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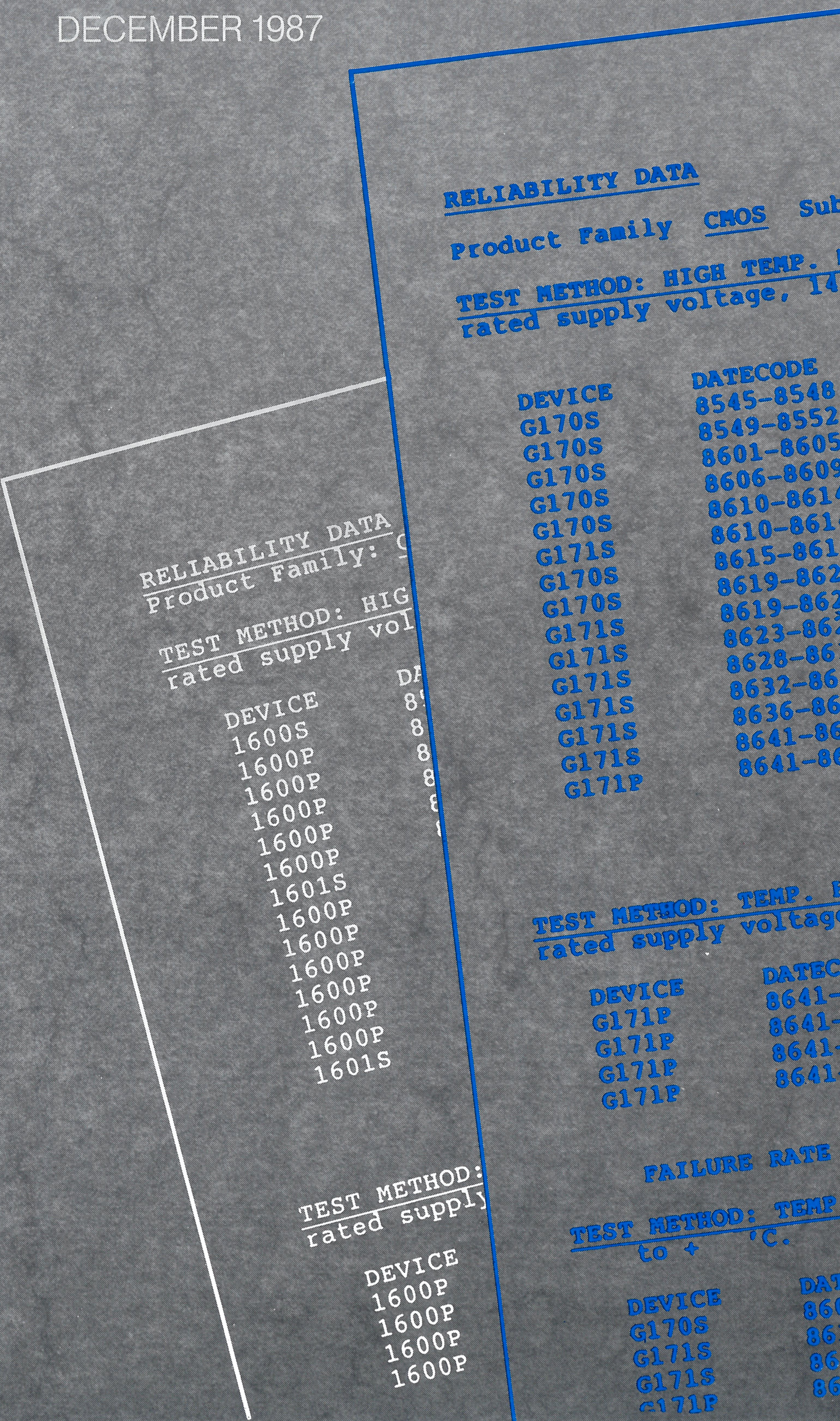
RELIABILITY UPDATE

DECEMBER 1987



INTRODUCTION

INMOS is an industry leader in VLSI product and has been supplying memory devices to a broad industry base of military and commercial users since 1980. As part of INMOS' commitment to provide its customer with high quality, its high performance devices have been, and will continue to be, evaluated for reliability through regular ongoing evaluations. The presentation of the data generated by these programs is the purpose of this Reliability Update. A brief description of INMOS reliability goals, monitored Burn-in studies and soft-error rates are discussed in this publication.

PRODUCT MONITORING PROGRAMME (PMP) OVERVIEW

Outgoing product reliability is evaluated through the Product Monitoring Program (PMP). The PMP regularly tests statistically significant samples of all INMOS products for compliance with INMOS quality and reliability goals.
All PMP samples are taken from standard production lots that have received the same manufacturing processing as standard product shipped to our customers. Therefore, the life test and plastic packaging data are statistically representative of the results any purchaser of INMOS product would obtain by conducting similar tests.
Plastic technology introduces another set of reliability concerns aside from operating life failure rates. The results of tests specifically oriented toward evaluation of plastic packaging performance are also presented. INMOS use advanced plastic packaging technologies that have high reliability performance levels.
The recent 'raw' data gathered is provided to give customers a view of the performance versus time and the option of computing rates of failure by their own methods (at the bottom of each chart the period's overall failure rate is calculated). INMOS computes individual life test failure rates to 55°C using 60% confidence level for lot specific estimates and 90% confidence for cumulative failure rates. The details of the computational method which includes a table that enables customers to convert these estimates to alternative confidence levels, are presented in the INMOS Quality Assurance and Reliability Bulletin.

Harry De Burlatte
Director of Quality

INMOS OUTGOING QUALITY AND RELIABILITY PLANS FOR MEMORY AND MICRO PRODUCTS

INMOS has established a set of goals for their standard product. These aggresive quality and reliability goals also require a sampling level that guarantees a number of failures to ensure the statistical significance and accuracy of the sampling. All goals are based on 90% confidence level.

SOFT ERROR RATE (SER) CHARACTERISATION

There has been, and continues to be, considerable debate in the industry regarding the best method of gathering soft-error rate (SER) data. INMOS has elected a hybrid philosophy of SER testing, using hot source accelerated characterisations and system level test data.
Our success in this approach lies in fundamental considerations that are outlined in a separate paper (Ref:1). Possibly because of the outgrowth of SER testing from the traditional treatments, the consequences of system architectures and the SER's dependence on cycle time have been long overlooked. The discussion in the paper reviews these considerations in the relatively simple circumstances common to the architectures of most SER test systems. The methodology has yielded close correlation to system-level data furnished by INMOS' customers and from INMOS' own system-level testing - the total data base encompassing differing INMOS products, differing test system architectures, and differing system operating conditions. The characterisation data has provided the means of estimating the SER in an application with an accuracy that is probably limited by the ability to simulate the sytems's memory access activity.
Reference 1 - Soft Error Rate Characterisation, issued February 1986.
Copies available from INMOS Sales Offices.

MONITORED BURN-IN (MBI) STUDIES - MANUFACTURING BURN-IN

All INMOS product is electrically tested and burnt-in prior to shipment. Historically, the industry has selected burn-in times using the MIL-Standards as a guide (when market would support the cost) or on a "best guess" basis dominatd by cost considerations. Until relatively recently, there has been no practical means of amassing the data base needed to make a technically sound choice of burn-in time/temperature conditions that minimise cost without creating an unknown jeopardy of increasing the rate of "early life" failures to the customer. INMOS have sophisticated monitor life test systems in their manufacturing locations enabling the monitored burn-in programme to periodically evaluate production lots and establish the infant mortality level and time to failure.

INMOS has been a leader in using monitored burn-in data combined with long term HTOL to establish the most cost effective burn-in schedule for products without compromising high standards of quality and reliability. These monitored burn-in studies began in 1982, with a tight correlation to failures identified by final electrical test.

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MIL STD 883C

(Standard Military Product to Class B)

- Colorado Springs, USA

  SRAMS

- Newport, Wales, UK

  Microcomputers

  Digital Signal Processors

  Selected SRAMs

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INMOS Quality Goals

- Outgoing electrical quality (all defects)

  OQL

  Year end 1986 - 300 PPM

  Year end 1987 - 200 PPM

  Year end 1988 - 100 PPM

  Year end 1989 - 50 PPM

- Outgoing mechanical quality (all defects)

  OQL

  Year end 1986 - 700 PPM

  Year end 1987 - 500 PPM

  Year end 1988 - 300 PPM

  Year end 1989 - 100 PPM

CMOS RELIABILITY DATA

TEST METHOD: HIGH TEMP. BIAS - 1000 HRS - Continuous operation at rated supply voltage and 140 °C.

Device Type	Device Hrs	Effective eV	Failure Rate
IMS 1403	1.57E6	0.70eV	10 FIT's
IMS 1423	2.99E6	0.72eV	29 FIT's
IMS 1600	4.28E6	0.76eV	11 FIT's
IMS 1620	3.63E6	0.65eV	25 FIT's
IMS 1630	4.44E5	1.00eV	10 FIT's
IMS A100	3.24E5	0.70eV	62 FIT's
IMS G17X	4.23E6	0.66eV	13 FIT's
IMS T414/212	1.01E6	0.77eV	37 FIT's
OVERALL LEVEL	1.85E7	0.71eV	13 FIT's

TEST METHOD: TEMP. HUMIDITY BIAS - 1000 HRS - Continuous operation at rated supply voltage, minimum power, 85 °C, 85% RH.

Device Type	Device Hrs	% Failure Rate
IMS 1403P	5.56E5	0.6 %
IMS 1423P	2.57E6	0.3 %
IMS 1600P	1.53E6	1.7 %
IMS 1620P	1.29E6	1.4 %
OVERALL LEVEL	5.94E6	0.8 %

TEST METHOD: TEMPERATURE CYCLE - 500 CYCLES - Air to Air, 10 minute dwell temperature -65 °C to +150 °C.

Device Type	Device Cycles	% Failure Rate
IMS 1403	8.0E5	0.24 %
IMS 1423	5.8E5	0.46 %
IMS 1600	2.3E5	0.84 %
IMS 1620	9.3E5	1.20 %
IMS G17X	4.9E5	0.55 %
IMS T414/212	1.7E5	1.10 %
OVERALL LEVEL	2.4E6	0.26 %

INMOS Test Flow

- Pre burn-in test
- Burn-in @ 140 °C 18H minimum
- Post burn-in test 98 °C minimum
- PDA (Percent Defect Allowed) 5% maximum
- Device symbolisation
- QA final acceptance

INMOS Reliability Standard

- **High Temperature Operating Life (HTOL)**

  140 °C, 5.5V Dynamic

  100 FITS for 1K hours @ 55 °C
- **Temperature Humidity and Bias (THB)**

  1% at 1K hours (85 °C/85% RH)
- **Temperature Cycling Condition C (TC/C)**

  1% at 1K cycles (-65 °C to 150 °C)
- **Based on 90% confidence level**

MILITARY CONFORMANCE TESTING ON ALL PRODUCT QUALIFIED TO MIL STD 883C METHOD 5005, CLASS B, GROUPS B,C AND D

QUALITY REQUIREMENTS PLANNING - GROUP B TESTS

Subgroup	Test	Method	Test Conditions	LTPD (n/c)
1	Physical Dimensions	2016	Per DP Outline Drawing/Customer S.C.D.	(2/0)
2	Resistance to Solvents	2015	4 Chemical Solutions	(4/0)
3	Solderability	2003	Soldering temperature of +245 °C on three devices minimum	10
4	Internal Visual and Mechanical	2014	Failure criteria based on design and construction requirements of DP spec	(1/0)
5	Bond Strength	2011	Test condition C or D	15
8	Electrical Parameters Electrostatic Discharge Sensitivity Electrical Parameters	3015	Category A minimum requirement for all products. Unless otherwise specified, test shall be performed only for initial qualification of new product.	(15/0)

QUALITY REQUIREMENTS PLANNING - GROUP C TESTS

Subgroup	Test	Method	Test Conditions	LTPD (n/c)
1	Steady State Life Test End Point Electrical	1005	Condition D 1000 hrs @ 125 °C	5
2	Temperature Cycling	1010	Ta = 65° C to +150° C, 10 cycles	15
2	Constant Acceleration	2001	Y1 Orientation 30,000g	
2	Hermeticity, Fine/Gross	1014	Tracer Gas (Fine) or Fluorocarbon (Gross)	
2	Visual Examination	1010	Per DP Specification	
2	End Point Electrical	5006	Per DP Specification/Customer S.C.D.	

MILITARY CONFORMANCE TESTING ON ALL PRODUCT QUALIFIED TO MIL STD 883C METHOD 5005, CLASS B, GROUPS B,C AND D

QUALITY REQUIREMENTS PLANNING - GROUP D TESTS

Subgroup	Test	Method	Test Conditions	LTPD (n/c)
1	Physical Dimensions	2016	Per DP Outline Drawing/Customer S.C.D.	15
2	Lead Integrity	2004	Test Condition B2, Lead Fatigue	15
3	Thermal Shock	1011	Ta = -55° C to 125° C, 15 cycles	15
3	Temperature Cycling	1010	Ta = -65° C to 150° C, 10 cycles	
3	Moisture Resistance	1004	90% Relative Humidity, 10 cycles	
3	Hermeticity Fine/Gross	1014	Tracer Gas (Fine) or Fluorocarbon (Gross)	
3	Visual Examination	1010	Per DP Specification/Customer S.C.D.	
3	End Point Electrical	5006	Per DP Specification/Customer S.C.D.	
4	Mechanical Shock	2002	1,500 (g) @ 0.5ms Y1	15
4	Vibration/Variable Freq.	2007	20 (g)	
4	Constant Acceleration	2001	Y1 Orientation 30,000 (g)	
4	Hermeticity Fine/Gross	1014	Tracer Gas (Fine) or Fluorocarbon (Gross)	
4	Visual Examination	1010	Per DP Specification/Customer S.C.D.	
4	End Point Electrical	5006	Per DP Specification/Customer S.C.D.	
5	Salt Atmosphere	1009	24 Hours	15
5	Hermeticity Fine/Gross	1014	Tracer Gas (Fine) or Fluorocarbon (Gross)	
5	Visual Examination	1010	Per DP Specification/Customer S.C.D.	
6	Internal Water Vapour	1018	5,000 ppm max water content @ Ta = +100° C	(5/1)
7	Adhesion of Lead Finish	2025	Bend 90 °C, Inspect at 10X to 20X magnif.	15

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