Analog Cable (48-Pin Connector), and a Confidence Card, or
- 8-pin Picoammeter Module (PAM) with 4-foot Unterminated Analog Cable for each PAM, and a PAM Confidence Box.

## Instrumentation

(1) VF, Voltage Forcing Supply
(3) VFIF, Voltage/Current Forcing Supplies
(1) DMM, Digital Multimeter Module

## Standard Software

MS-DOS V6.2 or Later Operating System
Borland Pascal w/Objects™ V7.0
Reedholm Pascal Instrument Drivers
Reedholm Test Environments:
EMPAC, Acquire, and EMAGE
Reedholm Graphics Analysis: GrafPAC
Reedholm Instrumentation Diagnostics

## Automatic Prober Integration

Most commercially available IEEE-488 controlled automatic probers can be integrated with the RI-40 at Reedholm's facility. Depending upon the prober, features include:

- Coordinate or wafer map movement
- Automatic intradie movement
- Control of multiple inkers w/delayed inking
- Off-line inking
- Error detection and recovery
- Input of wafer list for batch mode operation
- Support of OCR and bar–code readers
- Skip site on failure

## Enhancement Options

**Matrix Expansions:**

Up to 64 Picoamp Pins, or up to 96 Crosspoint Pins

**C-V Units (±100V):**

100kHz @ 15mV, or 1MHz @ 15mV or 100mV

**Source Measure Units:**

High Voltage (±250V, 10mA)
High Current (±10V, 5A)

**High Voltage (1500V) Option**

**Pulse Generators:**

Single- or Four-Channel

**Low Current Probe Cards:**

24 or 48 Device Pins

**Self Calibration Module**

**User Function Module**

In general, any IEEE-488 controlled instrument can be integrated into Reedholm's test system as an option. Contact Reedholm for detailed descriptions and specifications.

# Support

## Warranty

Each system comes with a twelve–month factory warranty for defective parts and labor. Additionally, extended warranty and service contracts are available.

## User Training

Training on the use of diagnostic and applications programs can occur at the factory or on site during installation. The class covers experiment control, data analysis, and system maintenance.

## Documentation

Complete documentation delivered with the test system includes comprehensive user's manuals describing hardware and software, along with schematics of system elements.

## Application Support

Technical phone, fax, and e-mail support is available from the U.S. Monday through Friday, excluding holidays. Contact us by

- Phone: (512) 869-1935
- FAX: (512) 869-0992
- e-mail: support@reedholm.com

Local technical support from Reedholm's distributors is also available in many parts of the world.

# Specifications

Instrument hardware specifications apply at the end of a 3-foot prober analog cable (PAC) without a probe card attached. Some commonly used wafer test accessories (especially probe cards) significantly reduce parametric testing accuracy. Extreme care is taken in designing the test environment to achieve maximum performance.

## Use Conditions

**Temperature: 18°–28°C.**

**Humidity: 10%–50% R.H. Non-Condensing**

**Nominal Power: 120V, 50 or 60Hz**

Regulated supplies isolate the instrumentation from power line variations of more than ±10%. Specify nominal voltage and frequency when different than nominal.

## Switching System

The switching sub-system is a critical element of a dc parametric test station. Reedholm has taken special care to develop low noise, high performance matrix switching modules. These specifications apply to the user function interface module as well as the CPM, PAM, and node switching of the function modules.

Hazard detection software prevents “hot” switching of relays, thereby maximizing the operational life of the relays.

| | |
|---|---|
| Maximum Stand-off Voltage | ±600V |
| Maximum Carrying Current | ±2A |
| Pin-to-Pin Leakage (Guarded with ±100V) | <±10pA |
| Pin-to-Pin Leakage (Unguarded with ±100V) | <±1nA |
| Pin-to-Pin Thermal EMF | <±10µV |
| Pin-to-Pin Resistance (Shorted) | <500mΩ |
| Switching Speed (Including Software Delay) | 1ms |

## Voltage/Current Forcing (VFIF) Module

| Mode | Range | Source Error | | Resolution |
|---|---|---|---|---|
| | | Offset | % of Value | |
| Voltage | 2.5V | 2.5mV | 0.05 | 1.25mV |
| | 5V | 5mV | 0.05 | 2.5mV |
| | 10V | 10mV | 0.05 | 5mV |
| | 25V | 25mV | 0.05 | 10mV |
| | 50V | 50mV | 0.05 | 25mV |
| | 100V | 100mV | 0.05 | 50mV |
| Current | 100nA | 200pA* | 0.20 | 25pA |
| | 1µA | 700pA* | 0.15 | 250pA |
| | 10µA | 5nA | 0.05 | 2.5nA |
| | 100µA | 50nA | 0.05 | 25nA |
| | 1mA | 500nA | 0.05 | 250nA |
| | 10mA | 5µA | 0.05 | 2.5µA |
| | 100mA | 50µA | 0.05 | 25µA |
| | 1A | 500µA | 0.10 | 250µA |

Notes:
1. Maximum output current on 1A range is ±200mA.
2. Settling time is <2.5ms to within 0.1%.
3. CMRR: <0.002% of range per output volt in current.

*4. Accuracy is determined with digital averaging approximating line cycle integration.

## Voltage Forcing (VF) Module

| Mode | Range | Source Error | | Resolution |
|---|---|---|---|---|
| | | Offset | % of Value | |
| Voltage | 2.5V | 2.5mV | 0.05 | 1.25mV |
| | 5V | 5mV | 0.05 | 2.5mV |
| | 10V | 10mV | 0.05 | 5mV |
| | 25V | 25mV | 0.05 | 10mV |
| | 50V | 50mV | 0.05 | 25mV |
| | 100V | 100mV | 0.10 | 50mV |

Notes:
1. Current limit fixed at >200mA.
2. Settling time is <500µs to within 0.1%.

## Digital Multimeter (DMM) Module

| 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 |

Notes:
1. Maximum output current on 1A range is 200mA. On other ranges, the maximum is 125% of range.
2. Settling time to 0.01% 4.0ms, 100nA Range
   2.3ms, 1µA Range
   1.7ms, 10µA-1A Ranges
   1.6ms, 250mV-100V Ranges
3. CMRR Voltage: <5uV/V (106db)
   CMMR Current: <1ppm of range per volt, 10µA-1A
   <2ppm of range per volt, 1µA
   <6ppm of range per volt, 100nA

*4. Accuracy is determined with digital averaging approximating line cycle integration.
5. Accuracy of current measured on a given range is proportional to range error and a percentage of current being measured. For example, measuring 50µA on the 100µA range would have uncertainly of: 50µA ± (20nA + 0.05% of 50µA)=50µA ± 45nA.
6. Range Error shown in parentheses () applies for an 8-hour period after auto zero, and for ±1°C.
7. When measuring current from sources with non-zero output conductance, add the following amounts to the error specification: ±(830ppm of value + 151pA)/mho.

## Picoammeter (PAM) Module

| Mode | Range | Measure Error | | Resolution |
|---|---|---|---|---|
| | | Offset | % of Value | |
| Current | 100pA | 250fA | 0.2 | 50fA |
| | 1nA | 500fA | 0.2 | 500fA |
| | 10nA | 20pA | 0.2 | 5pA |
| | 100nA | 200pA | 0.2 | 50pA |

Notes:
1. Current noise is 20fA RMS at BW of 20Hz. Averaging multiple readings will reduce the noise by the square root of the number of readings averaged.
2. Settling time is <15ms to within 0.1% above 1nA and <50ms for lower two ranges.
3. A/D conversion time is 50ms for 60Hz line frequency and 60ms for 50Hz line frequency.