(2020.11.04 Revised)

Comparison Evaluation of Operational Amplifier

オペアンプ比較試験結果報告Vol.2

KETI

J_Chip Consulting

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V. Environmental tests

Environmental test conditions

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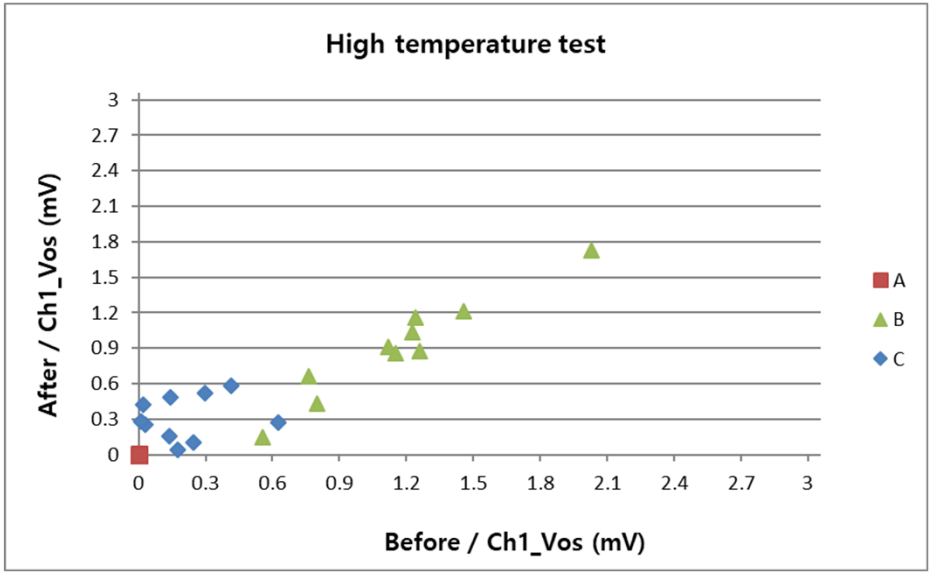
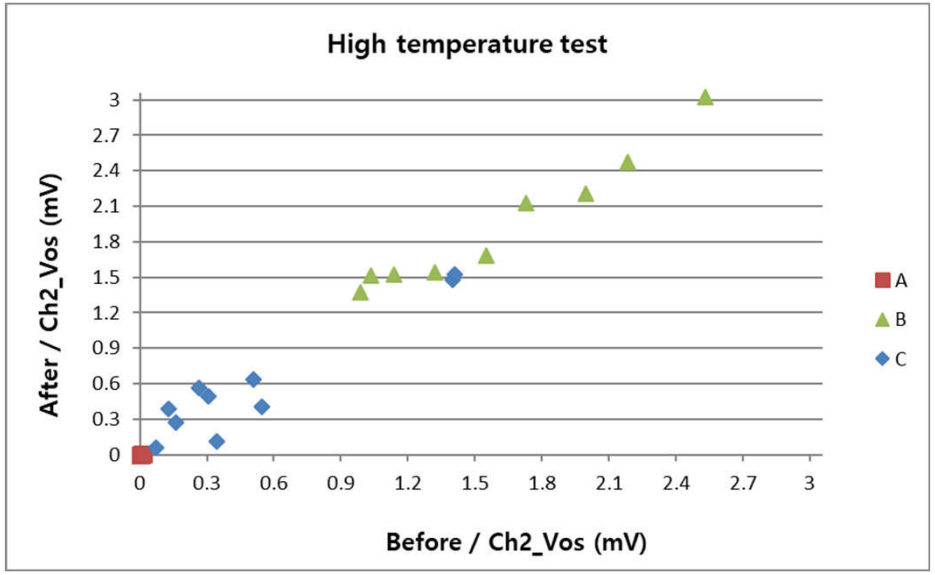
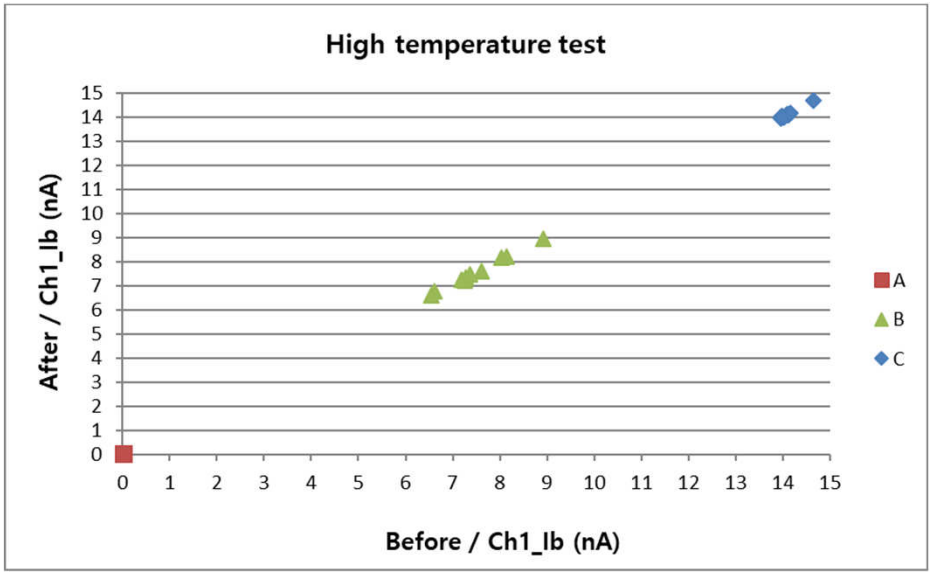
  - Low temperature test: (-40 ± 2) ℃, 500 hr
  - High temperature and high humidity operation test:
    (85 ± 2) ℃, (85 ± 3) % R.H., 500 hr
  - Thermal shock test: (125 ± 2) ℃, (-40 ± 2) ℃, each 10 min., 100 cycles

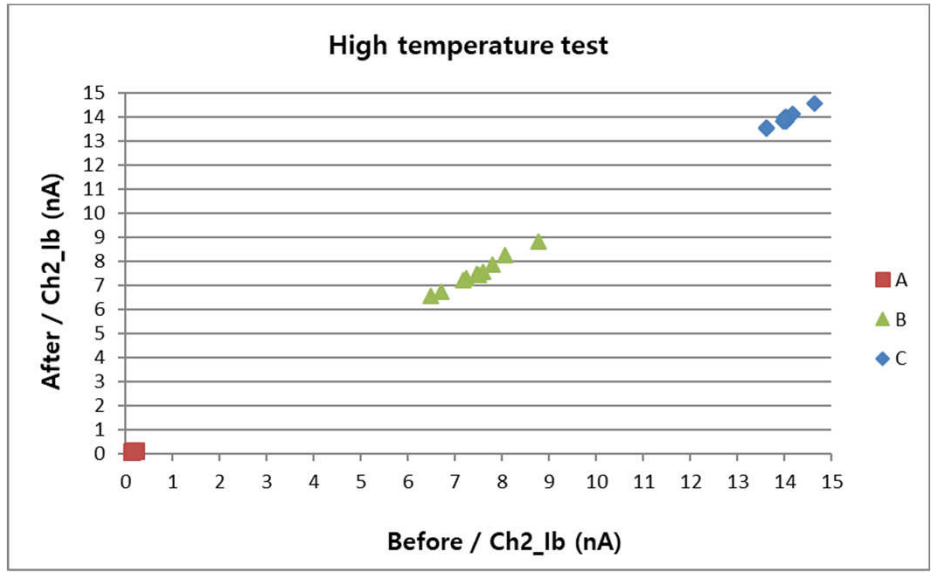
Summary

High temp. test









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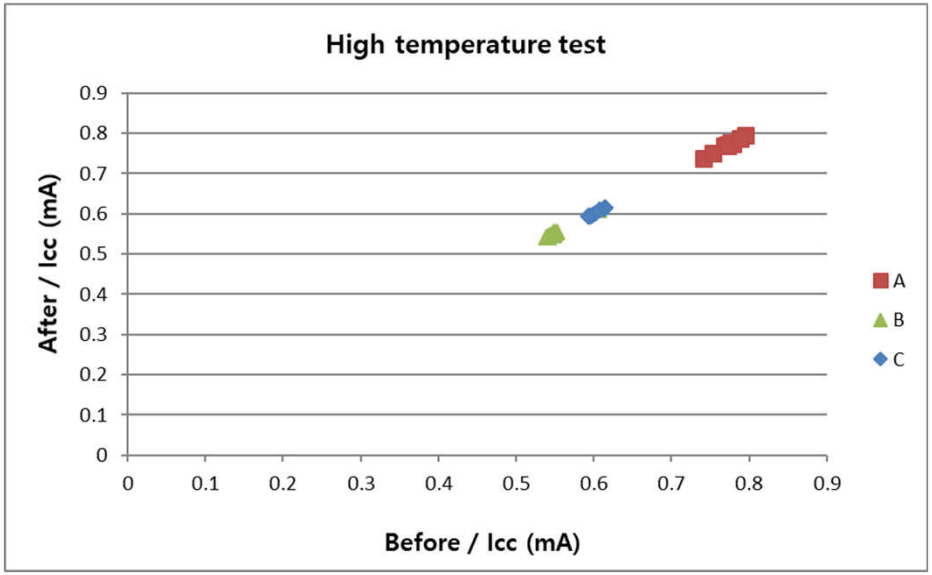

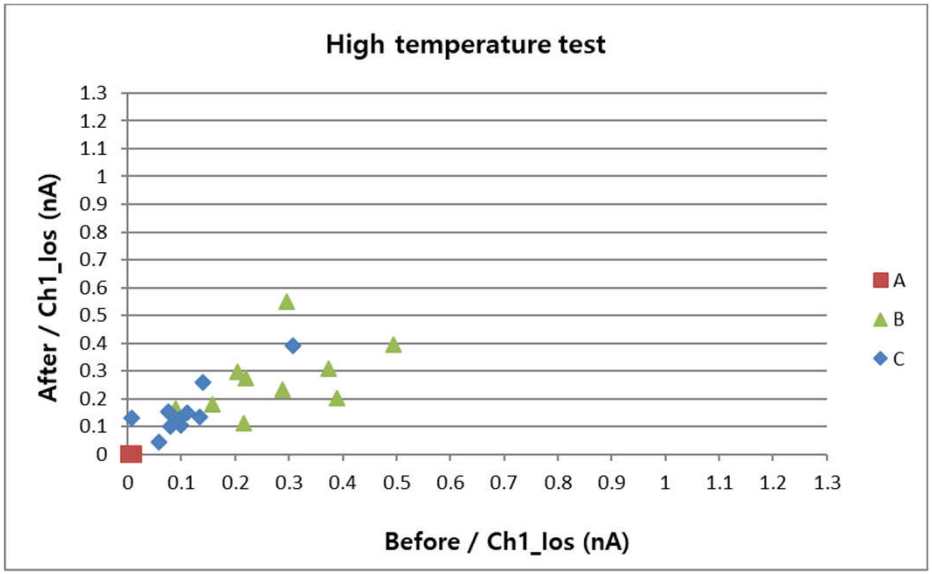

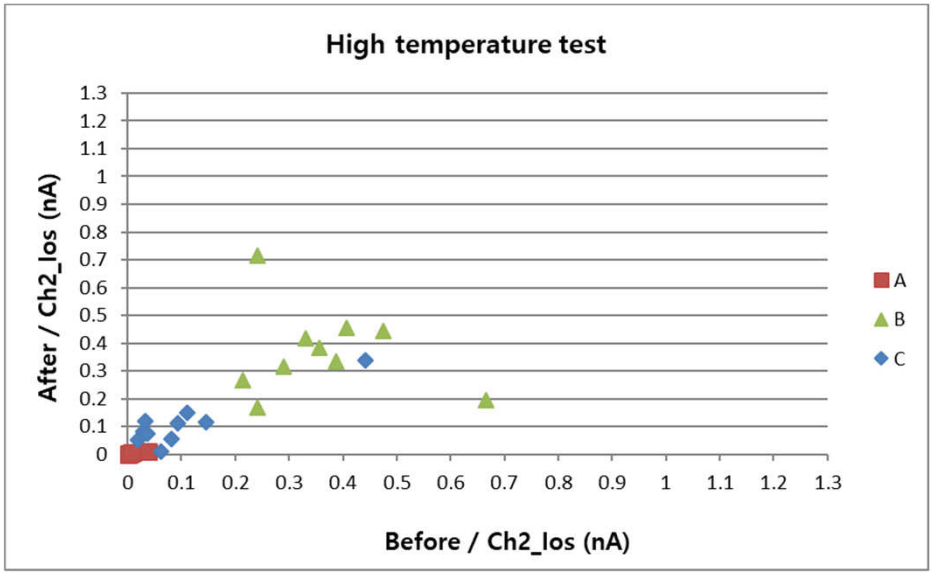

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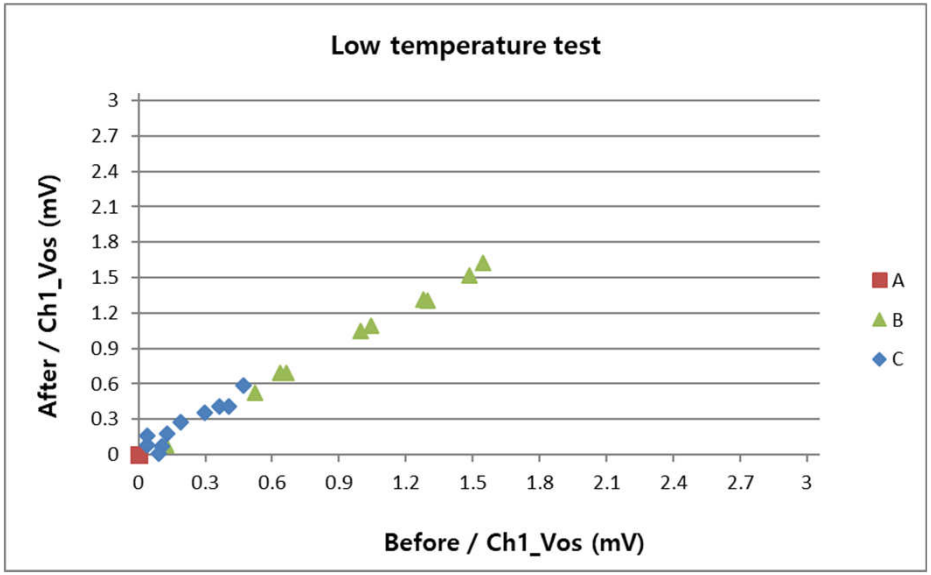

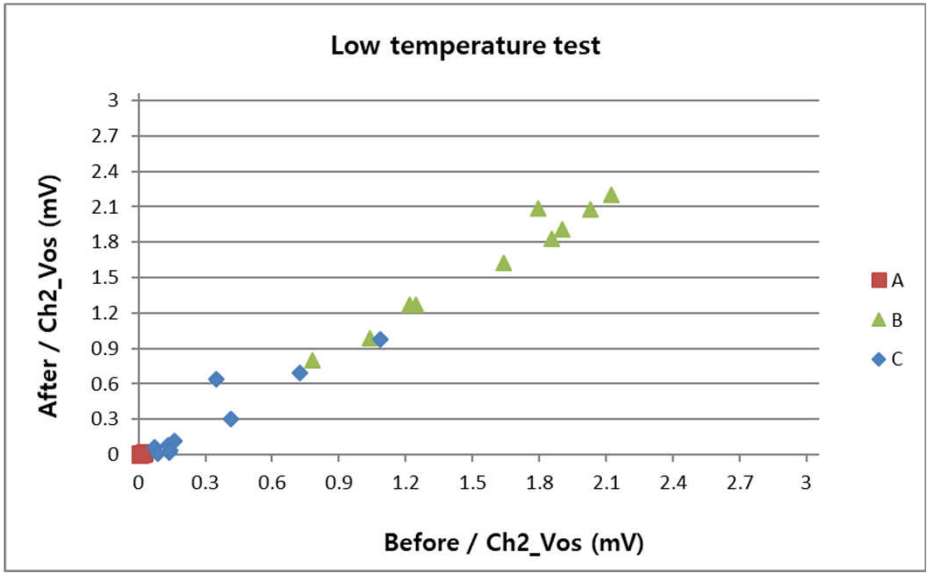

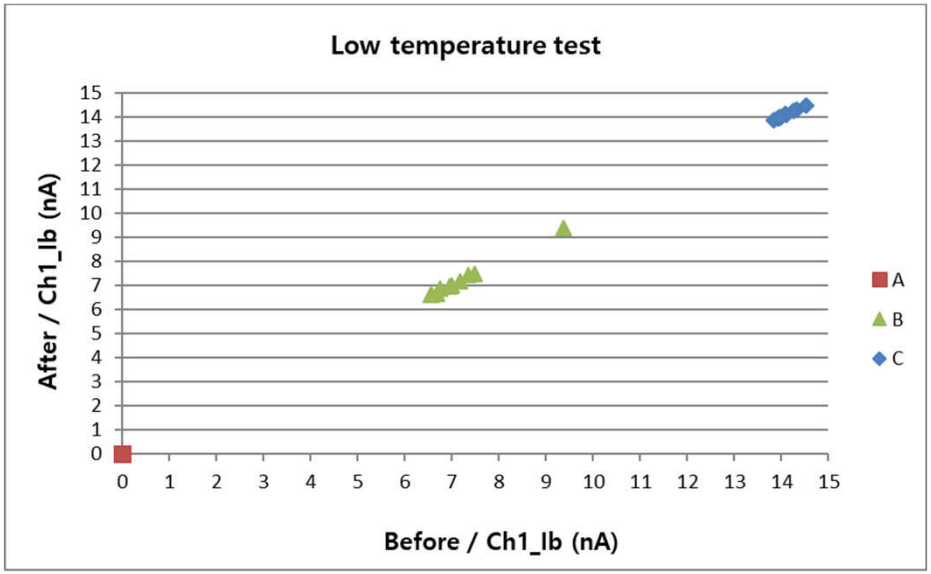

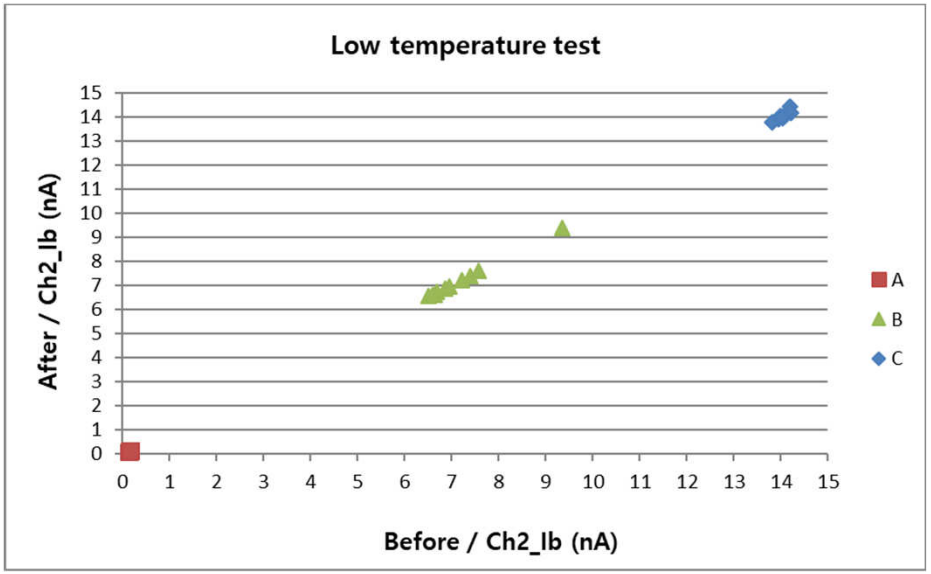

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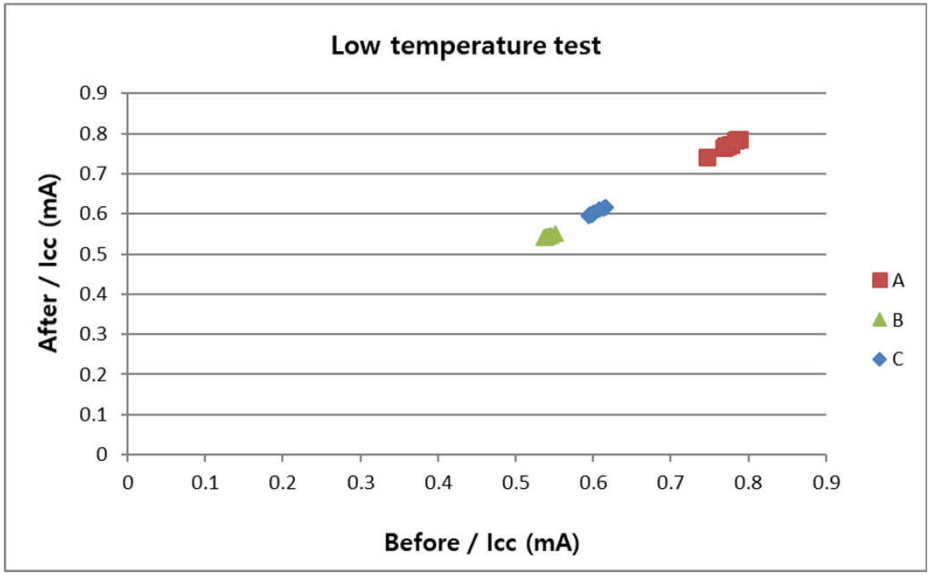
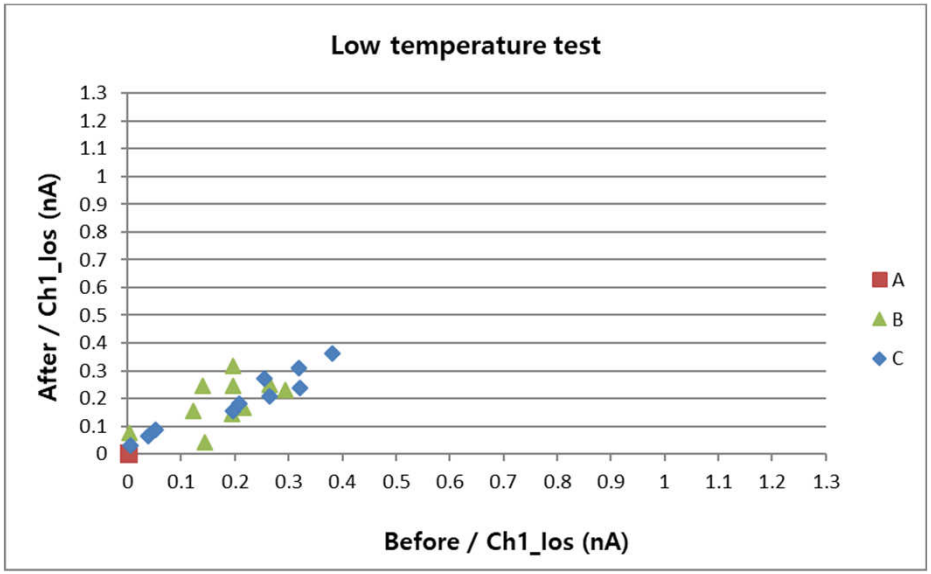
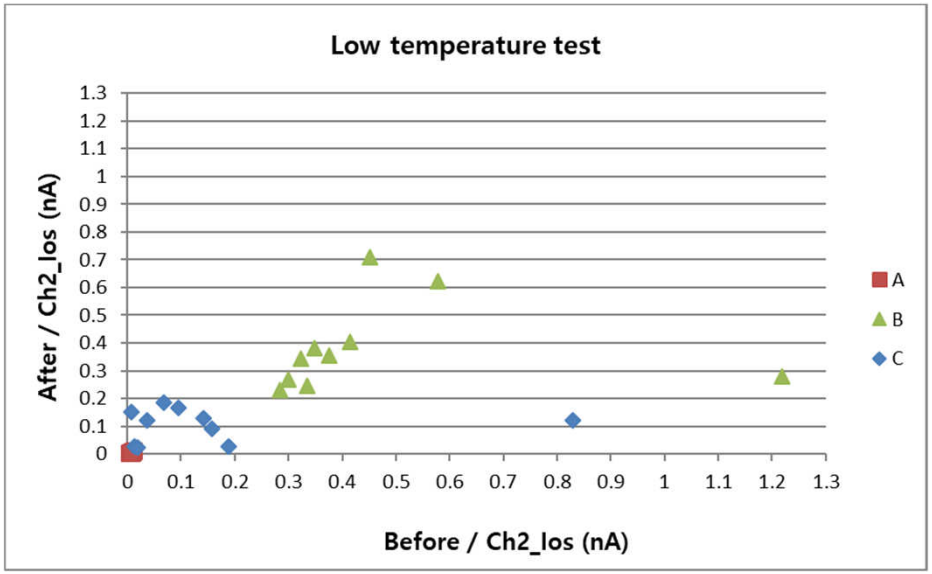
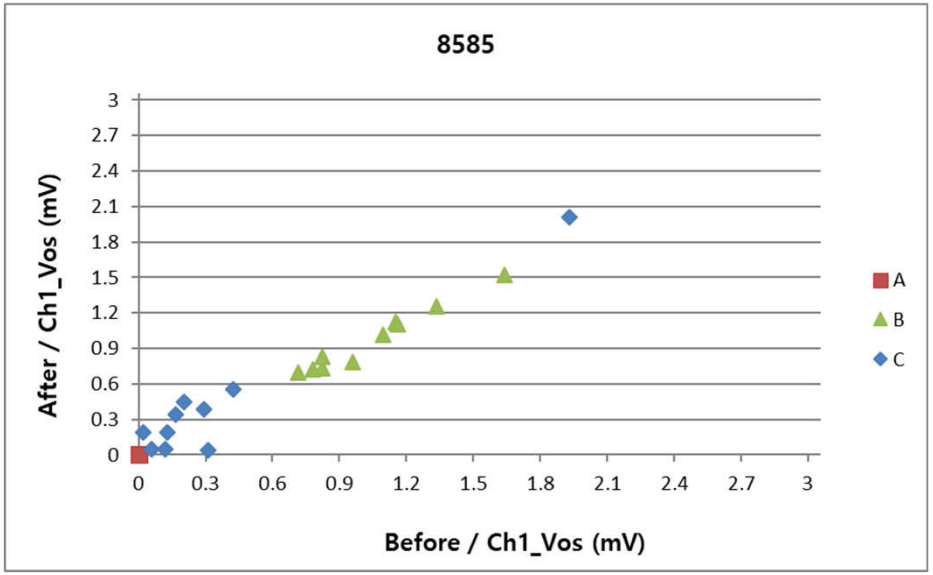


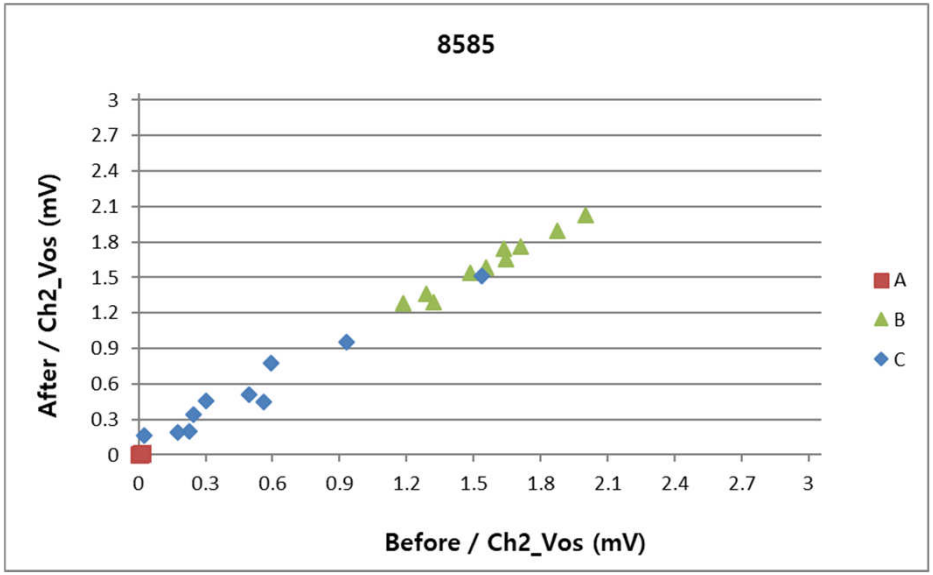


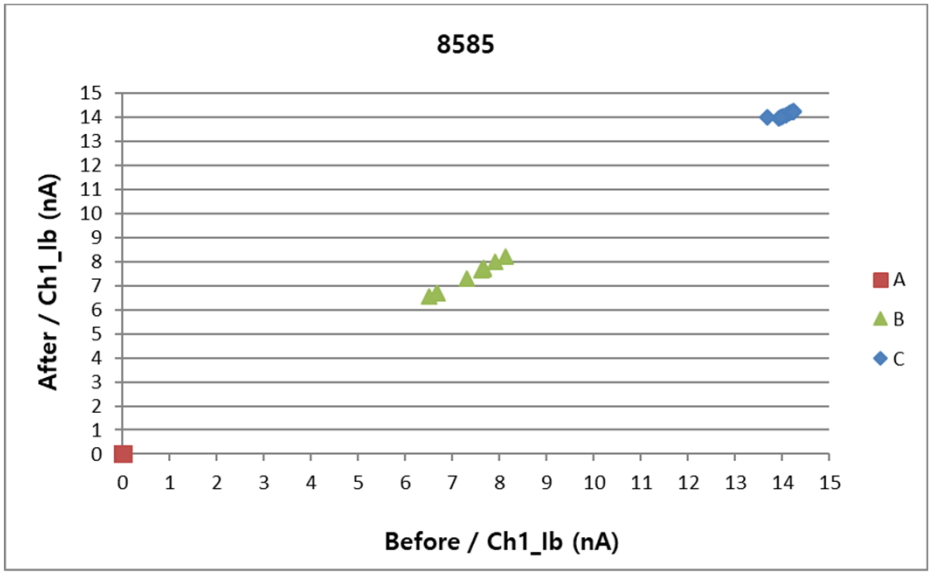


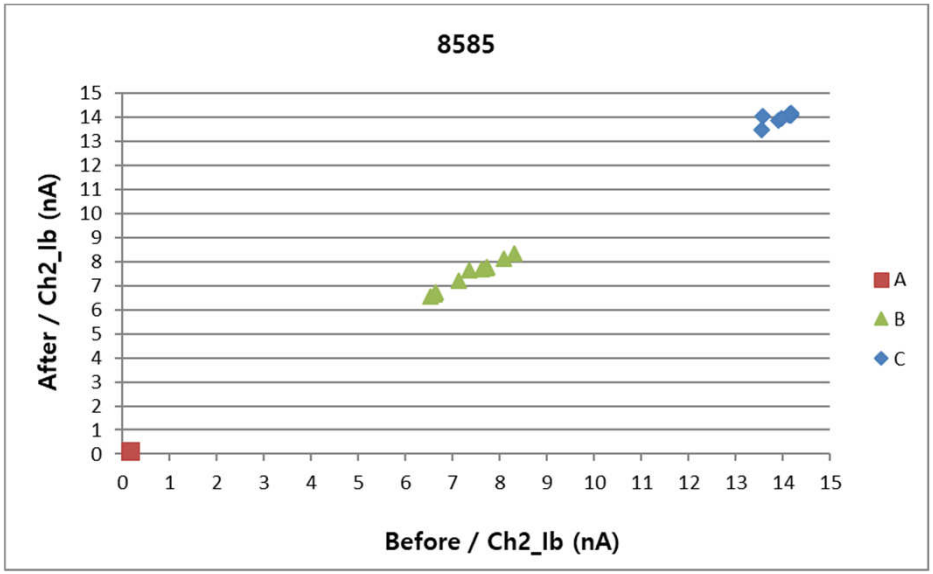
Summary

High temp. & high humidity









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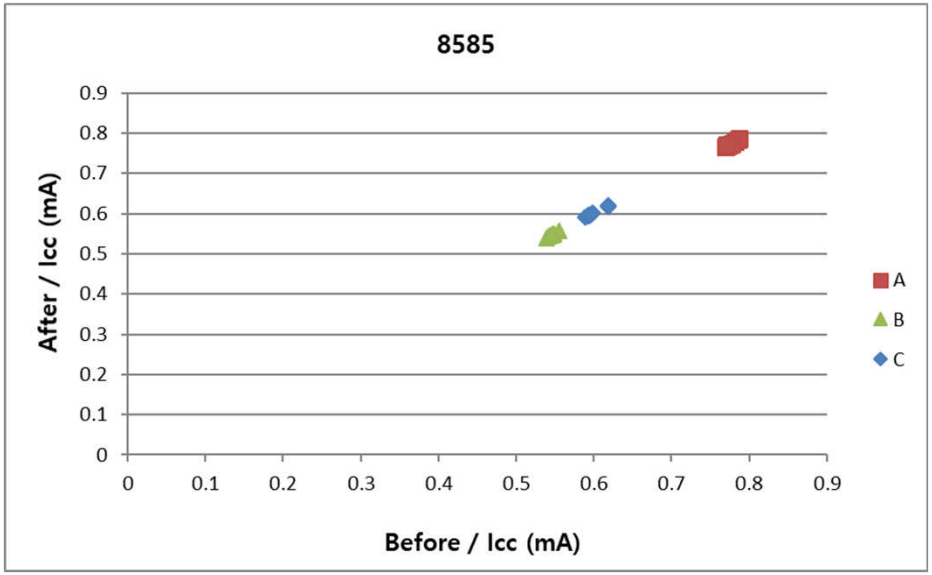
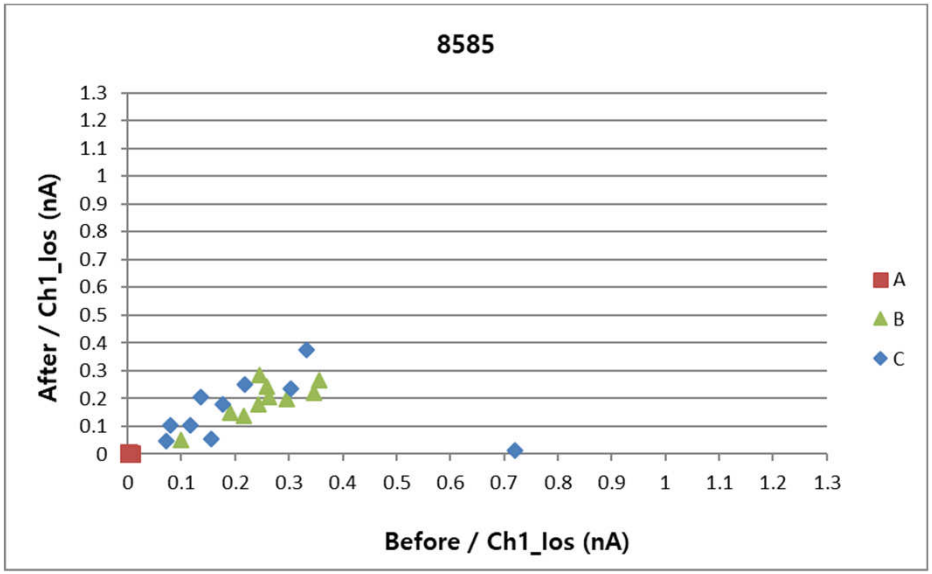
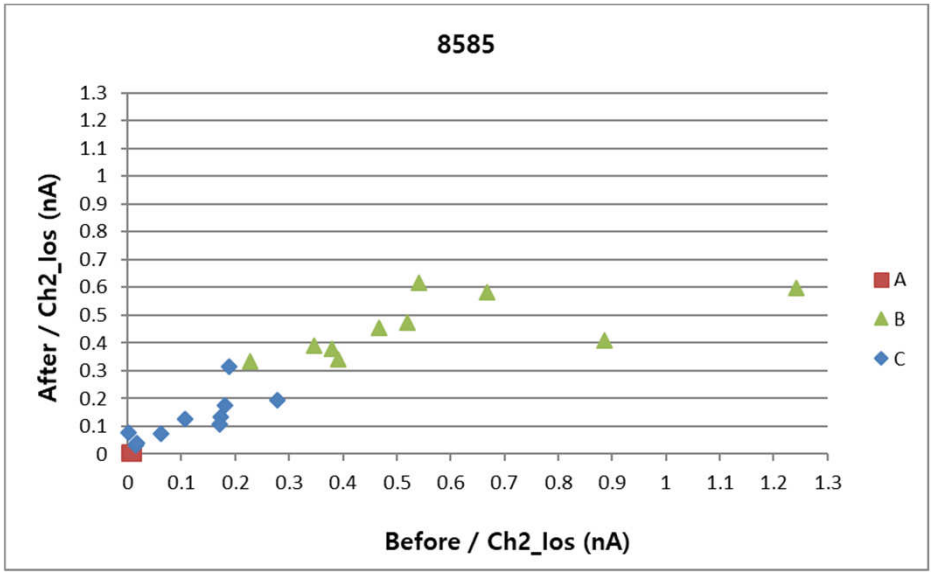
High temp. & high humidity

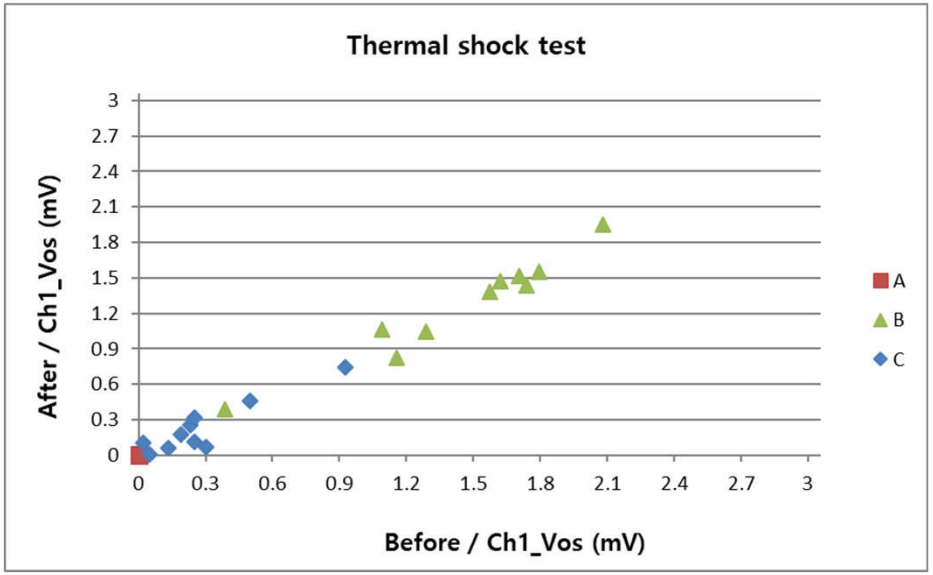


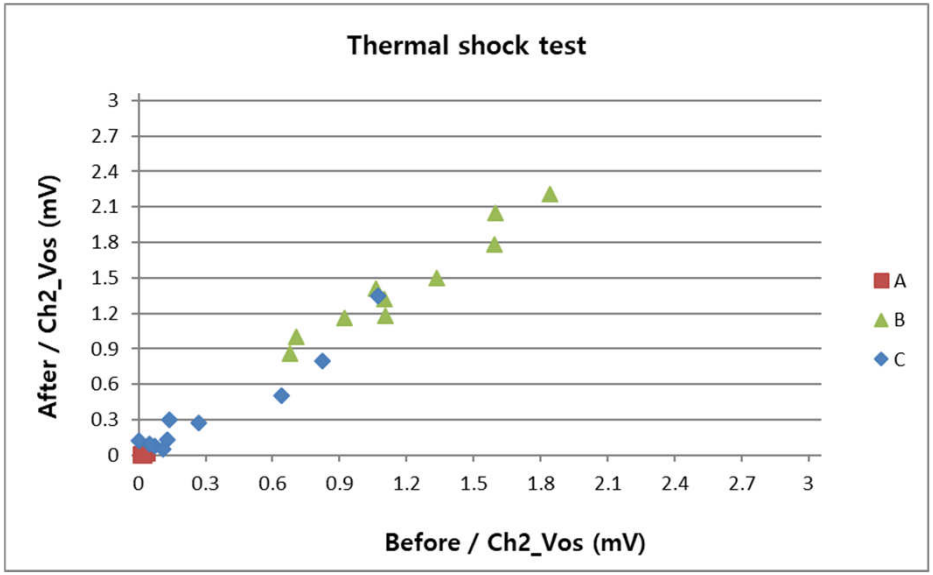


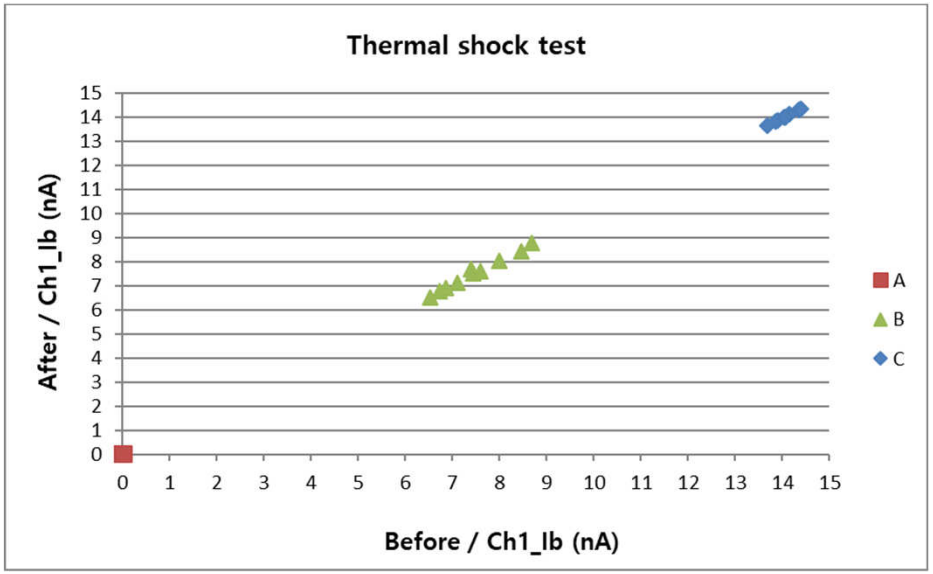


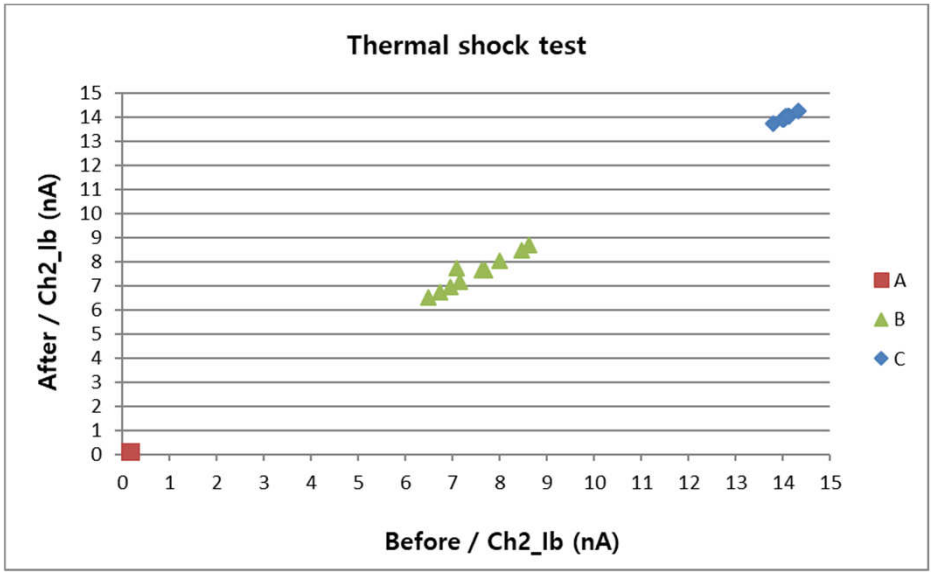
Summary

Thermal shock









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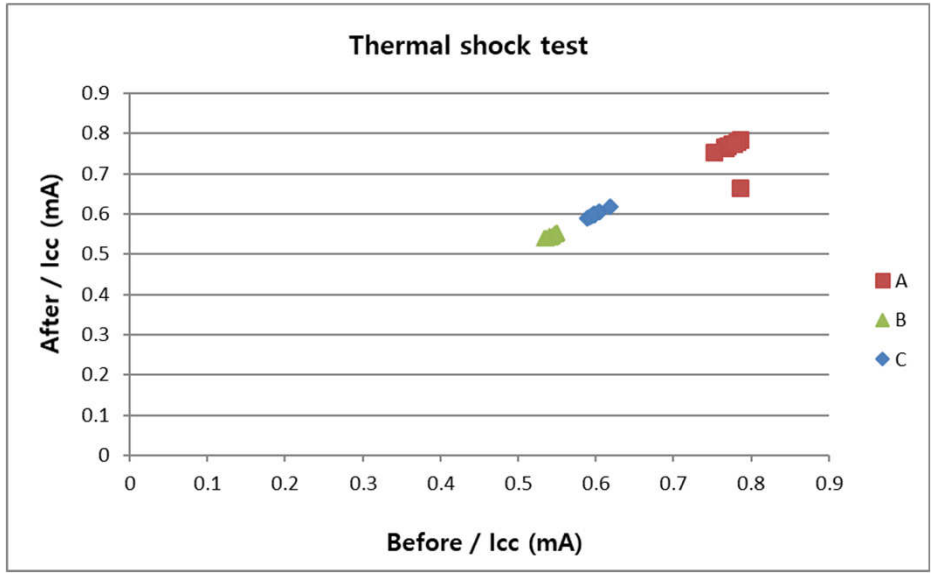

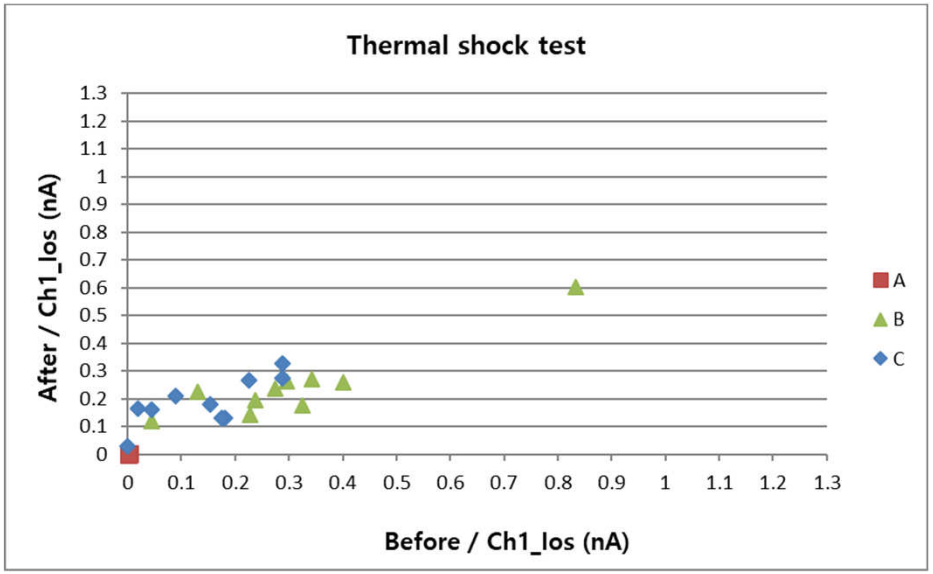

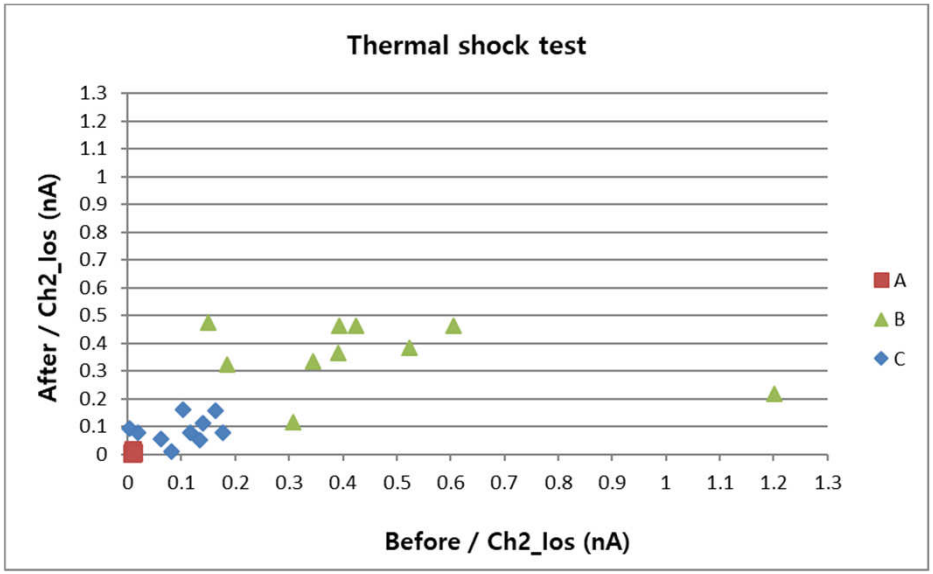

A社

High temp. test

High temperature test	Vos (mV)						Ib (nA)					
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1		Ch2	Ch2	
#1	0.0017	0.0017	0.0000	0.0061	0.0012	-80.3279	0.0149	0.0239	60.4027	0.2159	0.1434	-33.5804
#2	0.0012	0.0018	50.0000	0.0143	0.0095	-33.5664	0.0139	0.0229	64.7482	0.1700	0.1311	-22.8824
#3	0.0010	0.0026	160.0000	0.0030	0.0007	-76.6667	0.0116	0.0191	64.6552	0.1252	0.0964	-23.0032
#4	0.0010	0.0016	60.0000	0.0086	0.0042	-51.1628	0.0150	0.0246	64.0000	0.1671	0.1296	-22.4417
#5	0.0008	0.0011	37.5000	0.0083	0.0037	-55.4217	0.0153	0.0247	61.4379	0.1501	0.1172	-21.9187
#6	0.0009	0.0016	77.7778	0.0016	0.0012	-25.0000	0.0149	0.0244	63.7584	0.1581	0.1235	-21.8849
#7	0.0012	0.0018	50.0000	0.0036	0.0002	-94.4444	0.0130	0.0210	61.5385	0.1264	0.0988	-21.8354
#8	0.0011	0.0017	54.5455	0.0107	0.0059	-44.8598	0.0144	0.0232	61.1111	0.1693	0.1323	-21.8547
#9	0.0011	0.0015	36.3636	0.0122	0.0071	-41.8033	0.0144	0.0225	56.2500	0.1583	0.1237	-21.8572
#10	0.0005	0.0009	80.0000	0.0155	0.0083	-46.4516	0.0130	0.0236	81.5385	0.1704	0.1218	-28.5211
Average	0.0011	0.0016	60.6187	0.0084	0.0042	-54.9705	0.0140	0.0230	63.9440	0.1611	0.1218	-23.9780

A社

High temp. test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.0018	0.0031	72.2222	0.0390	0.0086	-77.9487	0.795	0.795	0.000
#2	0.0023	0.0020	-13.0435	0.0084	0.0048	-42.8571	0.772	0.773	0.130
#3	0.0089	0.0015	-83.1461	0.0043	0.0023	-46.5116	0.741	0.739	-0.270
#4	0.0025	0.0028	12.0000	0.0091	0.0053	-41.7582	0.776	0.777	0.129
#5	0.0025	0.0025	0.0000	0.0051	0.0033	-35.2941	0.779	0.775	-0.513
#6	0.0023	0.0031	34.7826	0.0013	0.0003	-76.9231	0.768	0.769	0.130
#7	0.0025	0.0018	-28.0000	0.0008	0.0030	275.0000	0.753	0.752	-0.133
#8	0.0028	0.0031	10.7143	0.0096	0.0048	-50.0000	0.772	0.770	-0.259
#9	0.0023	0.0023	0.0000	0.0073	0.0048	-34.2466	0.772	0.769	-0.389
#10	0.0020	0.0018	-10.0000	0.0081	0.0051	-37.0370	0.788	0.787	-0.127
Average	0.0030	0.0024	-0.4470	0.0093	0.0042	-16.7577	0.772	0.771	-0.130

B社

High temp. test

High temperature test	Vos (mV)						Ib (nA)					
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1		Ch2	Ch2	
#1	1.2619	0.8763	-30.5571	1.1392	1.5247	33.8395	8.0398	8.1659	1.5684	8.0668	8.2905	2.7731
#2	1.1174	0.9086	-18.6862	1.5490	1.6870	8.9090	6.6148	6.7605	2.2026	6.7137	6.7571	0.6464
#3	1.1510	0.8575	-25.4996	2.5312	3.0189	19.2675	7.2691	7.3507	1.1226	7.5118	7.4315	-1.0690
#4	2.0292	1.7292	-14.7842	1.7295	2.1283	23.0587	8.1375	8.2241	1.0642	7.8076	7.8959	1.1309
#5	1.2270	1.0347	-15.6724	1.3206	1.5426	16.8105	7.3561	7.4514	1.2955	7.4696	7.5098	0.5382
#6	0.7991	0.4323	-45.9016	0.9883	1.3686	38.4802	8.9286	8.9560	0.3069	8.7780	8.8468	0.7838
#7	0.7599	0.6595	-13.2123	2.1823	2.4688	13.1284	7.6013	7.6119	0.1394	7.5865	7.5610	-0.3361
#8	0.5542	0.1446	-73.9083	1.0354	1.5145	46.2720	7.2575	7.2195	-0.5236	7.2412	7.2947	0.7388
#9	1.2414	1.1633	-6.2913	1.9950	2.2033	10.4411	7.1984	7.2376	0.5446	7.1765	7.2214	0.6257
#10	1.4561	1.2104	-16.8738	2.6138	3.1149	19.1713	6.5389	6.5831	0.6760	6.4949	6.5645	1.0716
Average	1.1597	0.9016	-26.1387	1.7084	2.0572	22.9378	7.4942	7.5561	0.8397	7.4847	7.5373	0.6903

B社

High temp. test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.3730	0.3083	-17.3458	0.2416	0.1682	-30.3808	0.544	0.547	0.551
#2	0.0894	0.1647	84.2282	0.3553	0.3822	7.5711	0.542	0.546	0.738
#3	0.2163	0.1125	-47.9889	0.2421	0.7140	194.9195	0.606	0.611	0.825
#4	0.4951	0.3940	-20.4201	0.4076	0.4562	11.9235	0.548	0.548	0.000
#5	0.2956	0.5498	85.9946	0.2908	0.3155	8.4938	0.542	0.541	-0.185
#6	0.2194	0.2744	25.0684	0.6655	0.1932	-70.9692	0.553	0.556	0.542
#7	0.2884	0.2320	-19.5562	0.4742	0.4424	-6.7060	0.550	0.552	0.364
#8	0.3898	0.2035	-47.7937	0.2145	0.2663	24.1492	0.549	0.554	0.911
#9	0.1570	0.1816	15.6688	0.3311	0.4169	25.9136	0.547	0.551	0.731
#10	0.2046	0.2986	45.9433	0.3882	0.3344	-13.8588	0.539	0.543	0.742
Average	0.2729	0.2719	10.3798	0.3611	0.3689	15.1056	0.552	0.555	0.522

C社

High temp. test

High temperature test	Vos (mV)						Ib (nA)					
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1		Ch2	Ch2	
#1	0.1419	0.4836	240.8034	0.1610	0.2687	66.8944	14.1105	14.1019	-0.0609	13.6039	13.5535	-0.3705
#2	0.1750	0.0400	-77.1429	0.1301	0.3890	199.0008	13.9613	13.9787	0.1246	14.0321	14.0289	-0.0228
#3	0.2978	0.5231	75.6548	0.3064	0.4974	62.3368	14.0363	14.0149	-0.1525	14.0306	13.8362	-1.3855
#4	0.1384	0.1551	12.0665	0.3423	0.1154	-66.2869	14.6455	14.6926	0.3216	14.6401	14.5826	-0.3928
#5	0.4150	0.5806	39.9036	1.4016	1.4797	5.5722	13.9607	13.9706	0.0709	14.0101	13.8425	-1.1963
#6	0.6238	0.2727	-56.2841	0.2632	0.5677	115.6915	14.0115	13.9785	-0.2355	13.9627	13.8297	-0.9525
#7	0.2475	0.1007	-59.3131	0.0727	0.0625	-14.0303	13.9855	14.0328	0.3382	14.1694	14.1589	-0.0741
#8	0.0278	0.2516	805.0360	0.5078	0.6365	25.3446	14.0850	14.1258	0.2897	13.6050	13.5816	-0.1720
#9	0.0095	0.2803	2850.5263	1.4086	1.5257	8.3132	14.1691	14.1564	-0.0896	14.0245	14.0149	-0.0685
#10	0.0188	0.4192	2129.7872	0.5476	0.4056	-25.9313	13.9742	14.0250	0.3635	13.9916	13.9898	-0.0129
Average	0.2096	0.3107	596.1038	0.5141	0.5948	37.6905	14.0940	14.1077	0.0970	14.0070	13.9419	-0.4648

C社

High temp. test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.0994	0.1061	6.7404	0.0928	0.1110	19.6121	0.595	0.594	-0.168
#2	0.0961	0.1254	30.4891	0.0627	0.0102	-83.7321	0.596	0.595	-0.168
#3	0.0749	0.1525	103.6048	0.0321	0.1179	267.2897	0.594	0.594	0.000
#4	0.1401	0.2595	85.2248	0.1456	0.1169	-19.7115	0.614	0.614	0.000
#5	0.3078	0.3906	26.9006	0.0814	0.0539	-33.7838	0.598	0.598	0.000
#6	0.0069	0.1316	1807.2464	0.0199	0.0503	152.7638	0.613	0.613	0.000
#7	0.1103	0.1494	35.4488	0.4408	0.3395	-22.9809	0.614	0.614	0.000
#8	0.0795	0.1015	27.6730	0.0298	0.0835	180.2013	0.608	0.610	0.329
#9	0.0581	0.0439	-24.4406	0.1107	0.1516	36.9467	0.603	0.603	0.000
#10	0.1340	0.1359	1.4179	0.0367	0.0733	99.7275	0.593	0.595	0.337
Average	0.1107	0.1596	210.0305	0.1053	0.1108	59.6333	0.603	0.603	0.033

A社

Low temp. test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.0002	0.0009	350.0000	0.0180	0.0129	-28.3333	0.0130	0.0230	76.9231	0.1724	0.1221	-29.1763
#2	0.0002	0.0010	400.0000	0.0186	0.0134	-27.9570	0.0127	0.0227	78.7402	0.1649	0.1173	-28.8660
#3	0.0004	0.0001	-75.0000	0.0096	0.0068	-29.1667	0.0126	0.0225	78.5714	0.1604	0.1140	-28.9277
#4	0.0006	0.0015	150.0000	0.0153	0.0111	-27.4510	0.0118	0.0215	82.2034	0.1564	0.1118	-28.5166
#5	0.0001	0.0007	600.0000	0.0236	0.0171	-27.5424	0.0135	0.0238	76.2963	0.1696	0.1212	-28.5377
#6	0.0005	0.0014	180.0000	0.0085	0.0064	-24.7059	0.0122	0.0218	78.6885	0.1683	0.1207	-28.2828
#7	0.0015	0.0030	100.0000	0.0062	0.0046	-25.8065	0.0103	0.0186	80.5825	0.1371	0.0984	-28.2276
#8	0.0004	0.0012	200.0000	0.0115	0.0084	-26.9565	0.0130	0.0232	78.4615	0.1845	0.1322	-28.3469
#9	0.0003	0.0009	200.0000	0.0139	0.0101	-27.3381	0.0120	0.0214	78.3333	0.1731	0.1242	-28.2496
#10	0.0003	0.0010	233.3333	0.0092	0.0068	-26.0870	0.0132	0.0234	77.2727	0.1707	0.1227	-28.1195
Average	0.0005	0.0012	233.8333	0.0134	0.0098	-27.1344	0.0124	0.0222	78.6073	0.1657	0.1185	-28.5251

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Low temp. test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.0020	0.0023	15.0000	0.0081	0.0061	-24.6914	0.789	0.785	-0.507
#2	0.0020	0.0025	25.0000	0.0104	0.0081	-22.1154	0.771	0.768	-0.389
#3	0.0023	0.0018	-21.7391	0.0094	0.0066	-29.7872	0.786	0.785	-0.127
#4	0.0023	0.0023	0.0000	0.0086	0.0068	-20.9302	0.768	0.765	-0.391
#5	0.0020	0.0028	40.0000	0.0101	0.0084	-16.8317	0.776	0.774	-0.258
#6	0.0020	0.0018	-10.0000	0.0076	0.0058	-23.6842	0.773	0.771	-0.259
#7	0.0023	0.0025	8.6957	0.0063	0.0033	-47.6190	0.746	0.742	-0.536
#8	0.0020	0.0015	-25.0000	0.0040	0.0030	-25.0000	0.771	0.770	-0.130
#9	0.0020	0.0020	0.0000	0.0106	0.0104	-1.8868	0.777	0.774	-0.386
#10	0.0025	0.0025	0.0000	0.0053	0.0048	-9.4340	0.783	0.784	0.128
Average	0.0021	0.0022	3.1957	0.0080	0.0063	-22.1980	0.774	0.772	-0.285

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Low temp. test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.1234	0.0776	-37.1151	1.7964	2.0824	15.9207	6.6939	6.6783	-0.2330	6.5183	6.5728	0.8361
#2	0.5205	0.5235	0.5764	2.1230	2.2032	3.7777	7.3553	7.4245	0.9408	7.4042	7.4063	0.0284
#3	1.5473	1.6242	4.9699	1.0374	0.9881	-4.7523	6.5659	6.6116	0.6960	6.6387	6.6354	-0.0497
#4	1.0414	1.0897	4.6380	2.0308	2.0752	2.1863	6.7555	6.8650	1.6209	6.6957	6.7312	0.5302
#5	0.6375	0.6925	8.6275	1.2453	1.2680	1.8229	7.1746	7.1710	-0.0502	7.2199	7.2327	0.1773
#6	1.2785	1.3111	2.5499	1.6406	1.6259	-0.8960	6.9447	6.9421	-0.0374	6.8631	6.8910	0.4065
#7	0.9950	1.0510	5.6281	1.9042	1.9063	0.1103	9.3694	9.3856	0.1729	9.3565	9.4111	0.5836
#8	0.6648	0.6905	3.8658	0.7786	0.8024	3.0568	7.4895	7.4869	-0.0347	7.5812	7.6014	0.2664
#9	1.2966	1.3080	0.8792	1.8555	1.8266	-1.5575	6.9952	7.0258	0.4374	6.9445	6.9437	-0.0115
#10	1.4827	1.5139	2.1043	1.2151	1.2735	4.8062	6.5599	6.5970	0.5656	6.6067	6.6127	0.0908
Average	0.9588	0.9882	-0.3276	1.5627	1.6052	2.4475	7.1904	7.2188	0.4078	7.1829	7.2038	0.2858

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Low temp. test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.1442	0.0411	-71.4979	1.6184	0.2790	-82.7608	0.540	0.542	0.370
#2	0.0038	0.0770	1926.3158	0.3757	0.3546	-5.6162	0.537	0.540	0.559
#3	0.1409	0.2468	75.1597	0.3349	0.2456	-26.6647	0.538	0.542	0.743
#4	0.1964	0.3182	62.0163	0.3474	0.3809	9.6431	0.539	0.541	0.371
#5	0.2938	0.2285	-22.2260	0.4153	0.4046	-2.5765	0.545	0.546	0.183
#6	0.2166	0.1673	-22.7608	0.4512	0.7097	57.2917	0.542	0.544	0.369
#7	0.1231	0.1553	26.1576	0.5772	0.6213	7.6403	0.551	0.551	0.000
#8	0.2647	0.2502	-5.4779	0.2839	0.2303	-18.8799	0.541	0.544	0.555
#9	0.1939	0.1431	-26.1991	0.3232	0.3433	6.2191	0.542	0.544	0.369
#10	0.1972	0.2473	25.4057	0.3000	0.2670	-11.0000	0.546	0.547	0.183
Average	0.1775	0.1875	196.6893	0.5027	0.3836	-6.6704	0.542	0.544	0.370

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Low temp. test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.1296	0.1766	36.2654	0.4154	0.2987	-28.0934	13.9759	13.9898	0.0995	14.1009	14.1041	0.0227
#2	0.3625	0.4125	13.7931	0.0697	0.0594	-14.7776	14.3244	14.2951	-0.2045	14.1617	14.2150	0.3764
#3	0.0371	0.0767	106.7385	0.7240	0.6937	-4.1851	14.5245	14.5090	-0.1067	14.1927	14.4507	1.8178
#4	0.1047	0.0716	-31.6141	0.1384	0.0167	-87.9335	14.0869	14.1215	0.2456	13.9964	14.0389	0.3036
#5	0.1878	0.2774	47.7103	0.0855	0.0056	-93.4503	14.2609	14.2917	0.2160	14.2053	14.1984	-0.0486
#6	0.4048	0.4051	0.0741	0.1343	0.0829	-38.2725	13.9338	13.9663	0.2332	13.9557	13.9404	-0.1096
#7	0.0395	0.1573	298.2278	0.3466	0.6358	83.4391	13.8464	13.8887	0.3055	14.0768	14.0403	-0.2593
#8	0.2964	0.3540	19.4332	0.1590	0.1192	-25.0314	14.0985	14.0890	-0.0674	14.0354	13.9519	-0.5949
#9	0.0894	0.0102	-88.5906	0.1437	0.0330	-77.0355	13.9819	14.0055	0.1688	14.0181	14.0163	-0.0128
#10	0.4716	0.5835	23.7277	1.0869	0.9784	-9.9825	13.9438	13.9657	0.1571	13.8221	13.7987	-0.1693
Average	0.2123	0.2525	42.5766	0.3304	0.2923	-29.5323	14.0977	14.1122	0.1047	14.0565	14.0755	0.1326

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Low temp. test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.3185	0.3077	-3.3909	0.0375	0.1212	223.2000	0.600	0.600	0.000
#2	0.0395	0.0663	67.8481	0.0684	0.1868	173.0994	0.613	0.613	0.000
#3	0.1957	0.1550	-20.7971	0.8298	0.1212	-85.3941	0.616	0.615	-0.162
#4	0.2556	0.2728	6.7293	0.0133	0.0271	103.7594	0.598	0.599	0.167
#5	0.0533	0.0874	63.9775	0.0189	0.0225	19.0476	0.616	0.616	0.000
#6	0.0054	0.0324	500.0000	0.0946	0.1674	76.9556	0.601	0.602	0.166
#7	0.2087	0.1825	-12.5539	0.1418	0.1279	-9.8025	0.608	0.610	0.329
#8	0.3210	0.2374	-26.0436	0.1882	0.0286	-84.8034	0.597	0.597	0.000
#9	0.2647	0.2060	-22.1760	0.1566	0.0927	-40.8046	0.596	0.598	0.336
#10	0.3822	0.3610	-5.5468	0.0079	0.1506	1806.3291	0.595	0.594	-0.168
Average	0.2045	0.1909	54.8046	0.1557	0.1046	218.1587	0.604	0.604	0.067

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High temp. & high humidity test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.0005	0.0003	-40.0000	0.0168	0.0117	-30.3571	0.0125	0.0201	60.8000	0.1648	0.1166	-29.2476
#2	0.0006	0.0009	50.0000	0.0155	0.0106	-31.6129	0.0140	0.0222	58.5714	0.1788	0.1272	-28.8591
#3	0.0002	0.0001	-50.0000	0.0145	0.0109	-24.8276	0.0127	0.0208	63.7795	0.1677	0.1278	-23.7925
#4	0.0004	0.0009	125.0000	0.0123	0.0090	-26.8293	0.0137	0.0222	62.0438	0.1728	0.1320	-23.6111
#5	0.0002	0.0006	200.0000	0.0082	0.0059	-28.0488	0.0134	0.0211	57.4627	0.1662	0.1260	-24.1877
#6	0.0002	0.0007	250.0000	0.0031	0.0032	3.2258	0.0139	0.0218	56.8345	0.1730	0.1313	-24.1040
#7	0.0004	0.0009	125.0000	0.0145	0.0110	-24.1379	0.0143	0.0225	57.3427	0.1717	0.1310	-23.7041
#8	0.0001	0.0004	300.0000	0.0132	0.0106	-19.6970	0.0129	0.0205	58.9147	0.1571	0.1232	-21.5786
#9	0.0003	0.0009	200.0000	0.0178	0.0133	-25.2809	0.0139	0.0216	55.3957	0.1782	0.1358	-23.7935
#10	0.0005	0.0010	100.0000	0.0127	0.0092	-27.5591	0.0141	0.0219	55.3191	0.1740	0.1323	-23.9655
Average	0.0003	0.0007	126.0000	0.0129	0.0095	-23.5125	0.0135	0.0215	58.6464	0.1704	0.1283	-24.6844

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High temp. & high humidity test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.0071	0.0020	-71.8310	0.0076	0.0058	-23.6842	0.775	0.771	-0.516
#2	0.0020	0.0061	205.0000	0.0099	0.0071	-28.2828	0.771	0.768	-0.389
#3	0.0020	0.0038	90.0000	0.0063	0.0048	-23.8095	0.782	0.780	-0.256
#4	0.0025	0.0025	0.0000	0.0078	0.0056	-28.2051	0.787	0.786	-0.127
#5	0.0023	0.0025	8.6957	0.0058	0.0048	-17.2414	0.769	0.766	-0.390
#6	0.0023	0.0028	21.7391	0.0068	0.0058	-14.7059	0.769	0.766	-0.390
#7	0.0025	0.0018	-28.0000	0.0073	0.0046	-36.9863	0.772	0.769	-0.389
#8	0.0023	0.0023	0.0000	0.0038	0.0048	26.3158	0.786	0.785	-0.127
#9	0.0023	0.0020	-13.0435	0.0076	0.0061	-19.7368	0.777	0.775	-0.257
#10	0.0018	0.0020	11.1111	0.0078	0.0048	-38.4615	0.771	0.770	-0.130
Average	0.0027	0.0028	22.3671	0.0071	0.0054	-20.4798	0.776	0.774	-0.297

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High temp. & high humidity test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	1.1533	1.1182	-3.0434	1.8728	1.8900	0.9184	6.4995	6.5392	0.6108	6.5205	6.5367	0.2484
#2	0.8240	0.7337	-10.9587	2.0034	2.0308	1.3677	8.1291	8.2000	0.8722	8.3009	8.3459	0.5421
#3	1.3356	1.2525	-6.2219	1.4832	1.5350	3.4924	7.6585	7.7011	0.5562	7.3533	7.6488	4.0186
#4	1.6421	1.5218	-7.3260	1.2863	1.3594	5.6830	7.9013	7.9939	1.1720	8.0935	8.1277	0.4226
#5	0.7812	0.7197	-7.8725	1.5564	1.5824	1.6705	7.3047	7.3040	-0.0096	7.1245	7.1764	0.7285
#6	1.0947	1.0148	-7.2988	1.6356	1.7415	6.4747	7.6587	7.6897	0.4048	7.7226	7.7753	0.6824
#7	1.1591	1.1053	-4.6415	1.7082	1.7602	3.0441	6.6832	6.6752	-0.1197	6.6142	6.6448	0.4626
#8	0.7174	0.6927	-3.4430	1.1823	1.2830	8.5173	7.6130	7.6337	0.2719	7.6299	7.6688	0.5098
#9	0.8217	0.8267	0.6085	1.3202	1.2892	-2.3481	6.6640	6.6918	0.4172	6.6377	6.7303	1.3951
#10	0.9606	0.7832	-18.4676	1.6434	1.6571	0.8336	7.6731	7.7325	0.7741	7.7132	7.7361	0.2969
Average	1.0490	0.9769	-6.8665	1.5692	1.6129	2.9654	7.3785	7.4161	0.4950	7.3710	7.4391	0.9307

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High temp. & high humidity test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.2594	0.2443	-5.8211	0.3908	0.3395	-13.1269	0.539	0.540	0.186
#2	0.1903	0.1494	-21.4924	0.6668	0.5818	-12.7475	0.549	0.549	0.000
#3	0.3468	0.2190	-36.8512	0.8866	0.4097	-53.7898	0.547	0.547	0.000
#4	0.2423	0.1795	-25.9183	1.2422	0.5956	-52.0528	0.542	0.545	0.554
#5	0.2161	0.1359	-37.1124	0.5204	0.4723	-9.2429	0.555	0.557	0.360
#6	0.2443	0.2836	16.0868	0.3790	0.3793	0.0792	0.549	0.550	0.182
#7	0.2624	0.2048	-21.9512	0.2268	0.3342	47.3545	0.544	0.546	0.368
#8	0.3562	0.2655	-25.4632	0.5415	0.6178	14.0905	0.547	0.550	0.548
#9	0.0991	0.0502	-49.3441	0.3466	0.3903	12.6082	0.543	0.545	0.368
#10	0.2961	0.1984	-32.9956	0.4673	0.4536	-2.9317	0.547	0.549	0.366
Average	0.2513	0.1931	-24.0863	0.5668	0.4574	-6.9759	0.546	0.548	0.293

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High temp. & high humidity test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.3099	0.0424	-86.3182	0.2268	0.1956	-13.7566	13.9277	13.9182	-0.0682	13.8957	13.8646	-0.2238
#2	0.1261	0.1869	48.2157	0.3012	0.4608	52.9880	14.1500	14.1404	-0.0678	14.1430	14.1130	-0.2121
#3	0.1649	0.3401	106.2462	1.5373	1.5147	-1.4701	14.0838	14.0844	0.0043	14.1692	14.1429	-0.1856
#4	0.0582	0.0480	-17.5258	0.1736	0.1883	8.4677	14.2417	14.2273	-0.1011	14.1516	14.0944	-0.4042
#5	0.4260	0.5529	29.7887	0.9302	0.9550	2.6661	13.9710	13.9924	0.1532	13.5713	14.0106	3.2370
#6	0.2920	0.3843	31.6096	0.4936	0.5098	3.2820	14.0147	14.0066	-0.0578	13.5437	13.4705	-0.5405
#7	0.0179	0.1913	968.7151	0.0263	0.1664	532.6996	13.6713	13.9855	2.2982	14.1783	14.0726	-0.7455
#8	0.2010	0.4465	122.1393	0.5920	0.7789	31.5709	14.1906	14.1824	-0.0578	14.1268	14.0751	-0.3660
#9	1.9310	2.0111	4.1481	0.2460	0.3424	39.1870	14.2426	14.2144	-0.1980	14.1478	14.0846	-0.4467
#10	0.1205	0.0500	-58.5062	0.5616	0.4458	-20.6197	13.9734	13.9708	-0.0186	13.9642	13.9224	-0.2993
Average	0.3648	0.4254	114.8513	0.5089	0.5558	63.5015	14.0467	14.0722	0.1886	13.9892	13.9851	-0.0187

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High temp. & high humidity test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.1562	0.0538	-65.5570	0.0163	0.0317	94.4785	0.593	0.595	0.337
#2	0.0713	0.0459	-35.6241	0.1732	0.1340	-22.6328	0.619	0.620	0.162
#3	0.1170	0.1048	-10.4274	0.1814	0.1743	-3.9140	0.618	0.618	0.000
#4	0.0805	0.1040	29.1925	0.0166	0.0385	131.9277	0.599	0.602	0.501
#5	0.1368	0.2052	50.0000	0.1889	0.3140	66.2255	0.596	0.597	0.168
#6	0.3032	0.2368	-21.8997	0.0010	0.0771	7610.0000	0.589	0.590	0.170
#7	0.7198	0.0145	-97.9856	0.1071	0.1281	19.6078	0.618	0.619	0.162
#8	0.3320	0.3748	12.8916	0.1719	0.1072	-37.6382	0.598	0.601	0.502
#9	0.2184	0.2521	15.4304	0.0625	0.0730	16.8000	0.593	0.594	0.169
#10	0.1763	0.1785	1.2479	0.2780	0.1958	-29.5683	0.594	0.595	0.168
Average	0.2312	0.1570	-12.2731	0.1197	0.1274	784.5286	0.602	0.603	0.234

A社 Thermal shock test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.0010	0.0016	60.0000	0.0176	0.0104	-40.9091	0.0121	0.0190	57.0248	0.1576	0.1187	-24.6827
#2	0.0002	0.0003	50.0000	0.0122	0.0076	-37.7049	0.0136	0.0202	48.5294	0.1714	0.1174	-31.5053
#3	0.0001	0.0002	100.0000	0.0363	0.0257	-29.2011	0.0127	0.0196	54.3307	0.1520	0.1135	-25.3289
#4	0.0004	0.0005	25.0000	0.0146	0.0093	-36.3014	0.0134	0.0202	50.7463	0.1750	0.1302	-25.6000
#5	0.0011	0.0014	27.2727	0.0139	0.0098	-29.4964	0.0135	0.0206	52.5926	0.1883	0.1439	-23.5794
#6	0.0012	0.0033	175.0000	0.0135	0.0083	-38.5185	0.0134	0.0337	151.4925	0.1810	0.1386	-23.4254
#7	0.0011	0.0033	200.0000	0.0178	0.0110	-38.2022	0.0129	0.0331	156.5891	0.1725	0.1313	-23.8841
#8	0.0002	0.0008	300.0000	0.0150	0.0084	-44.0000	0.0137	0.0346	152.5547	0.1791	0.1355	-24.3439
#9	0.0001	0.0004	300.0000	0.0179	0.0120	-32.9609	0.0139	0.0348	150.3597	0.1807	0.1372	-24.0730
#10	0.0001	0.0011	1000.0000	0.0140	0.0090	-35.7143	0.0143	0.0359	151.0490	0.1781	0.1384	-22.2908
Average	0.0006	0.0013	223.7273	0.0173	0.0112	-36.3009	0.0134	0.0272	102.5269	0.1736	0.1305	-24.8714

A社 Thermal shock test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.0028	0.0023	-17.8571	0.0078	0.0058	-25.6410	0.767	0.765	-0.261
#2	0.0023	0.0008	-65.2174	0.0091	0.0175	92.3077	0.786	0.665	-15.394
#3	0.0020	0.0025	25.0000	0.0078	0.0020	-74.3590	0.786	0.784	-0.254
#4	0.0023	0.0023	0.0000	0.0094	0.0051	-45.7447	0.775	0.774	-0.129
#5	0.0025	0.0020	-20.0000	0.0121	0.0086	-28.9256	0.766	0.766	0.000
#6	0.0023	0.0023	0.0000	0.0111	0.0071	-36.0360	0.769	0.770	0.130
#7	0.0028	0.0025	-10.7143	0.0084	0.0058	-30.9524	0.752	0.753	0.133
#8	0.0025	0.0025	0.0000	0.0119	0.0061	-48.7395	0.782	0.780	-0.256
#9	0.0008	0.0018	125.0000	0.0091	0.0058	-36.2637	0.782	0.781	-0.128
#10	0.0020	0.0020	0.0000	0.0109	0.0068	-37.6147	0.778	0.776	-0.257
Average	0.0022	0.0021	3.6211	0.0098	0.0071	-27.1969	0.774	0.761	-1.642

B社

Thermal shock test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.3849	0.3897	1.2471	1.1053	1.1802	6.7764	8.0047	8.0531	0.6046	7.9934	8.0231	0.3716
#2	1.7946	1.5495	-13.6576	1.5992	2.0458	27.9265	8.4584	8.4448	-0.1608	8.4534	8.4894	0.4259
#3	1.2889	1.0437	-19.0240	0.6762	0.8606	27.2700	7.3945	7.6819	3.8867	7.6781	7.6692	-0.1159
#4	1.7036	1.5131	-11.1822	1.0639	1.4062	32.1741	6.5414	6.5358	-0.0856	6.4925	6.5379	0.6993
#5	1.6228	1.4711	-9.3480	0.7071	1.0025	41.7763	7.4507	7.5178	0.9006	7.0773	7.7442	9.4231
#6	1.5749	1.3861	-11.9881	1.5939	1.7811	11.7448	7.1135	7.1417	0.3964	7.1493	7.1740	0.3455
#7	2.0813	1.9472	-6.4431	1.3353	1.5019	12.4766	7.6006	7.6073	0.0882	7.6248	7.6321	0.0957
#8	1.7394	1.4392	-17.2588	1.8411	2.2120	20.1456	6.7217	6.7633	0.6189	6.7263	6.7362	0.1472
#9	1.0912	1.0621	-2.6668	1.1000	1.3203	20.0273	8.6850	8.7580	0.8405	8.6168	8.6812	0.7474
#10	1.1572	0.8263	-28.5949	0.9223	1.1655	26.3689	6.8583	6.9155	0.8340	6.9457	6.9365	-0.1325
Average	1.4439	1.2628	-11.8916	1.1944	1.4476	22.6686	7.4829	7.5419	0.7924	7.4758	7.5624	1.2007

B社

Thermal shock test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.0436	0.1193	173.6239	0.6053	0.4621	-23.6577	0.550	0.552	0.364
#2	0.3241	0.1785	-44.9244	0.3938	0.4618	17.2676	0.545	0.546	0.183
#3	0.8329	0.6020	-27.7224	0.3436	0.3336	-2.9104	0.542	0.543	0.185
#4	0.1302	0.2249	72.7343	0.3079	0.1154	-62.5203	0.534	0.539	0.936
#5	0.3430	0.2718	-20.7580	1.2019	0.2167	-81.9702	0.540	0.544	0.741
#6	0.2734	0.2366	-13.4601	0.3920	0.3638	-7.1939	0.550	0.552	0.364
#7	0.4008	0.2586	-35.4790	0.1497	0.4728	215.8317	0.547	0.549	0.366
#8	0.2273	0.1413	-37.8355	0.4239	0.4633	9.2946	0.547	0.550	0.548
#9	0.2953	0.2644	-10.4639	0.5237	0.3844	-26.5992	0.548	0.550	0.365
#10	0.2380	0.1958	-17.7311	0.1857	0.3224	73.6134	0.536	0.539	0.560
Average	0.3109	0.2493	3.7984	0.4528	0.3596	11.1156	0.544	0.546	0.461

C社 Thermal shock test

High temperature test	Vos (mV)						Ib (nA)					
	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)	Before Ch1	After Ch1	Change rate (%)	Before Ch2	After Ch2	Change rate (%)
#1	0.3023	0.0680	-77.5058	0.0707	0.0791	11.8812	14.3371	14.3152	-0.1528	13.7996	13.7409	-0.4254
#2	0.2484	0.1135	-54.3076	1.0731	1.3459	25.4217	13.9144	13.8741	-0.2896	14.0222	13.9332	-0.6347
#3	0.1909	0.1772	-7.1765	0.6389	0.5034	-21.2083	14.1455	14.1299	-0.1103	14.0615	14.0417	-0.1408
#4	0.4969	0.4614	-7.1443	0.1113	0.0524	-52.9200	13.8586	13.8287	-0.2158	14.0144	13.9344	-0.5708
#5	0.0501	0.0052	-89.6208	0.0032	0.1233	3753.1250	14.0519	13.9991	-0.3757	14.0342	13.9465	-0.6249
#6	0.0203	0.1072	428.0788	0.0498	0.0972	95.1807	14.4009	14.3458	-0.3826	14.3313	14.2652	-0.4612
#7	0.1327	0.0601	-54.7099	0.1265	0.1277	0.9486	14.0529	13.9935	-0.4227	13.9862	13.9271	-0.4226
#8	0.2335	0.2567	9.9358	0.1396	0.2969	112.6791	13.6822	13.6495	-0.2390	14.1275	14.0272	-0.7100
#9	0.2504	0.3205	27.9952	0.2706	0.2742	1.3304	14.0321	14.0136	-0.1318	14.1322	14.0623	-0.4946
#10	0.9256	0.7467	-19.3280	0.8237	0.7981	-3.1079	14.0577	13.9995	-0.4140	14.1109	14.0249	-0.6095
Average	0.2851	0.2317	15.6217	0.3307	0.3698	392.3330	14.0533	14.0149	-0.2734	14.0620	13.9903	-0.5094

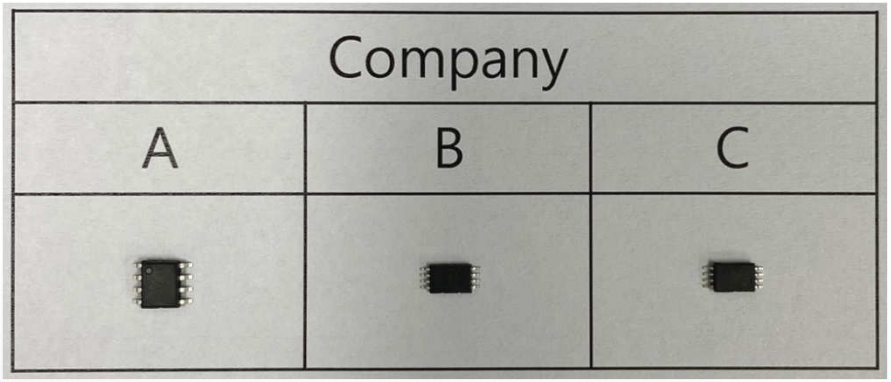
C社

Thermal shock test

High temperature test	Ios (nA)						Icc (mA)		
	Before	After	Change rate (%)	Before	After	Change rate (%)	Before	After	Change rate (%)
	Ch1	Ch1		Ch2	Ch2		Ch1	Ch1	
#1	0.2255	0.2672	18.4922	0.1400	0.1115	-20.3571	0.589	0.590	0.170
#2	0.0894	0.2119	137.0246	0.1030	0.1629	58.1553	0.597	0.599	0.335
#3	0.1806	0.1316	-27.1318	0.0612	0.0572	-6.5359	0.598	0.600	0.334
#4	0.2887	0.3261	12.9546	0.1768	0.0804	-54.5249	0.594	0.594	0.000
#5	0.1748	0.1316	-24.7140	0.0194	0.0801	312.8866	0.619	0.619	0.000
#6	0.0005	0.0291	5720.0000	0.1163	0.0768	-33.9639	0.605	0.605	0.000
#7	0.0199	0.1662	735.1759	0.0821	0.0117	-85.7491	0.598	0.598	0.000
#8	0.1539	0.1802	17.0890	0.0041	0.0919	2141.4634	0.591	0.592	0.169
#9	0.2877	0.2738	-4.8314	0.1635	0.1570	-3.9755	0.604	0.604	0.000
#10	0.0438	0.1609	267.3516	0.1342	0.0521	-61.1773	0.597	0.596	-0.168
Average	0.1465	0.1879	685.1411	0.1001	0.0882	224.6222	0.599	0.600	0.084

KETI試験結果のまとめ考察

1. 試験サンプル製品仕様詳細



Sample	Power supply Voltages, V_{CC} (V)		Input differential voltage range, V_{IDR} (V)	Input common mode voltage range, V_{ICR} (V)	Output short circuit duration	Junction temperature, T_J (°C)	Storage temperature, T_{stg} (°C)	Input current, per pin, I_{IN} (mA)
	Single	Split						
A	32	±16	32	-0.3~32	Continuous	150	-55~125	50
B	36	±18	36	-0.3~36	Continuous	150	-65~150	unknown
C	36	±18	36	-0.3~36	Continuous	150	-55~150	-10

Cord	メーカー名	国籍	Parats number	概要	保存温度
A	IK semicoductor	KOREA	IL358D	Bi-P, Dula 汎用品, SOIC-8	-55～+125℃
B	Diodes	USA	LM2904TH	Bi-P, Dula 汎用品, 36V耐圧, TSSOP-8	-65～+150℃
C	ローム	JPN	BA2904FV-E2	Bi-P, Dula 汎用品, SSOP-8	-55～+150℃

KETI試験結果のまとめ考察

2. 試験結果比較

試験項目	A: IK semiconductor	B: Diodes	C: ローム
内部断面観察	異常なし/異物なし	異常なし/異物なし	異常なし/異物なし
X線解析	異常なし/異物なし	異常なし/異物なし	異常なし/異物なし
SEM観察/成分分析	異常なし	異常なし	異常なし
高温保存試験	問題無し(規格内)	問題無し(規格内)	問題無し(規格内)
低温保存試験	問題無し(規格内)	問題無し(規格内)	問題無し(規格内)
高温高湿保存試験	問題無し(規格内)	問題無し(規格内)	問題無し(規格内)
サーマルショック試験	問題無し(規格内)	問題無し(規格内)	問題無し(規格内)

3. 考察

今回の試験内容は、内部観察/X線解析等及び静特性測定(環境試験)に限定したものである。静特性の一部では、測定方法に起因する疑問点も見られるが大きな異常/仕様規格外等は見られなかった。対象とした製品はいずれも開発から10年以上経過しているバイポーラプロセス構造の汎用オペアンプ定番製品であり品質は安定していると判断できる。

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