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RELIABILITY TEST REPORT (NO.: RA-D2304-01)

Updated Date: Nov. 3, 2023

PURPOSE

This is HTRB evaluation reliability test of NC1D120C30KT (TO-247-2L package assembled) in Novusem SiC Diodes products.

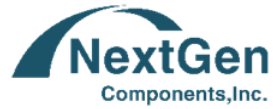
DEVICE DESCRIPTION

Part No.	NC1D120C30KT	Product	1200V30A
Package Case	TO247-2L	Ref. Standard	AEC-Q101-Rev-E
Test Start Date	2023/3/1	Test End Date	2023/4/18
Wafer Lot & Numbers	C2A11X80.1 #1	PKG Lot	DQ2305001

CONCLUSION

Reliability testing demonstration TO-247-2L package, NC1D120C30KT met HTRB evaluation requirements test per Novusem evaluation product evaluation specification.

Prepared By	Reviewed By	Approved By
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2023/4/20	2023/4/21	2023/4/24



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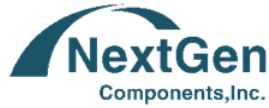
EVALUATION RESULTS AND ANALYSIS

No.	Item	Test Condition		Test Result	Rej/SS	Tested By
				Read Point	DQ2305001	
1	HTRB	High Temperature	Ta =175°C, VR =1200V	Initial	0/77	Limei Gan
				168 Hours	0/77	Limei Gan
				500 Hours	0/77	Limei Gan
				1000 Hours	0/77	Limei Gan

Table 1: Reliability evaluation results for device NC1D120C30KT, HTRB 1000H pass.

DEFINITION OF TEST FAILURE AFTER STRESSING

Parameter	Conditions	Acceptance Criterion 1	Acceptance Criterion 2	Item
IR	VR=1200V	$\leq 100\mu\text{A}$	<5X	HTRB
VF	IF=30A	$1.0\text{V} \leq \text{VF} \leq 1.7\text{V}$	+/-20%	HTRB
VR	IR=250μA	$\geq 1200\text{V}$	+/-20%	HTRB

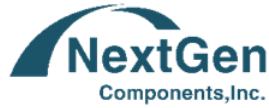


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HTRB TEST DATA

Part No.	Qty.	Package	Test Methods	Test Conditions	Test Result
NC1D120C30KT	77pcs	TO-247-2L	AEC-Q101-Rev E	Ta=175°C, VR=1200V	1000H pass

Test Items	IR				VF				VR				ΔIR				ΔVF				ΔVR							
	VR=1200V				IR=30A				IR=250μA				-5X				-20%				-20%							
Test Condition													5X				+20%				+20%							
LSL	-				1				1200				-				-				-							
USL	100				1.7				-				-				-				-							
Unit	μA				V				V				-				-				-							
Test Point	0	168	500	1000	0	168	500	1000	0	168	500	1000	0	168	500	1000	0	168	500	1000	0	168	500	1000	0	168	500	1000
1	10.16	2.51	2.43	3.09	1.42	1.42	1.42	1.42	1399	1423	1406	1401	1.00	0.25	0.24	0.30	0.00%	0.49%	0.28%	0.42%	0.00%	1.72%	0.50%	0.14%				
2	8.56	2.36	2.52	2.44	1.41	1.42	1.42	1.42	1395	1418	1388	1389	1.00	0.28	0.29	0.29	0.00%	0.35%	0.28%	0.64%	0.00%	1.65%	-0.50%	-0.43%				
3	8.40	2.59	3.49	3.91	1.42	1.42	1.42	1.42	1395	1399	1396	1390	1.00	0.31	0.42	0.47	0.00%	0.49%	0.14%	0.49%	0.00%	0.29%	0.07%	-0.36%				
4	14.02	5.67	5.49	5.51	1.41	1.42	1.42	1.42	1378	1396	1388	1383	1.00	0.40	0.39	0.39	0.00%	0.42%	0.35%	0.71%	0.00%	1.31%	0.73%	0.36%				
5	24.02	17.64	17.39	19.21	1.41	1.42	1.42	1.42	1400	1425	1405	1394	1.00	0.73	0.72	0.80	0.00%	0.50%	0.35%	0.71%	0.00%	1.79%	0.36%	-0.43%				
6	6.81	2.58	2.23	2.24	1.41	1.42	1.41	1.42	1388	1413	1393	1394	1.00	0.38	0.33	0.33	0.00%	0.28%	0.21%	0.57%	0.00%	1.80%	0.36%	0.43%				
7	6.15	2.27	2.30	2.40	1.41	1.42	1.41	1.42	1389	1406	1390	1385	1.00	0.37	0.37	0.39	0.00%	0.28%	0.14%	0.43%	0.00%	1.22%	0.07%	-0.29%				
8	19.80	18.19	18.58	18.94	1.41	1.42	1.42	1.42	1393	1413	1403	1398	1.00	0.92	0.94	0.96	0.00%	0.50%	0.07%	0.50%	0.00%	1.44%	0.72%	0.36%				
9	21.57	23.72	16.72	19.24	1.42	1.42	1.42	1.42	1361	1400	1386	1383	1.00	1.10	0.78	0.89	0.00%	0.21%	0.00%	0.35%	0.00%	2.87%	1.84%	1.62%				
10	20.71	5.11	6.16	5.55	1.40	1.41	1.41	1.41	1323	1325	1323	1284	1.00	0.25	0.30	0.27	0.00%	0.36%	0.29%	0.57%	0.00%	0.15%	0.00%	-2.95%				
11	9.02	2.40	2.31	2.33	1.42	1.42	1.42	1.42	1393	1413	1401	1395	1.00	0.27	0.26	0.26	0.00%	0.14%	0.00%	0.35%	0.00%	1.44%	0.57%	0.14%				
12	8.85	2.51	2.53	3.26	1.42	1.42	1.42	1.42	1399	1418	1405	1395	1.00	0.28	0.29	0.37	0.00%	0.21%	0.21%	0.57%	0.00%	1.36%	0.43%	-0.29%				
13	10.19	2.28	2.73	2.84	1.41	1.42	1.42	1.42	1414	1435	1418	1414	1.00	0.22	0.27	0.28	0.00%	0.28%	0.35%	0.50%	0.00%	1.49%	0.28%	0.00%				
14	6.43	2.21	2.19	4.65	1.41	1.42	1.41	1.42	1414	1441	1421	1406	1.00	0.34	0.34	0.72	0.00%	0.50%	0.14%	0.64%	0.00%	1.91%	0.50%	-0.57%				
15	10.04	2.46	2.64	2.71	1.41	1.42	1.42	1.42	1389	1420	1391	1388	1.00	0.25	0.26	0.27	0.00%	0.35%	0.14%	0.57%	0.00%	2.23%	0.14%	-0.07%				
16	6.64	2.40	2.50	2.99	1.41	1.42	1.41	1.42	1381	1406	1390	1378	1.00	0.36	0.38	0.45	0.00%	0.21%	0.07%	0.50%	0.00%	1.81%	0.65%	-0.22%				
17	12.66	2.61	4.35	3.20	1.40	1.41	1.41	1.41	1360	1371	1374	1331	1.00	0.21	0.34	0.25	0.00%	0.29%	0.21%	0.57%	0.00%	1.56%	1.78%	-1.41%				
18	13.19	2.56	3.91	4.56	1.40	1.41	1.40	1.41	1374	1395	1390	1348	1.00	0.19	0.30	0.35	0.00%	0.21%	0.00%	0.43%	0.00%	1.53%	1.16%	-1.89%				
19	11.77	5.49	5.38	6.46	1.39	1.40	1.39	1.40	1260	1270	1283	1251	1.00	0.47	0.46	0.55	0.00%	0.22%	0.00%	0.43%	0.00%	0.79%	1.83%	-0.71%				
20	8.38	2.73	2.70	2.82	1.41	1.42	1.42	1.42	1385	1403	1391	1381	1.00	0.33	0.32	0.34	0.00%	0.14%	0.28%	0.64%	0.00%	1.30%	0.43%	-0.29%				
21	19.99	3.32	4.16	5.29	1.41	1.42	1.42	1.42	1370	1395	1389	1348	1.00	0.17	0.21	0.26	0.00%	0.21%	0.21%	0.50%	0.00%	1.82%	1.39%	-1.61%				
22	9.30	2.66	2.75	2.99	1.41	1.42	1.42	1.42	1349	1380	1360	1360	1.00	0.29	0.30	0.32	0.00%	0.21%	0.14%	0.57%	0.00%	2.30%	0.82%	0.82%				
23	8.49	2.44	2.34	2.72	1.41	1.42	1.42	1.42	1383	1406	1398	1390	1.00	0.29	0.28	0.32	0.00%	0.35%	0.21%	0.57%	0.00%	1.66%	1.08%	0.51%				
24	8.82	2.38	2.65	2.73	1.41	1.42	1.41	1.42	1381	1376	1374	1370	1.00	0.27	0.30	0.31	0.00%	0.35%	0.21%	0.64%	0.00%	-0.36%	-0.51%	-0.80%				
25	6.84	2.48	2.33	2.44	1.41	1.42	1.42	1.42	1375	1390	1388	1374	1.00	0.36	0.34	0.36	0.00%	0.14%	0.14%	0.57%	0.00%	1.09%	0.95%	-0.07%				
26	8.01	2.40	2.83	3.19	1.41	1.42	1.42	1.42	1389	1403	1386	1391	1.00	0.30	0.35	0.40	0.00%	0.43%	0.35%	0.78%	0.00%	1.01%	-0.22%	0.14%				
27	11.57	2.81	3.08	3.53	1.41	1.42	1.41	1.42	1383	1375	1373	1371	1.00	0.24	0.27	0.31	0.00%	0.43%	0.14%	0.64%	0.00%	-0.58%	-0.72%	-0.87%				
28	11.65	2.43	3.11	3.80	1.41	1.41	1.41	1.42	1410	1435	1423	1413	1.00	0.21	0.27	0.33	0.00%	0.14%	0.14%	0.71%	0.00%	1.77%	0.92%	0.21%				
29	13.21	2.63	3.16	3.86	1.41	1.42	1.42	1.42	1414	1445	1428	1418	1.00	0.20	0.24	0.29	0.00%	0.14%	0.14%	0.64%	0.00%	2.19%	0.99%	0.28%				
30	5.01	7.84	8.53	7.90	1.40	1.41	1.41	1.41	1289	1318	1291	1256	1.00	1.57	1.70	1.58	0.00%	0.36%	0.29%	0.36%	0.00%	2.25%	0.16%	-2.56%				
31	6.34	2.45	2.42	2.67	1.41	1.41	1.41	1.41	1408	1428	1419	1399	1.00	0.39	0.38	0.42	0.00%	0.28%	0.36%	0.50%	0.00%	1.42%	0.78%	-0.64%				
32	7.16	2.55	2.85	2.84	1.41	1.42	1.41	1.42	1401	1415	1398	1396	1.00	0.36	0.40	0.40	0.00%	0.21%	0.14%	0.42%	0.00%	1.00%	-0.21%	-0.36%				
33	8.57	2.09	2.35	2.34	1.41	1.42	1.42	1.42	1394	1420	1403	1398	1.00	0.24	0.27	0.27	0.00%	0.28%	0.21%	0.57%	0.00%	1.87%	0.65%	0.29%				
34	9.81	2.29	2.36	3.35	1.42	1.42	1.42	1.42	1391	1404	1398	1393	1.00	0.23	0.24	0.34	0.00%	0.14%	0.21%	0.49%	0.00%	0.93%	0.50%	0.14%				
35	12.27	2.58	3.26	3.96	1.41	1.42	1.42	1.42	1409	1431	1419	1409	1.00	0.21	0.27	0.32	0.00%	0.42%	0.28%	0.71%	0.00%	1.56%	0.71%	0.00%				
36	9.79	2.27	2.32	2.90	1.42	1.42	1.42	1.42	1400	1423	1410	1400	1.00	0.23	0.24	0.30	0.00%	0.21%	0.14%	0.57%	0.00%	1.64%	0.71%	0.00%				
37	13.67	2.80	3.10	4.60	1.41	1.42	1.42	1.42	1401	1428	1413	1400	1.00	0.20	0.23	0.34	0.00%	0.50%	0.28%	0.71%	0.00%	1.93%	0.86%	-0.07%				
38	10.74	2.35	2.34	3.72	1.41	1.42	1.42	1.42	1406	1426	1415	1404	1.00	0.22	0.22	0.35	0.00%	0.35%	0.14%	0.64%	0.00%	1.42%	0.64%	-0.14%				



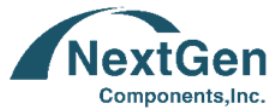
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HTRB TEST DATA

Part No.	Qty.	Package	Test Methods	Test Conditions	Test Result
NC1D120C30KT	77pcs	TO-247-2L	AEC-Q101-Rev E	Ta=175°C, VR=1200V	1000H pass

Test Items	IR	VF		VR		ΔIR			ΔVF			ΔVR		
Test Condition	VR=1200V	IF=30A		IR=250μA										
LSL	-	1		1200		-5X			-20%			-20%		
USL	100	1.7		-		5X			+20%			+20%		
Unit	μA	V		V		-			-			-		

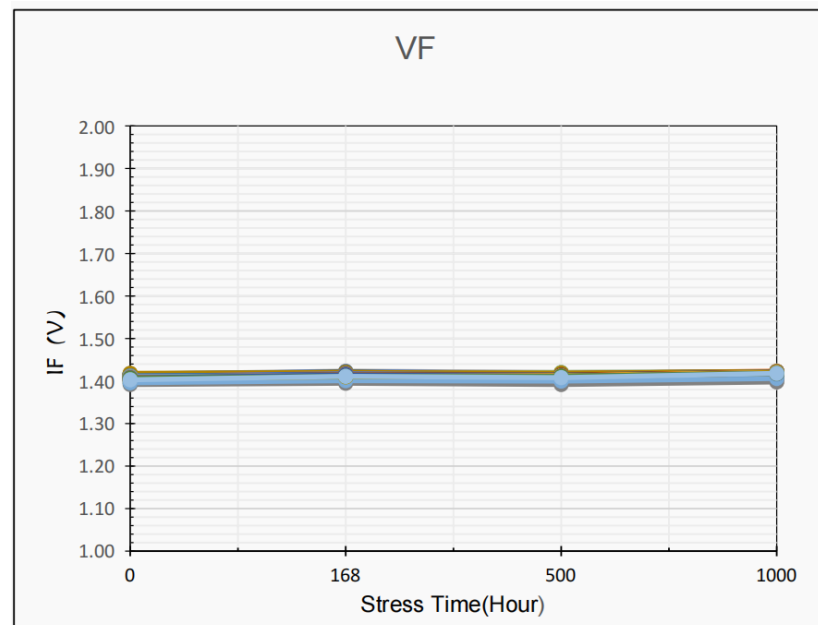
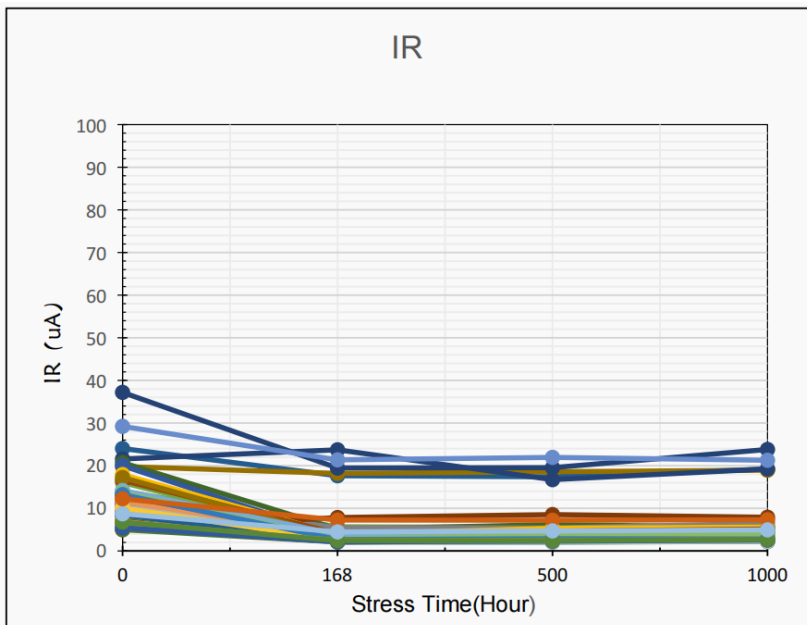
39	10.33	2.19	2.43	3.30	1.42	1.42	1.42	1.42	1406	1430	1411	1409	1.00	0.21	0.24	0.32	0.00%	0.28%	0.21%	0.49%	0.00%	1.71%	0.36%	0.21%
40	8.39	2.32	2.19	2.20	1.42	1.42	1.42	1.42	1383	1406	1400	1395	1.00	0.28	0.26	0.26	0.00%	0.21%	0.35%	0.42%	0.00%	1.66%	1.23%	0.87%
41	11.08	2.46	3.11	3.60	1.41	1.42	1.42	1.42	1401	1406	1398	1396	1.00	0.22	0.28	0.32	0.00%	0.42%	0.21%	0.57%	0.00%	0.36%	-0.21%	-0.36%
42	13.01	2.84	2.85	3.97	1.41	1.42	1.42	1.42	1405	1429	1415	1406	1.00	0.22	0.22	0.31	0.00%	0.28%	0.28%	0.57%	0.00%	1.71%	0.71%	0.07%
43	5.61	2.14	2.29	2.55	1.41	1.41	1.41	1.42	1390	1384	1380	1371	1.00	0.38	0.41	0.45	0.00%	0.35%	0.21%	0.64%	0.00%	-0.43%	-0.72%	-1.37%
44	12.51	2.47	3.41	3.60	1.42	1.42	1.42	1.42	1408	1418	1405	1399	1.00	0.20	0.27	0.29	0.00%	0.14%	0.00%	0.28%	0.00%	0.71%	-0.21%	-0.64%
45	6.15	2.24	2.27	2.55	1.41	1.41	1.41	1.42	1375	1388	1386	1374	1.00	0.36	0.37	0.41	0.00%	0.28%	0.14%	0.64%	0.00%	0.95%	0.80%	-0.07%
46	4.99	2.10	2.06	2.24	1.41	1.41	1.41	1.42	1394	1406	1396	1390	1.00	0.42	0.41	0.45	0.00%	0.21%	0.14%	0.64%	0.00%	0.86%	0.14%	-0.29%
47	5.79	2.14	2.08	2.27	1.41	1.41	1.41	1.42	1388	1410	1385	1386	1.00	0.37	0.36	0.39	0.00%	0.21%	0.21%	0.57%	0.00%	1.59%	-0.22%	-0.14%
48	6.80	2.29	2.44	2.64	1.41	1.41	1.41	1.42	1375	1396	1385	1376	1.00	0.34	0.36	0.39	0.00%	0.28%	0.14%	0.78%	0.00%	1.53%	0.73%	0.07%
49	12.29	2.63	3.09	3.60	1.41	1.41	1.41	1.42	1394	1423	1408	1399	1.00	0.21	0.25	0.29	0.00%	0.35%	0.14%	0.64%	0.00%	2.08%	1.00%	0.36%
50	12.07	2.80	3.47	4.41	1.41	1.41	1.41	1.42	1390	1391	1384	1388	1.00	0.23	0.29	0.37	0.00%	0.35%	0.21%	0.64%	0.00%	0.07%	-0.43%	-0.14%
51	8.54	2.63	2.63	2.50	1.41	1.42	1.41	1.42	1389	1406	1394	1395	1.00	0.31	0.31	0.29	0.00%	0.28%	0.07%	0.50%	0.00%	1.22%	0.36%	0.43%
52	10.25	2.81	3.20	3.67	1.41	1.41	1.41	1.42	1385	1378	1371	1375	1.00	0.27	0.31	0.36	0.00%	0.14%	0.14%	0.64%	0.00%	-0.51%	-1.01%	-0.72%
53	8.69	2.48	2.69	5.03	1.41	1.41	1.41	1.42	1400	1420	1414	1395	1.00	0.29	0.31	0.58	0.00%	0.14%	0.14%	0.64%	0.00%	1.43%	1.00%	-0.36%
54	12.72	3.07	3.50	2.83	1.41	1.42	1.41	1.42	1395	1415	1403	1399	1.00	0.24	0.27	0.22	0.00%	0.43%	0.07%	0.50%	0.00%	1.43%	0.57%	0.29%
55	8.59	2.65	2.46	3.56	1.41	1.42	1.41	1.42	1386	1405	1396	1386	1.00	0.31	0.29	0.41	0.00%	0.43%	0.21%	0.71%	0.00%	1.37%	0.72%	0.00%
56	17.92	3.84	5.32	5.59	1.41	1.41	1.41	1.42	1369	1364	1366	1364	1.00	0.21	0.30	0.31	0.00%	0.21%	0.07%	0.64%	0.00%	-0.37%	-0.22%	-0.37%
57	10.97	3.02	3.13	3.42	1.41	1.42	1.41	1.42	1380	1376	1371	1375	1.00	0.28	0.29	0.31	0.00%	0.43%	0.21%	0.57%	0.00%	-0.29%	-0.65%	-0.36%
58	16.04	3.55	3.45	3.72	1.41	1.41	1.41	1.42	1375	1391	1395	1369	1.00	0.22	0.22	0.23	0.00%	0.14%	0.14%	0.50%	0.00%	1.16%	1.45%	-0.44%
59	8.39	2.43	2.86	3.01	1.41	1.41	1.41	1.42	1388	1388	1381	1380	1.00	0.29	0.34	0.36	0.00%	0.14%	0.14%	0.64%	0.00%	0.00%	-0.50%	-0.58%
60	16.56	4.10	4.63	5.15	1.41	1.42	1.41	1.42	1374	1380	1375	1375	1.00	0.25	0.28	0.31	0.00%	0.43%	0.35%	0.85%	0.00%	0.44%	0.07%	0.07%
61	12.02	2.65	2.90	2.70	1.41	1.41	1.41	1.42	1361	1368	1354	1361	1.00	0.22	0.24	0.22	0.00%	0.28%	0.14%	0.71%	0.00%	0.51%	-0.51%	0.00%
62	17.23	3.27	4.03	4.66	1.41	1.41	1.41	1.41	1333	1334	1329	1310	1.00	0.19	0.23	0.27	0.00%	0.14%	0.00%	0.50%	0.00%	0.08%	-0.30%	-1.73%
63	37.19	19.45	19.53	23.80	1.41	1.41	1.41	1.42	1346	1354	1353	1339	1.00	0.52	0.53	0.64	0.00%	0.21%	0.00%	0.57%	0.00%	0.59%	0.52%	-0.52%
64	13.43	3.51	3.58	4.67	1.40	1.40	1.40	1.41	1271	1283	1289	1258	1.00	0.26	0.27	0.35	0.00%	0.43%	0.36%	0.86%	0.00%	0.94%	1.42%	-1.02%
65	14.18	3.88	4.30	4.62	1.40	1.40	1.40	1.41	1254	1270	1273	1263	1.00	0.27	0.30	0.33	0.00%	0.36%	0.29%	0.72%	0.00%	1.28%	1.52%	0.72%
66	11.65	2.52	3.66	3.33	1.41	1.41	1.41	1.42	1374	1379	1374	1370	1.00	0.22	0.31	0.29	0.00%	0.35%	0.21%	0.71%	0.00%	0.36%	0.00%	-0.29%
67	10.36	2.80	3.10	3.46	1.41	1.41	1.41	1.42	1360	1361	1365	1360	1.00	0.27	0.30	0.33	0.00%	0.28%	0.28%	0.71%	0.00%	0.07%	0.37%	0.00%
68	10.03	2.56	3.10	2.65	1.41	1.41	1.41	1.42	1353	1363	1359	1351	1.00	0.26	0.31	0.26	0.00%	0.00%	0.07%	0.64%	0.00%	0.74%	0.44%	-0.15%
69	29.22	21.36	21.94	21.27	1.41	1.41	1.41	1.42	1350	1343	1336	1333	1.00	0.73	0.75	0.73	0.00%	0.14%	-0.07%	0.64%	0.00%	-0.52%	-1.04%	-1.26%
70	13.58	2.85	3.73	4.11	1.41	1.41	1.41	1.42	1348	1354	1353	1341	1.00	0.21	0.27	0.30	0.00%	0.14%	0.14%	0.64%	0.00%	0.45%	0.37%	-0.52%
71	13.21	2.68	2.86	2.82	1.41	1.41	1.41	1.42	1349	1353	1353	1348	1.00	0.20	0.22	0.21	0.00%	0.28%	0.28%	0.71%	0.00%	0.30%	0.30%	-0.07%
72	12.24	7.25	7.20	7.32	1.41	1.41	1.41	1.42	1353	1360	1350	1341	1.00	0.59	0.59	0.60	0.00%	0.21%	0.21%	0.71%	0.00%	0.52%	-0.22%	-0.89%
73	6.19	2.29	2.53	2.69	1.41	1.41	1.41	1.42	1359	1360	1359	1353	1.00	0.37	0.41	0.44	0.00%	0.36%	0.28%	0.78%	0.00%	0.07%	0.00%	-0.44%
74	6.64	2.47	2.42	2.58	1.41	1.41	1.41	1.42	1370	1386	1375	1368	1.00	0.37	0.36	0.39	0.00%	0.21%	0.28%	0.92%	0.00%	1.17%	0.36%	-0.15%
75	5.44	2.14	2.28	2.56	1.41	1.41	1.41	1.42	1405	1418	1404	1399	1.00	0.39	0.42	0.47	0.00%	0.50%	0.28%	0.78%	0.00%	0.93%	-0.07%	-0.43%
76	6.75	2.41	2.40	2.69	1.41	1.41	1.41	1.42	1373	1394	1383	1379	1.00	0.36	0.35	0.40	0.00%	0.36%	0.36%	0.85%	0.00%	1.53%	0.73%	0.44%
77	8.71	4.47	4.69	4.94	1.40	1.41	1.41	1.42	1365	1366	1365	1358	1.00	0.51	0.54	0.57	0.00%	0.57%	0.36%	1.07%	0.00%	0.07%	0.00%	-0.51%

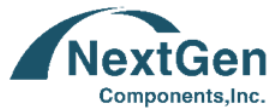


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HTRB TEST DATA

Part No.	Qty.	Package	Test Methods	Test Conditions	Test Result
NC1D120C30KT	77pcs	TO-247-2L	AEC-Q101-Rev E	Ta=175°C, VR=1200V	1000H pass

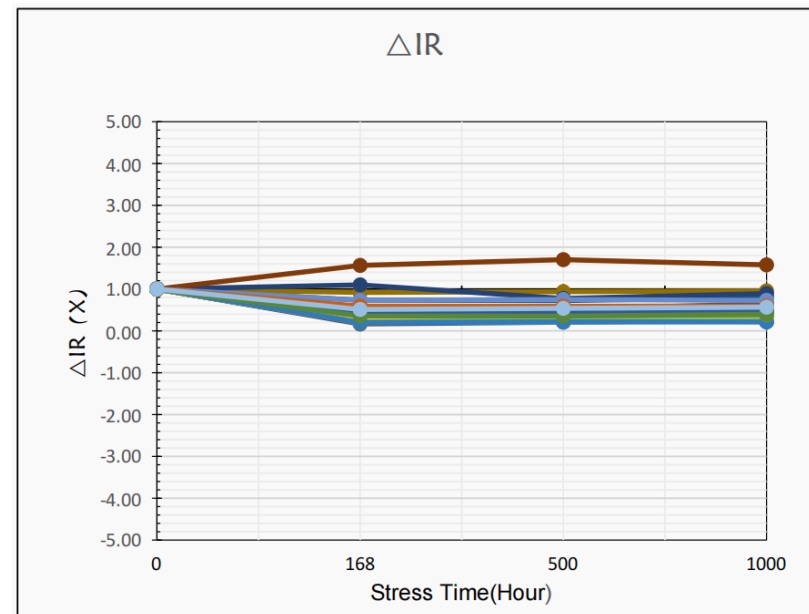
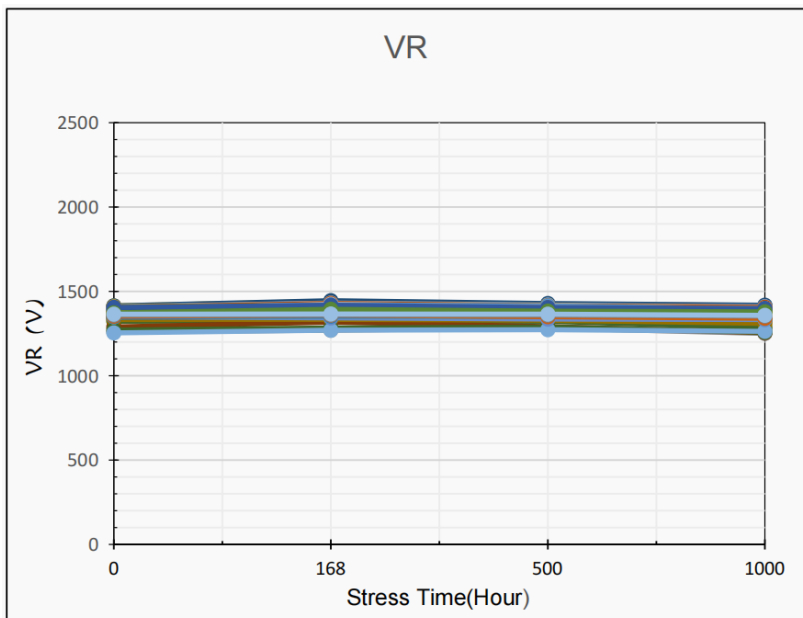


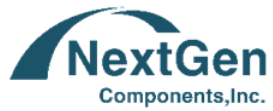


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HTRB TEST DATA

Part No.	Qty.	Package	Test Methods	Test Conditions	Test Result
NC1D120C30KT	77pcs	TO-247-2L	AEC-Q101-Rev E	Ta=175°C, VR=1200V	1000H pass





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HTRB TEST DATA

Part No.	Qty.	Package	Test Methods	Test Conditions	Test Result
NC1D120C30KT	77pcs	TO-247-2L	AEC-Q101-Rev E	Ta=175°C, VR=1200V	1000H pass

