Setting up Experiments

Electromigration

Along with a few optional cells at the top of the input grid, shown in Figure 6, the subsections for EM test setup include:

- **General Set-up Parameters**
  The experiment bank number being used is entered along with the number of devices in the experiment. Whether to return to ambient temperature after the experiment has finished and whether to measure the optional offset voltages are also entered.
- **Time Parameters**
  The time parameters include the experiment duration, the initial stress time between scans, and a multiplier used to set a log or linear stress time step. In addition, the thermal soak time is included.
- **Stress Parameter**
  The stress parameters include the stress temperature and the current or current density used to accelerate the failure mechanism. The temperature ramp rate is also included along with a cell to indicate whether stress is removed while failed devices are shorted.

	Comment	Fab 10 EM Experiment				Tracking	
	Operator	17249		Facility	San Jose		
EM Scanner 1	Process	CMOS12		Structure	2		

General Setup/Parameters							
Bank	1	Devices	32	Temp Off	N	Meas Offsets	Y
Time Parameters							
Length	1k	Delay	600	Multiplier	1.1	Soak	15
Stress Parameters							
Temperature	400	Idens	_	Current	15m		
Ramp Rate	5	Area		Zero Strs	Y		
Test/Fail Parameters							
Inf Min R	65	Inf I	1m	Fail %	30		
Inf Max R	150	Inf J		Jump %	2		

Figure 6 - Electromigration Input Grid

Stress Migration

Along with same optional cells at the top of the input grid, shown in Figure 7, the subsections for stress migration test setup include:

- **General Set-up Parameters**
  The experiment bank number being used is entered along with the number of devices in the experiment. Whether to return to ambient temperature after the experiment is also entered.
- **Time Parameters**
  The time parameters include the experiment duration, the initial stress time between scans, and a multiplier used to set a log or linear stress time step. In addition, the thermal soak time is included.
- **Stress Parameters**
  The stress parameters include the stress temperature and the temperature ramp rate.
- **Test/Fail Parameters**
  In this section, resistance limits used for the infant scans are entered along with the test current or test current density used during all scans. The failing resistance shift for each device under stress is also included, as well as the resistance increase that will cause “no data” scan test results to be stored.

	Comment	Fab 10 Stress Migration Experiment				Tracking	
	Operator	17243		Facility	San Jose		
Stress MI 1	Process	CMOS12		Structure	1		

General Setup/Parameters							
Bank	1	Devices	32	Temp Off	N		
Time Parameters							
Length	1k	Delay	600	Multiplier	1.1	Soak	15
Stress Parameters							
Temperature	400	Ramp	5				
Test/Fail Parameters							
Inf Min R	65	Test I	_1m	Fail %	30		
Inf Max R	150	Test J		Jump %	2		
Area							

Figure 7 - Stress Migration Input Grid

Joule Heat

Unlike test setup for EM and stress migration tests, the Joule Heat test requires two input grids, which are shown in Figures 8 and 9. Along with a few optional cells at the top of the first input grid, it contains subsections for general setup and test parameters for a single experiment. The second grid contains a section for the temperature ramp parameters, which are used by all experiments in the same oven.

- **General Set-up Parameters**
  The experiment bank number being used is entered along with the number of devices in the experiment.
- **Test Parameters**
  The test parameters include the resistance limits used for the infant scans along with the test current used during the infant scans. The parameters include the start and stop stress current, as well as the current step size, to use at each temperature.

  The percentage shift, which defines the final resistance for each device under stress, is also included in this subsection of the grid, along with the time to wait for DUT cooling before making the next current or temperature step, the delay between resistance measurements, and the maximum time to wait for a failure at step.
- **Ramp Parameters**
  The ramp parameters include the start and stop temperature and the temperature step size. Also included are the temperature ramp rate, the length of time to wait at each temperature before current stress and DUT measurements begin, and whether to return the thermal chamber to ambient temperature at the end of the ramp.

  Lastly, the experiment setup file name(s) are specified for the three possible experiments sharing this Joule heat ramp input grid.

Comment: FAB 10 Joule Heat Experiment | Tracking:
Operator: 17243 | Facility: San Jose
Process: CMOS12 | Structure: 3

Joule Heat 1

General Setup/Parameters

Bank	01	Devices	32

Test Parameters

Inf I	1m	Cool Delay	60
Inf Min R	45	Meas Delay	120
Inf Max R	110	Time Out	30_
Start I	10m		
Stop I	20m		
Step I	5m		
Change %	1		

Figure 8 - Joule Heat Test Input Grid

Joule Heat Ramp

Ramp Parameters

Bank	01	1st RMT	JH1
Start Temp	300	2nd RMT	JH2
Stop Temp	400	3rd RMT	JH3
Step Temp	50_		
Ramp Rate	5		
Soak Time	15		
Temp Off	N		

Figure 9 - Joule Heat Ramp Input Grid

Handling Data

Whether experiments are running or complete, information is available in the form of logs, reports, and summaries. Figure 10 exemplifies a graphical output.

For each EM or stress migration experiment, multiple data files can be generated by reprocessing the original data using new failure limits. Each new data file can then be analyzed separately.

- **Logs**
  A sequential log of each experiment contains dates and times of start-up, completion, and time each scan is taken. Other pertinent information is also recorded in the log.
- **Reports**
  Each report consists of an experiment description, the set-up conditions, and the information for each scan, which includes scan number, scan type (infant, scheduled, and post), elapsed time, number of devices failed, percentage of devices failed, temperature, measured voltage, and stress current. Reports can either be displayed on the monitor or sent to the printer.
  Reports can also be sent to disk for later retrieval and can include data from either individual devices or all devices in an experiment. Another option allows viewing results of only the first and last scheduled scans and the post scans.
- **Summaries**
  A summary can be generated in two different ASCII file formats: one in report format for printing and one in PRN format for graphing via EMAGE. The summaries available include: lognormal, cumulative failure, test result over time, and change in result from initial value over time.
  For Joule heat tests, summaries are generated in PRN format and include plots of resistance over time at each current and temperature and final resistance as a function of current at each temperature.

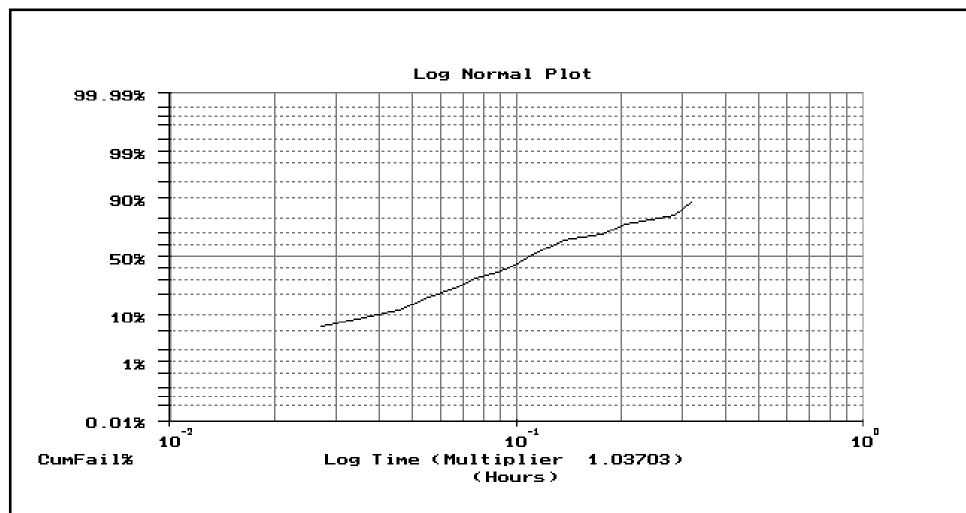
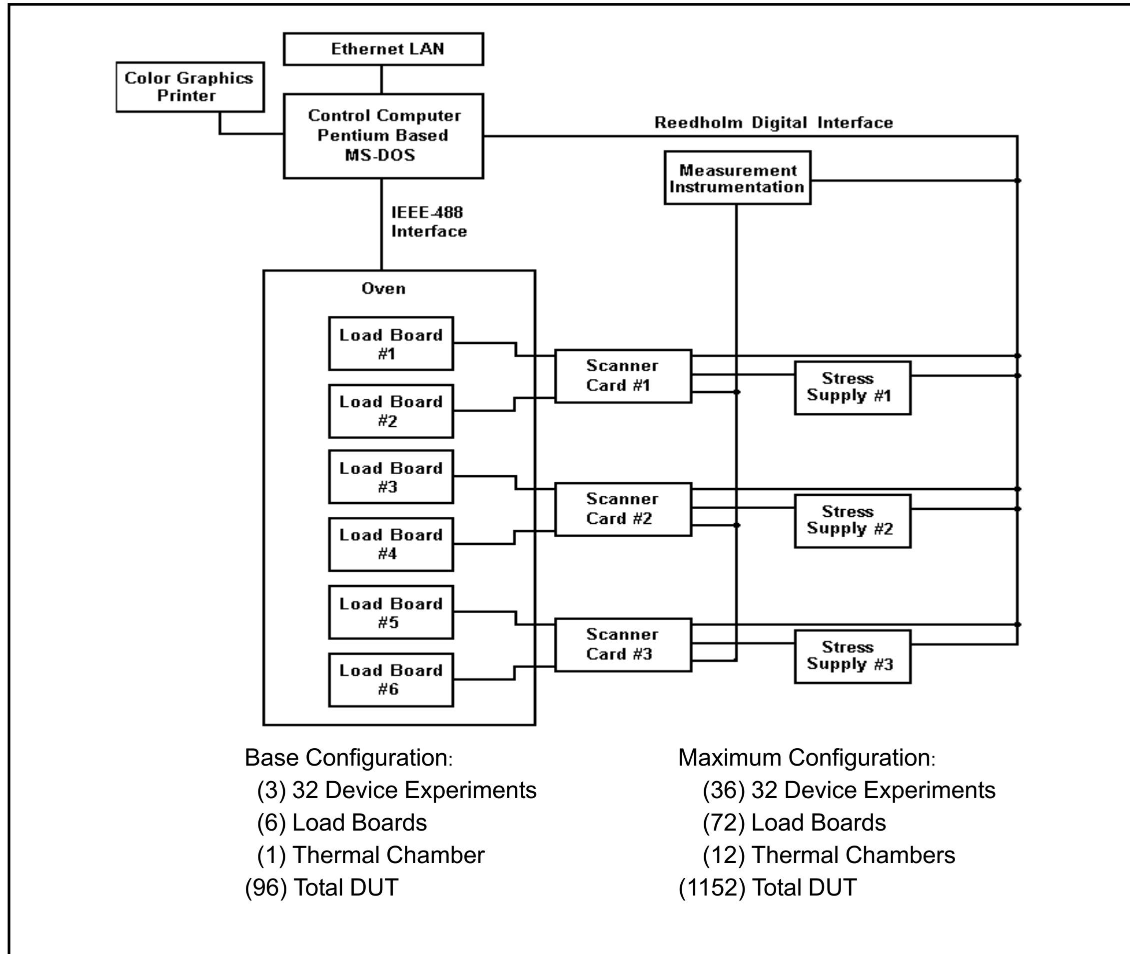


Figure 10 - EMAGE Cumulative Fail Plot

RI-52 System Block Diagram



Base System Configuration

Instrument Enclosure

Floor Standing Dimensions:
L24” x W36” x H62”
L610mm x W914mm x H1575mm
Switching Instrument Supplies
(2) Backplane Assemblies

Tester Computer and Printer

Check with factory for present models.

Thermal Chamber

Check with factory for present model.

Stress Instrumentation

(3) ISM, Current Stress Modules

Test Instrumentation

(1) DMM, 16-Bit Digital Multimeter
(1) VFIF, Voltage/Current Forcing Module
(1) CPM, Crosspoint Matrix Module

Interconnection

(3) Scanner Modules
(1) Node Extender Module
(2) Node Terminator Modules
(6) 6’ DUT Oven Analog Cables
(3) 6’ Extrusion Oven Analog Cables
(3) 32” High Temperature Analog Cables

Load Boards

(6) Device Load Boards (16 DUT each)

Specifications

Use Conditions

Temperature: 18°C - 28°C
Humidity: 10% - 60% R.H. Non-Condensing
Nominal Power:
System 120V, 60Hz
Thermal Chamber 240V, 60Hz

Instrument Enclosure

For a standard configuration, the RI-52 enclosure is a seven foot, mobile rack with separate card files for scanner modules and measurement instrumentation. The test computer and printer are placed on a table adjacent to the instrumentation chassis.

Inside the test system, static power units provide dc voltages to the scanner and the instrument backplanes.

Switching System

A critical element of a dc reliability system is the switching sub-system. Reedholm has taken special care to develop low noise, high performance scanner modules. In addition, hazard detection software prevents "hot" switching of relays and thereby maximizes the operational life of the relays.

Maximum Stand-off Voltage ±600V
Maximum Carrying Current ±2A
Experiment Isolation Resistance $10^{11}\Omega$
Measurement Leakage Resistance
$10^{11}\Omega$/Total Number of Experiments in Group
Switching Speed (Including Software Delay) 1ms

Current Stress Module (ISM)

Mode	Range	Source Error		Resolution
		Offset	% of Value	
Current	10mA	5µA	0.05	2.5µA
	100mA	50µA	0.05	25µA
Voltage	100V	100mV	0.05	50mV

Digital Multimeter (DMM) Module

Mode	Range	Measure Error		Resolution
		Offset	% of Value	
Voltage	0.25V	250µV (50µV)	0.03	7.8125µV
	0.5V	250µV (50µV)	0.03	15.625µV
	1V	300µV (75µV)	0.03	31.25µV
	2.5V	500µV (100µV)	0.03	78.125µV
	5V	1mV (200µV)	0.03	156.25µV
	10V	2mV (400µV)	0.03	312.5µV
	25V	5mV (1mV)	0.03	781.25µV
	50V	10mV (2mV)	0.03	1.5625mV
	100V	20mV (4mV)	0.03	3.125mV
Current	100nA	100pA*	0.20	3.125pA.
	1µA	300pA*	0.15	31.25pA
	10µA	2nA*	0.05	312.5nA
	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

Voltage/Current Forcing (VFIF) Module

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)V	0.05	3.125mV
Current	100nA	200pA*	0.20	3.125pA
	1µA	700pA*	0.15	31.25pA
	10µA	2nA (700pA)	0.05	312.5pA
	100µA	20nA (6nA)	0.05	3.125nA
	1mA	200nA (60nA)	0.05	31.25nA
	10mA	2µA (600nA)	0.05	312.5nA
	100mA	20µA (6µA)	0.05	3.125µA
	1A	200µA (60µA)	0.10	31.25µA

Notes:
1. ISM Voltage compliance maximum 100V.
2. DMM and VFIF current accuracy on two lowest ranges is measured with line cycle integration.
3. DMM Range Error in parenthesis ( ) applies for eight-hour period after auto-zero and for ± 1°C.
*4. Accuracy is determined with digital averaging approximating line cycle integration.

Support

Warranty

Each system comes with a twelve-month factory warranty covering defective parts and workmanship. Extended warranty and service contracts can be negotiated.

User Training

Training on the use of the system and software can occur at the factory or on site during installation. The training includes the starting of simple experiments.

Documentation

Complete documentation is delivered with the test system. This includes comprehensive user's manuals describing hardware and software along with schematics of all instrumentation, load boards, and cabling.

Technical Support

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

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

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