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Qualification Test Report on NE292series

Prepared on : February 20, 2001

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This report presents the qualification test results on NE292series.
NE292series are Hetero Junction FET die that utilizes hetero junction between Si-doped AlGaAs and undoped InGaAs to create high mobility electrons.

1. *Test Device*
   NE29283B (83B : hermetic seal ceramic package)

2. *Qualification test*
   A series of qualification tests consists of following items :
   1) *High Temperature DC Bias Test*
   2) *High Temperature Reverse Bias Test*
   3) *High Temperature Storage Test*

   The test conditions are shown in Table 1. The test parameters and criteria are shown in Table 2.

3. *Test Results*
   1) *High Temperature DC Bias Test (HTPT)*
      No failure has been observed in HTPT until 5000 hours. The test results are shown in Table 3 and the change of all parameters are shown in Figure 1.

   2) *High Temperature Reverse Bias Test (HTBT)*
      No failure has been observed in HTBT until 5000 hours. The test results are shown in Table 3 and the change of all parameters are shown in Figure 2.

   3) *High Temperature Storage Test (HT)*
      In order to investigate metallurgical stability such as gate, drain and source electrodes, HT-test were performed at Ta=227℃, 259℃, 295℃ and 337℃.
      The test results are shown in Table 4 and the change of all parameters are shown in Figure 3 ~ 6. The failure mode has been confirmed to be VGF degradation.
      The decrease of VGF is considered to be due to gate schottky degradation caused by some metallurgical reaction between Ti of gate metal (Ti-Al) and AlGaAs in gate recess.
      The Weibull plots and the Arrhenius plots are shown in Figure 7 and 8 respectively.
      They were plotted according to the results under the failure mode of △VGF = -20%.
      The MTTF value at the channel temperature of 125℃ was estimated to be 4.0×10^8 hours under the failure mode of △VGF = -20% (activation energy of 1.86eV).

4. *Conclusion*
   From above-mentioned HT-test result, the MTTF value of NE29283B is estimated to be 4.0×10^8 hours at the channel temperature of 125℃.
   Moreover, no failure has been observed in HTPT and HTBT until 5000 hours.
   Therefore, the NE292series demonstrates high reliability performance for the operating at channel temperature of 125℃ and below.

Table 1. Qualification test item and test condition

Test Item	*Test Condition*	*Quantity*	*Remarks*
High Temperature DC Bias Test	*Tch=175℃, Vds=3V, Ids=15mA* *t=5000hr, up to F(t)>50%*	*20pcs*	*No degradation* *up to 5000hr*
High Temperature Reverse Bias Test	*Ta=150℃, Vgss=-2.4V* *t=5000hr, up to F(t)>50%*	*20pcs*	*No degradation* *up to 5000hr*
High Temperature Storage Test	*Ta=227℃, 259℃, 295℃, 337℃*	*each 10pcs*	*No degradation* *up to 5000hr*

Table 2. Electrical parameter and Criteria

Electrical Parameter	*Symbol*	*Test Condition*	*Delta Criteria*
Gate to Source Forward Voltage	*VF(GS)*	*VGS= 1uA*	±20%
Gate to Source Leak Current	*IGSO*	*VGS= -3V*	*+300nA or +100% whichever is greater*
Drain Current	*IDS*	*VDS= 0.5V, VGS= 0V*	±20%
Saturated Drain Current	*IDSS*	*VDS= 2.0V, VGS= 0V*	±20%
Transconductance	*gm*	*VDS= 2.0V, IDS= 10mA*	±20%
Gate to Source Cutoff Voltage	*Vp*	*VDS= 2.0V, IDS= 100uA*	±20%

Table 3. Summary of Qualification Test Results on NE29283B

Test Item	Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)						Ref. Figure
		168	500	1088	2094	3259	5011	
High Temperature DC Bias Test	Tch=175℃ Vds=3.0V, Ids=15mA	0/20	0/20	0/20	0/20	0/20	0/20	Figure 1

Test Item	Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)						Ref. Figure
		236	473	1426	2091	3047	5048	
High Temperature Reverse Bias Test	Ta=150℃ Vgss=-2.4V	0/20	0/20	0/20	0/20	0/20	0/20	Figure 2

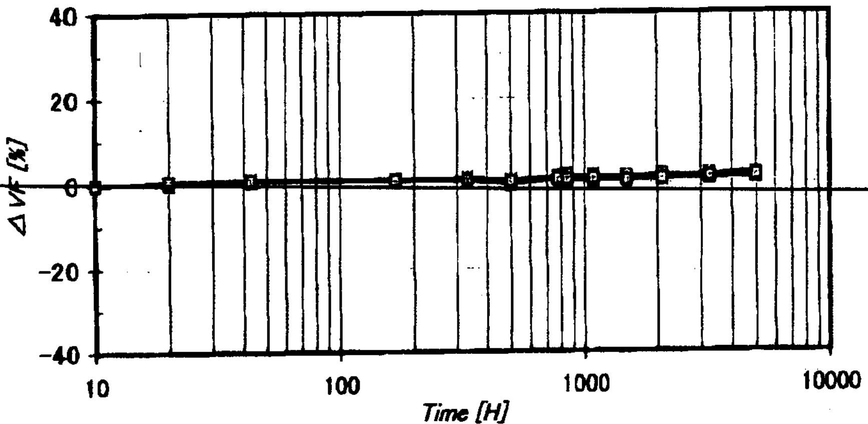
Table 4. Summary of High Temperature Storage Test Results on NE29283B

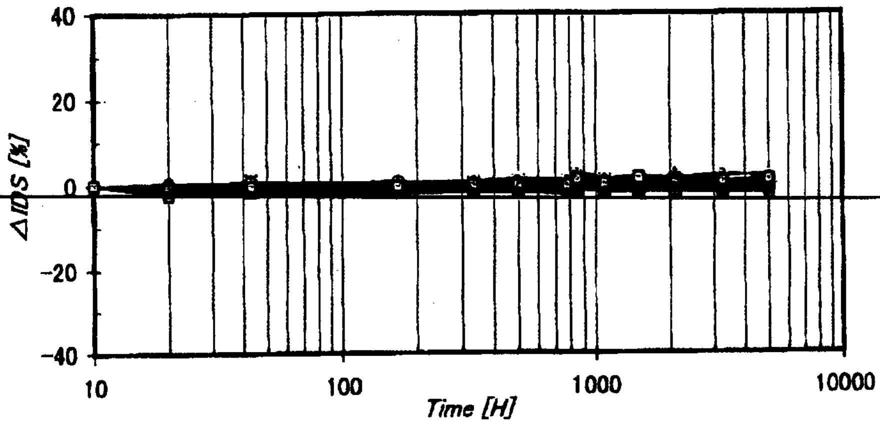
Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)									Ref. Figure
	24	168	495	1072	1525	2000	3122	4122	5075	
Ta=227℃	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	Figure 3

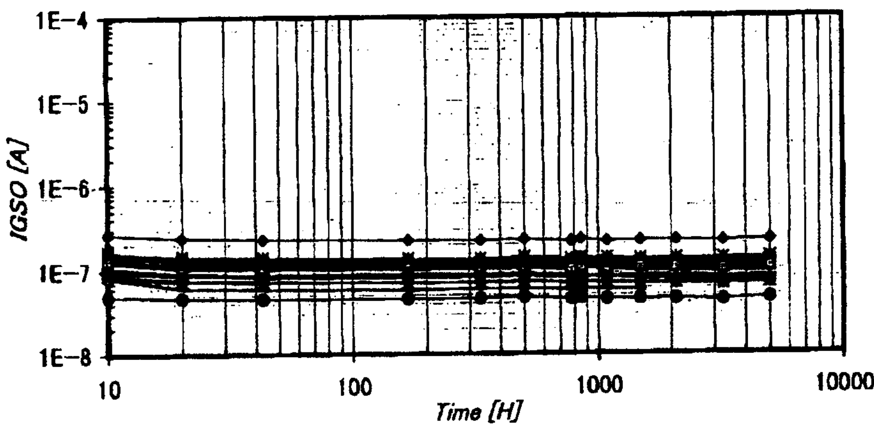
Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)									Ref. Figure
	24	48	96	168	352	495	740	1072	1525	
Ta=259℃	0/10	0/10	0/10	0/10	0/10	6/10	10/10	10/10	10/10	Figure 4

Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)						Ref. Figure
	6	12	24	48	96		
Ta=295℃	0/10	0/10	0/10	0/10	0/10		Figure 5

Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)									Ref. Figure
	0.5	1	2	4	8	16	32	64	96	
Ta=337℃	0/10	0/10	0/10	10/10	10/10	10/10	10/10	10/10	10/10	Figure 6







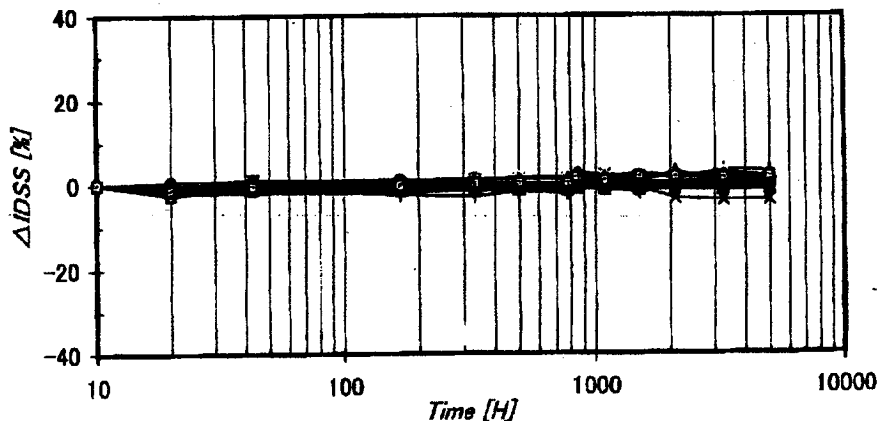
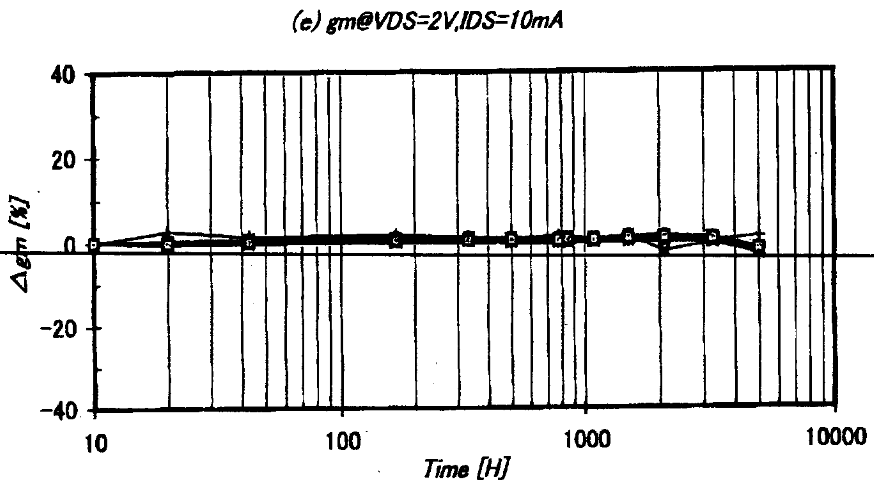


Figure 1-1. High Temperature DC Bias Test Results (Tch=175℃,Vds=3V,Ids=15mA)



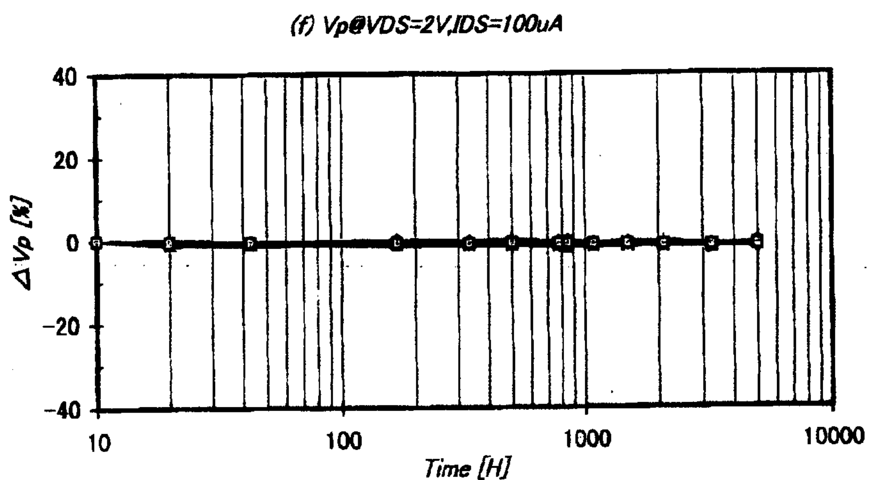


Figure 1-2. High Temperature DC Bias Test Results (Tch=175℃,Vds=3V,Ids=15mA)

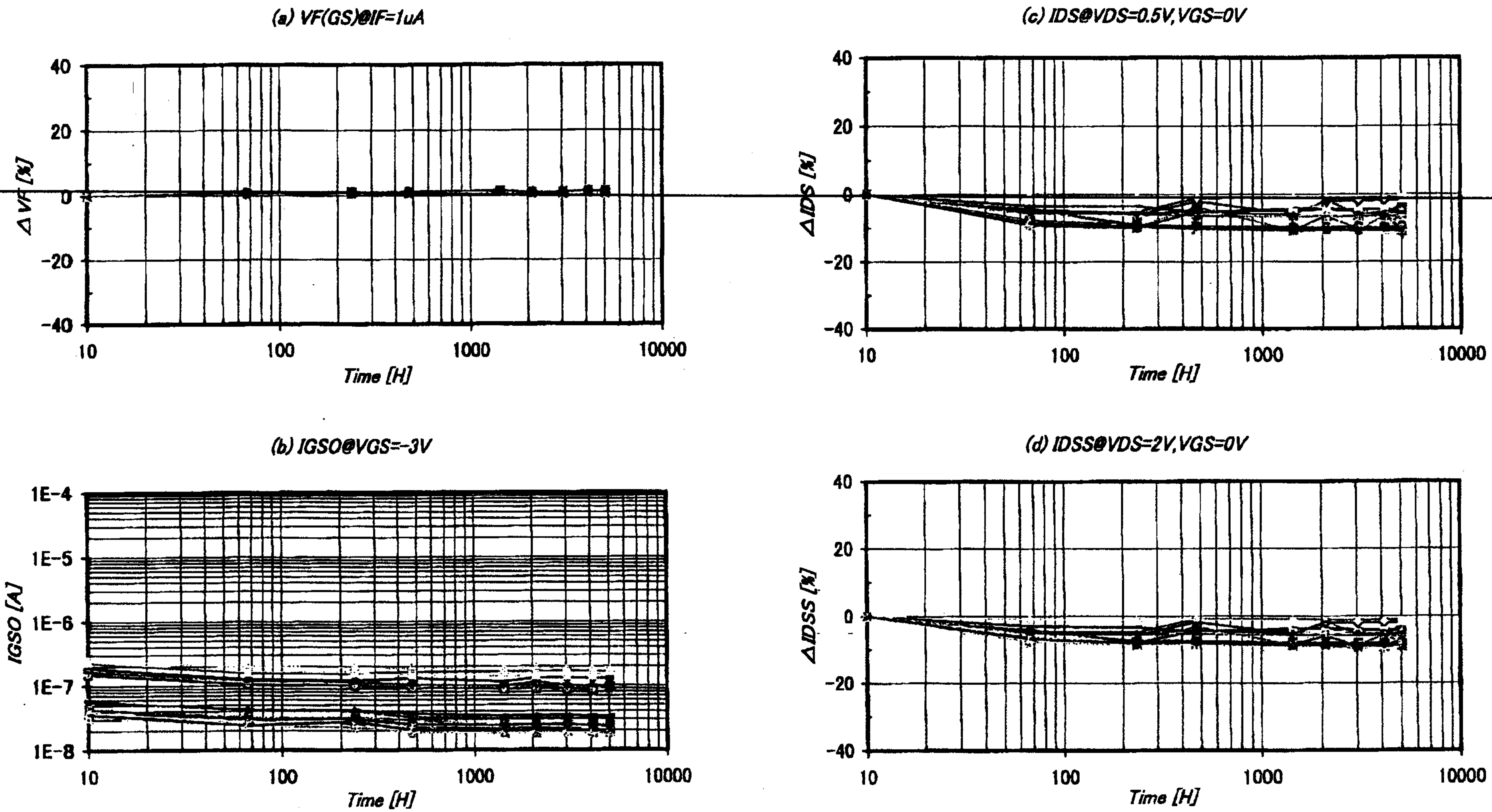


Figure 2-1. High Temperature Reverse Bias Test Results (Ta=150°C,Vgss=-2.4V)

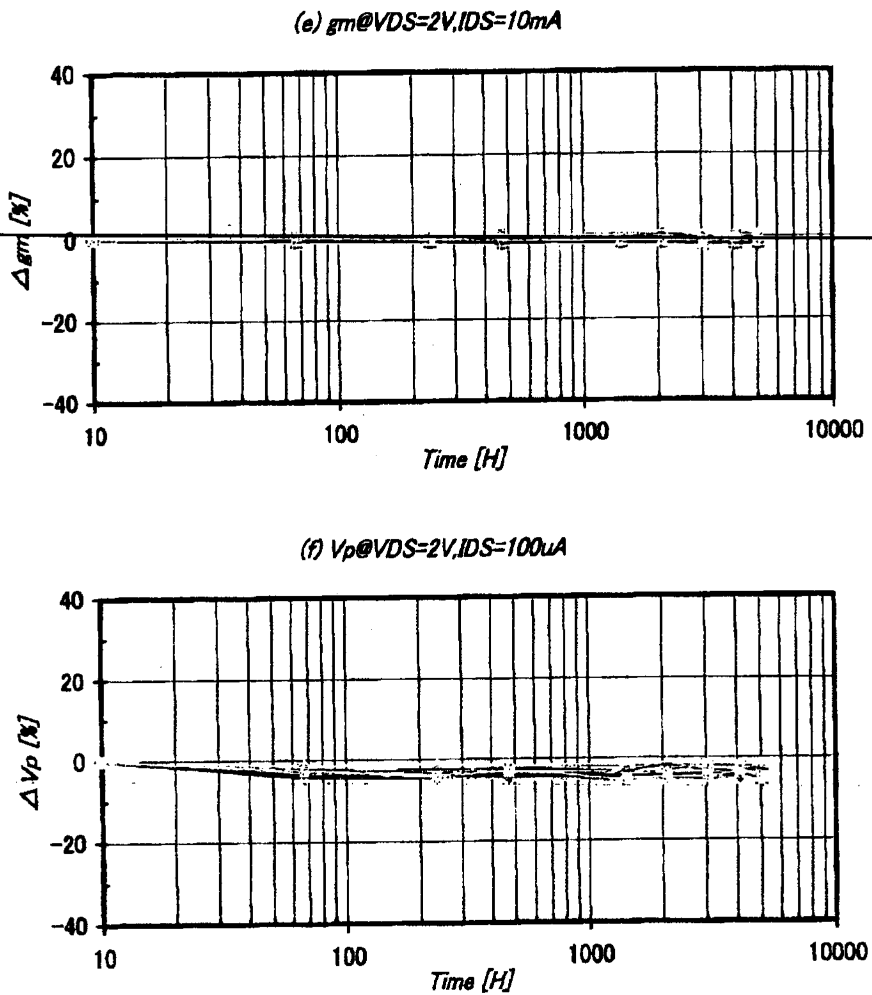


Figure 2-2. High Temperature Reverse Bias Test Results (Ta=150℃,Vgss=-2.4V)

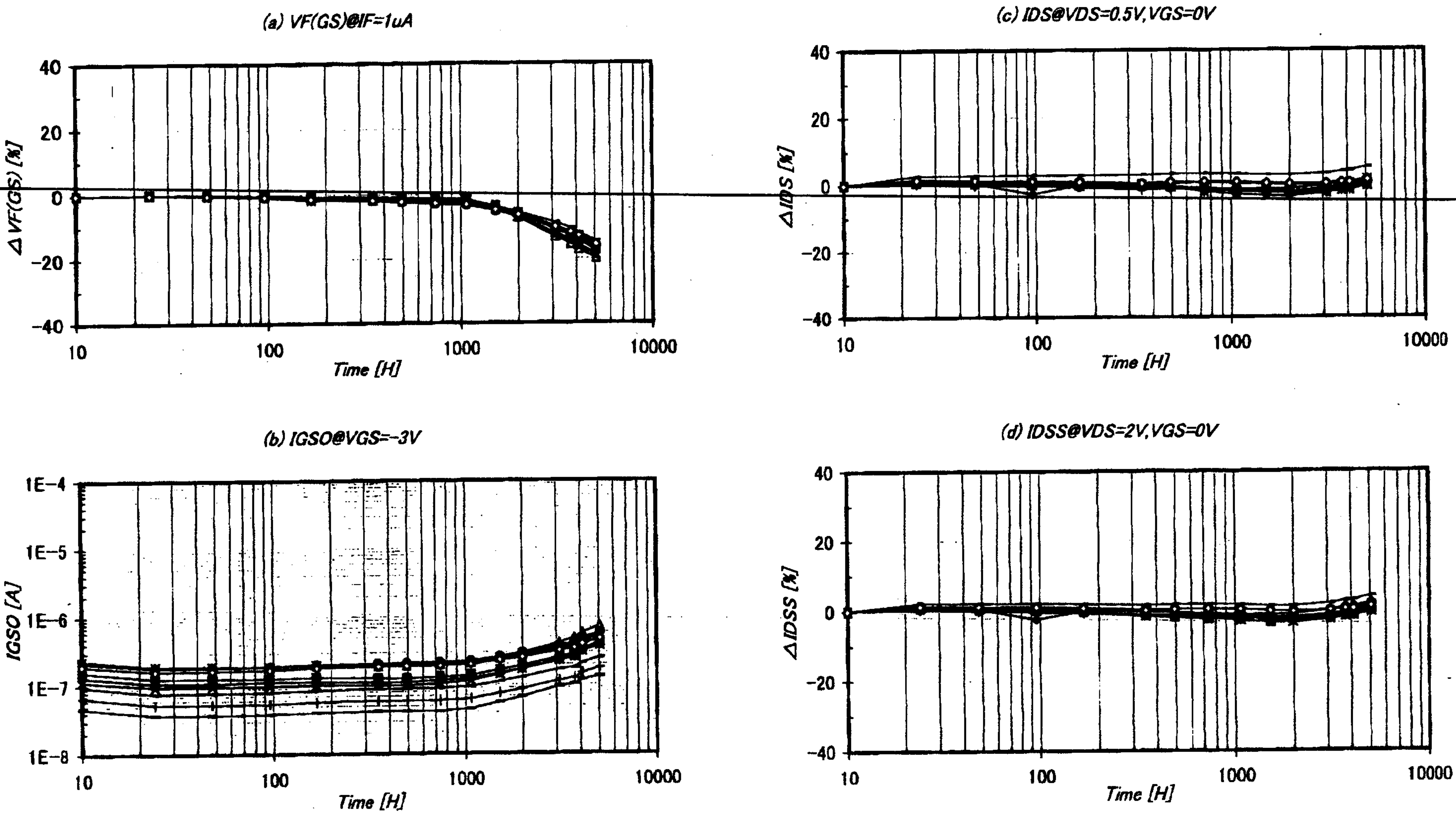


Figure 3-1. High Temperature Storage Test Results (Ta=227°C)

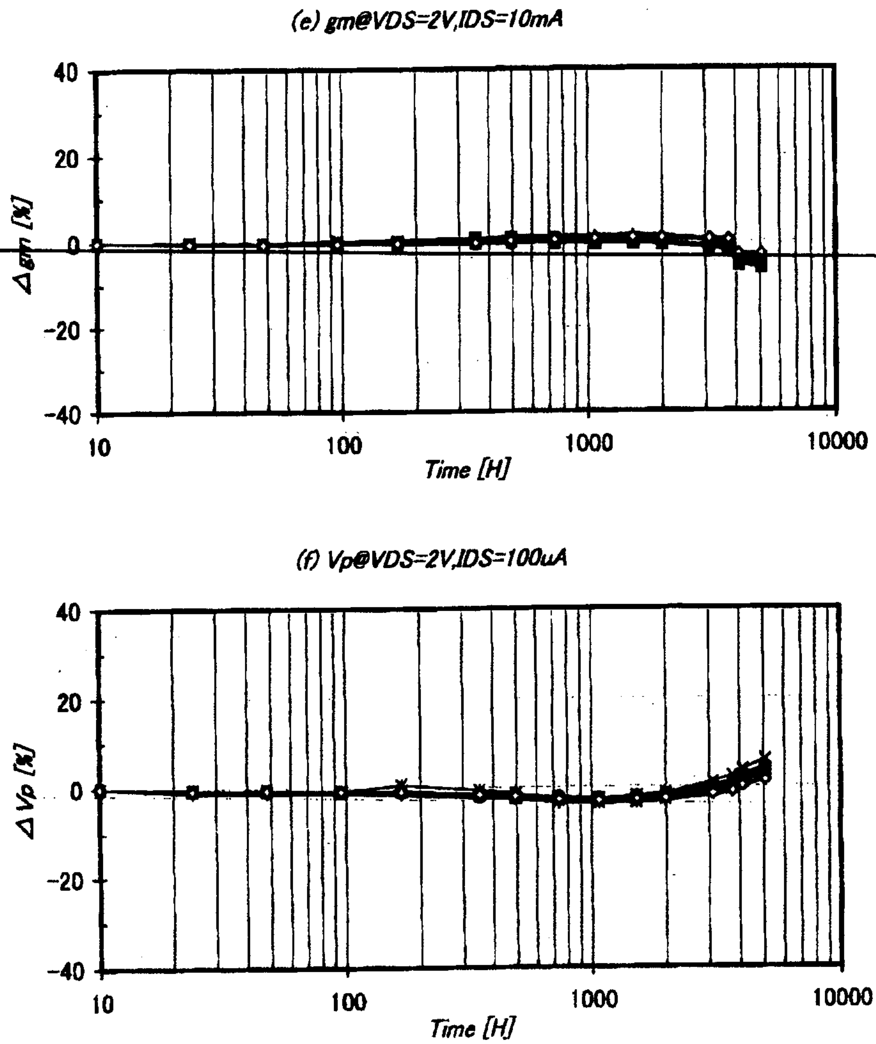


Figure 3-2. High Temperature Storage Test Results (Ta=227°C)

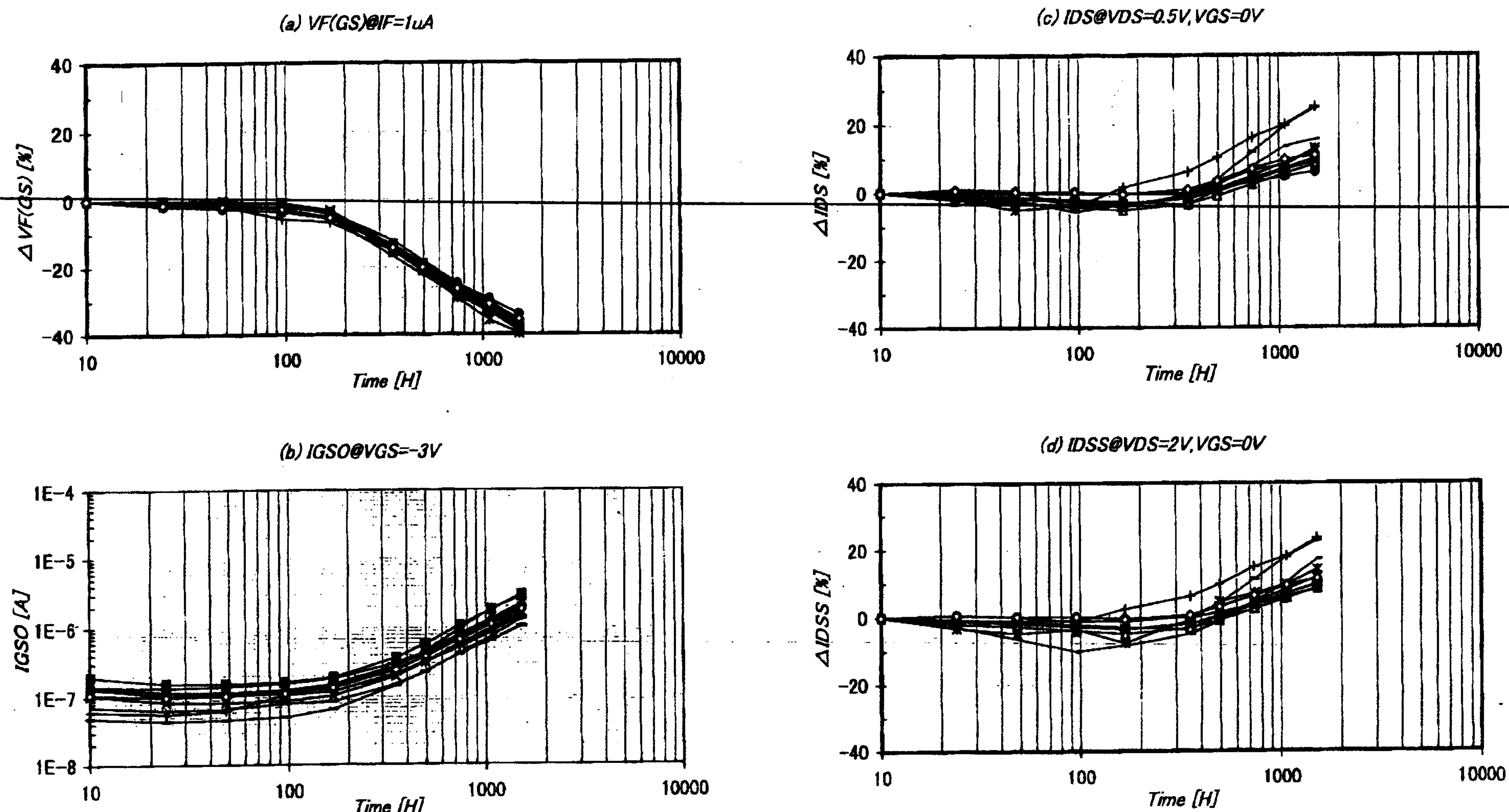
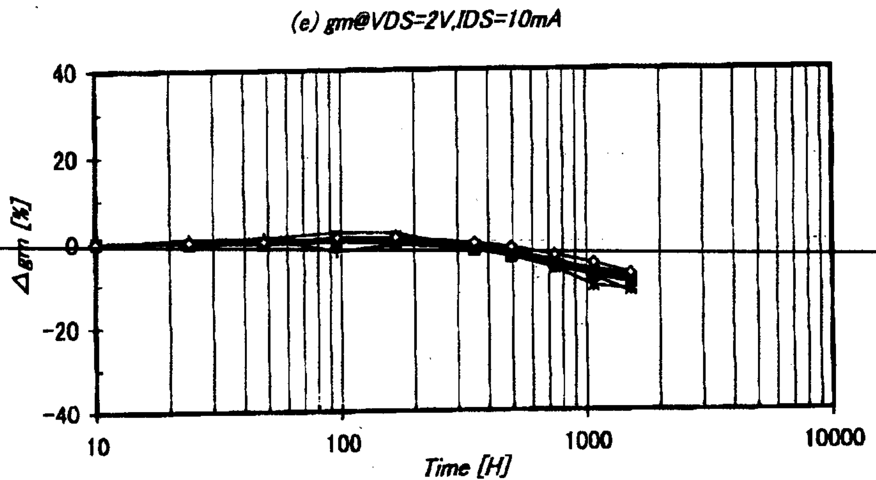


Figure 4-1. High Temperature Storage Test Results (Ta=259℃)



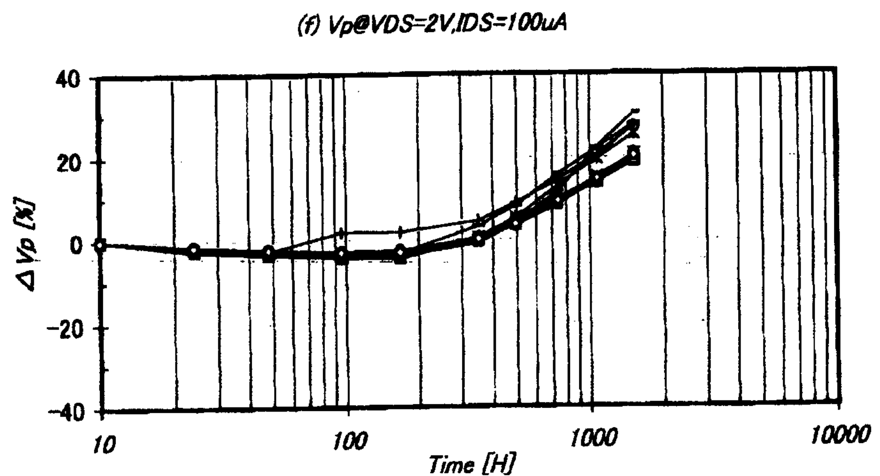


Figure 4-2. High Temperature Storage Test Results (Ta=259℃)

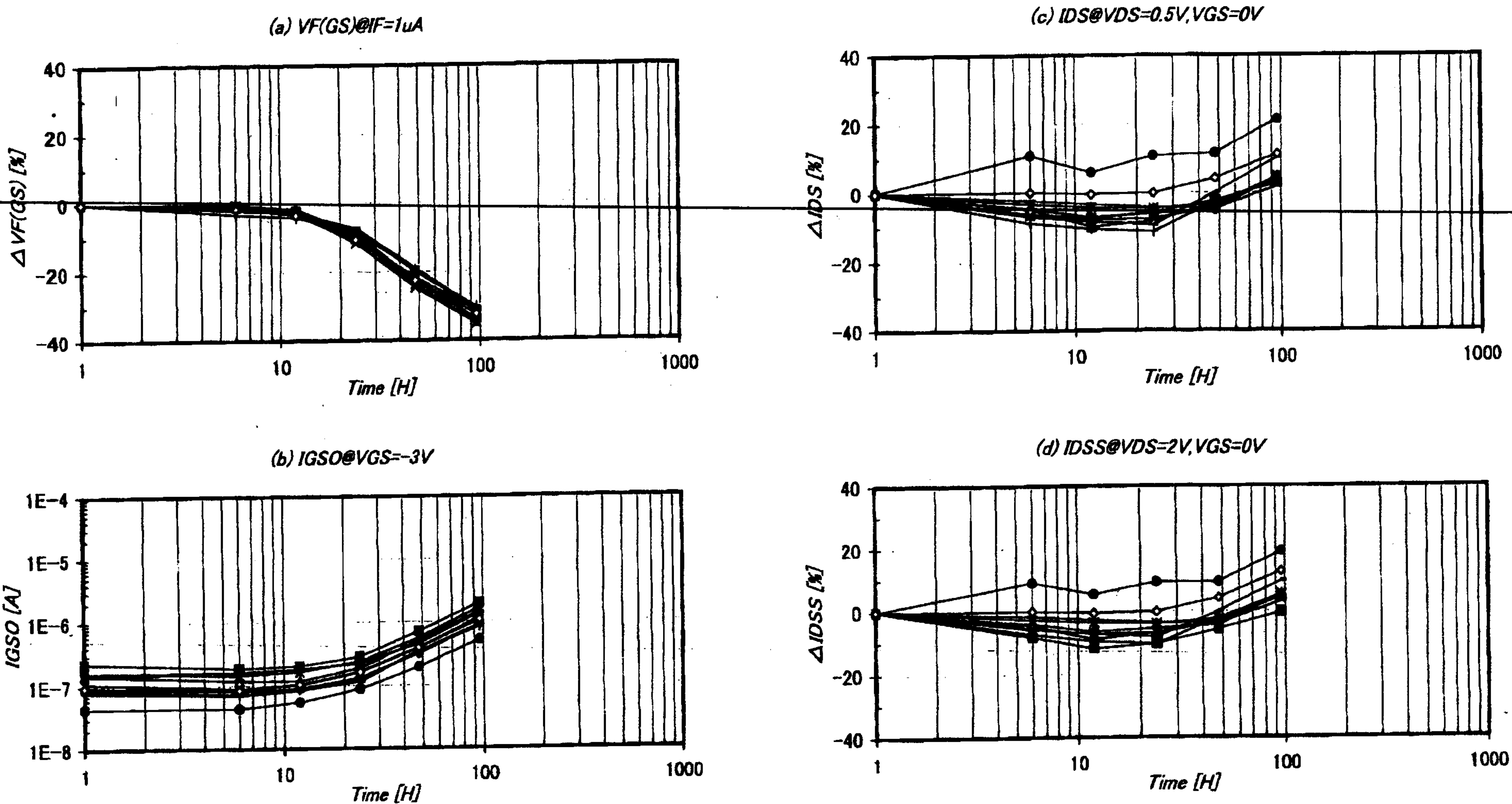


Figure 5-1. High Temperature Storage Test Results (Ta=295℃)

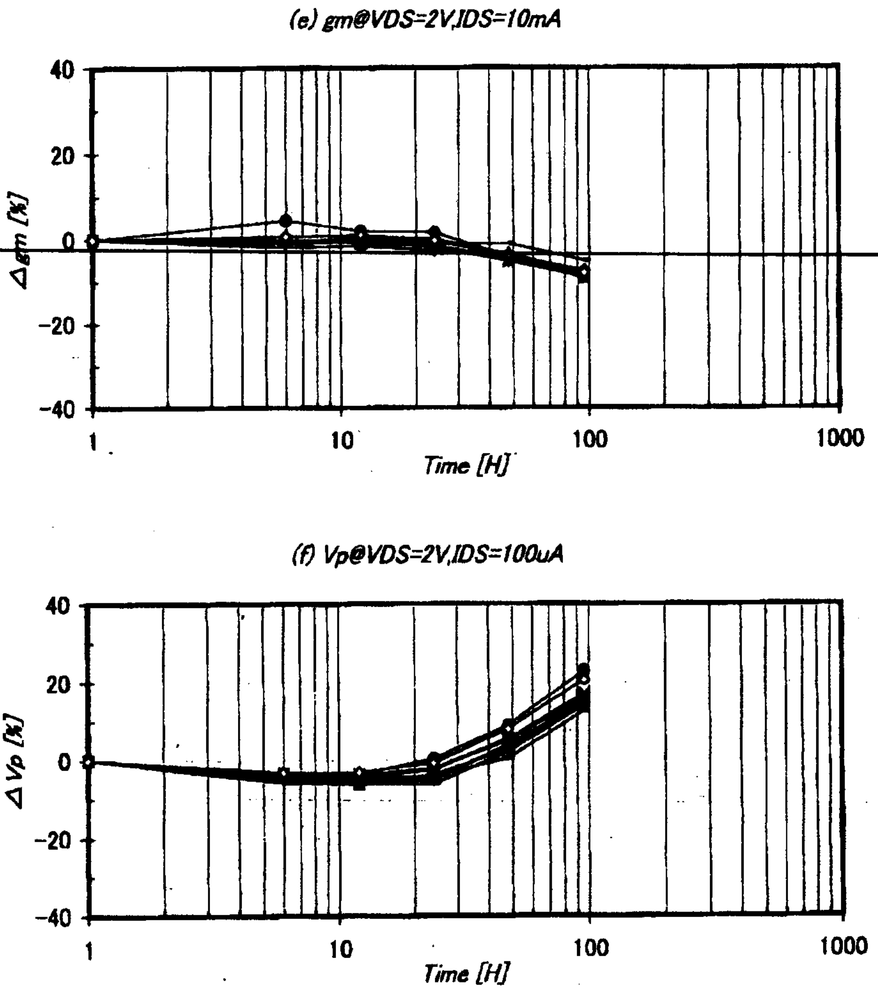


Figure 5-2. High Temperature Storage Test Results (Ta=295℃)

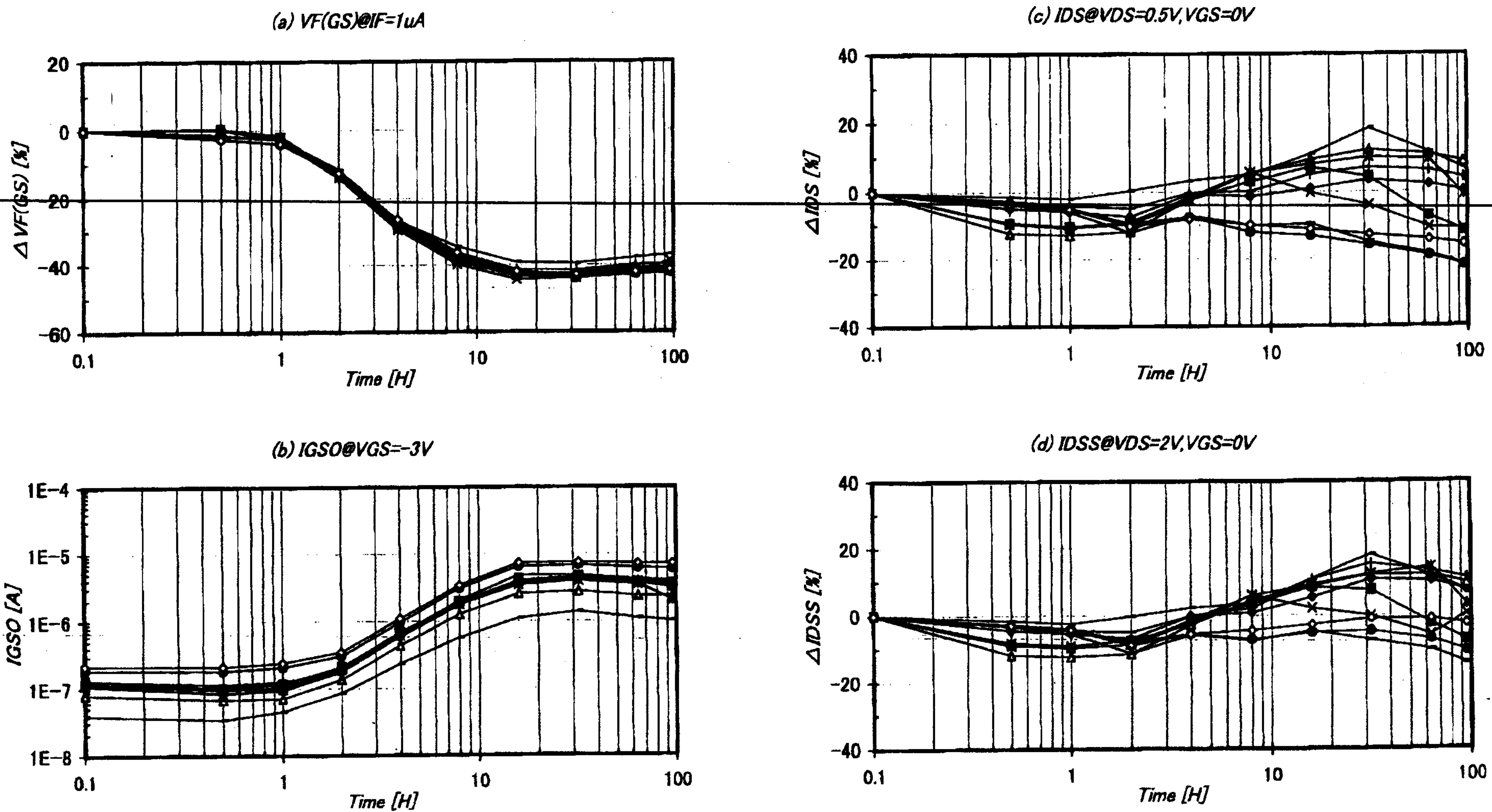


Figure 6-1. High Temperature Storage Test Results (Ta=337°C)

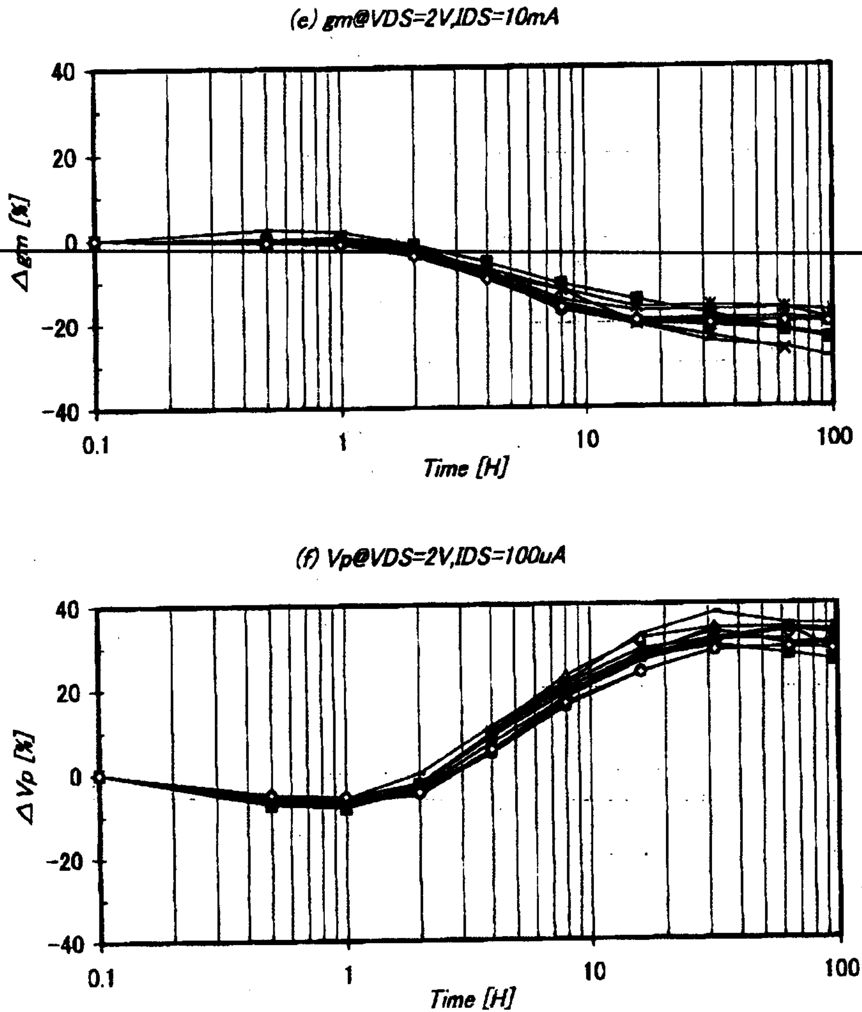


Figure 6-2. High Temperature Storage Test Results (Ta=337℃)

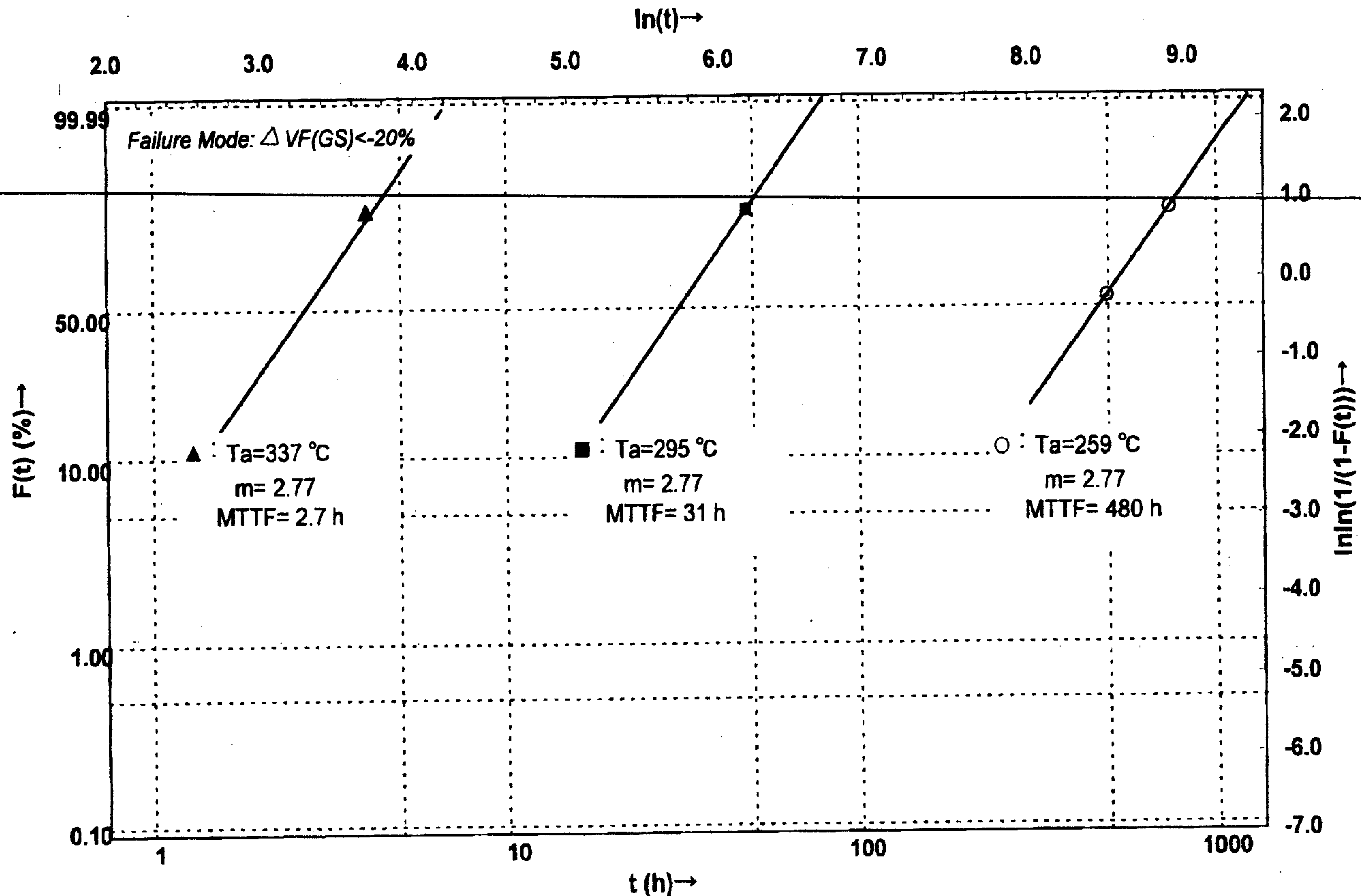


Figure 7 Weibull plots on High Temperature Storage Test Results

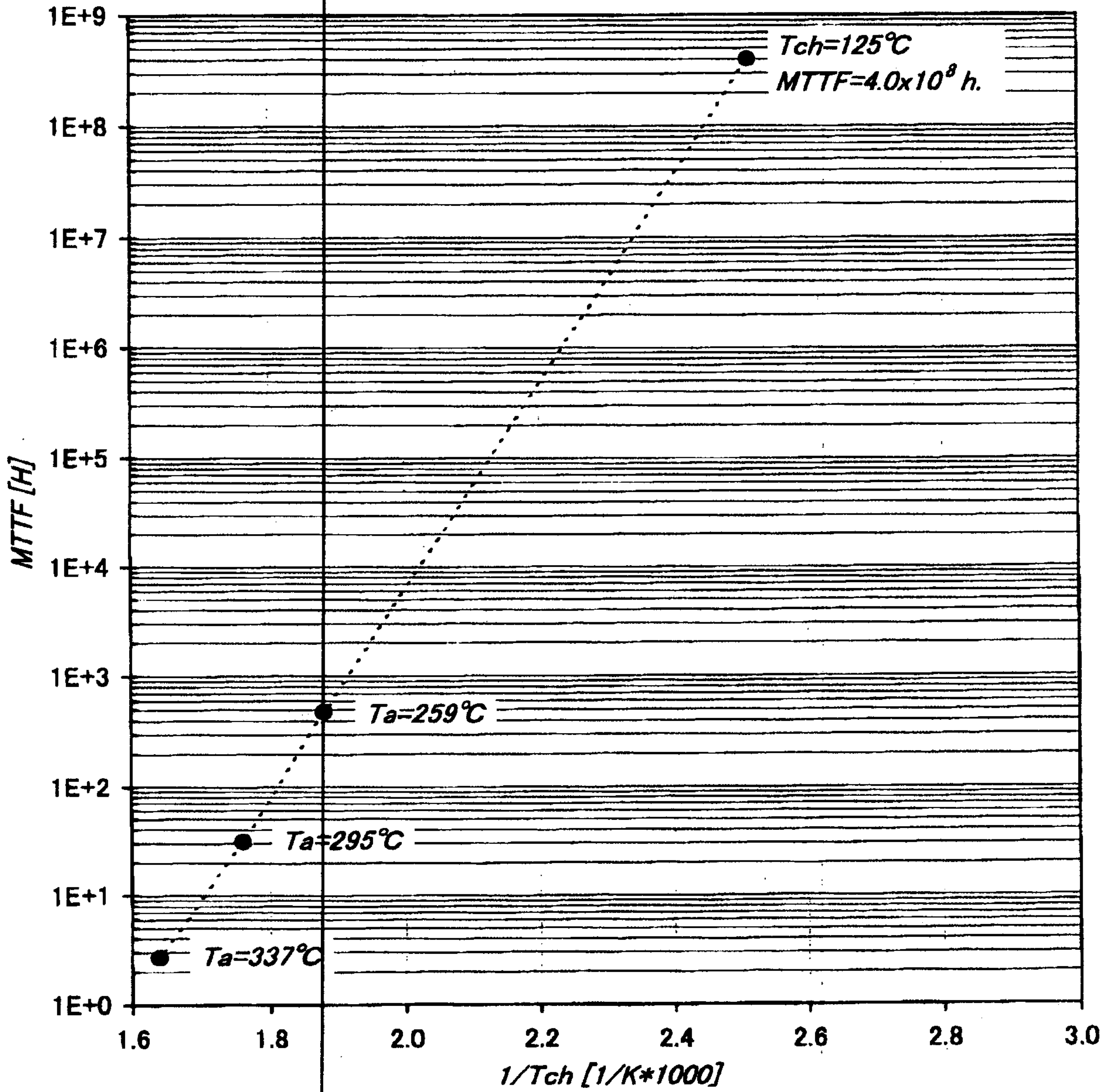


Figure 8. Arrhenius plots on High Temperature Storage Test Results