REEDHOLM

SUPPORT NOTE

SN-122

Movement Times with EG2001 Probers

I) Overview

Total test time when using an automatic prober includes communication delays as well as prober movement times. This note provides die-to-die movement times of the Electroglas EG2001 prober for those wanting to maximize throughput. Die-to-die times are broken down into communication times and actual prober movement times.

Timing data for serial (RS-232C) communication as well as Start/End-of-Test TTL handshaking is based on an internal Electroglas memo from 1998, reproduced in section IV) of this document. Additional timing data was taken under control of two Reedholm software environments:

- RDS DOS 8.03
- RDS Intranet 1.1

A) Electroglas Probing Speed Findings

The EG2001X cannot be run much faster than using the RS-232 mode with a direct TTL connection and using START/EOT signals instead of handshaking through a computer communication port.

Such a conclusion seems to contradict table 4 in this document, but the times in that table were for conditions under which no communication occurred with a test computer. That type of environment is one in which ink is the only clue about quality of a die.

Parametric testing applications require die location as well as test data per die, so site information is exchanged between the prober and the test controller. Location of sites to be tested is typically stored in the test program, and that information is sent to the prober. Eliminating prober-controller communication does not have a major impact on throughput. Based on the fastest times reported by Electroglas, test communication overhead of 20 msec is <20% of total time it takes to step from one die to another.

B) Probing Speed Under IEEE-488 Control

Without operating in time-sharing mode, and with using the IEEE-488 interface, some Reedholm customers approach die-to-die stepping times of 100 msec per die. That is close to the limit of 2001X stepping speed.

For most parametric test system applications, stepping time of 100 to 200 msec is insignificant because total test times are tens of seconds per die. On the other hand, prober movement time is often the largest factor in throughput testing thousands of die per wafer in dc final test requirements.

II) Prober Speed Factors

EG2001 prober movement times are known for these interfaces:

- TTL (data from Electroglas memo)
- RS-232 (data from Electroglas memo)
- IEEE-488 (data taken using RDS DOS 8.0)
- IEEE-488 (data taken using RDS Intranet 1.0)

A) Serial Interface Not Supported

Although data on serial interface speed is provided in this note, Reedholm no longer provides RS232 prober interfaces. That is because the full handshaking required to have robust serial handshaking is seldom implemented on the 2001X prober interface.

Employees who were at Reedholm when the RS-232 interface was provided recall the IEEE-488 mode being faster but this recollection is not documented. More recent experiments show the IEEE-488 mode being slightly slower than that of the RS-232 times in the Electroglas memo (table 4).

B) DC Test Applications

In dc test applications gathering a few parameters per die from thousands of die per wafer, a few msec of additional movement time is costly in terms of throughput. But prober movement speed is not the only factor in throughput.

It does not take many problems with loss of synchronization of an RS-232C interface before a slight speed advantage is eliminated. Thus, robustness of the IEEE-488 interface (e.g., 100% hardware handshake and ability to readily pass information between the tester and prober) outweighs potentially faster speeds with a serial interface. Without abandoning the IEEE-488 interface, times can be shortened through optimization and multi-die probing.

1) Optimization

Optimizing test conditions by characterizing each test and fix-ranging instruments where practical can have a major impact on test speeds. Through optimization assistance, Reedholm has helped some customers reduce test times by 10:1.

2) Multi-Die Probing

If the probe card is set up to touch down on multiple die at the same time, total movement times are calculated by dividing by the number of die being accessed. For example, movement time of 90 msec and communication time of 20 msec per die, or 110 msec total per die, would be reduced to 50 msec (90/3 + 20) per die if three die were probed at each prober touchdown.

III) Probing Times in IEEE-488 Mode

Reedholm has been providing DOS based test systems with IEEE-488 interfaces for nearly 20 years. To complement those test systems, Reedholm released Intranet based software that communicates with probers through the IEEE-488 bus.

A) Times with RDS DOS 8.0

An Acquire test plan was created consisting of one test that takes no time (empty user function) with a target of 500 die for a nominal 150mm wafer. Test execution time was 2.75 msec in simulation mode. This experiment can be duplicated by using the test plan and probing pattern files in folder 2001time.

Die Size (mils)	Total time (sec)	Total Die	Stepping Time (sec)
15 x 15	113	500	0.226
30 x 30	116	500	0.232
60 x 60	118	500	0.236
120 x 120	124	500	0.248
240 x 240	114	427	0.267
480 x 480	28	94	0.298

Table 1 –IEEE-488 Times w/RDS DOS 8.0

For both cases of IEEE-488 timing measurements, overtravel was 3 mils and Z-clearance was 20 mils to match data from the Electroglas memo. Also, prober software version in both cases was 249799-101.CD.

Although there is not enough space on a 6” wafer for 500 of the largest die, there was a consistent progression in stepping times as step size increased.

B) Times with RDS Intranet 1.0

As expected, timing for the Intranet version was virtually identical. Slight differences were due to use of an equation in the Intranet checkout (took <10µsec) versus 2.75 msec for a simulated test under DOS.

Die Size (mils)	Total time (sec)	Total Die	Stepping Time (sec)
15 x 15	112	500	0.224
30 x 30	113	500	0.226
60 x 60	117	500	0.234
120 x 120	122	500	0.244
240 x 240	112	427	0.262
480 x 480	27	94	0.287

Table 2 –IEEE-488 Times w/RDS Intranet 1.0

IV) EG Memo

Basic prober speed information in this section was taken from an electronic file memo dated 9/22/98 written to Mr. WeiBing Chu from Chuck Heebner of Electroglas. Reformatting of the memo from was done to make the information more accessible, and some editing was done to expand/clarify what seemed to be intended. The original memo is available as a Notepad file, 2001TPUT1, on Reedholm’s in-house server.

A) Timing Tables

The first column in table 3 is for RS-232 speed with 20 mils of Z clearance instead of 10 mils. The RS-232 code reads the TS message and sends back a bin code so there is software overhead not encountered with the TTL interface, hence the mention of the computer type, etc. The second column in table 3 is data from the first column with 64 milliseconds added as the estimated time overhead to use a Z-type of 0.25mil instead of 0.5mil which results in a total Z move of 46mils.

Table 4 uses the TTL interface for the TEST START-TEST COMPLETE message. A difference in throughput compared to table 3 is readily apparent. RS-232 times are slower due to software overhead and an extra 10 mils of Z-travel.

B) RS232 Test Conditions

Data were taken under these conditions:

- TSXnYn read until CR received (CR=carriage return, the only terminator) then TC0 is sent for a bin code.
- No inking, no theta angle (no off axis or theta comp probing).
- All tests done with the same computer and program (MS Visual C/C++, Blaise Asynch lib v.4.0).
- Computer was a T.I. 4000E 486 DX2/50.

These were the 2001X conditions:

- Time: 12:51:48, Date: 07/07/94
- Output filename: 20011.TST
- Software: 249799-001DB
- Z-type: 0.5
- Overtravel in mils: 3
- Clearance in mils: 20

Die Size (mils)	Stepping Time (seconds)	
	0.5 Ztype	0.25 Ztype
40 X 40	0.130	0.194
50 X 50	0.130	0.194
100 X 100	0.141	0.205
150 X 150	0.151	0.215
200 X 200	0.159	0.223
250 X 250	0.162	0.226
300 X 300	0.169	0.233
350 X 350	0.179	0.243
400 X 400	0.184	0.248
450 X 450	0.199	0.263
500 X 500	0.196	0.260
550 X 550	0.229	0.293
600 X 600	0.209	0.273
800 X 800	0.240	0.304

Table 3 – RS-232 Movement Times

C) TTL Interface Times

The data in table 4 was taken using a PC for control, measuring from "TF" to "PC", and dividing the total time by the number of dice probed. In this case however, the TTL Test Start signal was shorted to the Test Complete signal. This is a throughput test measuring die-to-die stepping time with a TTL interface, NOT RS-232 or GPIB. It is the fastest the prober can move.

Data were taken under these conditions:

- Time: 12:42:45, Date: 5/6/94
- Output filename: A:TEST1
- Software: 249799-121.DA
- Z-type: 0.5
- Overtravel in mils: 3
- Clearance in mils: 10
- Starting die size: 15
- End die size: 300
- Die increment: 15
- ID: 2001X.DA.249799-121

Die Size (mils)	Total time (sec)	Total Die	Stepping Time (sec)
15 x 15	33.06	413	0.080
30 x 30	35.15	410	0.086
45 x 45	38.23	425	0.090
60 x 60	42.35	452	0.094
75 x 75	39.87	411	0.097
90 x 90	40.59	405	0.100
105 x 105	41.96	405	0.104
120 x 120	16.20	154	0.105
135 x 135	43.83	403	0.109
150 x 150	44.77	403	0.111
165 x 165	46.03	406	0.113
180 x 180	46.74	404	0.116
195 x 195	42.95	363	0.118
210 x 210	41.41	345	0.120
225 x 225	25.10	209	0.120
240 x 240	27.19	223	0.122
255 x 255	30.10	243	0.124
270 x 270	27.40	217	0.126
285 x 285	24.66	193	0.128
300 x 300	22.69	174	0.130

Table 4 - TTL Start-EOT Times

D) Unexplained and Uncertain Data

Some references in the Electroglas memo were not fully understood at the time this note was published.

- Surprisingly, non-monotonic test increases were not explained or even mentioned in the original memo.
- Z-type seems to be a standard EG term, but is not explained in the EG user manual.