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Reliability Testing Data

1064nm High Power Polarization Maintaining Isolator

Type C Package (20W)

The following data has been measured according to the Telcordia testing Specification GR-1221-CORE, ISSUE 2 to demonstrate the 1064 nm High Power Polarization Maintaining Isolator (C-type package) meets industrial reliability standards.

This document is not a Telcordia report but represents one example of the reliability testing capability at Optizone. Reliability reports on any Telcordia-qualified Optizone product may be obtained following the signing of a mutual non-disclosure agreement (NDA).

Data obtained are the results of the following tests, under the stated test conditions (Table 1). Eleven samples comprised the tested lot.

- Impact Test
- Vibration Test
- Thermal shock test
- High temperature storage test (Dry Heat)
- High temperature storage test (Damp Heat)
- Low temperature storage test
- Temperature cycling test

Table 1 – Reliability test conditions

No.	Test Titles	Test conditions
1	Impact test	5 times per direction for 6 directions (on 3 axes) ; 500G ; 1ms
2	Vibration	20G maximum acceleration, 20-2000Hz, 4 minutes per cycle and 4 cycles per axis
3	Thermal Shock	Temperature range: ΔT = 100C (within the operation temp range of device under test) Dwell time at extremes: >/=30minutes, Transfer time: </=2minutes, 20 cycles
4	High Temp(Dry Heat)	Temp: 85℃(±2)℃, Humidity: ＜40%RH, for 168,500,1000 and 2000hrs
5	High Temp(Damp Heat)	Temp: 85℃(±2)℃, Humidity: 85%(±5%)RH, for 168,500,1000 and 2000 hrs
6	Low Temp Storage	Temp: -40℃(±5℃), Humidity: uncontrolled, for 168,500,1000 and 2000 hrs
7	Temp cycling	-40℃ to 85℃(±2℃), 2℃/ min, dwell time at extremes: >/=15minutes For 100, 500 cycles

Telcordia specifications provide the following Pass/Fail criteria (Table 2). Table 3 shows the test results.

Table 2 – Telcordia Pass/Fail criteria

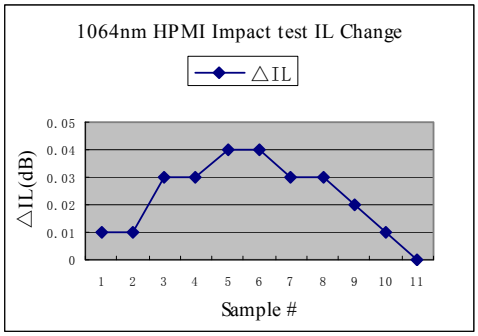
Parameters	Max./Min. allowable value
ΔIL (insertion loss change)	≤0.5 dB
IL (insertion loss)	≤1.2 dB
ER (extinction ratio)	≥20 dB
IS (isolation)	≥25 dB
RL(I) – return loss, input	≥50 dB
RL(O) return loss, output	≥50 dB

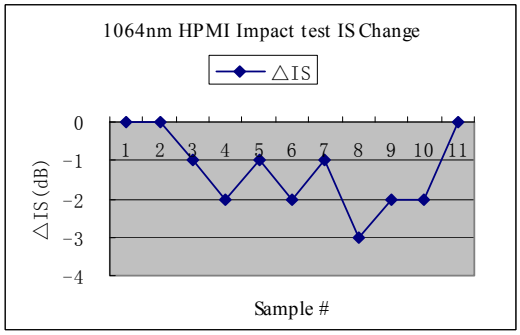
Table 3 – Result of reliability testing

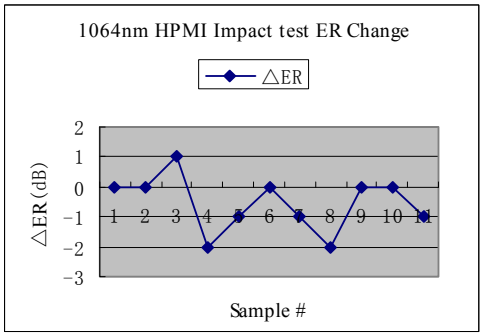
Test	Sample Size	Number of Failures	Test Result
Mechanical Shock(Impact Test)	11	0	Pass
Vibration	11	0	Pass
Thermal Shock	11	0	Pass
High Temp Storage(Dry)	11	0	Pass
High Temp Storage(Damp)	11	0	Pass
Low Temp Storage	11	0	Pass
Temp Cycling	11	0	Pass

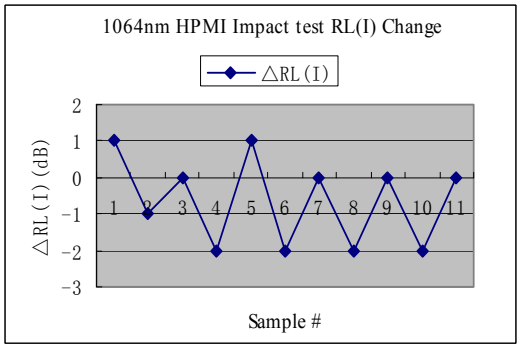
Results of Impact Testing

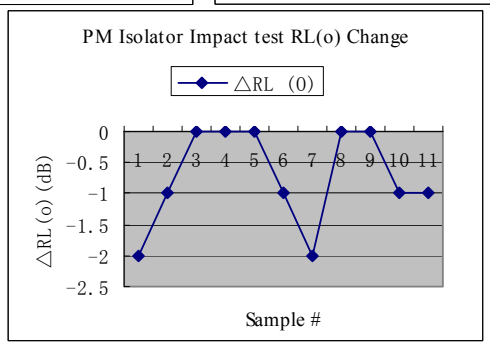
Sample	Start					End					Change				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.85	23	22	55	55	0.86	23	22	56	53	0.01	0	0	1	-2
2	0.87	25	23	56	56	0.88	25	23	55	55	0.01	0	0	-1	-1
3	0.92	25	25	55	54	0.95	24	26	55	54	0.03	-1	1	0	0
4	0.86	26	23	56	55	0.89	24	21	54	55	0.03	-2	-2	-2	0
5	1.01	24	26	54	52	1.05	23	25	55	52	0.04	-1	-1	1	0
6	0.95	28	22	56	55	0.99	26	22	54	54	0.04	-2	0	-2	-1
7	0.89	26	24	53	54	0.92	25	23	53	52	0.03	-1	-1	0	-2
8	0.87	25	25	54	53	0.90	22	23	52	53	0.03	-3	-2	-2	0
9	0.93	27	26	55	55	0.95	25	26	55	55	0.02	-2	0	0	0
10	0.98	26	22	56	56	0.99	24	22	54	55	0.01	-2	0	-2	-1
11	0.95	25	24	55	54	0.95	25	23	55	53	0.00	0	-1	0	-1





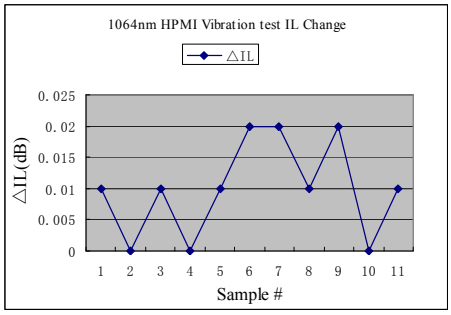


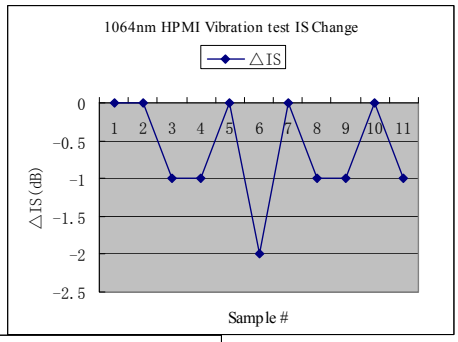


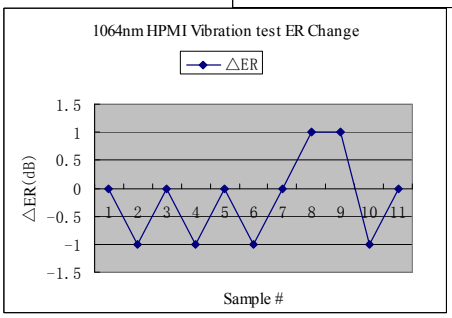


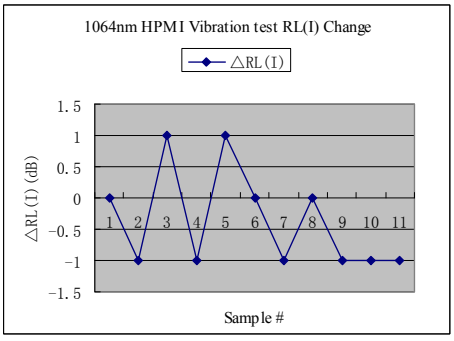
Results of Vibration Testing

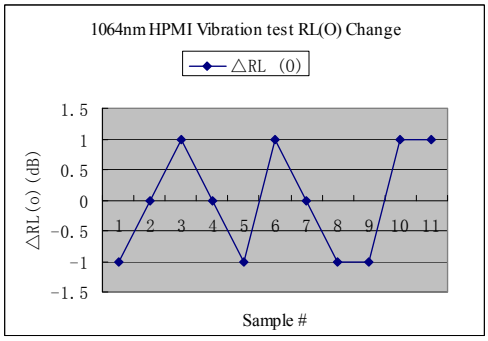
Sample	Start					End					Change				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.89	28	23	53	55	0.90	28	23	53	54	0.01	0	0	0	-1
2	0.86	25	24	55	53	0.86	25	23	54	53	0	0	-1	-1	0
3	0.95	27	22	54	52	0.96	26	22	55	53	0.01	-1	0	1	1
4	0.88	26	25	56	54	0.88	25	24	55	54	0	-1	-1	-1	0
5	0.97	23	22	52	56	0.98	23	22	53	55	0.01	0	0	1	-1
6	0.95	28	23	52	55	0.97	26	22	52	56	0.02	-2	-1	0	1
7	0.80	25	25	54	53	0.82	25	25	53	53	0.02	0	0	-1	0
8	0.96	26	21	55	54	0.97	25	22	55	53	0.01	-1	1	0	-1
9	0.93	24	22	53	56	0.95	23	23	52	55	0.02	-1	1	-1	-1
10	0.98	26	25	56	55	0.98	26	24	55	56	0	0	-1	-1	1
11	0.92	25	23	55	53	0.93	24	23	54	54	0.01	-1	0	-1	1





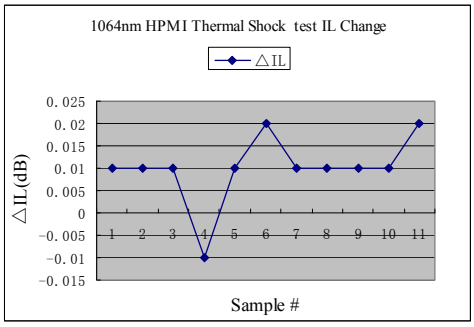


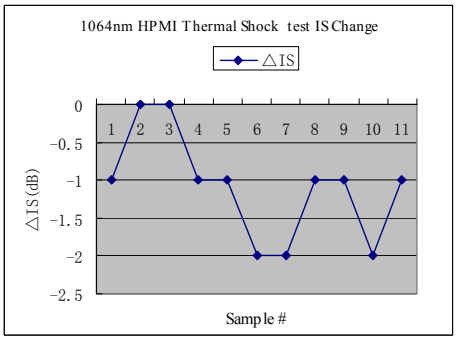


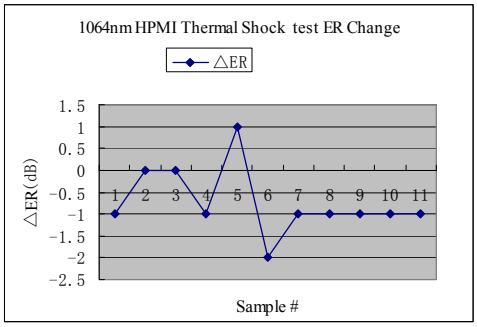


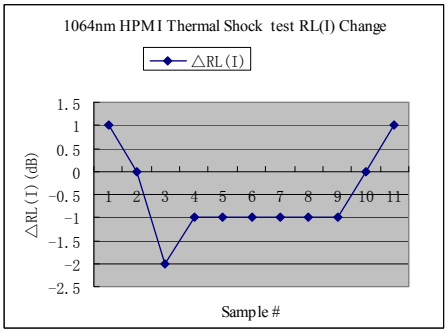
Results of Thermal Shock Testing

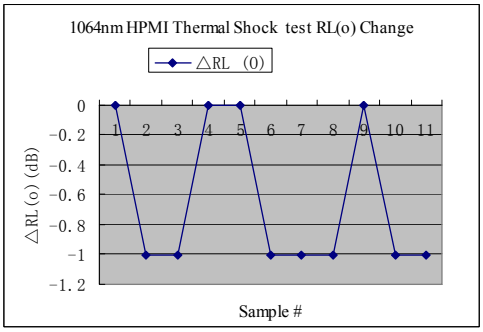
Sample	Start					End					Change				
	IL	IS	ER	RL(I)	RL (o)	IL	IS	ER	RL(I)	RL (o)	△IL	△IS	△ER	△RL(I)	△RL (o)
1	0.92	27	23	55	52	0.93	26	22	56	52	0.01	-1	-1	1	0
2	0.95	26	21	53	53	0.96	26	21	53	52	0.01	0	0	0	-1
3	0.89	25	21	54	54	0.90	25	21	52	53	0.01	0	0	-2	-1
4	1.01	28	23	53	52	1.00	27	22	52	52	-0.01	-1	-1	-1	0
5	0.96	24	22	56	52	0.97	23	23	55	52	0.01	-1	1	-1	0
6	0.97	25	23	53	54	0.99	23	21	52	53	0.02	-2	-2	-1	-1
7	1.05	26	24	54	53	1.06	24	23	53	52	0.01	-2	-1	-1	-1
8	0.95	25	22	55	54	0.96	24	21	54	53	0.01	-1	-1	-1	-1
9	0.89	27	23	54	52	0.90	26	22	53	52	0.01	-1	-1	-1	0
10	0.88	25	21	53	56	0.89	23	20	53	55	0.01	-2	-1	0	-1
11	0.86	26	24	54	55	0.88	25	23	55	54	0.02	-1	-1	1	-1











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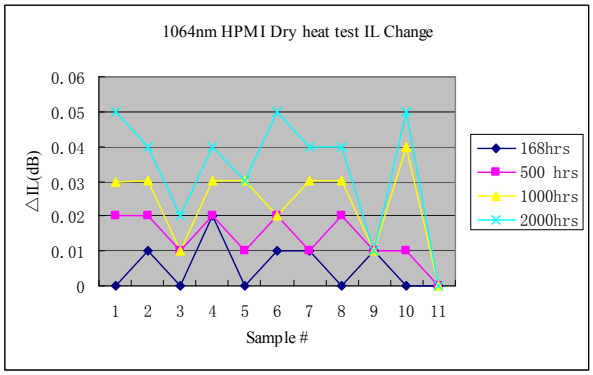
Results from Dry Heat Testing

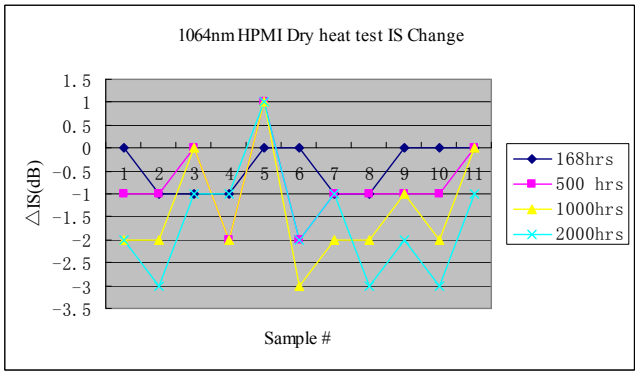
Sample	Start					168hrs					Change 1				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.91	26	24	56	54	0.91	26	24	54	55	0	0	0	-2	1
2	0.89	27	23	55	56	0.9	26	23	54	55	0.01	-1	0	-1	-1
3	0.92	26	22	52	55	0.92	25	22	52	53	0	-1	0	0	-2
4	0.86	25	23	54	53	0.88	24	23	54	53	0.02	-1	0	0	0
5	1.02	24	24	56	55	1.02	24	24	55	54	0	0	0	-1	-1
6	0.97	26	22	53	54	0.98	26	23	53	55	0.01	0	1	0	1
7	0.95	25	23	54	53	0.96	24	22	54	53	0.01	-1	-1	0	0
8	0.88	26	24	55	55	0.88	25	23	55	55	0	-1	-1	0	0
9	0.89	24	23	56	52	0.9	24	22	55	52	0.01	0	-1	-1	0
10	0.98	28	22	55	53	0.98	28	21	56	52	0	0	-1	1	-1
11	1.04	27	25	54	54	1.04	27	24	54	53	0	0	-1	0	-1

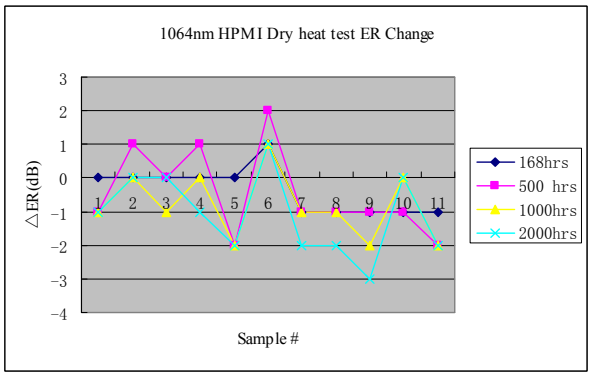
Sample	500 hrs					Change 2 (△0---500)					1000hrs				
	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)	IL	IS	ER	RL(I)	RL (O)
1	0.93	25	23	55	54	0.02	-1	-1	-1	0	0.94	24	23	54	55
2	0.91	26	24	54	55	0.02	-1	1	-1	-1	0.92	25	23	53	55
3	0.93	26	22	53	54	0.01	0	0	1	-1	0.93	26	21	53	53
4	0.88	23	24	55	53	0.02	-2	1	1	0	0.89	23	23	54	53
5	1.03	25	22	56	54	0.01	1	-2	0	-1	1.05	25	22	54	53
6	0.99	24	24	53	54	0.02	-2	2	0	0	0.99	23	23	54	55
7	0.96	24	22	53	55	0.01	-1	-1-	-1	2	0.98	23	22	53	54
8	0.9	25	23	55	54	0.02	-1	-1	0	1	0.91	24	23	54	53
9	0.9	23	22	54	53	0.01	-1	-1	2	1	0.9	23	21	53	54
10	0.99	27	21	55	53	0.01	-1	-1	0	0	1.02	26	22	55	52
11	1.04	27	23	55	53	0	0	-2	1	-1	1.04	27	23	54	52

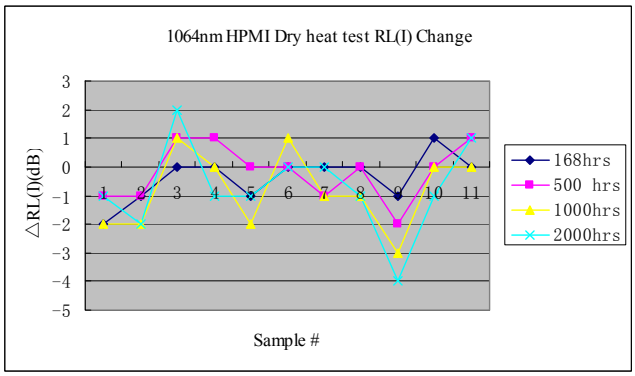
Sample	Change 3 (△0---1000)					2000hrs					Total Change (△0---2000)				
	△IL	△IS	△ER	△RL(I)	△RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.03	-2	-1	-2	1	0.96	24	23	55	54	0.05	-2	-1	-1	0
2	0.03	-2	0	-2	-1	0.93	24	23	53	55	0.04	-3	0	-2	-1
3	0.01	0	-1	1	-2	0.94	25	22	54	54	0.02	-1	0	2	-1
4	0.03	-2	0	0	0	0.9	24	22	53	54	0.04	-1	-1	-1	1
5	0.03	1	-2	-2	-2	1.05	25	22	55	53	0.03	1	-2	-1	-2
6	0.02	-3	1	1	1	1.02	24	23	53	53	0.05	-2	1	0	-1
7	0.03	-2	-1	-1	1	0.99	24	21	54	54	0.04	-1	-2	0	1
8	0.03	-2	-1	-1	-2	0.92	23	22	54	53	0.04	-3	-2	-1	-2
9	0.01	-1	-2	-3	2	0.9	22	230	52	53	0.01	-2	-2	-4	1
10	0.04	-2	0	0	-1	1.03	25	22	54	53	0.05	-3	0	-1	0
11	0	0	-2	0	-1	1.04	26	23	55	53	0	-1	-2	1	-1

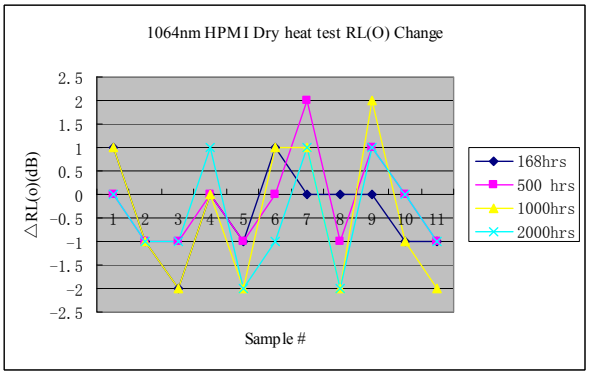
Results from Dry Heat Testing (continued)











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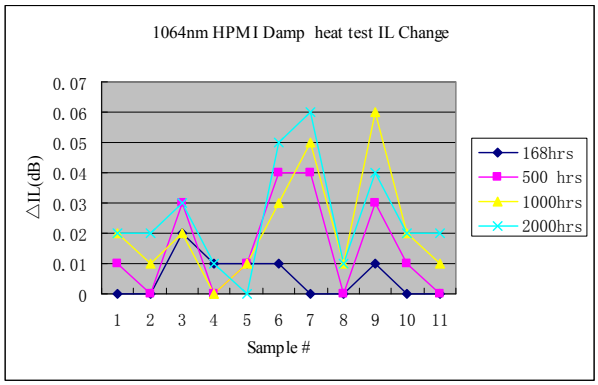
Results from Damp Heat Testing

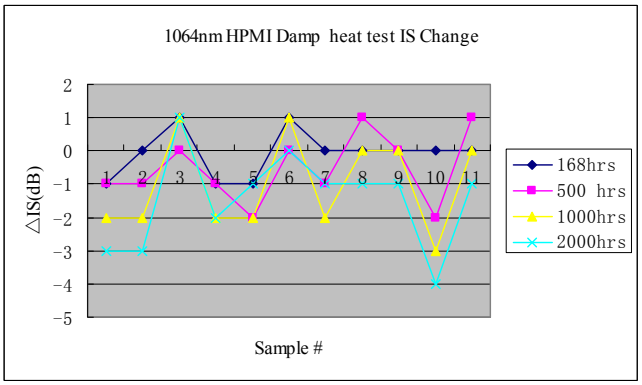
	Start					168hrs					Change 1				
Sample	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.9	26	23	56	54	0.9	25	23	56	55	0	-1	0	0	1
2	0.92	27	22	54	53	0.92	27	22	55	54	0	0	0	1	1
3	0.88	24	23	55	56	0.9	25	22	54	55	0.02	1	-1	-1	-1
4	0.95	28	24	53	55	0.96	27	25	53	55	0.01	-1	1	0	0
5	0.93	26	22	55	55	0.94	25	22	54	54	0.01	-1	0	-1	-1
6	0.94	25	23	56	54	0.95	26	23	56	54	0.01	1	0	0	0
7	0.87	24	24	54	53	0.87	24	24	55	54	0	0	0	1	1
8	0.98	25	23	56	55	0.98	25	23	55	55	0	0	0	-1	0
9	0.96	26	21	54	54	0.97	26	20	53	53	0.01	0	-1	-1	-1
10	1.01	27	24	55	56	1.01	27	24	56	55	0	0	0	1	-1
11	0.97	26	23	53	55	0.97	26	22	54	54	0	0	-1	1	-1

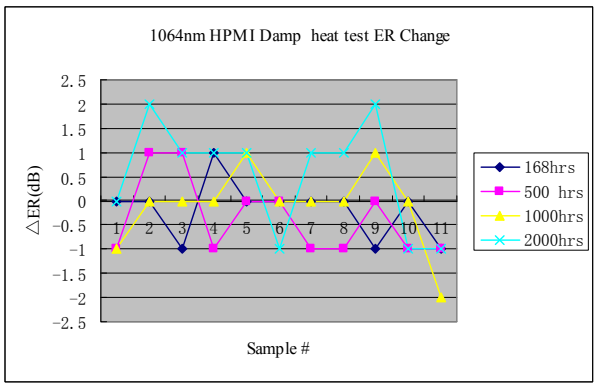
	500hrs					Change 2 (Δ0---500)					1000hrs				
Sample	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.91	25	22	55	55	0.01	-1	-1	-1	1	0.92	24	22	54	55
2	0.92	26	23	53	54	0	-1	1	-1	1	0.93	25	22	53	55
3	0.91	24	24	53	54	0.03	0	1	-2	-2	0.9	25	23	54	53
4	0.95	27	23	54	54	0	-1	-1	1	-1	0.95	26	24	53	55
5	0.94	24	22	55	53	0.01	-2	0	0	-2	0.94	24	23	54	53
6	0.98	25	23	55	55	0.04	0	0	-1	1	0.97	26	23	54	54
7	0.91	23	23	54	55	0.04	-1	-1	0	2	0.92	22	24	53	56
8	0.98	26	22	54	56	0	1	-1	-2	1	0.99	25	23	55	54
9	0.99	26	21	53	54	0.03	0	0	-1	0	1.02	26	22	54	55
10	1.02	25	23	55	55	0.01	-2	-1	0	-1	1.03	24	24	54	55
11	0.97	27	22	54	54	0	1	-1	1	-1	0.98	26	21	55	56

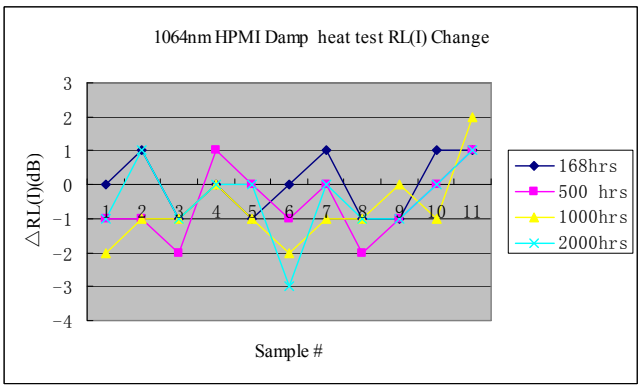
	Change 3 (Δ0---1000)					2000hrs					Total Change (Δ0---2000)				
Sample	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.02	-2	-1	-2	1	0.92	23	23	55	55	0.02	-3	0	-1	1
2	0.01	-2	0	-1	2	0.94	24	24	55	54	0.02	-3	2	1	1
3	0.02	1	0	-1	-3	0.91	25	24	54	54	0.03	1	1	-1	-2
4	0	-2	0	0	0	0.96	26	25	53	54	0.01	-2	1	0	-1
5	0.01	-2	1	-1	-2	0.93	25	23	55	53	0	-1	1	0	-2
6	0.03	1	0	-2	0	0.99	25	22	53	53	0.05	0	-1	-3	-1
7	0.05	-2	0	-1	3	0.93	23	25	54	55	0.06	-1	1	0	2
8	0.01	0	0	-1	-1	0.99	24	24	55	55	0.01	-1	1	-1	0
9	0.06	0	1	0	1	1	25	23	53	56	0.04	-1	2	-1	2
10	0.02	-3	2	-1	-1	1.03	23	23	55	55	0.02	-4	-1	0	-1
11	0.01	0	-2	2	1	0.99	25	22	54	55	0.02	-1	-1	1	0

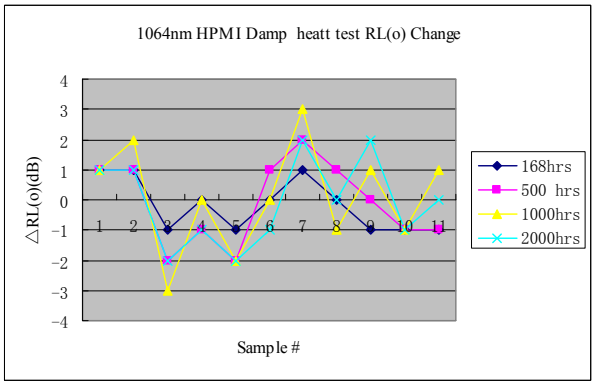
Results from Damp Heat Testing (continued)











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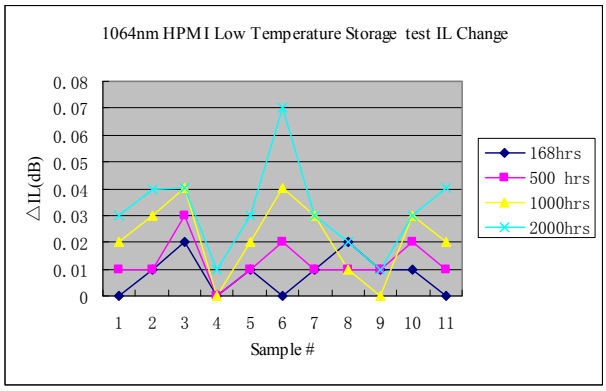
Results from Low Temperature Storage Testing

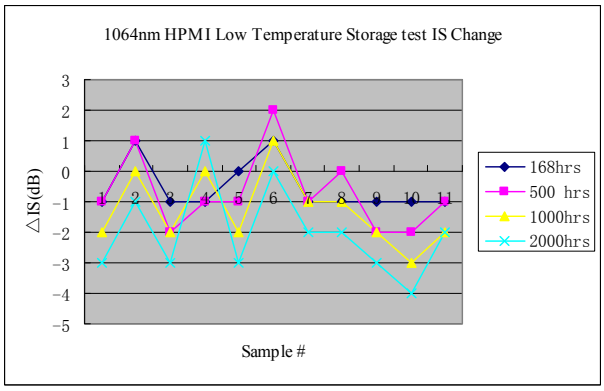
Sample	Start					168hrs					Change 1				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.9	27	23	55	54	0.9	26	23	55	55	0	-1	0	0	1
2	0.92	26	24	54	55	0.93	27	25	54	56	0.01	1	1	0	1
3	0.88	28	23	55	53	0.9	27	22	56	54	0.02	-1	-1	1	1
4	0.95	25	22	56	55	0.95	24	23	55	54	0	-1	1	-1	-1
5	0.96	26	25	55	54	0.97	26	24	56	55	0.01	0	-1	1	1
6	0.89	25	23	53	56	0.89	26	24	54	54	0	1	1	1	-2
7	0.99	27	24	55	55	1	26	25	55	54	0.01	-1	1	0	-1
8	0.97	28	22	55	56	0.99	27	22	56	55	0.02	-1	0	1	-1
9	0.96	28	23	54	54	0.97	27	22	55	54	0.01	-1	-1	1	0
10	0.93	27	22	56	55	0.94	26	23	55	54	0.01	-1	1	-1	-1
11	0.88	26	24	55	55	0.88	25	23	54	53	0	-1	-1	-1	-2

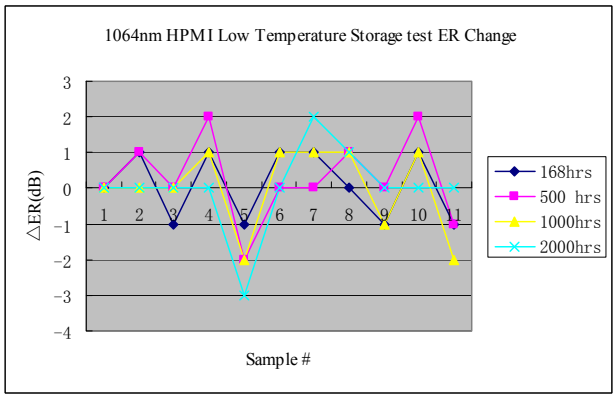
Sample	500hrs					Change 2 (Δ0---500)					1000hrs				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.91	26	23	56	55	0.01	-1	0	1	1	0.92	25	23	55	56
2	0.93	27	25	55	56	0.01	1	1	1	1	0.95	26	24	54	55
3	0.91	26	23	55	55	0.03	-2	0	0	2	0.92	26	23	55	56
4	0.95	24	24	54	53	0	-1	2	-2	-2	0.95	25	23	54	55
5	0.97	25	23	55	56	0.01	-1	-2	0	2	0.98	24	23	54	55
6	0.91	27	23	55	55	0.02	2	0	2	-1	0.93	26	24	55	56
7	1	26	24	54	54	0.01	-1	0	-1	-1	1.02	26	25	55	55
8	0.98	28	23	56	54	0.01	0	1	1	-2	0.98	27	23	53	5
9	0.97	26	23	54	53	0.01	-2	0	0	-1	0.96	16	22	56	54
10	0.95	25	24	54	55	0.02	-2	2	-2	0	0.96	24	23	55	56
11	0.89	25	23	54	53	0.01	1	-1	-1	-2	0.9	24	22	55	54

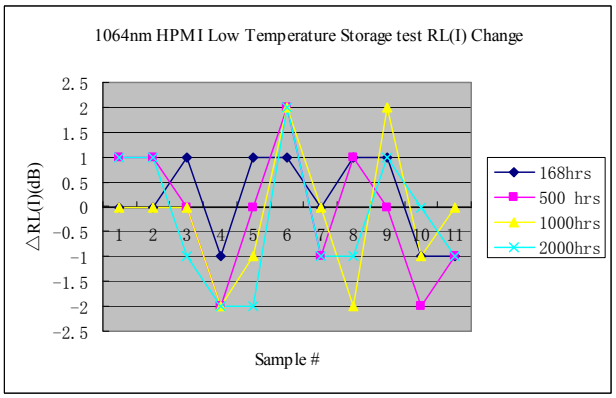
Sample	Change 3 (Δ0---1000)					2000hrs					Total Change (Δ0---2000)				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.02	-2	0	0	2	0.93	24	23	56	56	0.03	-3	0	1	2
2	0.03	0	0	0	0	0.96	25	24	55	55	0.04	-1	0	1	0
3	0.04	-2	0	0	3	0.92	25	23	54	55	0.04	-3	0	-1	2
4	0	0	1	-2	0	0.96	26	22	54	54	0.01	1	0	-2	-1
5	0.02	-2	-2	-1	1	0.99	23	22	53	56	0.03	-3	-3	-2	2
6	0.04	1	1	2	0	0.96	25	23	55	55	0.07	0	0	2	-1
7	0.03	-1	1	0	0	1.02	25	26	54	54	0.03	-2	2	-1	-1
8	0.01	-1	1	-2	-1	0.99	26	23	54	54	0.02	-2	1	-1	-2
9	0	-2	-1	2	0	0.97	25	23	55	55	0.01	-3	0	1	1
10	0.03	-3	1	-1	1	0.96	23	22	56	55	0.03	-4	0	0	0
11	0.02	-2	-2	0	-1	0.92	24	24	54	53	0.04	-2	0	-1	-2

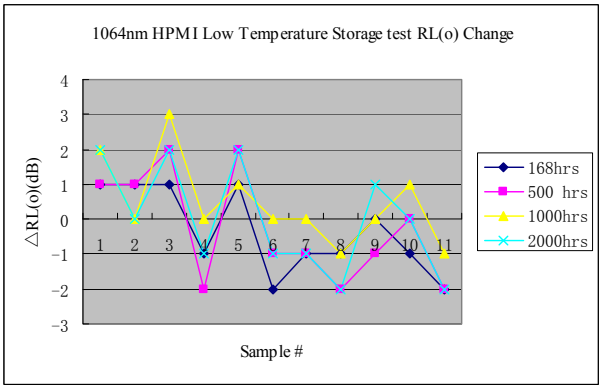
Results from Low Temperature Storage Testing (continued)











Results from Temperature Cycling Testing

Sample	Start					100 Cycles					Change 1				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)	△IL	△IS	△ER	△RL(I)	△RL (O)
1	0.92	24	23	55	56	0.93	24	22	55	56	0.01	0	-1	0	0
2	0.95	26	22	56	55	0.95	25	23	56	54	0	-1	1	0	-1
3	0.89	25	24	54	55	0.9	25	23	55	56	0.01	0	-1	1	1
4	0.96	27	23	56	54	0.96	26	23	55	55	0	-1	0	-1	1
5	0.97	26	22	56	55	0.98	27	23	56	56	0.01	1	1	0	1
6	0.96	28	23	54	53	0.96	28	23	55	54	0	0	0	1	1
7	0.93	25	22	55	55	0.93	24	24	54	54	0	-1	2	-1	-1
8	0.92	24	24	54	56	0.93	25	23	53	55	0.01	1	-1	-1	-1
9	0.99	26	22	56	55	1	25	22	55	54	0.01	-1	0	-1	-1
10	0.88	28	23	55	54	0.89	27	23	54	55	0.01	-1	0	-1	1
11	1.06	27	22	55	55	1.06	26	23	55	54	0	-1	1	0	-1

Sample	500 Cycles					Change 2 (Δ0---500)				
	IL	IS	ER	RL(I)	RL (O)	IL	IS	ER	RL(I)	RL (O)
1	0.94	23	22	56	55	0.02	-1	-1	1	-1
2	0.96	25	23	55	56	0.01	-1	1	-1	1
3	0.91	24	23	53	56	0.02	-1	-1	-1	1
4	0.96	26	23	55	55	0	-1	0	-1	1
5	0.99	27	25	55	54	0.02	1	3	-1	-1
6	0.96	26	22	53	56	0	-2	-1	-1	3
7	0.95	24	24	53	55	0.02	-1	2	-2	0
8	0.95	23	25	56	54	0.03	-1	1	2	-2
9	1.01	25	23	56	53	0.02	-1	1	0	-2
10	0.9	26	22	55	55	0.02	-2	-1	0	1
11	1.07	25	25	56	56	0.01	-2	3	1	1

Results from Temperature Cycling Testing (continued)