Reliability Qualification Report

for

Serial NOR Flash with Pb/Halogen Free (Industrial)

AS25F1128MQ-70SIN : 8SOP (208mils)
AS25F1128MQ-70WIN : 8 WSON (6x5mm)

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4-1. Product reliability qualification test summary

1. Information

1.1 Device Code

- AS25F1128MQ-70SIN

1.2 Design Information

- Design Rule : .65nm technology.
- Cell Size ($6F^2$) : 0.15um x 0.3um = $0.045um^2$
- Chip Size (with S/L: 60um) : 3,052 mm x 3,320 mm = $12.07mm^2$

1.3 Wafer Fabrication

- Foundry : SMIC
- Technology : 2 Poly / 3 Metal 65nm.
- Gate Oxide : 44 Å / 156 Å dual gate oxide
- Gate : n+ / p+ poly + Co-Salicide
- Metal : W / AlCu
- Top layer : Passivation UV SiN 6000 Å

1.4 Assembly

Package : 8pin SOP 208-mils

- Assembly house : GREATEK
- Test Location : ChipMOS.
- Lead frame : SHINKO A-194
- Molding compound : Sumitomo G700
- Wire Material : TANAKA 4N

Package : 8L WSON (6x5x0.85mm)

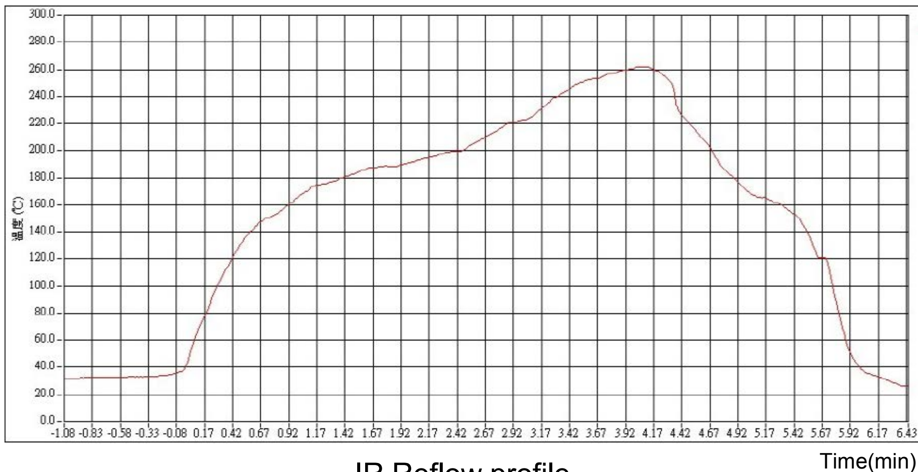
- Assembly house : GREATEK
- Test Location : ChipMOS.
- Lead frame : A194
- Molding compound : Sumitomo G700H
- Wire Material : TANAKA 4N
- Lead Finish : Pure Tin

2. Product Reliability Test Description

Test item		Test Condition	Reference	SS(ea)	Acceptance Criteria
EFR		125℃, VCC=2.2V VIH=1.95V, Dynamic	JESD22A108 JESD74	5400ea	1000ppm
HTOL		125℃, VCC=2.2V VIH=1.95V, Dynamic	JESD22A108	300ea	0fail
Endurance		85℃, VCC=2.2V VIH=1.95V	JESD22A117	231ea	0fail
HTS		150℃	JESD22A103	180ea	0fail
TC		-65℃/150℃	JESD22A104	180ea	0fail
PCT		121℃/100%RH 30psia	JESD22A102	180ea	0fail
THB		85℃/85%RH, VCC * 1.2	JESD22A101	135ea	0fail
HAST		130℃/85%RH 33.3psia, VCC * 1.2	JESD22A110	180ea	0fail
ESD	HBM	C=100pF, R=1.5K 3 times stressing Forward each pin against Vss or Vcc	MIL-STD-883F	9ea	0fail
	CDM	Field	JESD22C101	9ea	0fail
		Direct	ESDASTM 5.3.1	9ea	0fail
	MM	C=200pF 3 times stressing Forward each pin against Vss or Vcc	JESD22A115	9ea	0fail
Latch up	I-test	Positive / Negative	JESD78	18ea	0fail
	V-test	Positive			
Precon		Refer to below	JESD22A113	675ea	0fail

❖ With Precondition as follows :

T/C 5 cycle ➔ T/H 192hrs ➔ IR reflow (3times)
(-65℃/150℃) (30℃/60%RH) (T peak = 260℃)



IR Reflow profile

3. Test Results Summary

3-1. Test Result Summary

Item	Result			
	Test Results	QFAEP2174	QFAEP2173	QFAEP2172
EFR	0/5400	0/1800	0/1800	0/1800

Item	Result			
	Lot Number	168hrs	504hrs	1008hrs
HTOL	QFAEP2174	0/100	0/100	0/100
	QFAEP2173	0/100	0/100	0/100
	QFAEP2172	0/100	0/100	0/100

Item	Result				
	Lot Number	10kcycles	20kcycles	50kcycles	100kcycles
Endurance (85℃)	QFAEP2174	0/77	0/77	0/77	0/77
	QFAEP2173	0/77	0/77	0/77	0/77
	QFAEP2172	0/77	0/77	0/77	0/77

Item	Result			
	After Pre-condition	168hrs	504hrs	1008hrs
HTS	N.A	0/180	0/180	0/180

Item	Result			
	After Pre-condition	200 Cycles	500 Cycles	700 Cycles
T/C	N/A	0/180	0/180	0/180

Item	Result		
	After Pre-condition	96hrs	168hrs
PCT	N/A	0/180	0/180

Item	Result			
	After Pre-condition	168hrs	504hrs	1008hrs
THB	N/A	0/135	0/135	0/135

Item	Result		
	After Pre-condition	48hrs	96hrs
HAST	N/A	0/180	0/180

3-2. ESD Test Result Summary

Item	Results
HBM (± 2000V)	Pass (0/9, 3lots) 2000V Pass
MM (± 200V)	Pass (0/9, 3lots) 200V Pass
CDM (± 1000V)	Pass (0/9, 3lots) 1000V Pass

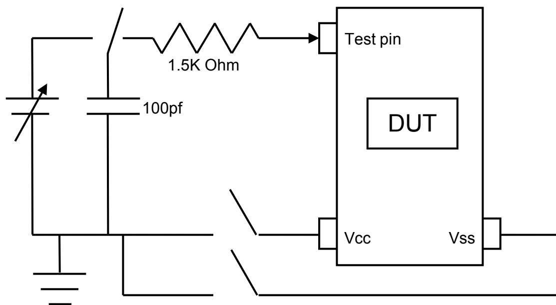


Fig 3-2-1 Test Circuit of HBM

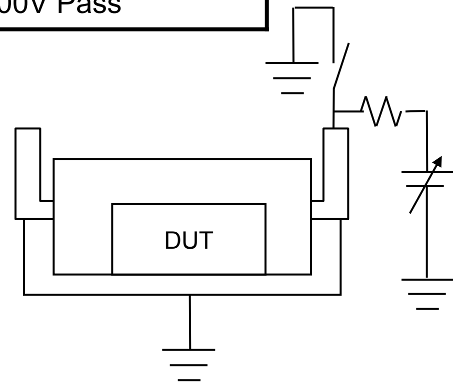


Fig 3-2-2 Test Circuit of CDM

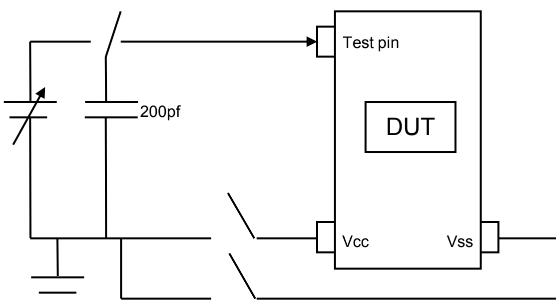


Fig 3-2-3 Test Circuit of MM

3-3. Latch-up immunity

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Input Pin Level</th><th rowspan="2">Measurement Pin</th><th rowspan="2">Test Condition</th><th>Latch-up Voltage & Current</th></tr>
<tr><th>Result</th></tr>
<tr><td rowspan="2">Vcc Pin</td><td>Vcc</td><td rowspan="2">Vcc
(see Fig 3-3-1)</td><td rowspan="2">Vcc, over >= 3.0V
Temp=85°C</td><td rowspan="2">Pass(0/9, 3 lots)
>= 3.0V</td></tr>
<tr><td>GND</td></tr>
<tr><td rowspan="2">Input Pin</td><td>Vcc</td><td rowspan="2">Input
(see Fig 3-3-2)</td><td rowspan="4">Icc, trig >=±150mA
Temp = 85°C</td><td rowspan="2">Pass(0/9, 3 lots)
> ± 150mA</td></tr>
<tr><td>GND</td></tr>
<tr><td rowspan="2">Output Pin</td><td>Vcc</td><td rowspan="2">Output
(see Fig 3-3-2)</td><td rowspan="2">Pass(0/9, 3 lots)
> ± 150mA</td></tr>
<tr><td>GND</td></tr>
</table>

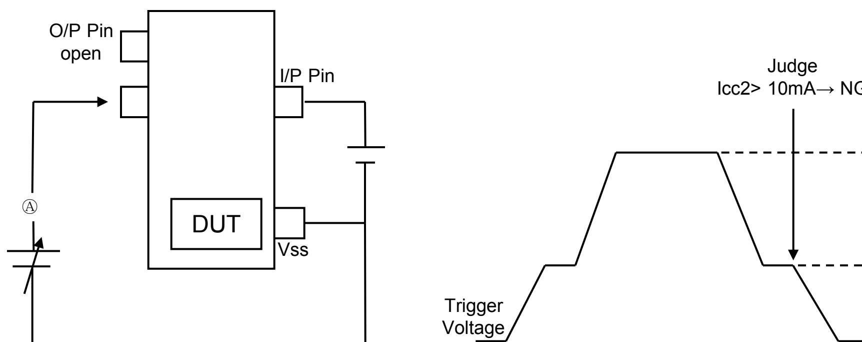


Fig 3-3-1 Set up of Power Supply Over Voltage Latch-up test

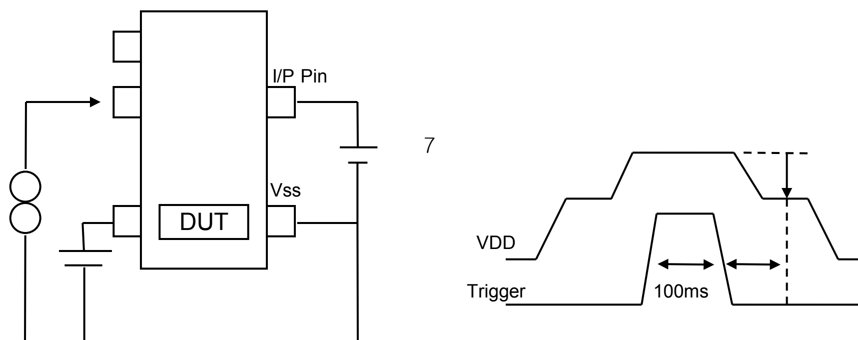


Fig 3-3-2 Set up of Current Injection Latch-up test

3-4. Pre-condition Result

Item	Result
Pre-Con	Pass Level III (0/675)

Estimation of hard error rate from HTOL

1. Acceleration factor

To Estimate of hard error rate from EFR and HTOL, we assumed the acceleration factors as follows:

Thermal Acceleration Factor : $AF_{th} = \exp(Ea/K_B)*[(1/T_{c_use}) - (1/T_{c_stress})]$

$Ea = 0.77eV$, $T_{c_use} = 85^{\circ}C$, $T_{c_stress} = 125^{\circ}C$, $K_B = 8.62*10^{-5}$ eV/K

Electrical Acceleration Factor : $AF_{el} = \exp[\beta(V_{stress}-V_{use})]$

$\beta=3.82$, $VCC_{_use} = 1.95V$, $VCC_{_stress} = 2.2$ V(EFR), 2.2 V(HTOL)

Where

Ea : Activation Energy(eV)

K_B : Boltzman constant($8.62*10^{-5}$ eV/K)

T : Absolute temperature(K)

β : Voltage acceleration factor(1/V)

2. Hard Error Rate Estimated

- 1.8 V power supply products
- Actual usage condition ; $T_{c_use} = 85^{\circ}C$, $VCC_{_use} = 1.95V$
- Test condition :

$T_{c_stress} = 125^{\circ}C$, $VCC_{_stress} = 2.0V$(EFR), 2.0V(HTOL),

Assuming that failure time depend on exponential and weibull distribution.

Thermal acceleration : $AF_{th} = 12.27$ ($T_{c_use} = 85^{\circ}C \rightarrow T_{c_stress} = 125^{\circ}C$)

Electrical acceleration of EFR : $AF_{el(EFR)} = 2.60$ ($VCC_{_use} = 1.95V \rightarrow VCC_{_stress} = 2.2V$)

Electrical acceleration of HTOL : $AF_{el(HTOL)} = 2.60$ ($VCC_{_use} = 1.95V \rightarrow VCC_{_stress} = 2.2V$)

Total acceleration of EFR = $AF_{th} \times AF_{el(EFR)} = 31.88$

Total acceleration of HTOL = $AF_{th} \times AF_{el(HTOL)} = 31.88$

Hard Error Rate = (failure count at confidential level = 60%)*10^9 / (2*(Device hours)*AF)

, where device hours from HTOL stress is sample size multiplied by stress time, and voltage and temperature acceleration factors.

Duration	Sample Size	No. of Failure	FIT (C.L.=60%)	MTTF (years)
168H	300	0	570	200
504H	300	0	190	600
1008H	300	0	95	1200

Product reliability qualification test result

Test items	Conditions	Samples	No of fail
EFR	Ta = 125°C, VCC = 2.2V 48hrs	1800 * 3	0
HTOL Test	Ta = 125°C, VCC = 2.2V 1008hrs	100 * 3	0
Endurance	85℃, VCC=2.2V, 100k cycle	77 * 3	0
HTS Test	Ta= 150°C 1008hrs	45 * 4	0
TC Test	-65°C / 150°C* 700cycle	45 * 4	0
HAST Test	130°C / 85% RH VCC * 1.2 t = 96hrs	45 * 4	0
THB Test	85°C / 85% RH VCC * 1.2 1008hrs	45 * 3	0
PCT Test	Ta=121°C, 30psi 100% RH, 168hrs	45 * 4	0
ESD Test	HBM V=±2000V	3 * 3	0
	MM V=±200V	3 * 3	0
	CDM V=±1000V	3 * 3	0
Latch-up Test	Current Injection I = ± 150mA	3 * 3	0
	PSOV = ± 3.0V	3 * 3	0
Pre-condition	Temp. cycle(-65°C/150°C,5cycle)+ Soak (30°C/60%RH,192hrs)+ IR Reflow(250°C, 3 times)	675	0