QDD-400G-DR4 Design Verification Testing Report

Reviewers

Department	Name	Review Date
Technical Testing Department	Liuchang	2022-5-24

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1. Purpose

This document summarizes the results of the Design Verification Test (DVT) of the Photonics 400GBASE-DR4 QSFP-DD Series product. The testing was performed by Photonics PQV Department to verify products performance over the specified range of operating conditions.

2. Applicable Part Numbers

The applicable part numbers to this qualification report are shown in the table below.

Applicable Part Numbers		
SPQ-4E-DR-CDFB	SPQ-4E-DR-CDFB-xx	
SPQ-4E-DR-CDFE	SPQ-4E-DR-CDFE-xx	

3. Results Summary

The DVT results are summarized in the following table. All parameters were measured at voltage and case temperature range: 3.13V to 3.47V, 0°C to 70°C unless otherwise noted.

Section	Parameter [1]	Min	Max	Measured Range	Pass/ Total
4.1	TDECQ (dB)[2]		3.4	1.38 ~ 2.91	11/11
4.2	Launch power in OMAouter minus TDECQ, each lane for ER → 4.5dB (dBm)	-1.6		-1.03 ~ 1.05	11/11
4.3	TDECQ-10*log10(Ceq), each lane (dBm) [2]		3.4	1.45 ~ 2.92	11/11
4.4	Average launch power, per lane (dBm) [2]	-2.4	4	0.66 ~ 1.89	11/11
4.5	Outer Optical Modulation Amplitude (OMAouter), per lane (dBm) [2]	-0.2	4.2	0.7 ~ 2.9	11/11
4.6	Difference in launch power between two lanes (OMAouter) (dB)		4	0.02 ~ 0.94	11/11
4.7	Extinction ratio (dB) [2]	3.5		6.1 ~ 7.4	11/11
4.8	Wavelength each lane [2] (nm)	1304.5	1317.5	1309.2 ~ 1314.5	11/11
4.9	Side mode suppression ratio (dB)	30		42.7 ~ 52.0	11/11
4.10	Bias Current (mA)	0	150	46.8 ~ 97.6	11/11
4.11	Tx DDMI Accuracy (dB)	-3	3	-0.38 ~ 1.18	11/11
4.12	RIN17.1 OMA[2,9] (dB)		-136	-139.5 ~ -136.58	11/11
4.13	Signaling rate, each lane range(ppm)[11,12]	-100	100	-100~100	11/11
	Average launch power of OFF(dBm)		-20	←-20	11/11
5.2	Rx Sensitivity (OMAouter), per lane (dBm) – Informative only -[3]		-4.5	-10.7 ~ -8.5	11/11
5.3	Difference in receive power between any two lanes (OMAouter) (dB)		4.1	0.04 ~ 1.84	11/11
5.4	LOS Assert (dBm) [5]	-15		-13.0 ~ -11.6	11/11
5.5	LOS De-assert (dBm) [5]		-8.4	-12.0 ~ -10.7	11/11
5.6	LOS Hysteresis (dB)	0.5	5	0.6 ~ 1.29	11/11
5.7	Overload@OMA=4.7dBm(dBm)	4.7		4.7	11/11
5.8	Damage threshold (dBm)[11]	5.5		5.6	11/11
5.9	Rx DDMI Accuracy(dB)	-3	+3	-0.69~0.61	11/11
6.2	Tx Return Loss (dB)		-26	-40.9 ~ -35	11/11
6.3	Rx Return Loss (dB)		-26	-43.8 ~ -39.1	11/11
7.2	Signaling rate per lane [4] (ppm)		26.5625 ± 100	26.5625	11/11
7.3	Near-end Eye Height [4] (mV)	70		73.3 ~ 124.6	11/11
7.4	Near-end ESMW [4] (UI)		0.265	0.134 ~ 0.196	11/11
7.5	Far-end Eye Height [4] (mV)	30		31.9 ~ 64.1	11/11

Section	Parameter [1]	Min	Max	Measured Range	Pass/ Total
7.6	Far-end ESMW [4] (UI)		0.2	0.113 ~ 0.174	11/11
7.7	Differential Output Voltage Test [4] (mV)		900	562 ~ 706	11/11
7.8	AC Common Mode Output Voltage Test [4] (mV)		17.5	2.48 ~ 16.7	11/11
7.9	DC Common Mode Output Voltage Test [4] (mV)	-350	2850	-70.4 ~ -6.3	11/11
7.10	Rise time [7] (ps)	9.5		16.6 ~ 33.4	11/11
7.11	Fall time [7] (ps)	9.5		14.0 ~ 25.0	11/11
7.12	TP4 Near-end Eye Diagram [8]				See note 8
7.13	TP4 Far-end Eye Diagram [8]				See note 8
8.2	Power consumption (W)		12	8.9 ~ 10.4	11/11
8.3	Inrush current P6 [11] (mA)		4800	2870 ~ 2920	11/11
9.2	Jitter Tolerance (TP1a)@high_loss [10]				See note 10
9.3	Jitter Tolerance (TP1a)@low_loss [10]				See note 10
10.2	VCC DDMI Accuracy (%)	-3	3	1.09~1.6	11/11
10.3	Module RMS noise output 10 Hz - 10 MHz(mV)[11,13]		15	0.46~0.51	11/11
11.2	TEMP DDMI Accuracy (°C)	-3	+3	0.37~1.38	11/11
	Stressed receiver sensitivity (OMAouter) [6] (dBm)		-2.5	-6.5 ~ -4.9	See note 6

Note:

1. The optical power is launched into 9/125μm SMF.
2. Test patterns Test-pattern definitions and related subclauses

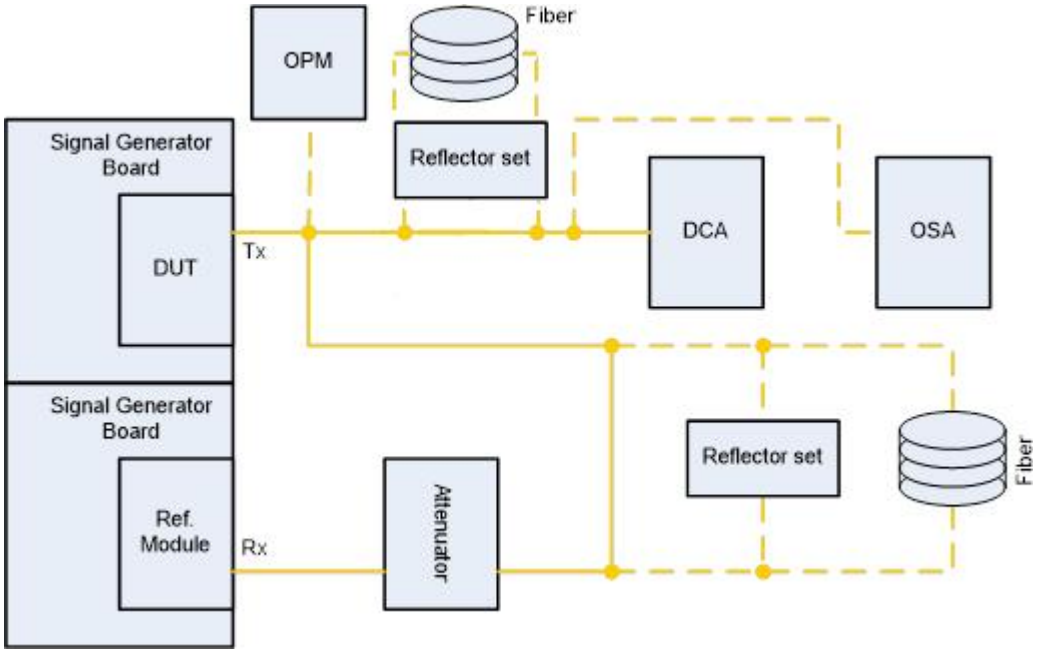
Pattern	Pattern description
Square wave	Square wave (8 threes, 8 zeros)
3	PRBS31Q
4	PRBS13Q
5	Scrambled idle
6	SSPRQ

Parameter	Pattern
Wavelength	Square wave, 3, 4, 5, 6 or valid 200GBASE-R or 400GBASE-R signal
Side mode suppression ratio	3, 5, 6 or valid 200GBASE-R or 400GBASE-R signal
Average optical power	3, 5, 6 or valid 200GBASE-R or 400GBASE-R signal
Outer Optical Modulation Amplitude (OMA_{outer})	4 or 6
Transmitter and dispersion eye closure for PAM4 (TDECQ)	6
Extinction ratio	4 or 6
$RIN_{15.1}OMA$ and $RIN_{16.5}OMA$	Square wave

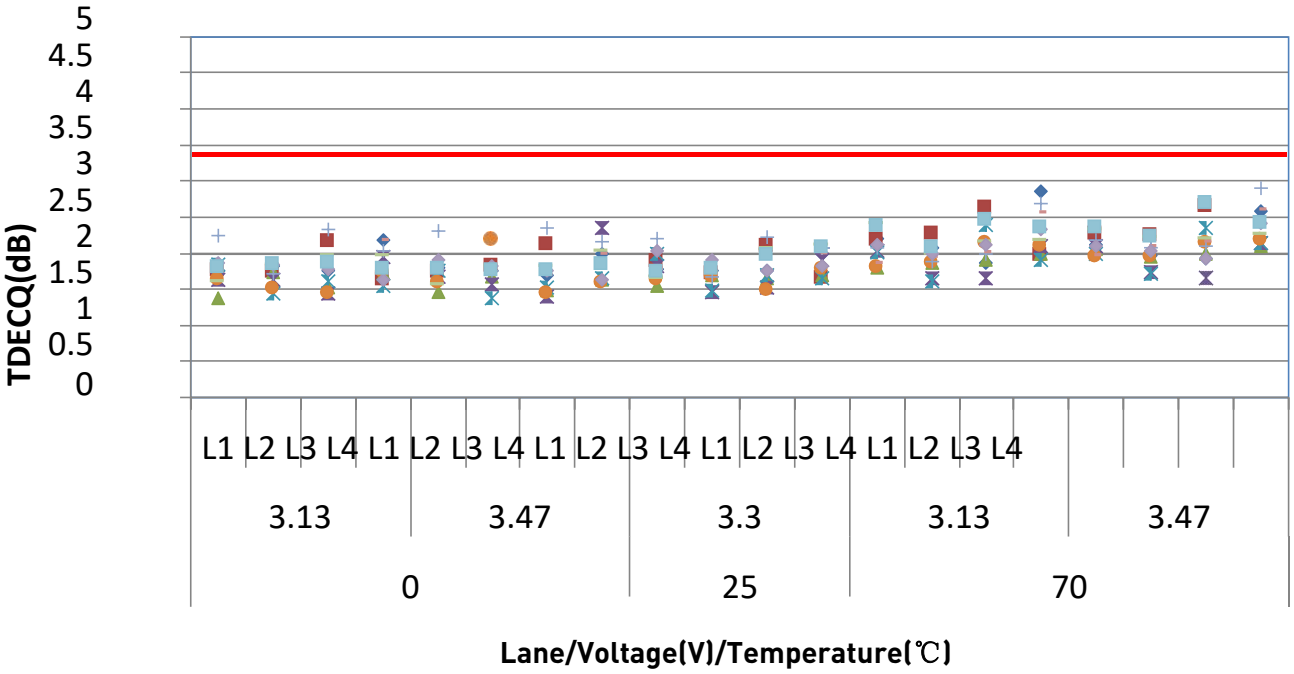
3. Measured with a PRBS31Q test pattern @53.125Gb/s.
4. Measured with a PRBS13Q test pattern @53.125Gb/s.
5. Measured with a PRBS31Q test pattern @53.125Gb/s, BER ← 2.4e-4 optical input power whose range is from -3.5dBm to -22.5dBm.
6. Measured by Central Calibration and Services. For details see Report:
7. 《J7I2020813 DR4.pdf》, 《J7I2020814 DR4.pdf》 & 《J7I2020817 DR4.pdf》.
8. The test pattern used is PRBS13Q, the transitions within sequences of three zeros and

9. three threes, and three threes and three zeros, respectively, are measured
10.
11. @53.125Gb/s.
12. Picture excerpts from《Keysight 400GAUI-8 for one channel at normal temperature & Voltage test Report for Photonics》.
13. 9. See 802.3-2015 (68.6.7).
14. See 802.3bs_D3.5 (Annex 120E), table excerpts from《DR4_Ch5_JTOL_High loss_3.3V_35°C》and《DR4_Ch5_JTOL_LOW loss_3.3V_35°C》.
15. Measured at room temperature and 3.3V.
16. Measured with a PRBS31Q test pattern @53.125Gb/s,Signaling rate±100ppm,offset± 10ppm, Receive power at -8dBm,record sensitivity.
17. 13. See SFF-8431 REV4.1(D.17.2).

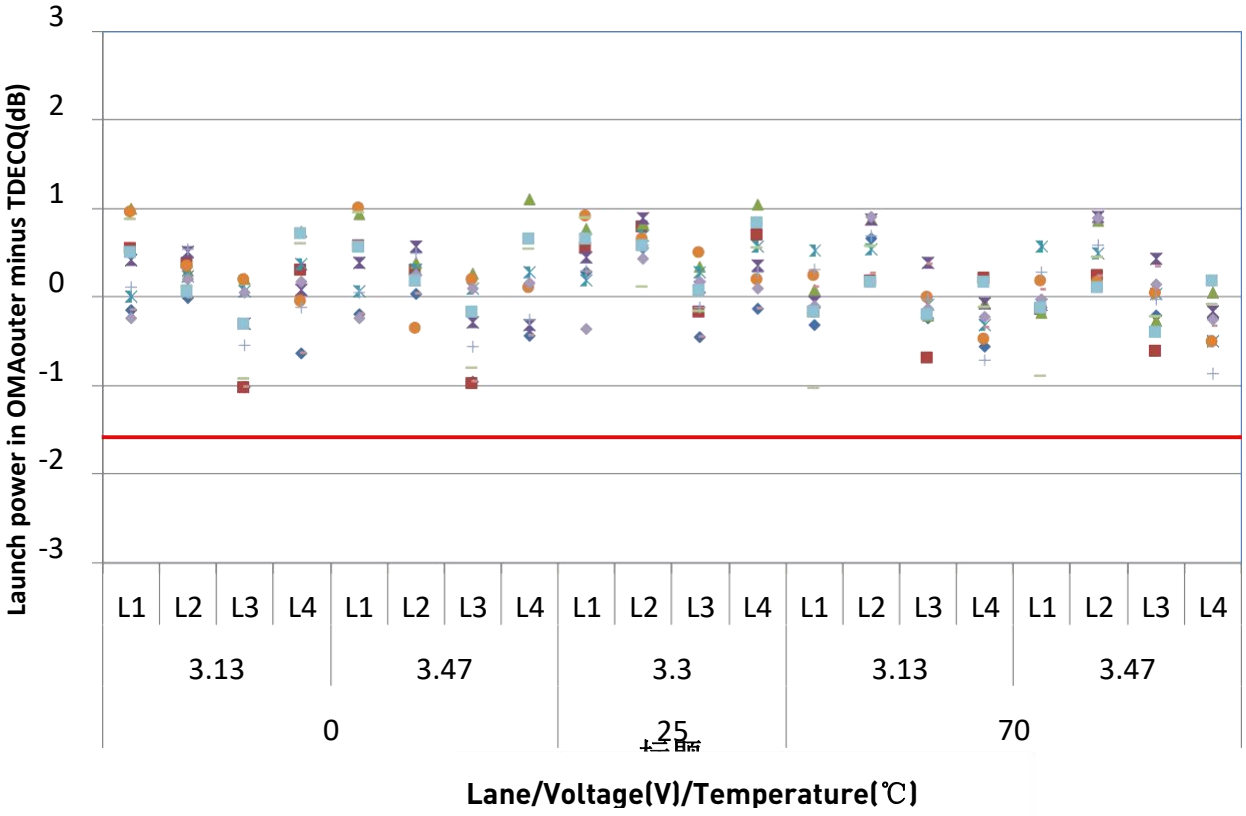
4. Transmitter Tests



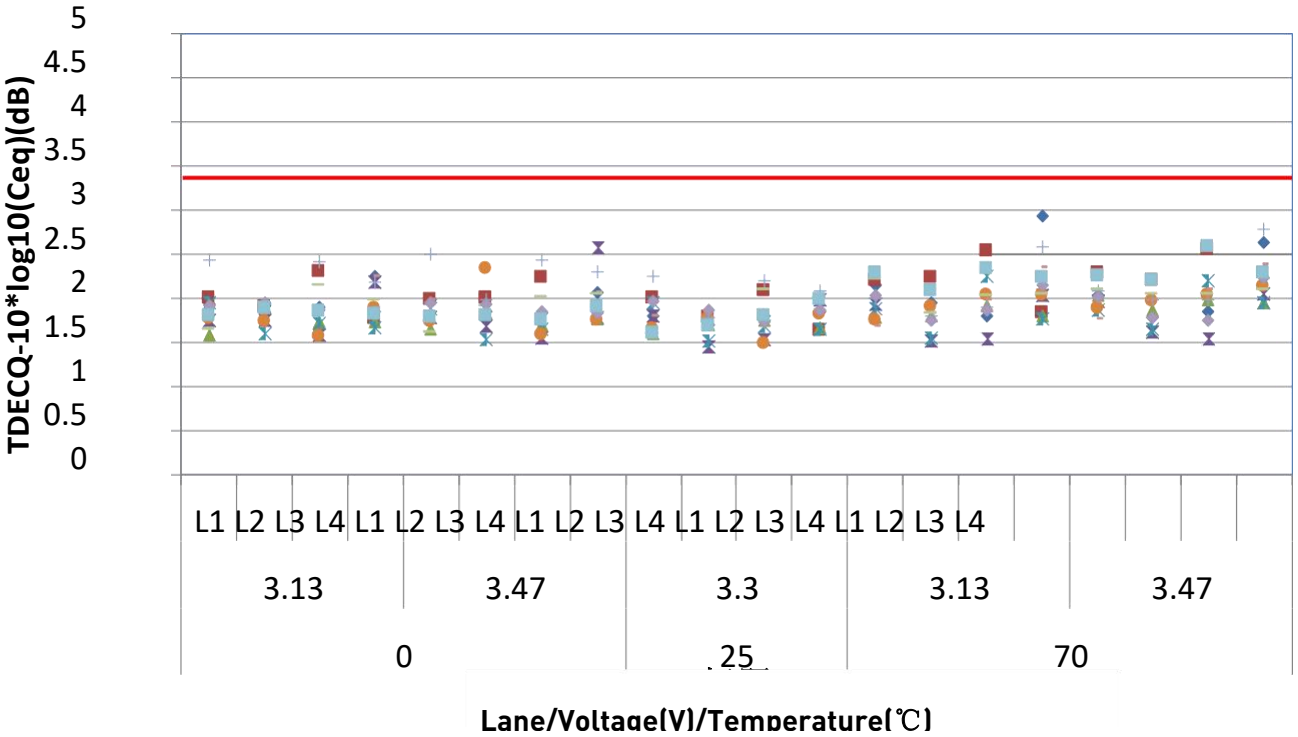
4.1 TDECQ Testing Results



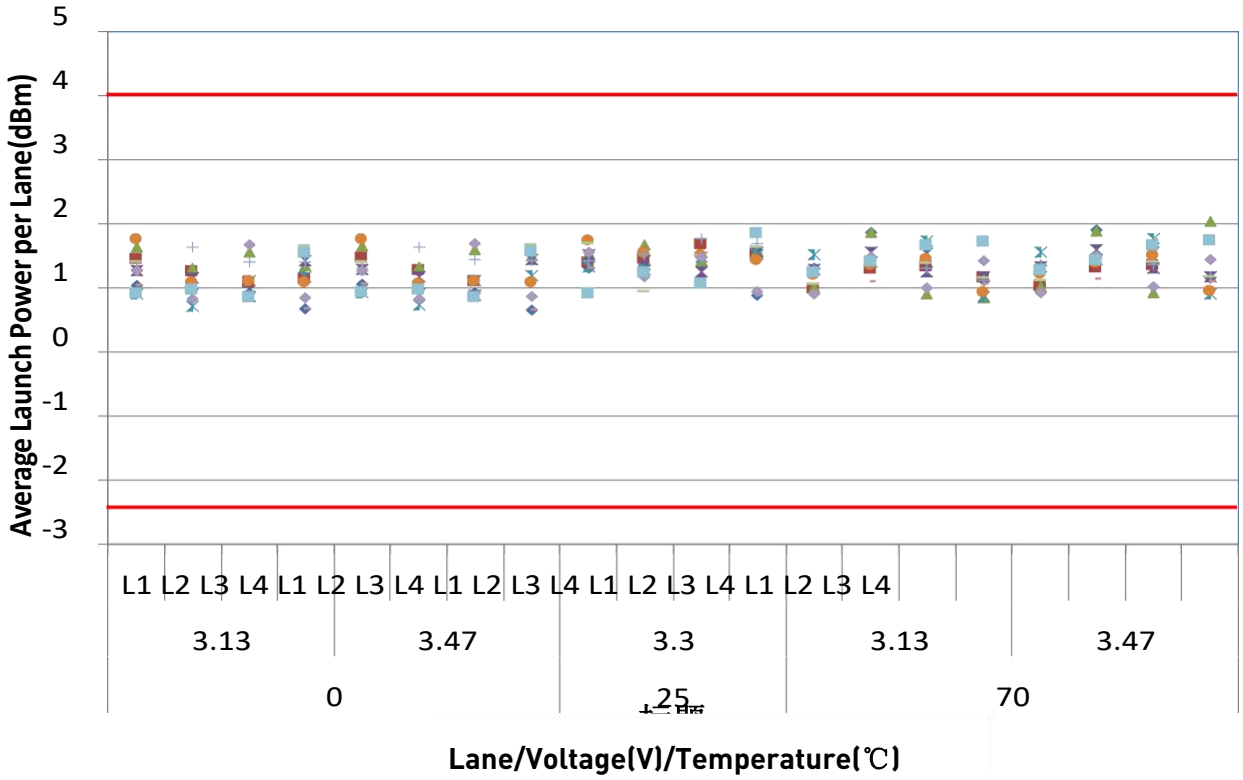
4.2 Launch power in OMAouter minus TDECQ Testing Results



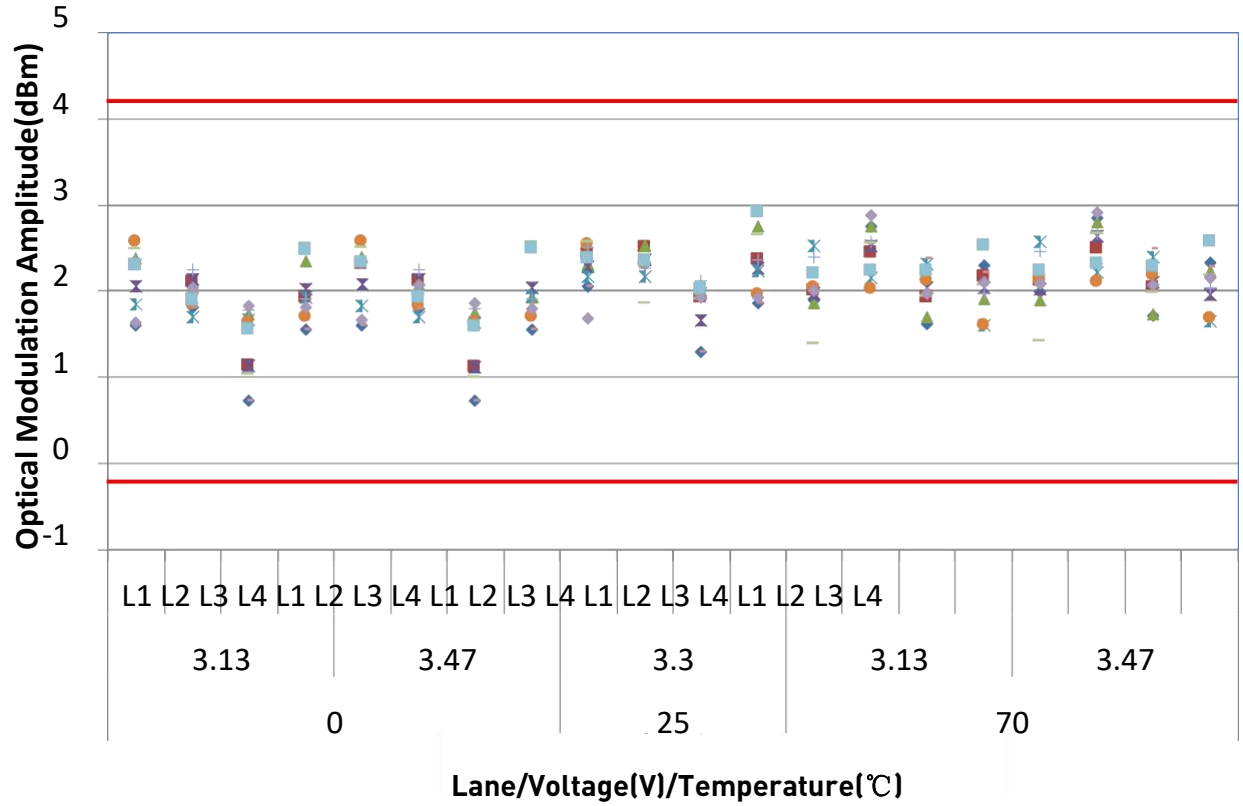
4.3 TDECQ-10*log10(Ceq), each lane Testing Results



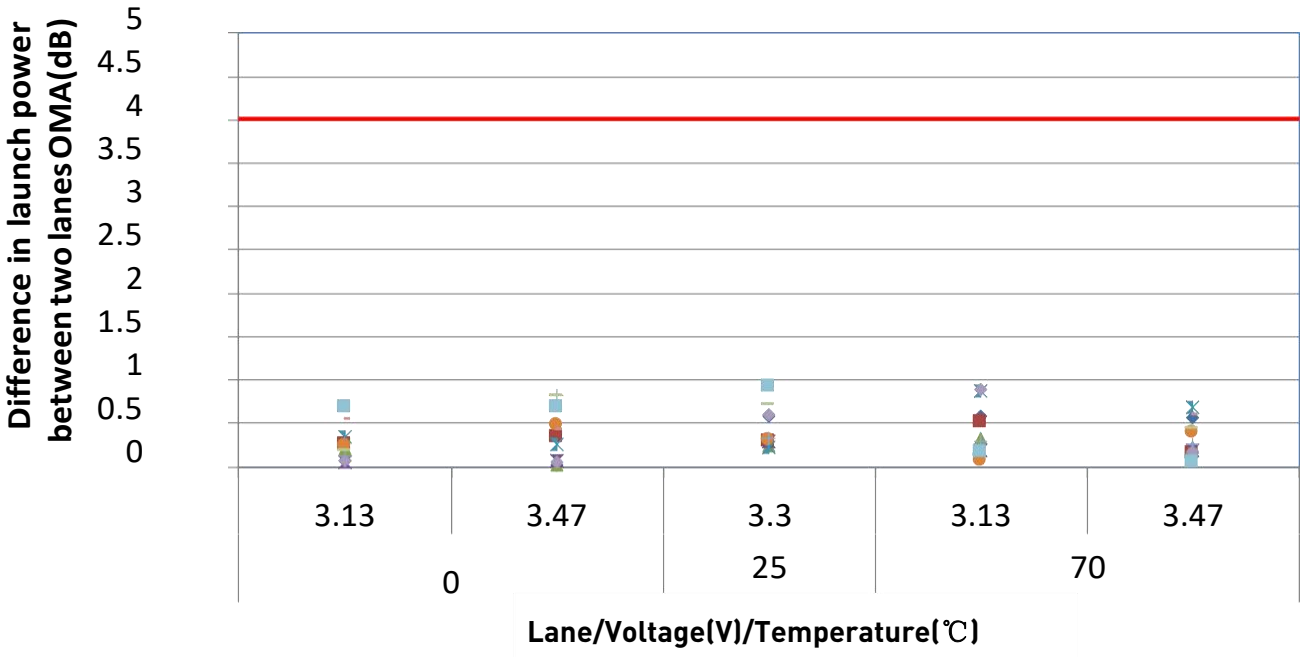
4.4 Average Launch Power per Lane Testing Results



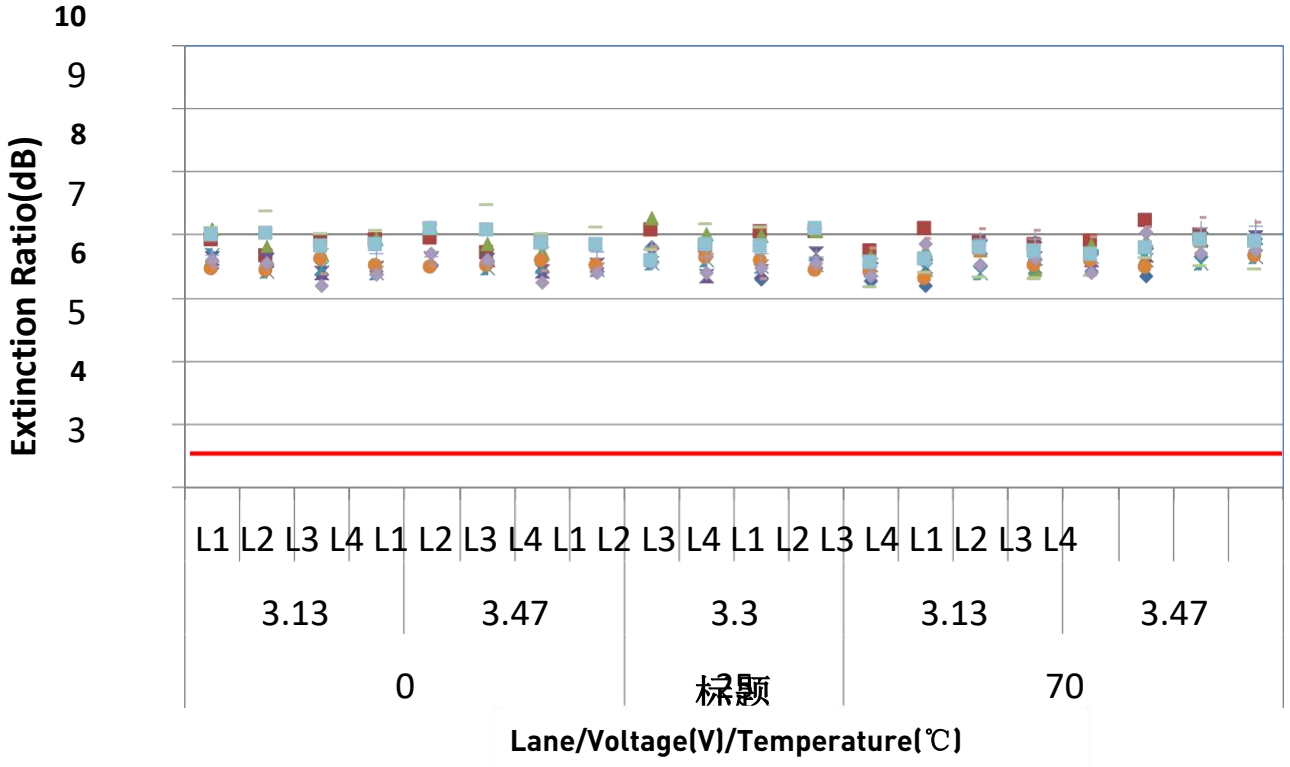
4.5 Optical Modulation Amplitude Testing Results



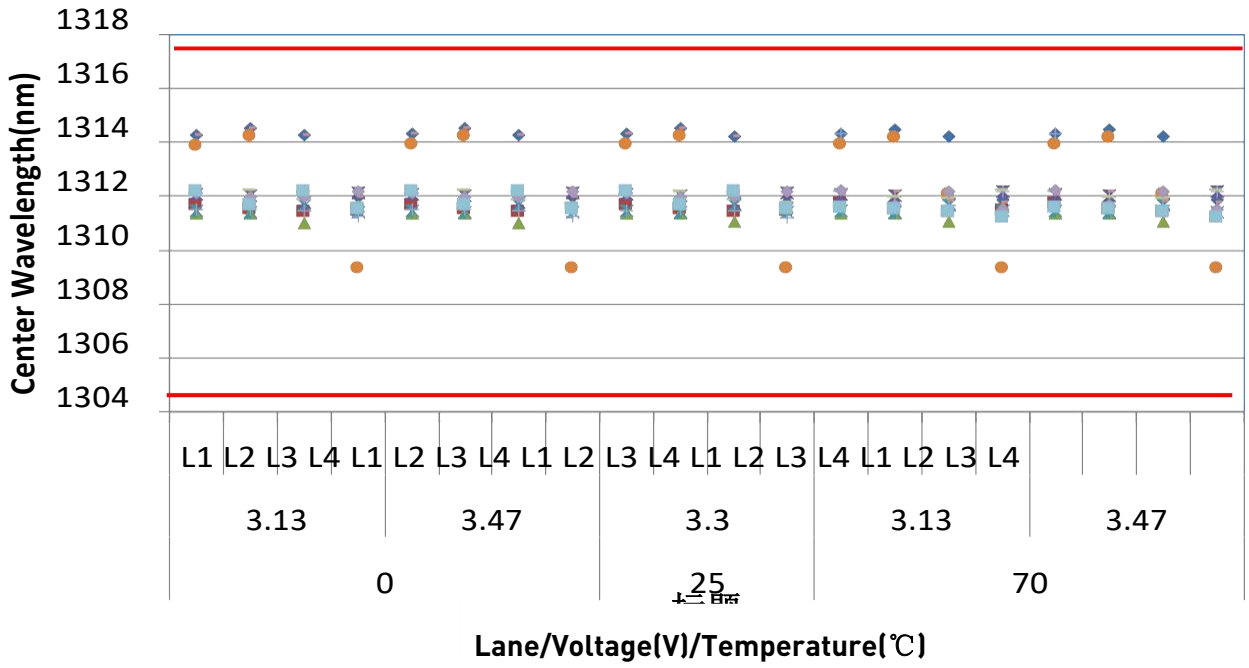
4.6 Difference in launch power between two lanes (OMA) Testing Results



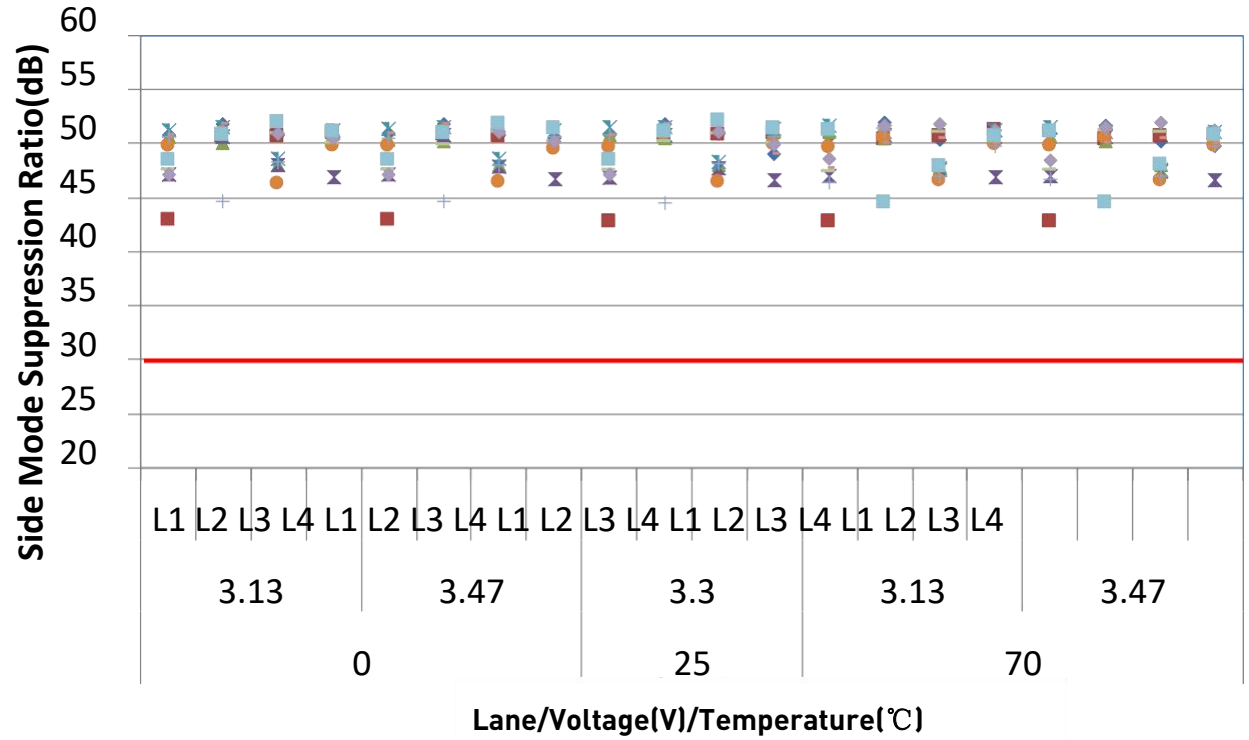
4.7 Extinction Ratio Testing Results



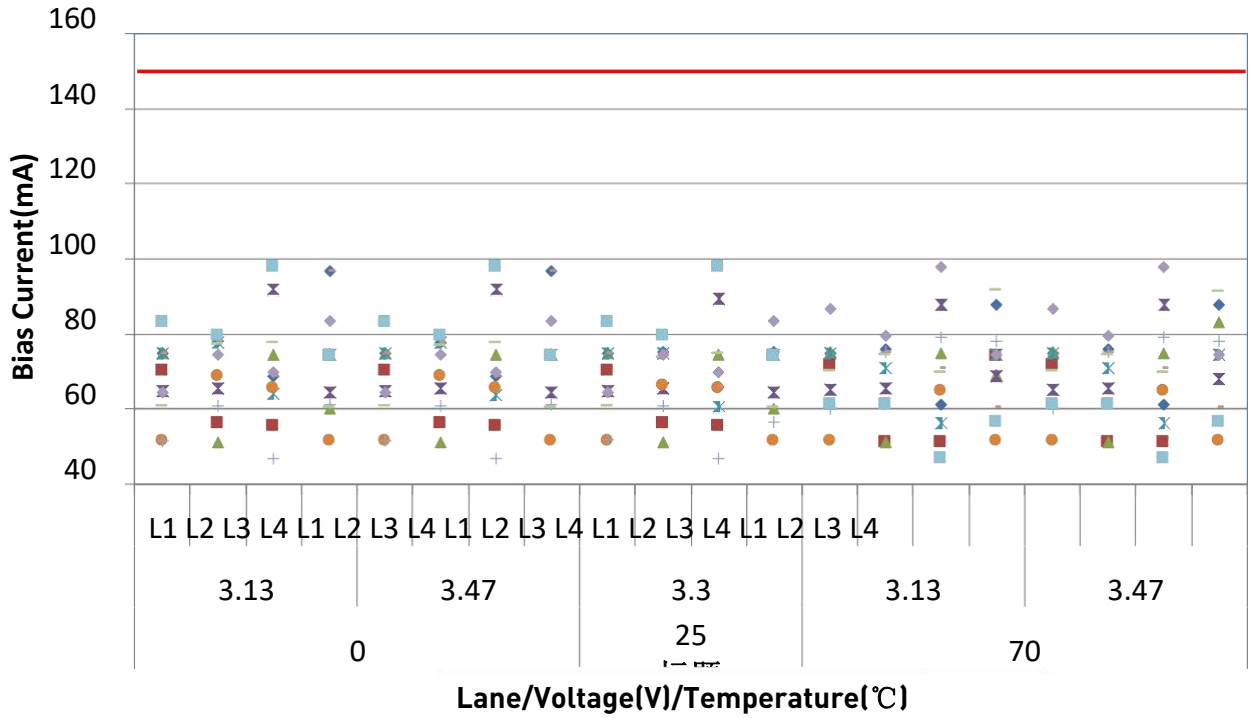
4.8 Center Wavelength Testing Results



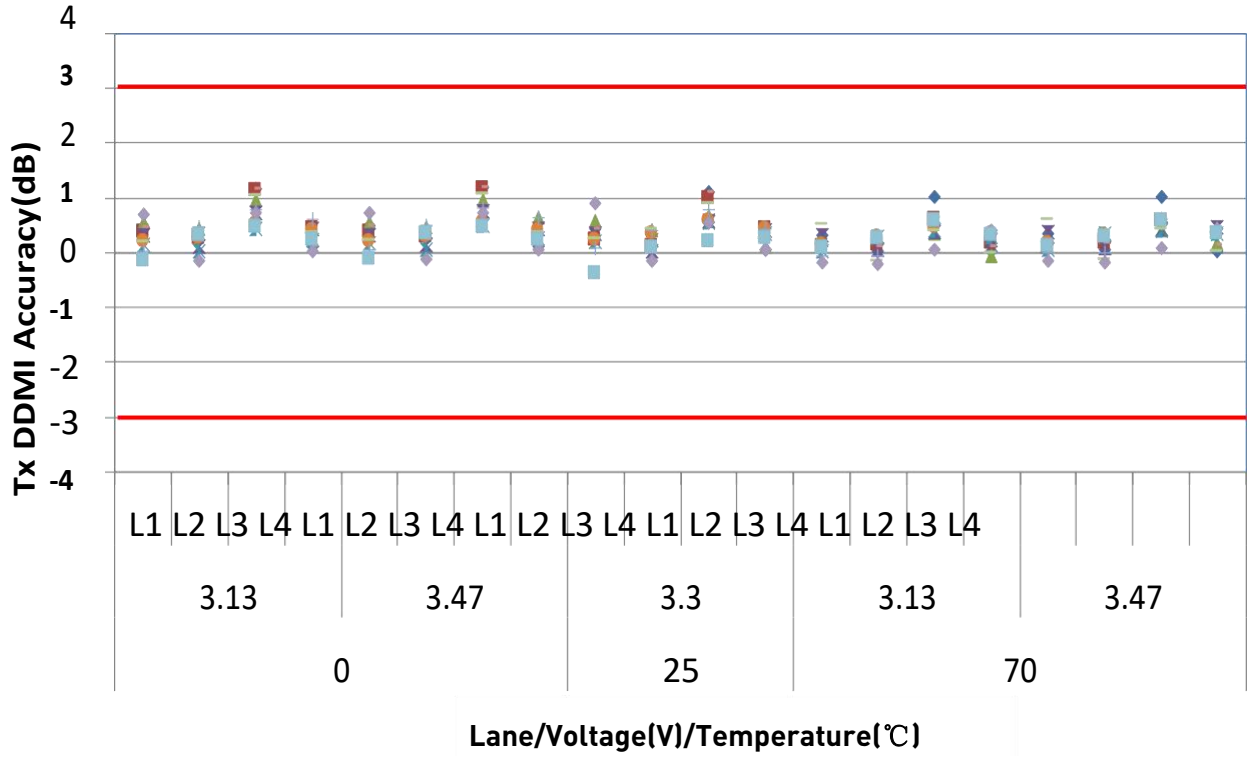
4.9 Side Mode Suppression Ratio Results



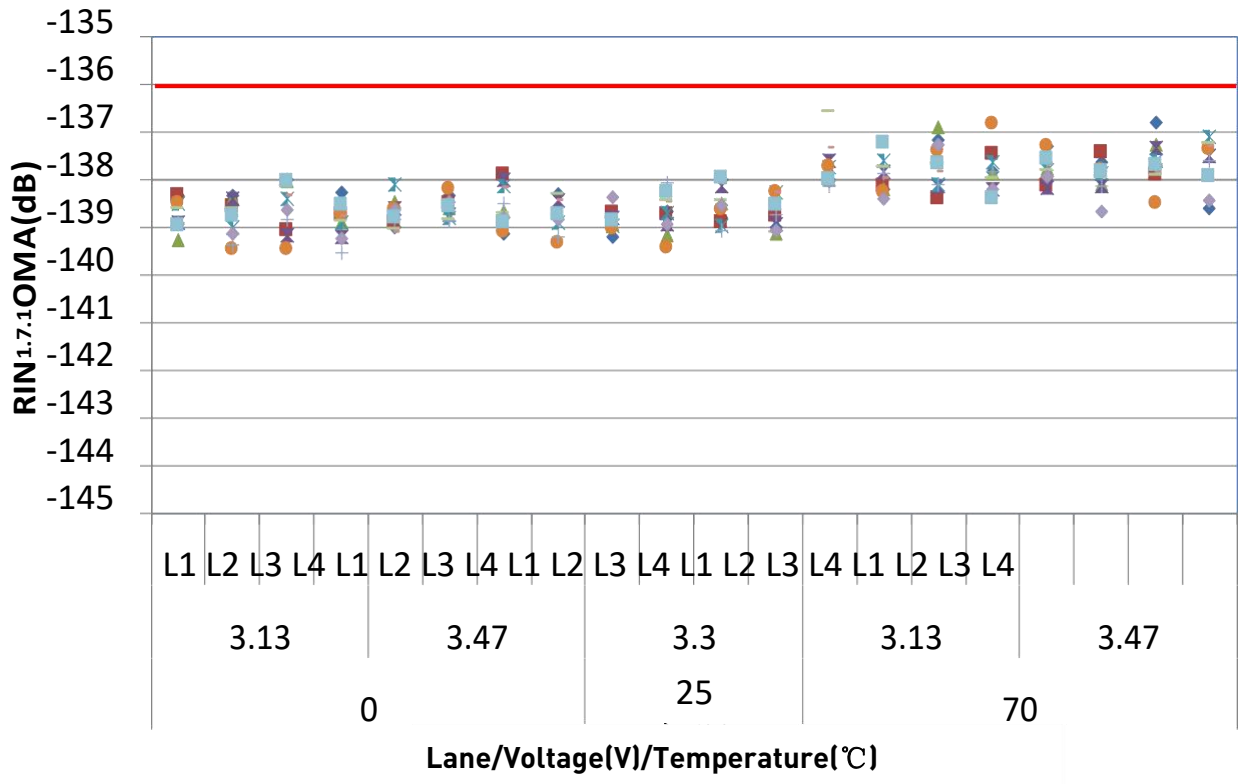
4.10 Bias Current Testing Results



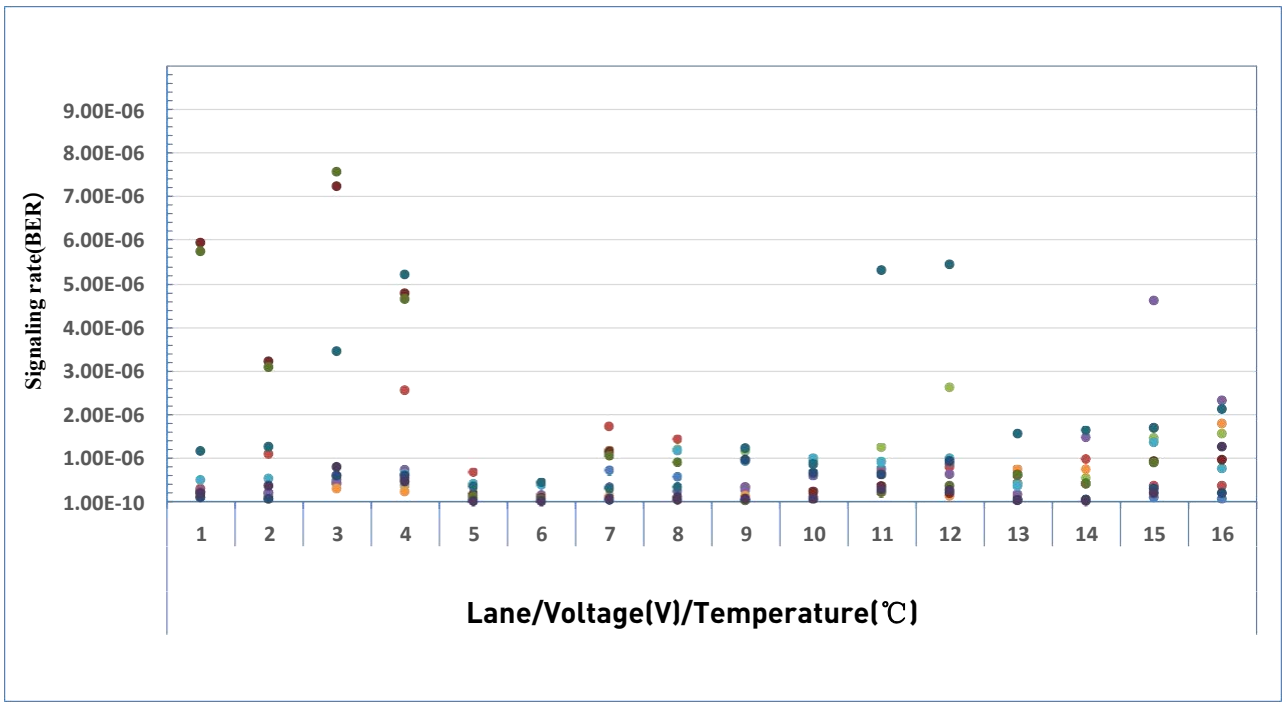
4.11 Tx DDMI Accuracy Testing Results



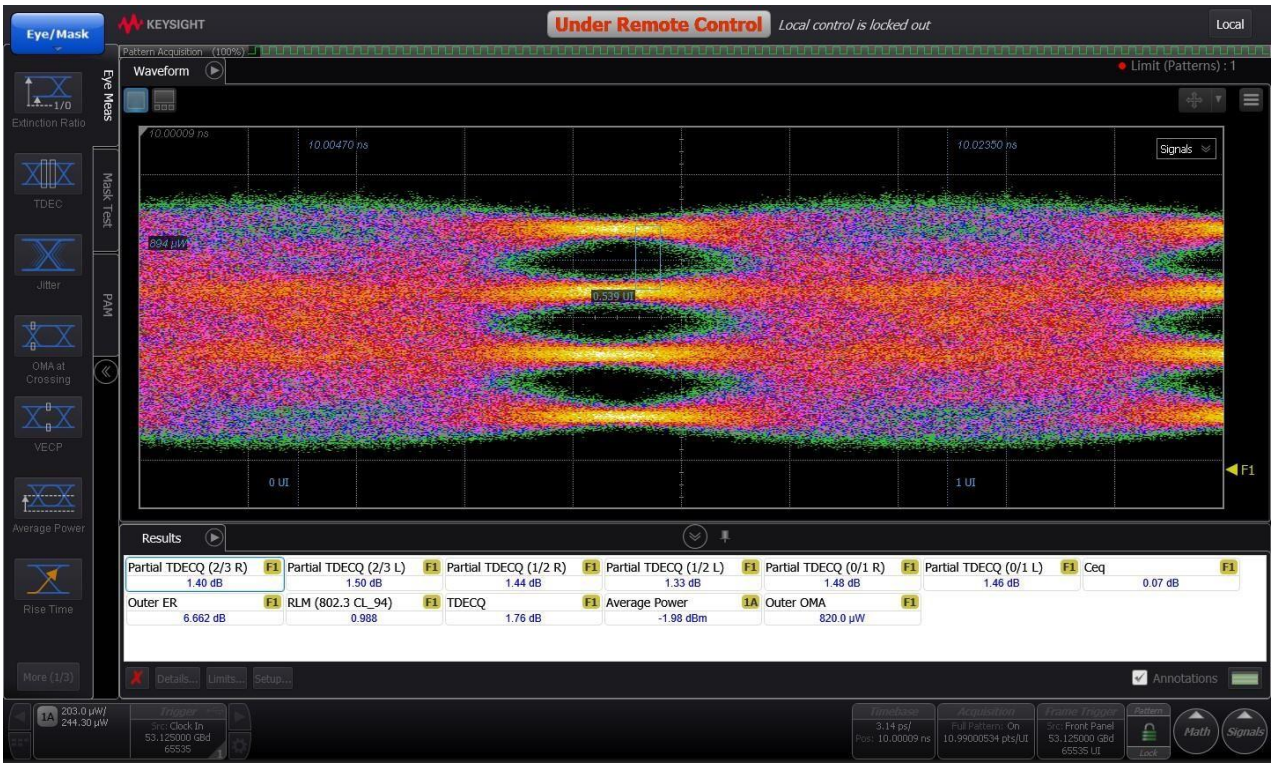
4.12 RIN17.1OMA Testing Results



4.13 Signaling rate±100ppm,offset±10ppm@-8dBm Testing Results

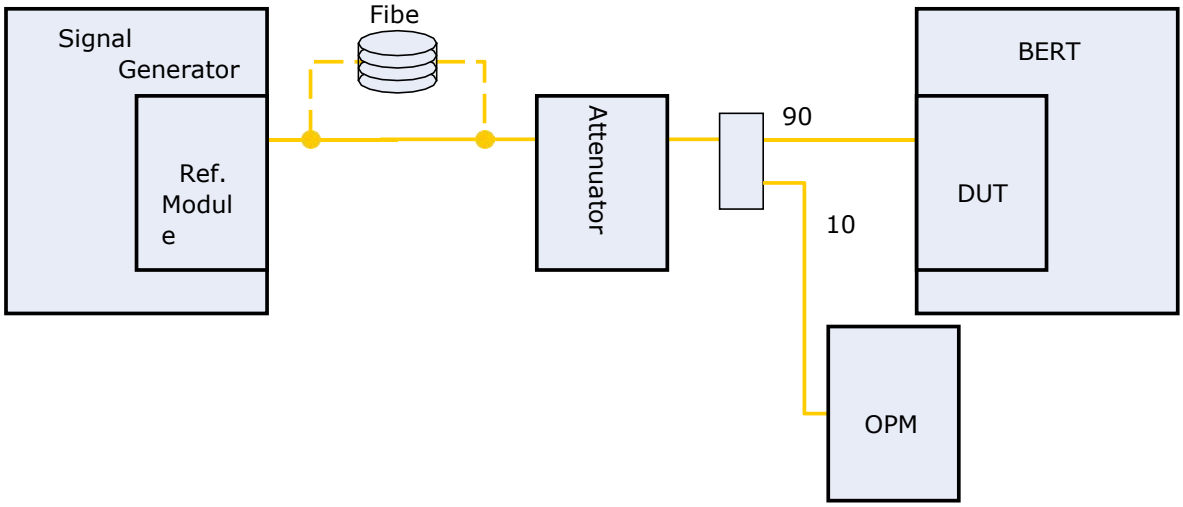


4.14 TX Eye Diagram

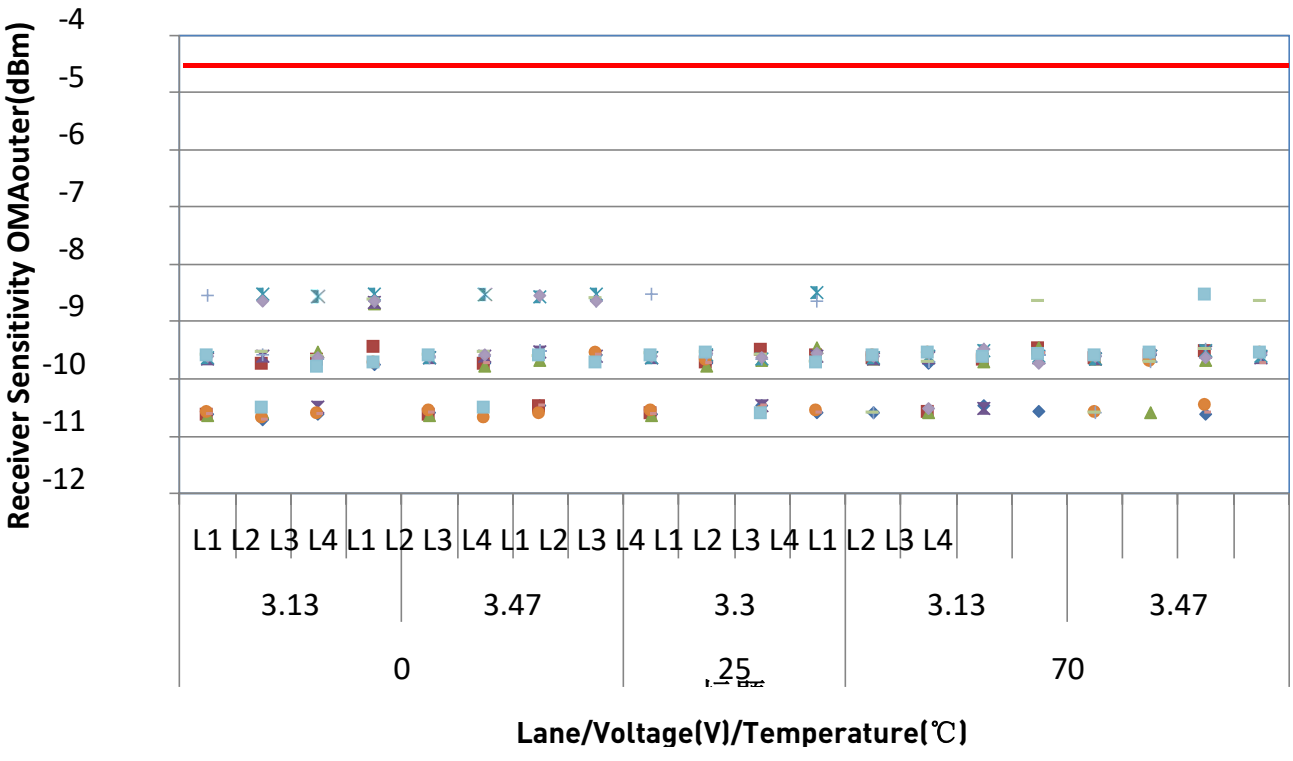


5. Receiver Tests

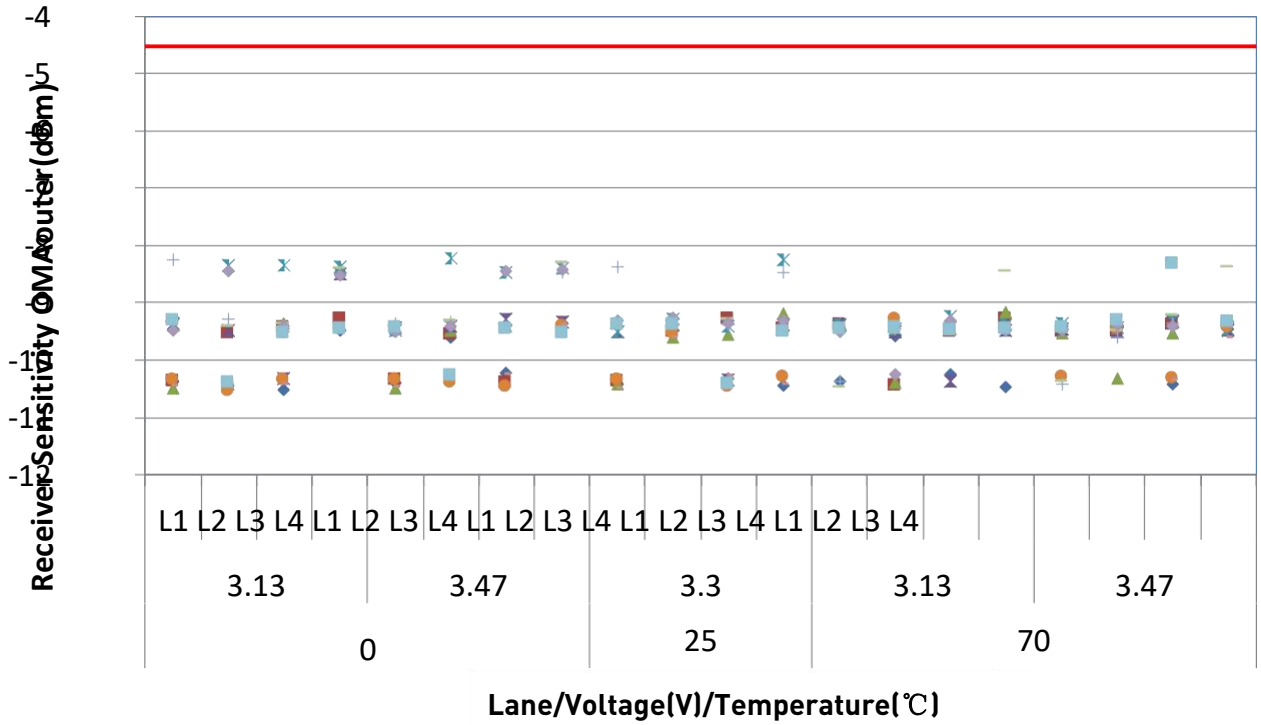
5.1 Testing Setup



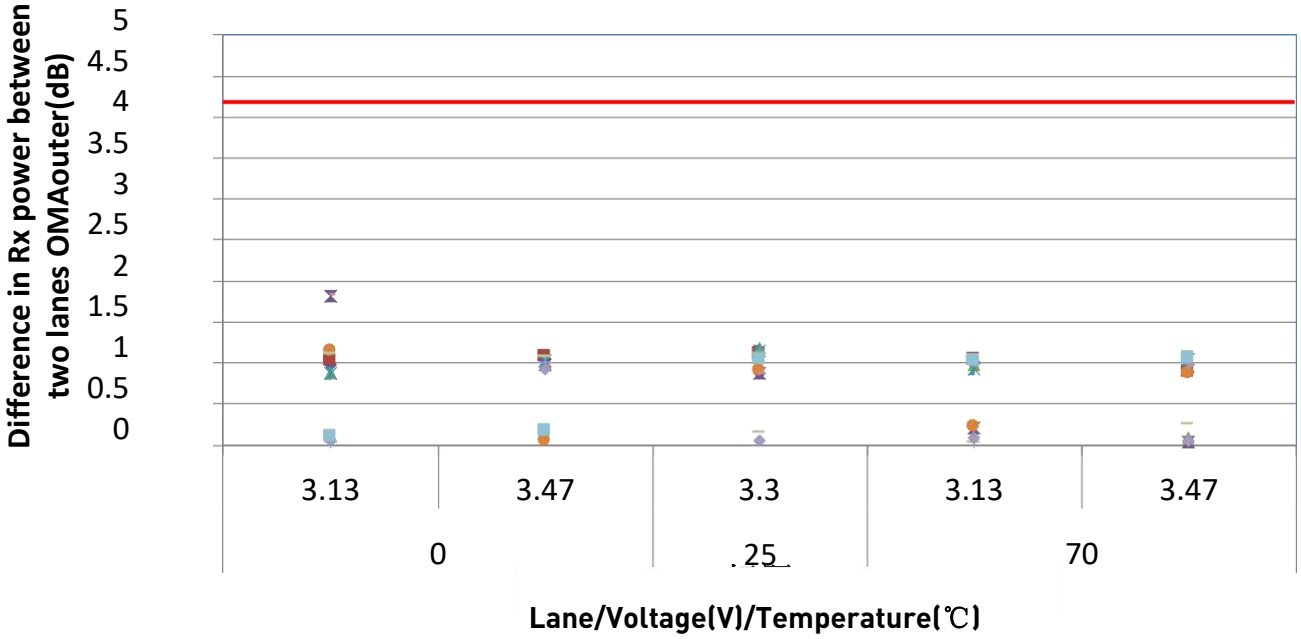
5.2 Receiver Sensitivity (OMAouter) Testing Results - Informative only



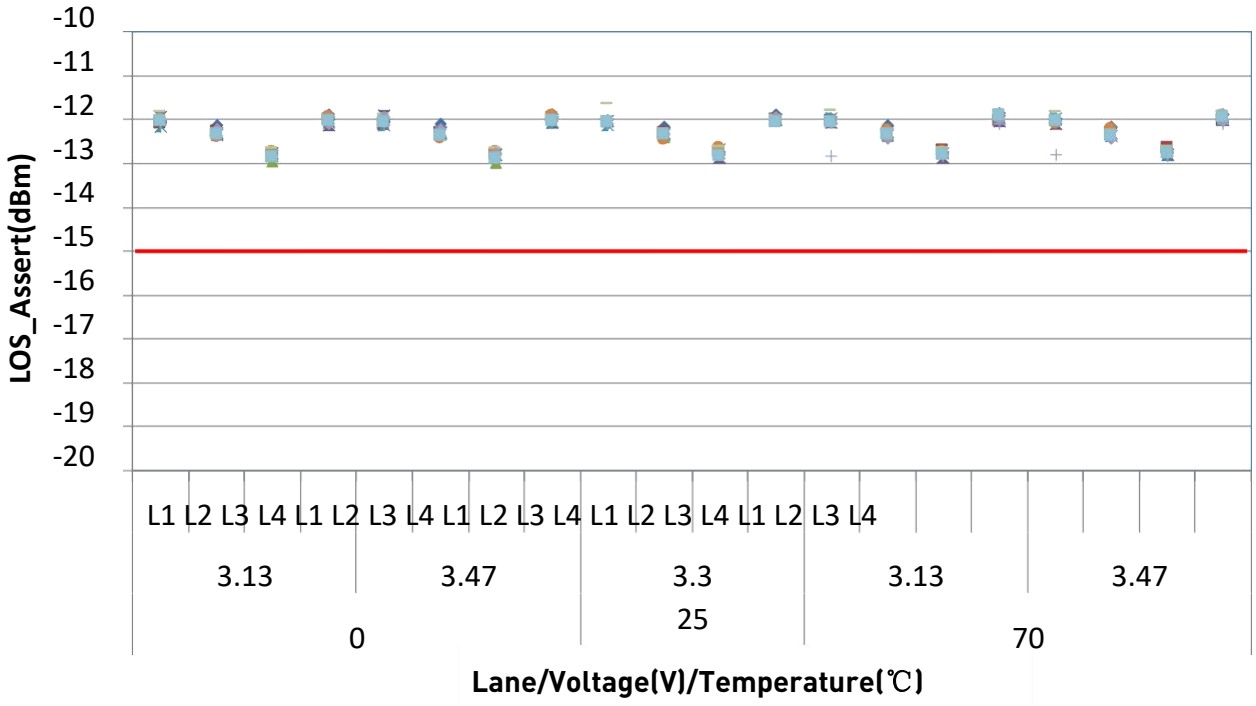
Informative Receiver Sensitivity with power supply noise and 21.4dB optical return loss added:



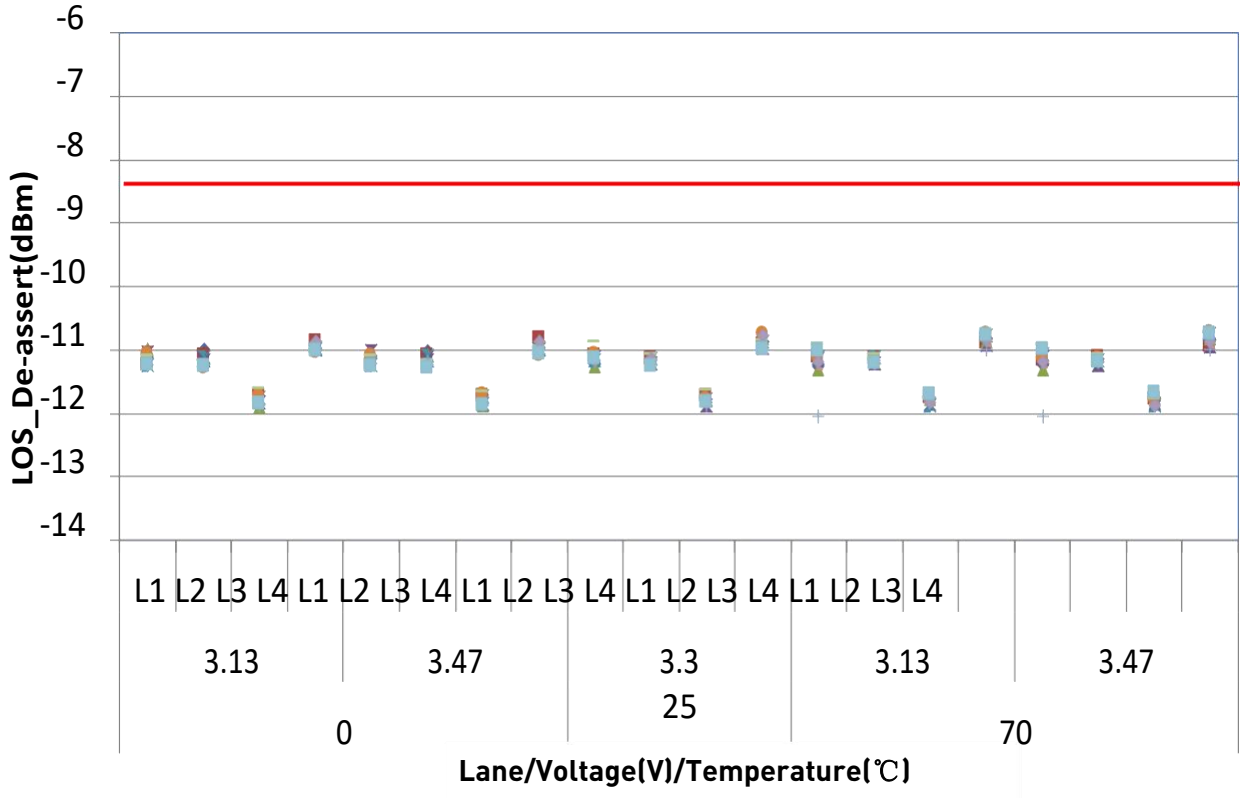
5.3 Difference in Rx power between two lanes (OMAouter) Testing Results



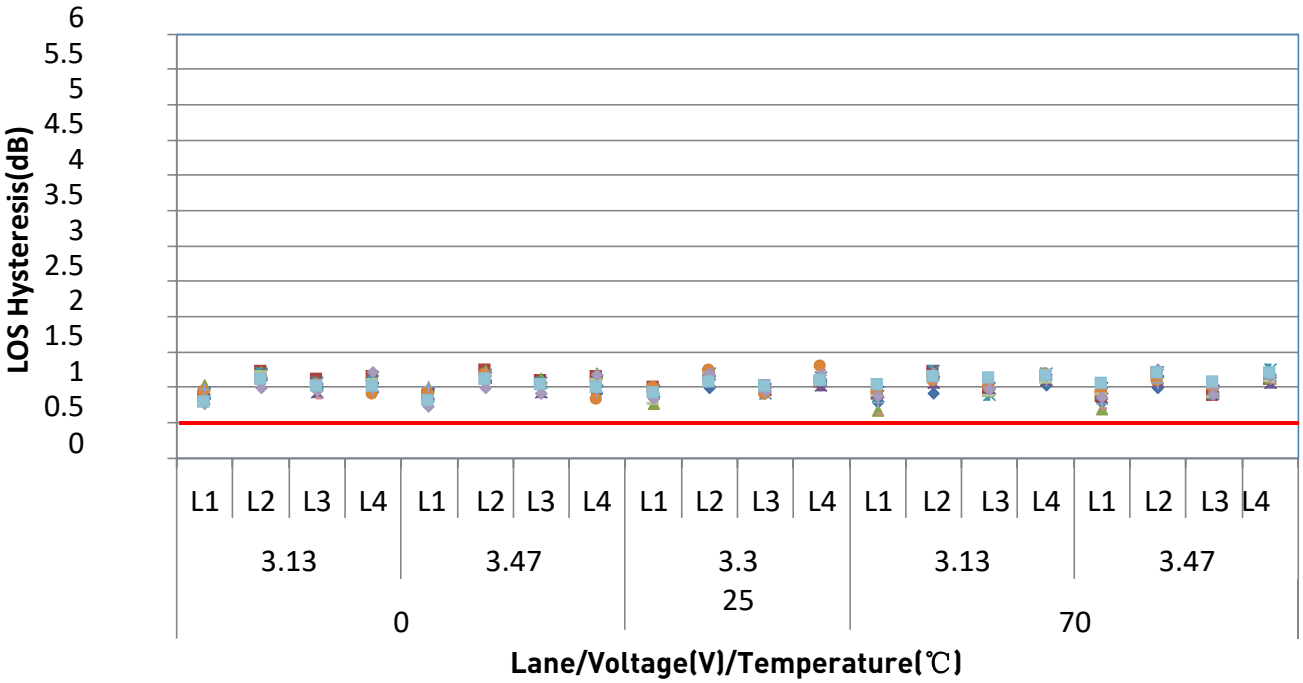
5.4 LOS_Assert Testing Results



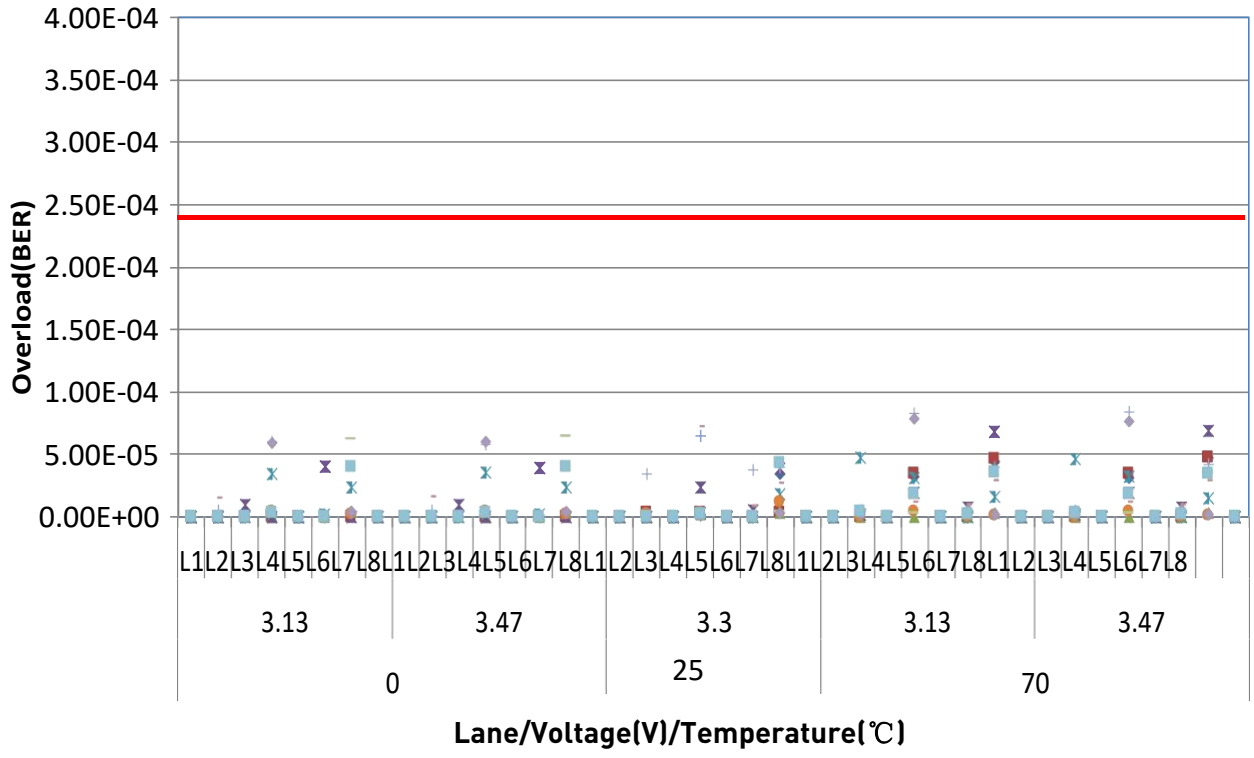
5.5 LOS_De-assert Testing Results



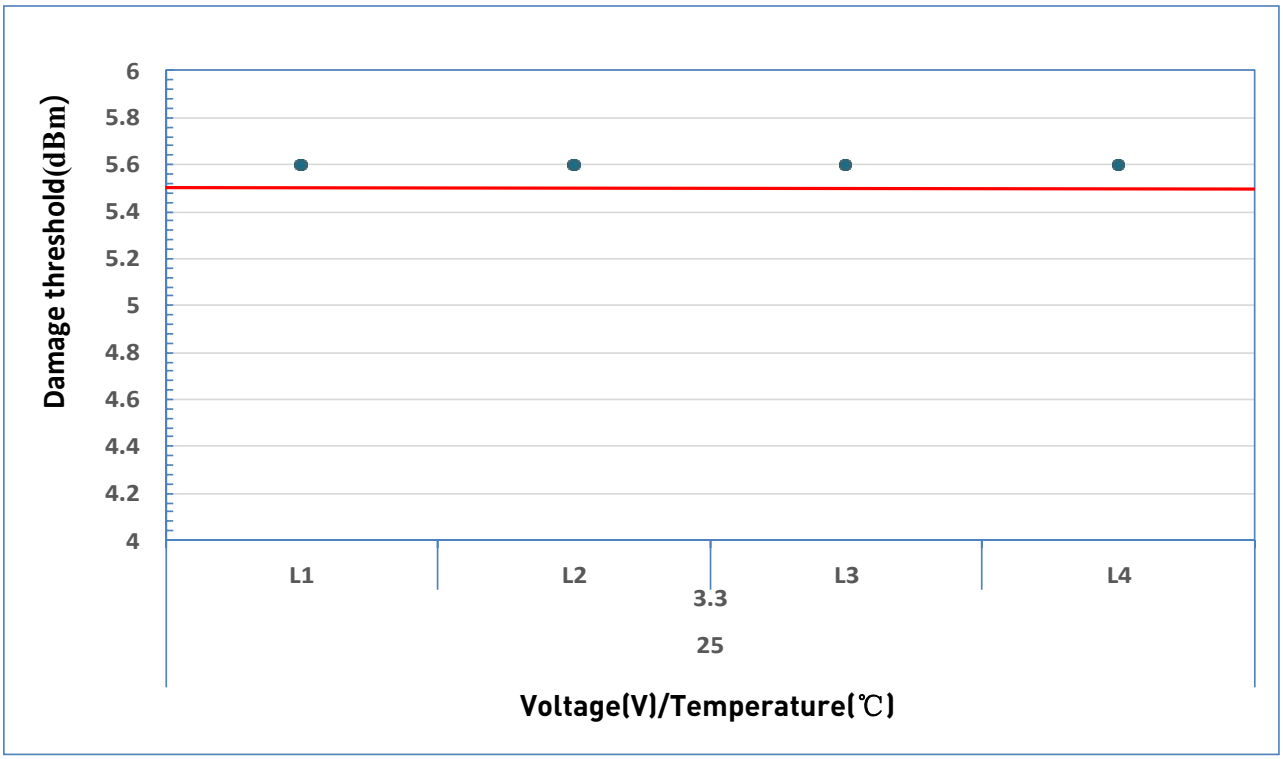
5.6 LOS Hysteresis Testing Results



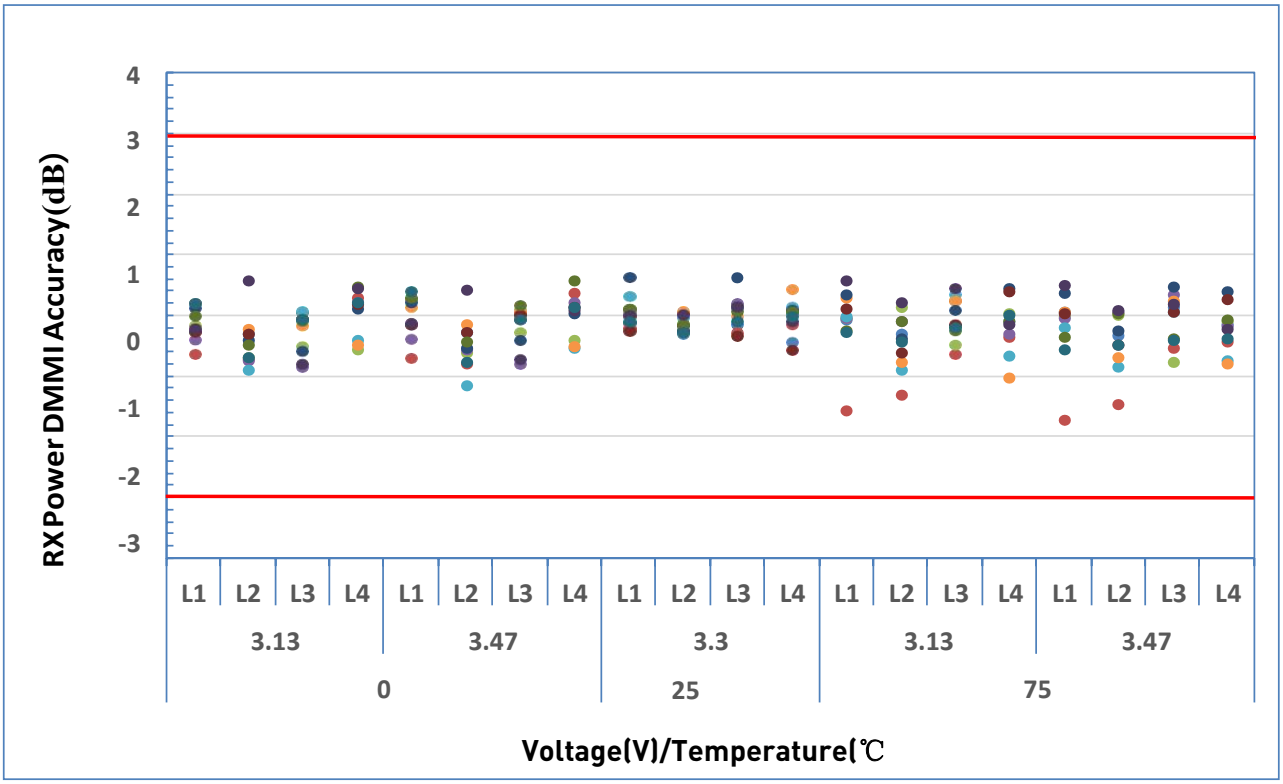
5.7 Overload@OMA=4.7dBm Testing Results



5.8 Damage threshold Testing Results

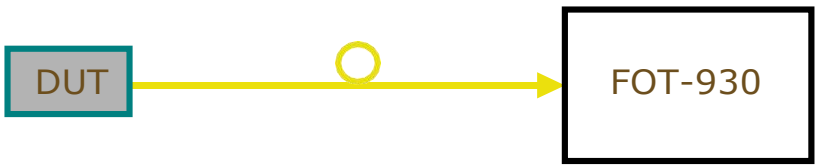


5.9 RX Power DMMI Accuracy Testing Results

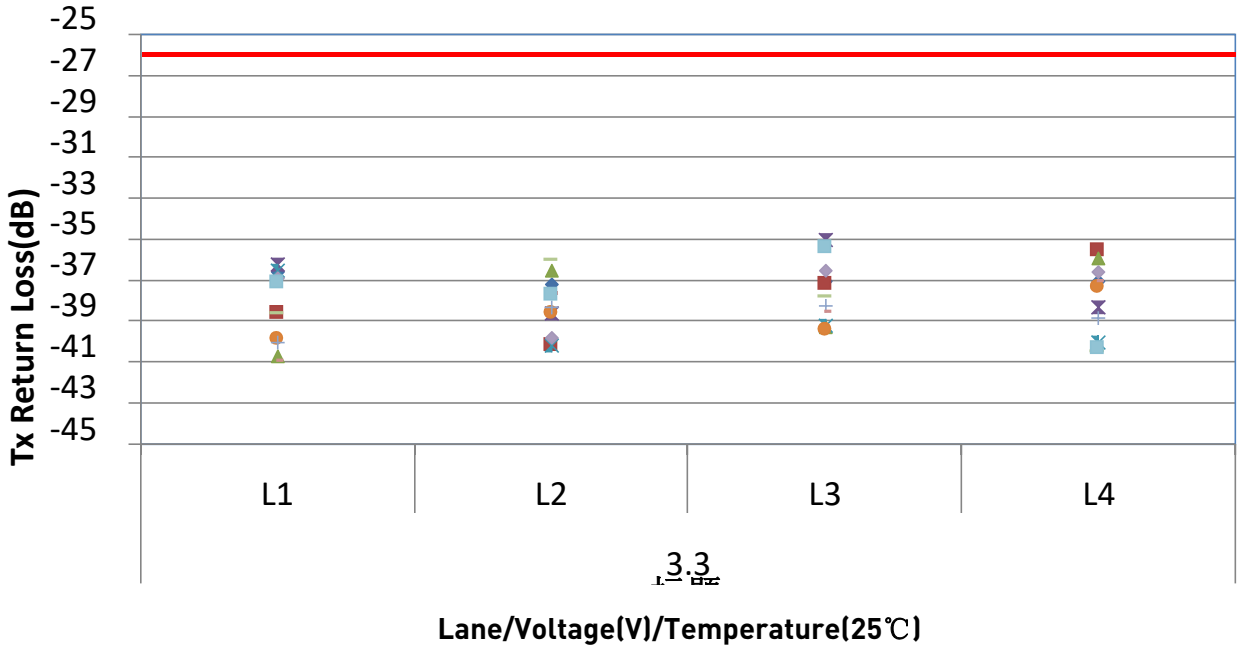


6. Return Loss Tests

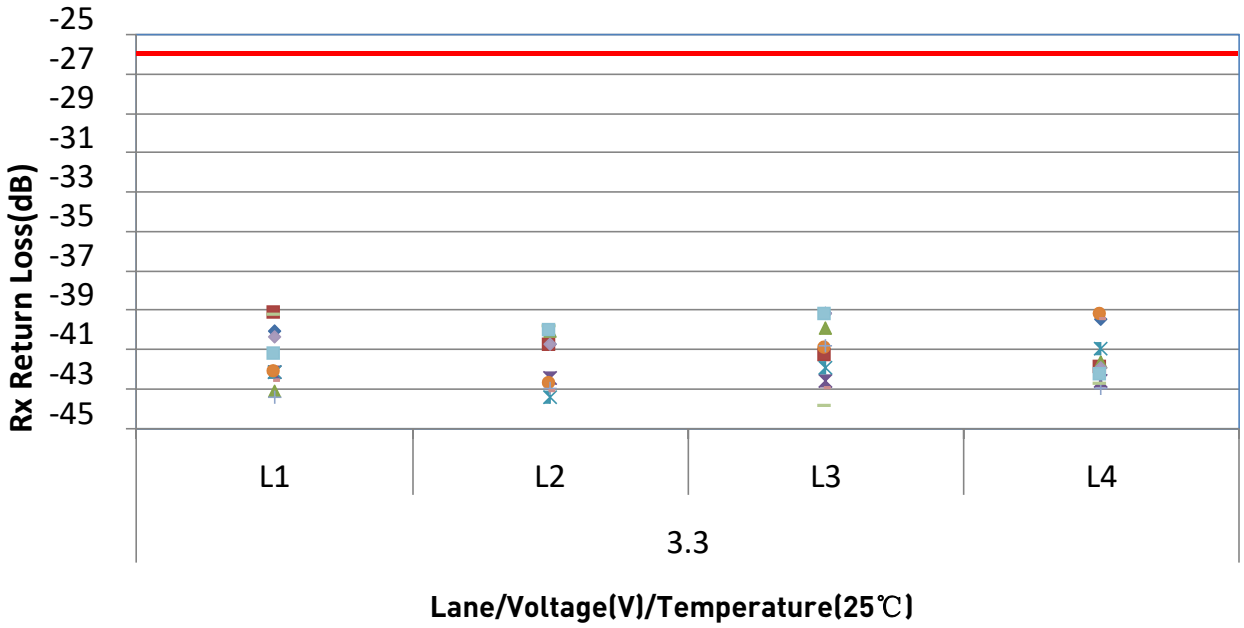
6.1 Testing Setup



6.2 Tx Return Loss Testing Results



6.3 Rx Return Loss Testing Results



7. 400GAUI-8 Tests

7.1 TP4 Testing Setup

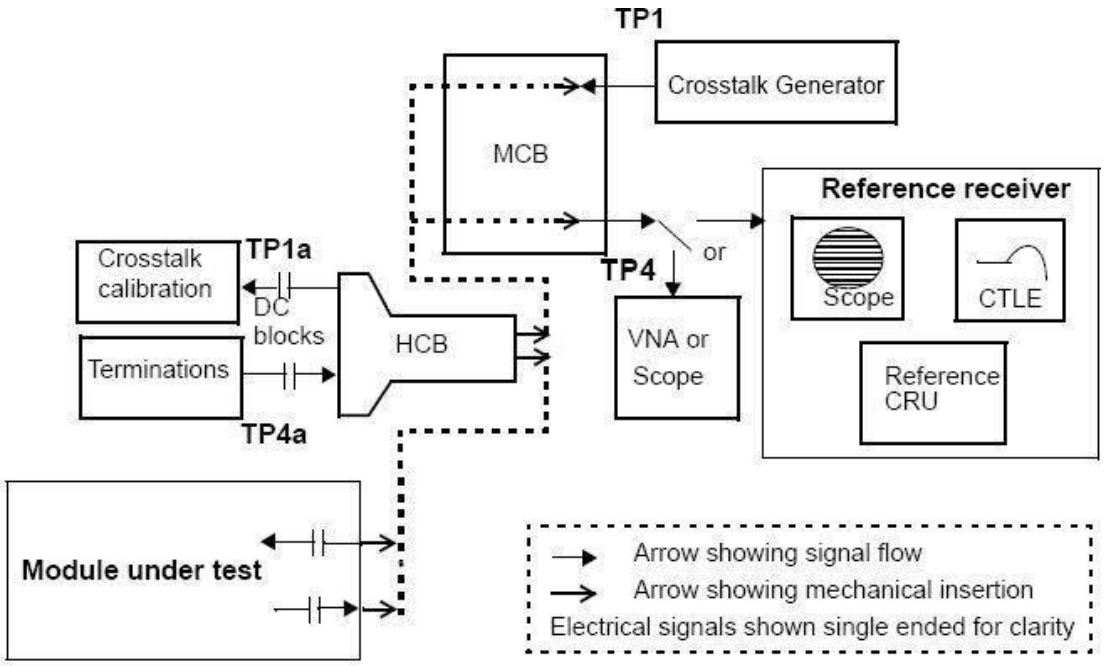
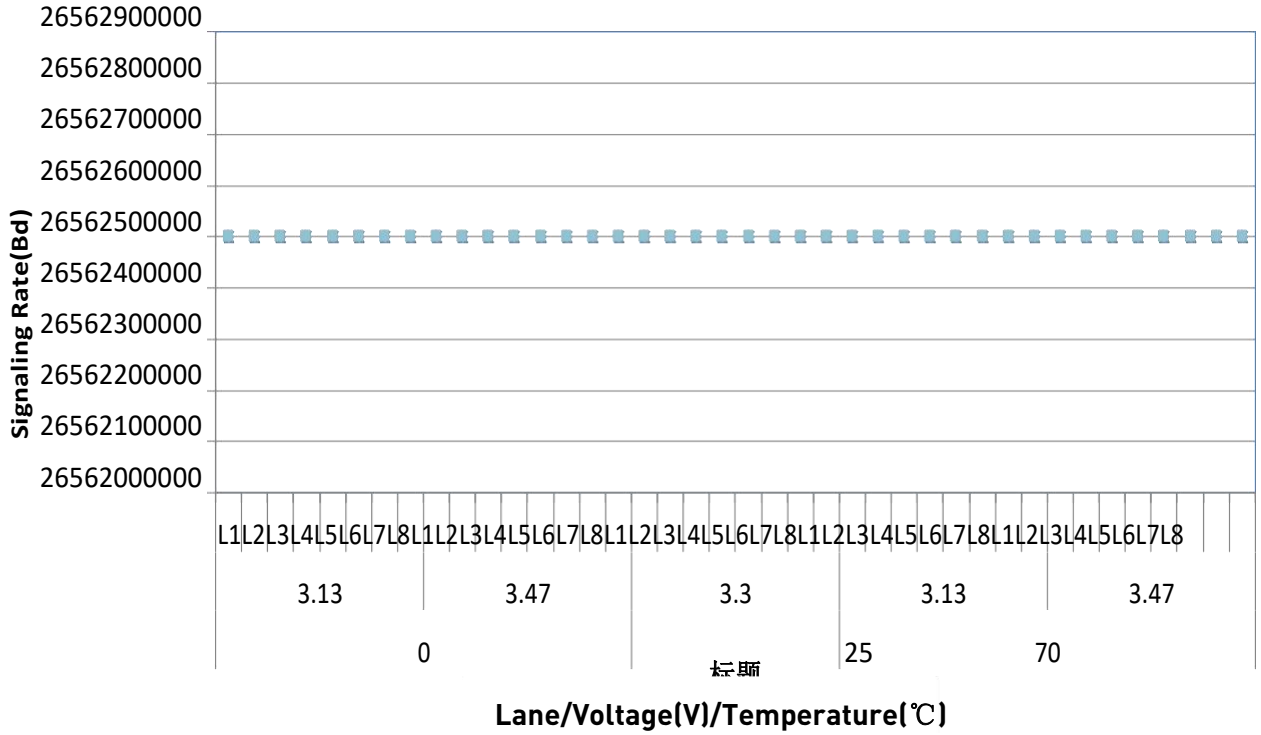
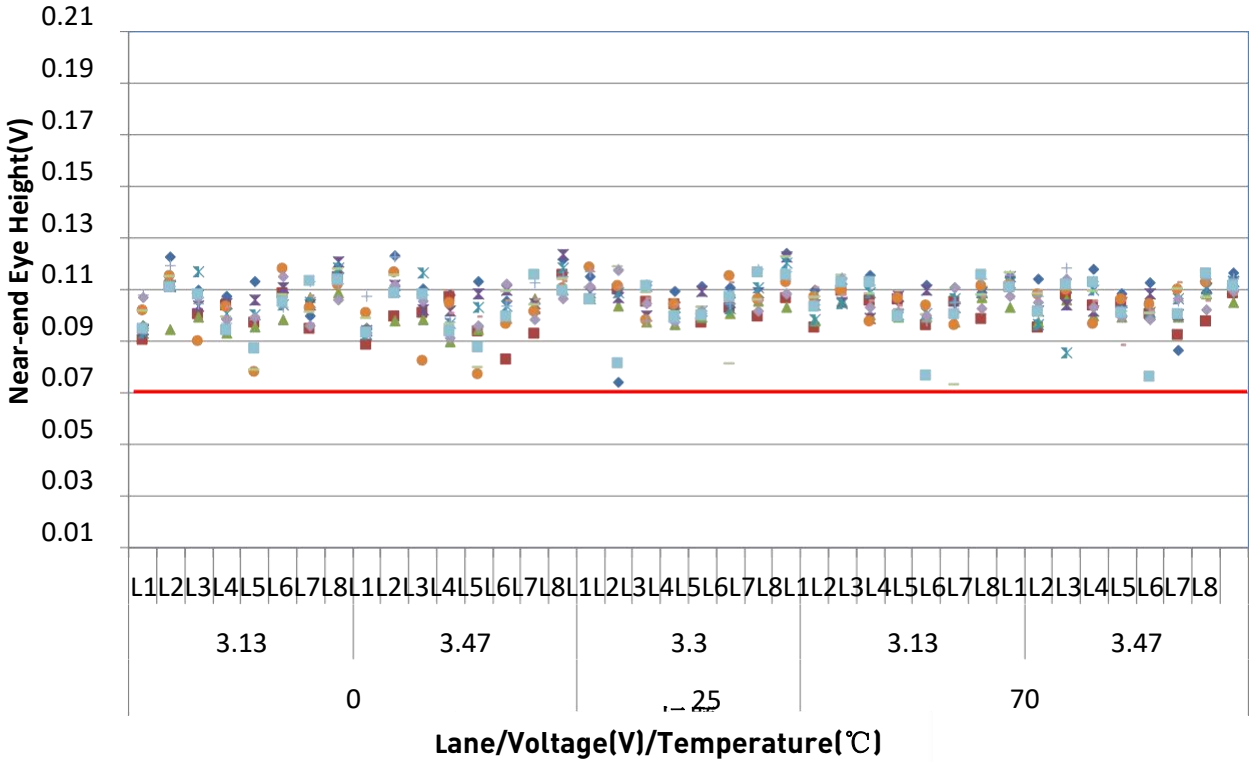


Figure 83E–11—Example module output test configuration

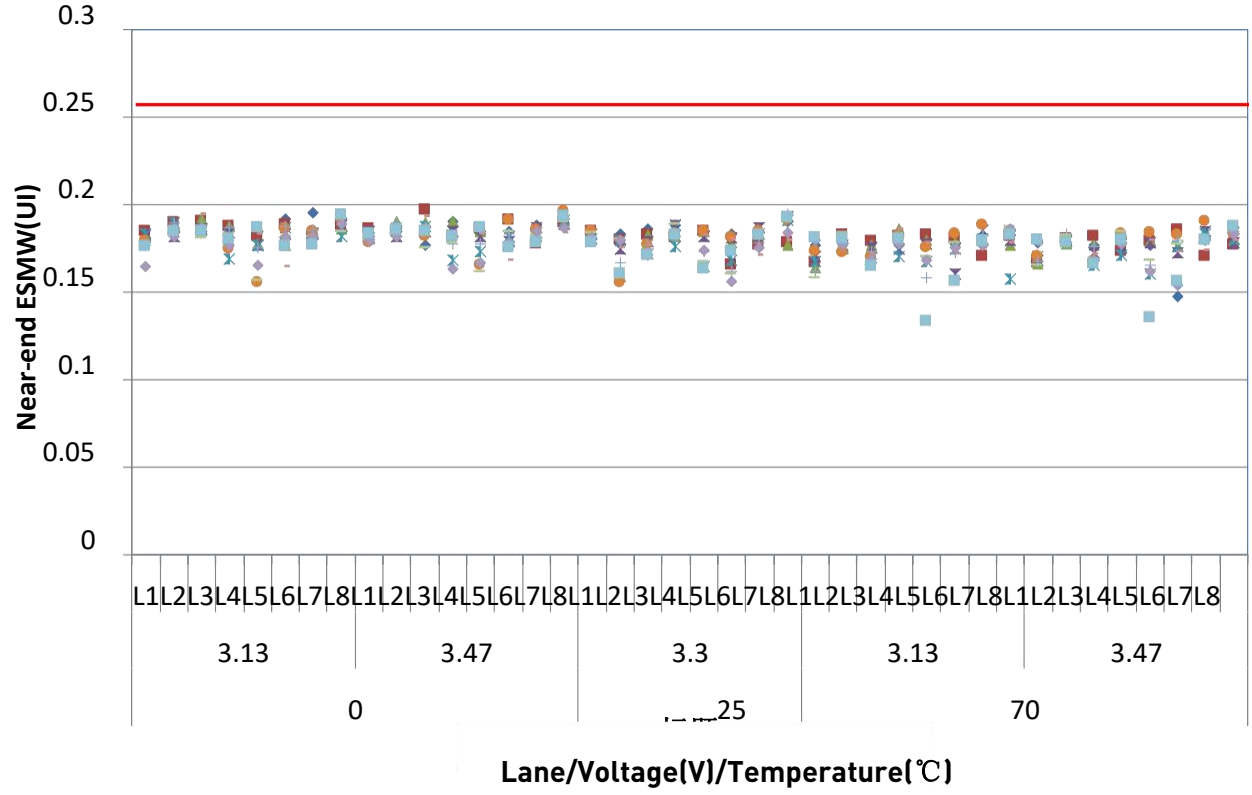
7.2 Signaling Rate Testing Results



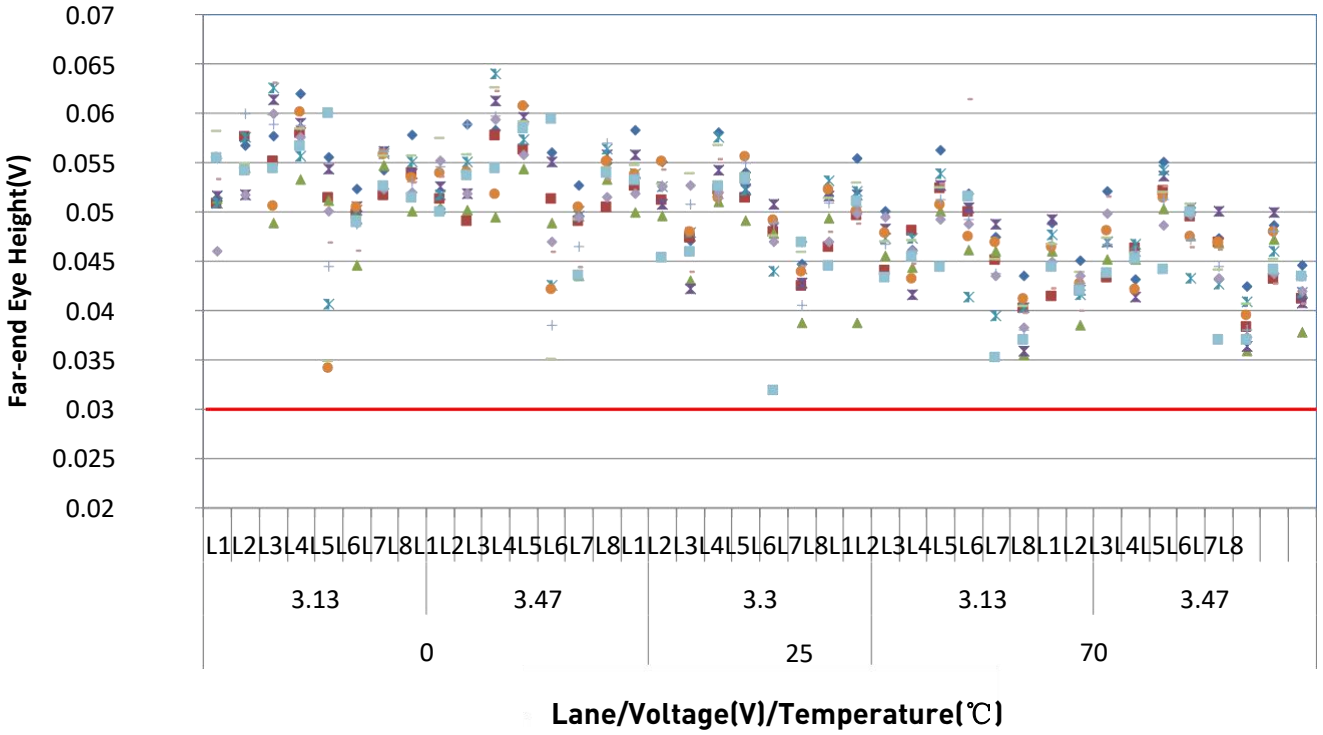
7.3 Near-end Eye Height Testing Results



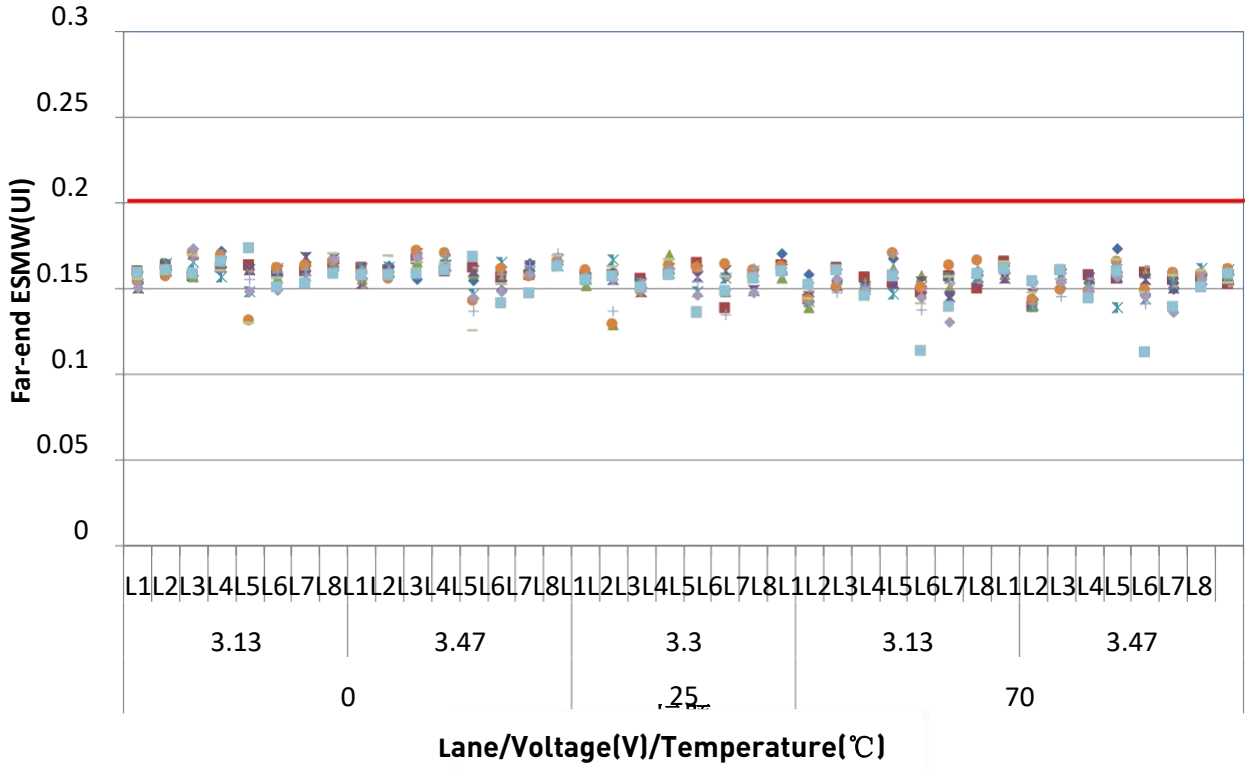
7.4 Near-end ESMW Testing Results



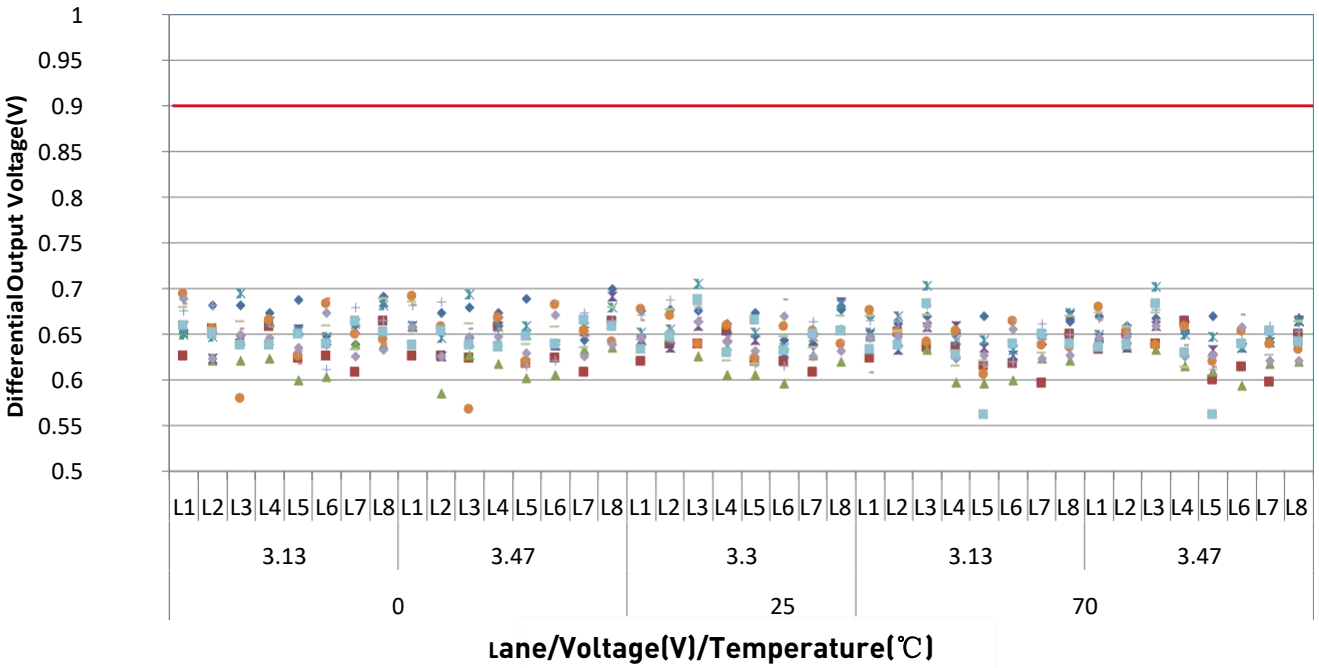
7.5 Far-end Eye Height Testing Results



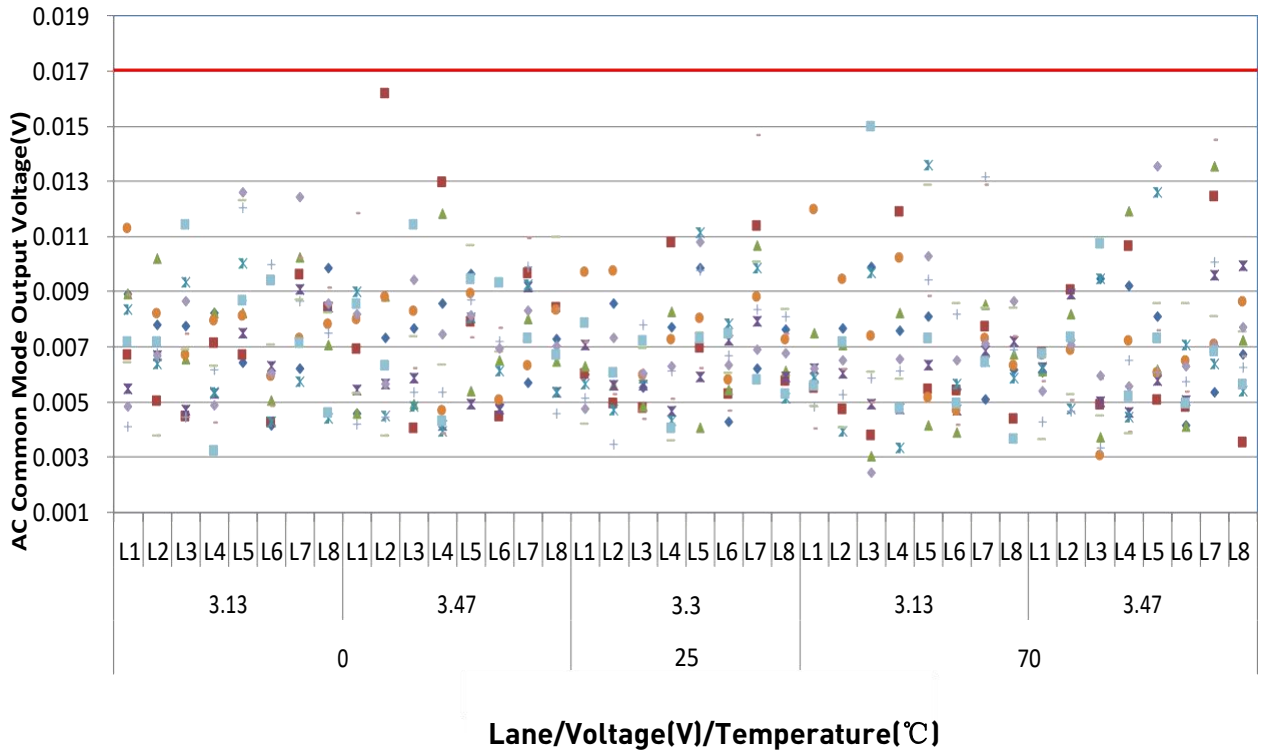
7.6 Far-end ESMW Testing Results



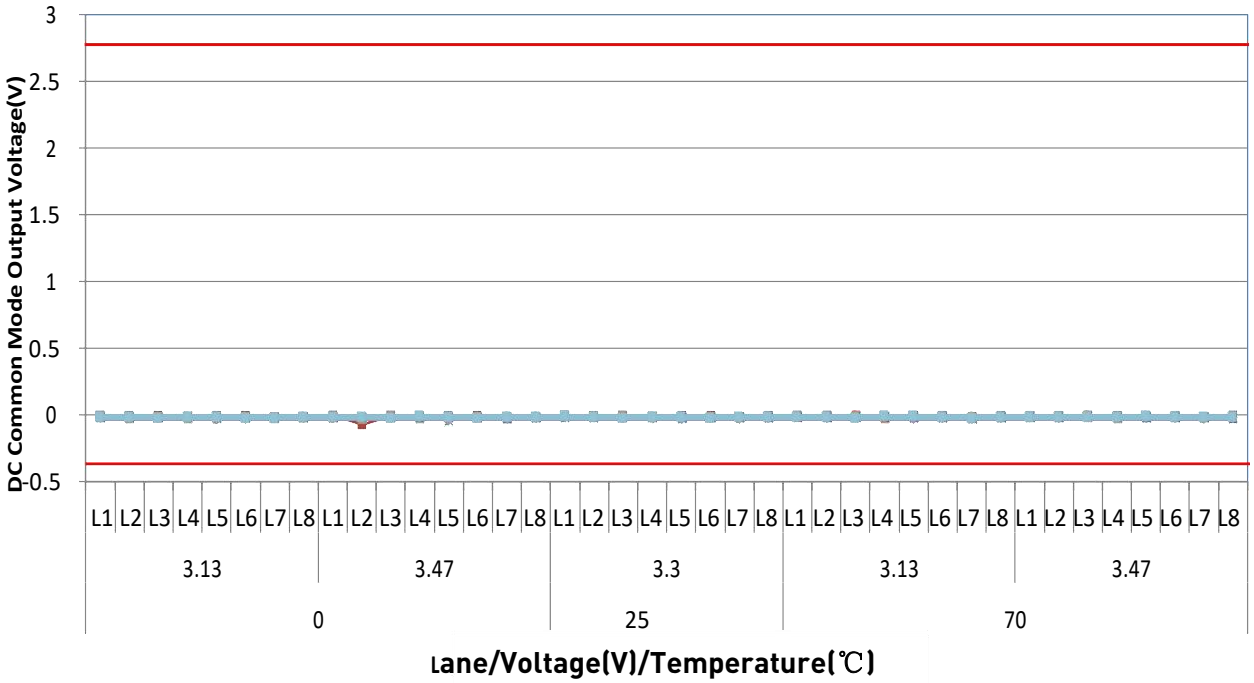
7.7 Differential Output Voltage Testing Results



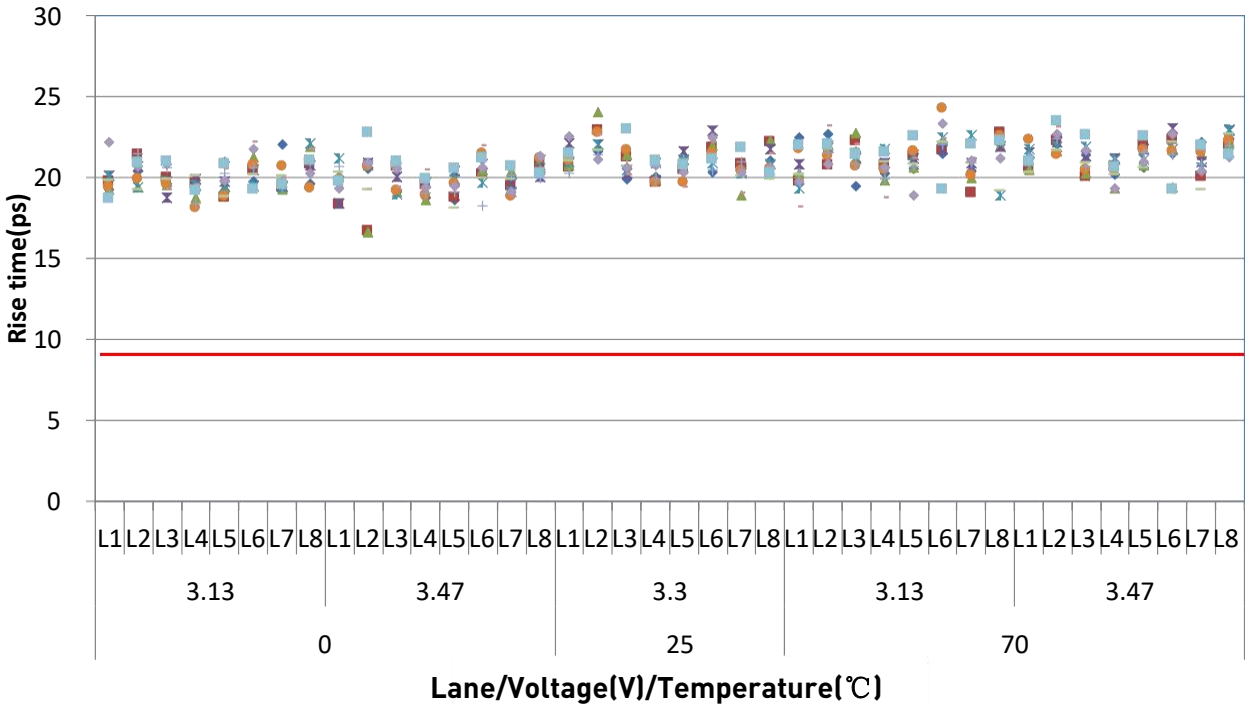
7.8 AC Common Mode Output Voltage Testing Results



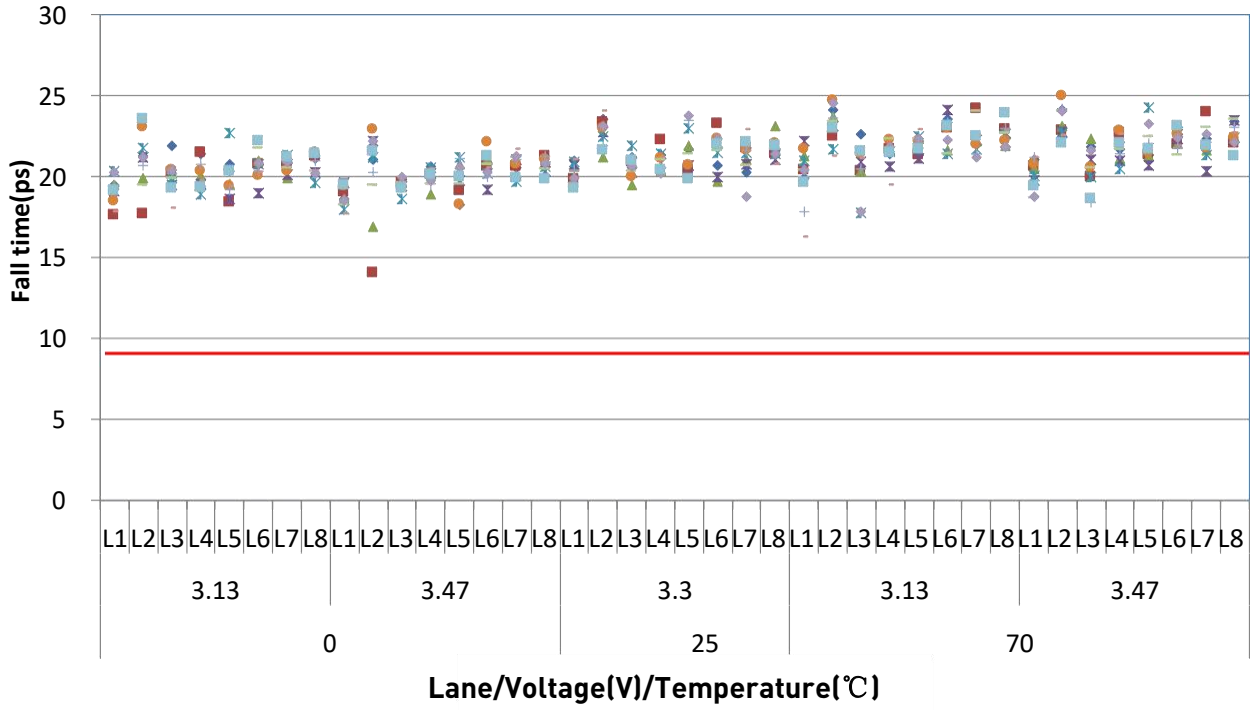
7.9 DC Common Mode Output Voltage Testing Results



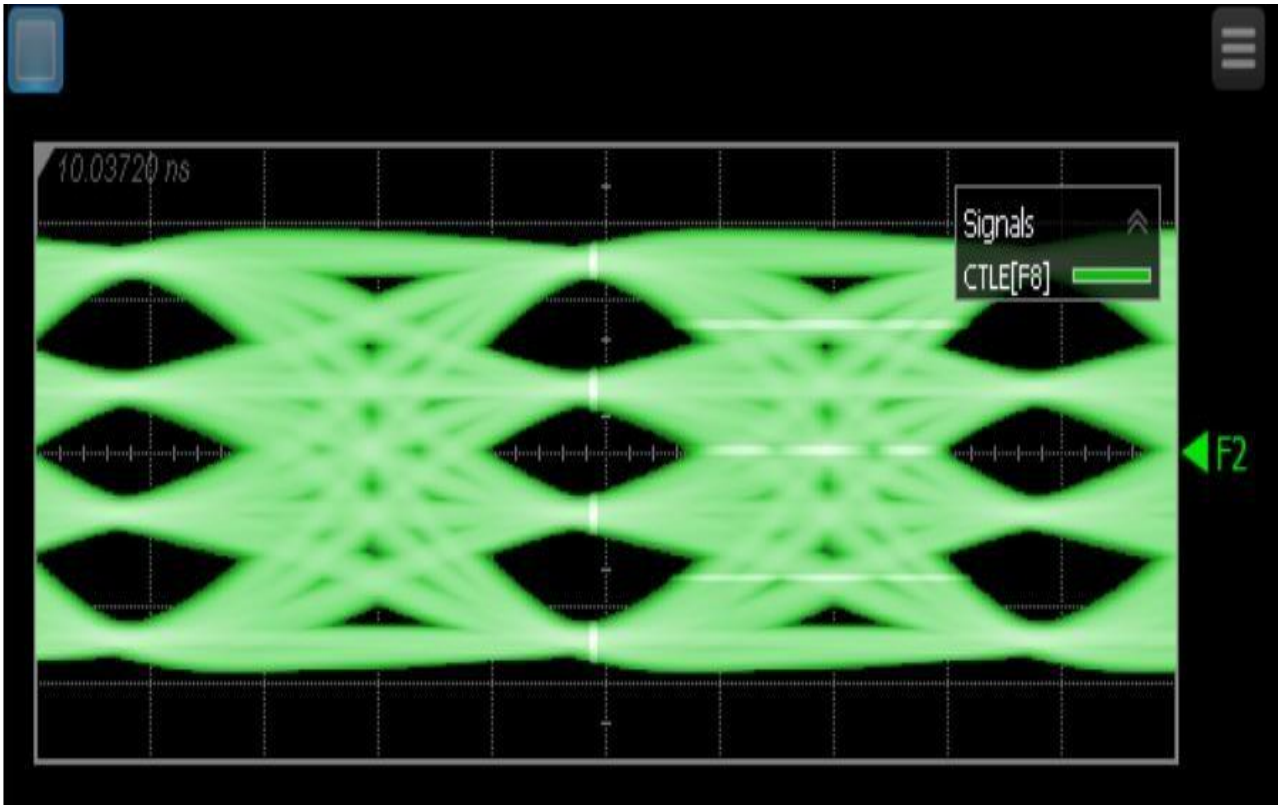
7.10 Rise time Testing Results



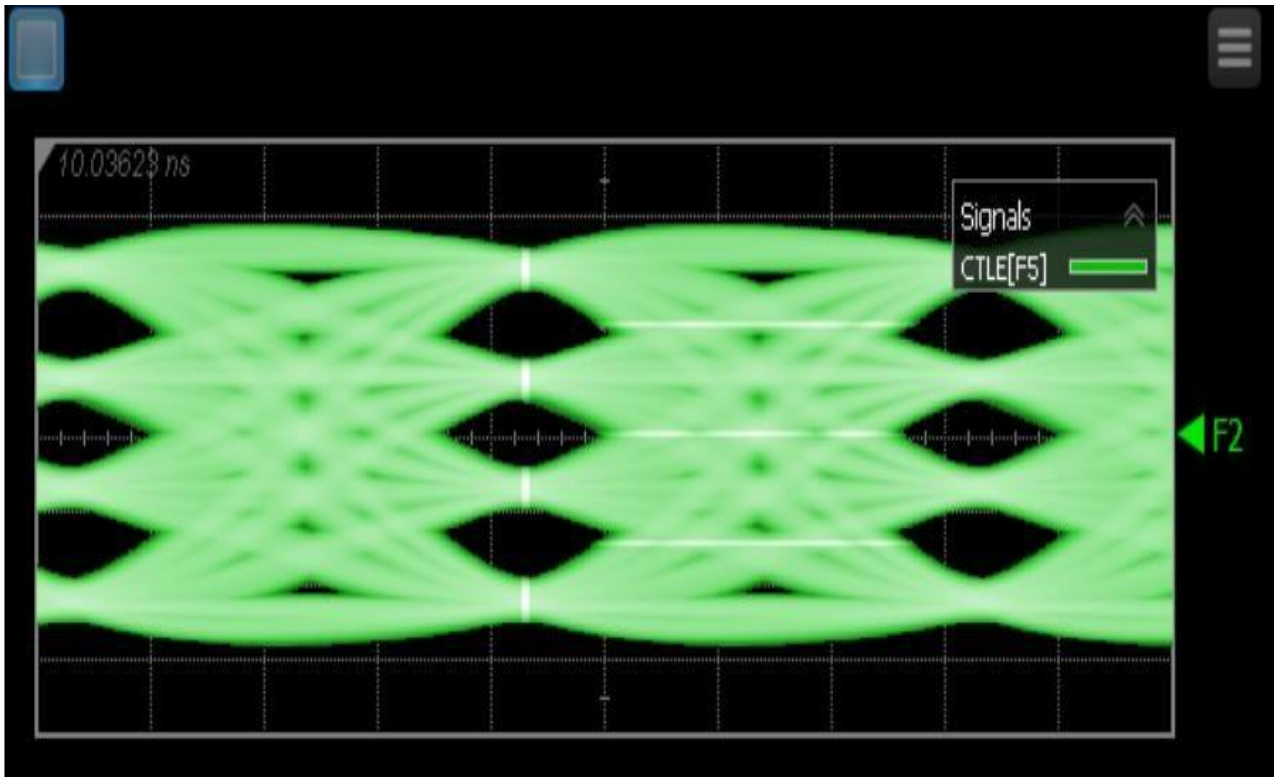
7.11 Fall time Testing Results



7.12 TP4 Near-end Eye Diagram

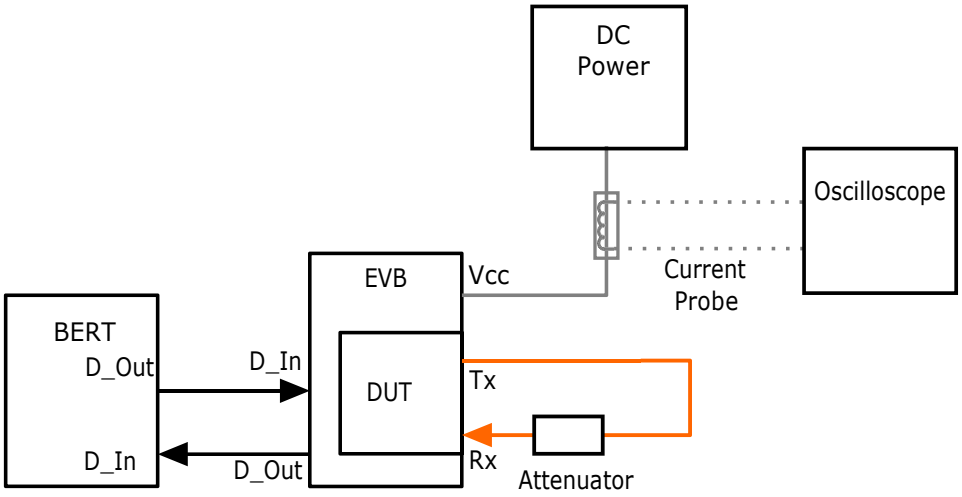


7.13 TP4 Far-end Eye Diagram

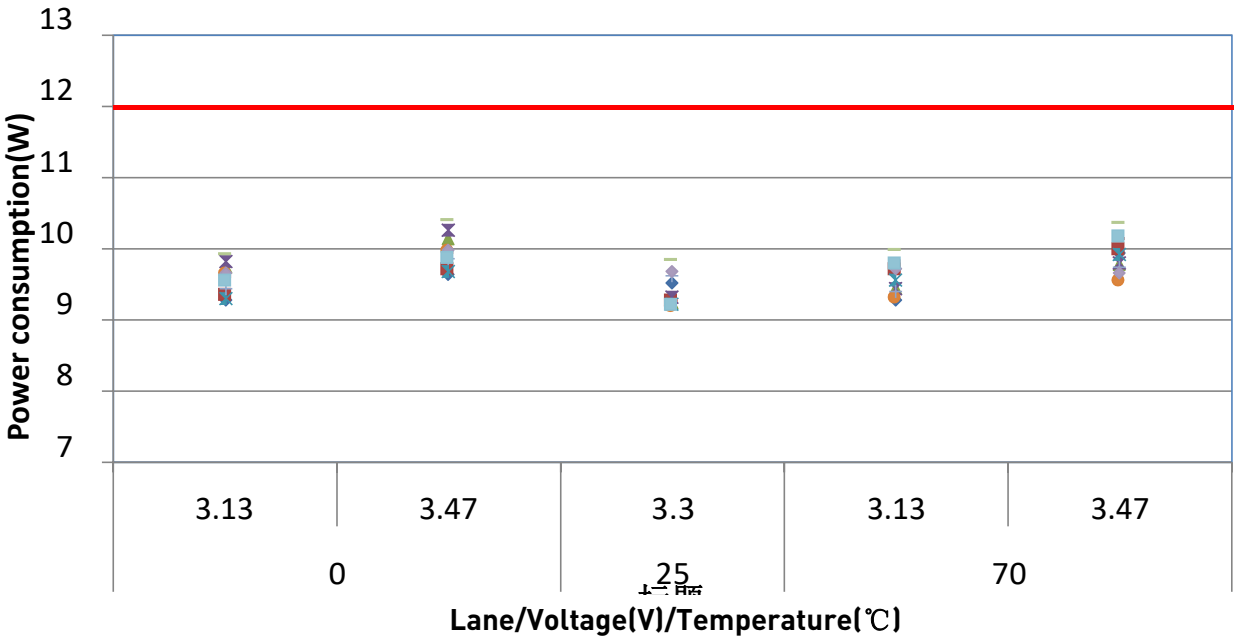


8. Power consumption Tests

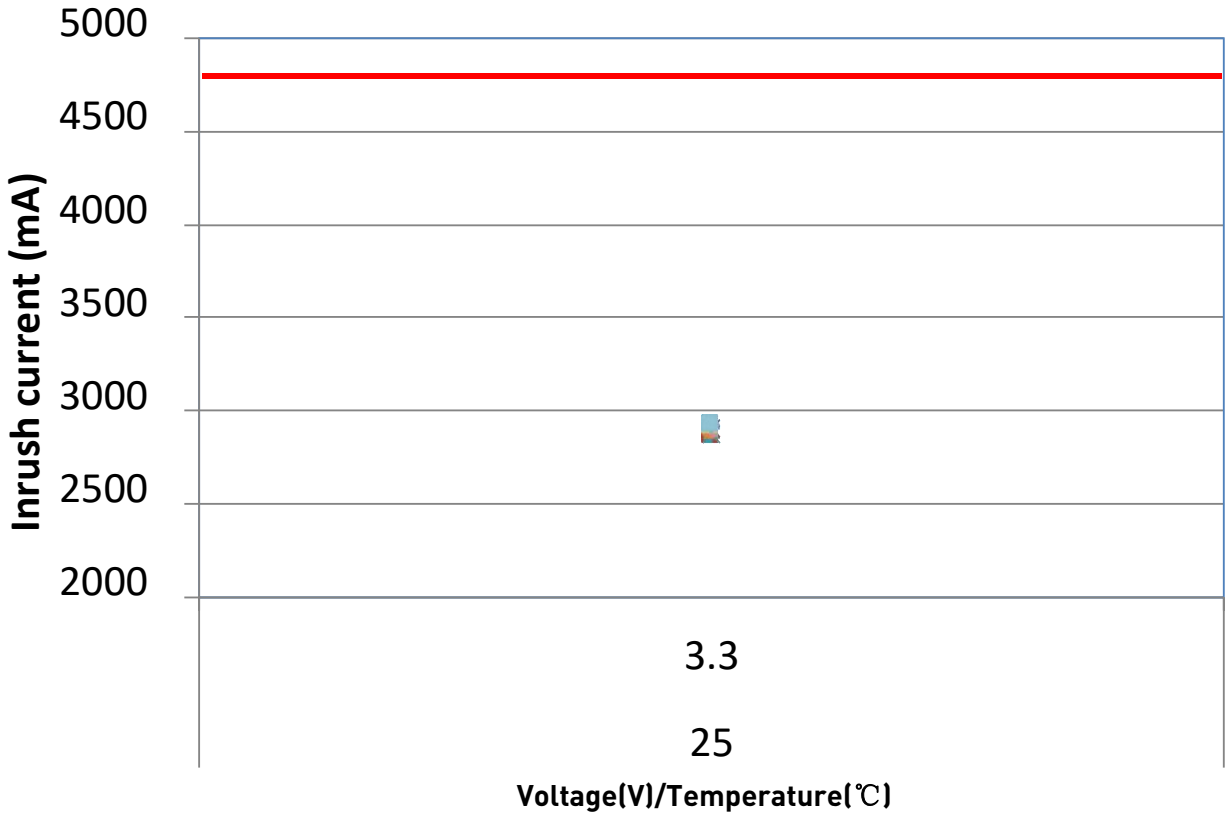
8.1 Testing Setup



8.2 Power consumption Testing Results



8.3 Inrush current P6 Testing Results



9. Jitter Tolerance(TP1a) Tests

9.1 TP1a Testing Setup

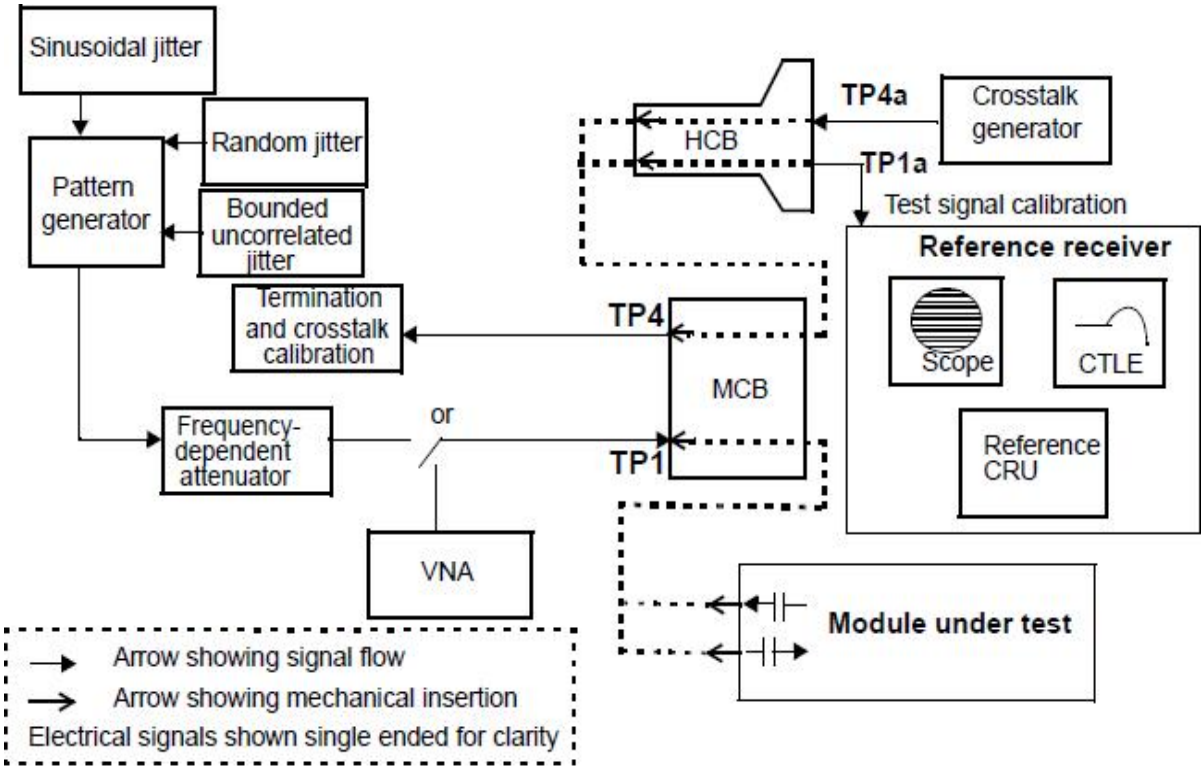


Figure 120E–12—Example module stressed input test

9.2 TP1a@high_loss Testing Results

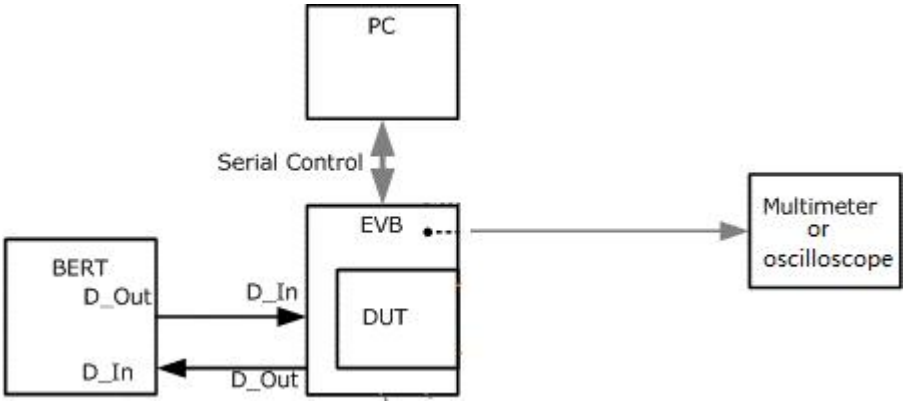
No.	Jitter Freq. [Hz]	Mask[UI]	Upper Limit[UI]	Lower Limit[UI]	Meas. [UI]	Meas.Judge	FL
1	40,000,000	0.050	0.500	0.050	0.202	PASS	---
2	20,000,000	0.050	0.500	0.050	0.170	PASS	---
3	12,000,000	0.050	0.700	0.050	0.172	PASS	---
4	4,000,000	0.050	2.000	0.050	0.234	PASS	---
5	1,333,000	0.150	5.000	0.150	0.610	PASS	---
6	40,000	5.000	100.000	5.000	59.102	PASS	---

9.3 TP1a@low_loss Testing Results

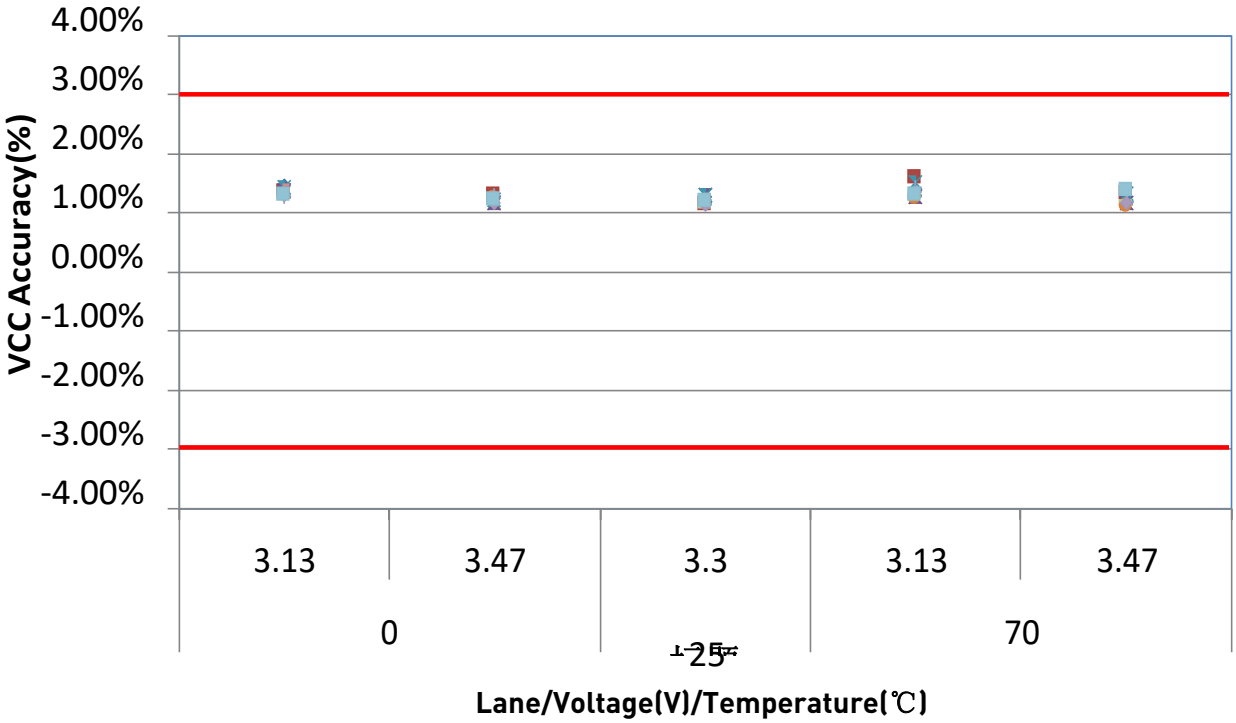
No.	Jitter Freq. [Hz]	Mask[UI]	Upper Limit[UI]	Lower Limit[UI]	Meas. [UI]	Meas.Judge	FL
1	40,000,000	0.050	0.500	0.050	0.134	PASS	---
2	20,000,000	0.050	0.500	0.050	0.134	PASS	---
3	12,000,000	0.050	0.700	0.050	0.172	PASS	---
4	4,000,000	0.050	2.000	0.050	0.234	PASS	---
5	1,333,000	0.150	5.000	0.150	0.696	PASS	---
6	40,000	5.000	100.000	5.000	66.870	PASS	---

10. Voltage Tests

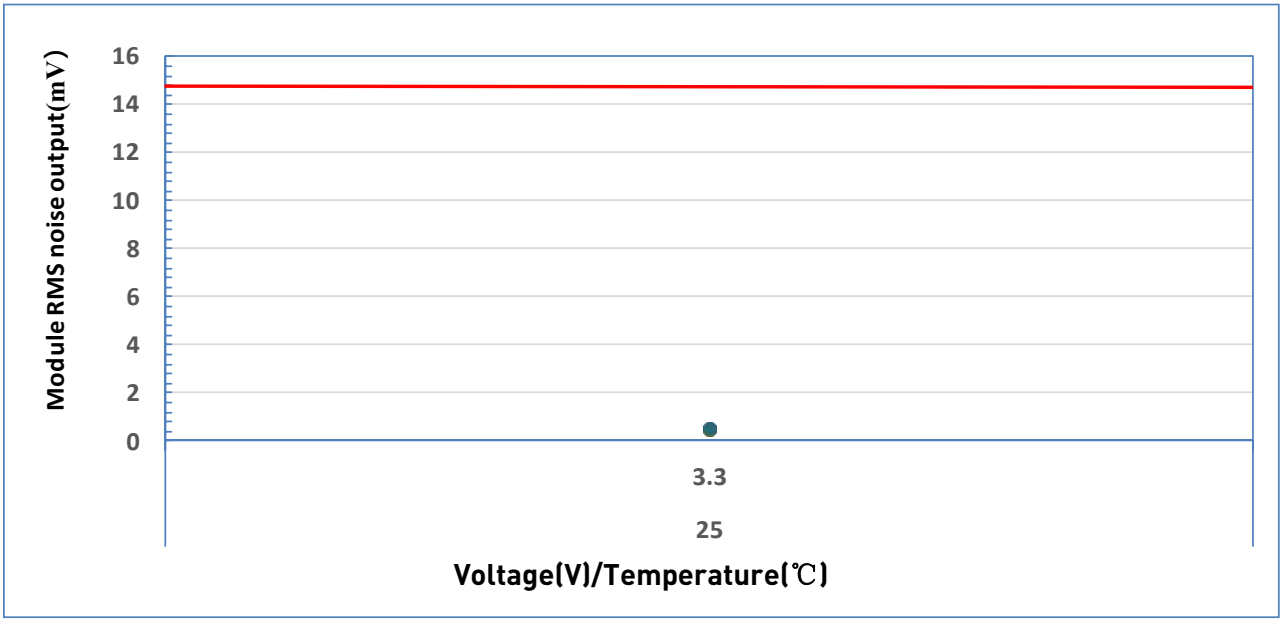
10.1 Voltage Testing Setup



10.2 VCC Accuracy Testing Results

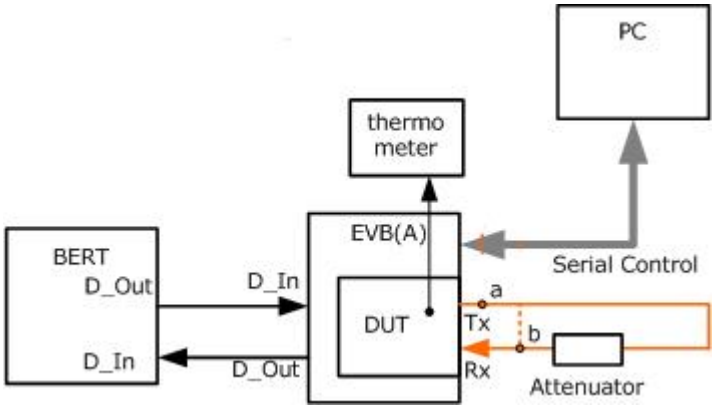


10.3 Module RMS noise output 10Hz-10MHz Testing Results

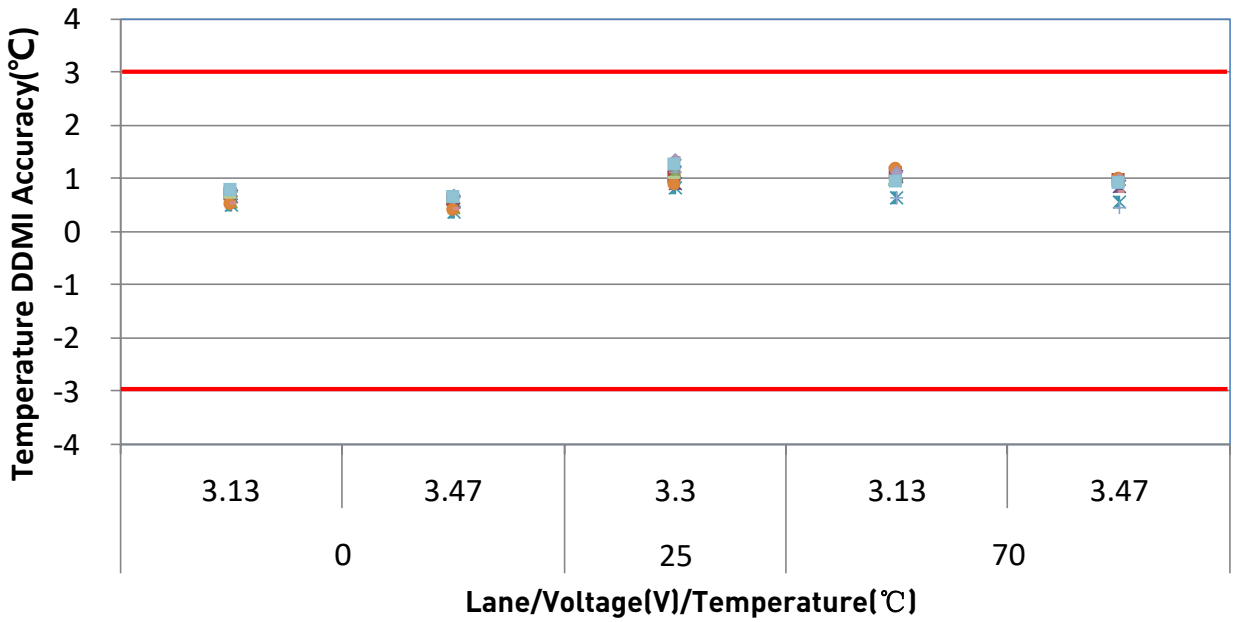


11. Temperature DDMI Accuracy Tests

11.1 Temperature DDMI Accuracy Testing Setup



11.2 Temperature DDMI Accuracy Testing Results



12. Testing Equipment

Index	Name	Type	SN	Manufactory	Test item
1	BERT	CFP-Bert	CFP-01	Photonics	100GBE Signal Generation
2	OPTICAL SPECTRUM ANALYZER	86146B	US41500122	AGILENT	WAVELENGTH, SMSR, SPECTRAL WIDTH.
3	OPM	FPM-8210	82104204	ILX LightWave	OPTICAL POWER
4	DC POWER	E3632A	MY54226666	AGILENT	CURRENT
5	Chamber	WD6005	201103015	SHANG HAI ELECTRIC	Simulation Environment
6	ATTENUATOR	OPTI-ATTEN	14020102	DAWEI COMMUNICATION	SEN,LOS_A/DA_LEVEL
7	DCA	DCA-X86100D (86116C&86107A)	MY54360434	KEYSIGHT	EYE PATTERN, CAUI-8, RIN
8	CURRENT PROBE	TCP202	B035511	TEK	INRUSH CURRENT
9	FUNCTION GENERATOR	AWG520	J320591	TEK	Power noise
10	MULTIMETER	17B	84110083	FLUKE	Voltage
11	TEMPERATUR E MONITOR	HH509R	12000446	OMEGA	Temperature monitor
12	SIGNAL GENERATOR	8648D	4108A01122	AGILENT	CLOCK
13	OPTICAL SWITCH	1x4	14S4214-3007	LIGHTWAVELINK	CHANGE CHANNEL

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