

QDD-400G-FR4 Design Verification Testing Report

Reviewers

Department	Name	Review Date
Technical Testing Department	YangQin	2022-6-2

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1. Purpose

This document summarizes the results of the Design Verification Test (DVT) of the Photonics 400GBASE-FR4 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-FR-CDFB	SPQ-4E-FR-CDFB-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) ^{2,13}		3.4	1.2 ~ 2.66	11/11
4.2	Average launch power, per lane (dBm) ²	-3.2	4.4	0.22 ~ 2.92	11/11
4.3	Outer Optical Modulation Amplitude (OMA _{outer}), per lane (dBm) for TDECQ < -1.4dB; for 1.4dB < TDECQ < 3.4dB	-0.2; -1.6 +TDECQ	3.7	0.65 ~ 3.26	11/11
4.4	Difference in launch power between two lanes (OMA _{outer}) (dB)		4	0.26 ~ 1.79	11/11
4.5	Extinction ratio (dB) ²	3.5		4.8 ~ 6.0	11/11
4.6	Lane 1 Wavelength ² (nm)	1264.5	1277.5	1273.3~ 1274.4	11/11
4.6	Lane 2 Wavelength ² (nm)	1284.5	1297.5	1291.9~1294.4	11/11
4.6	Lane 3 Wavelength ² (nm)	1304.5	1317.5	1311.9~1314.7	11/11
4.6	Lane 4 Wavelength ² (nm)	1324.5	1337.5	1331.1~1332.3	11/11
4.7	Side mode suppression ratio (dB)	30		45.9 ~ 54.1	11/11
4.8	Bias Current (mA) ⁶			57.5~86.2	11/11
4.9	Tx DDMI Accuracy (dB)	-3	3	-1.19 ~ 0.88	11/11
4.10	RIN _{15.6 OMA} ^{2, 9} (dB)		-136	-142.6 ~ -136.3	11/11
4.11	Spectral Width[20dB](nm)		0.4	0.23~0.35	11/11
4.12	Total average launch power(dBm)		10.4	7.0~8.2	11/11
4.13	TECQ(dB)		3.4	0.92~2.91	11/11
4.14	TDECQ - TECQ (dB)		2.5	0~0.4	11/11
4.15	Over/under-shoot(%) (max)		22	6.45~17.76	11/11
4.16	Transmitter power excursion(dBm)		1.8	-1.47~1.18	11/11
4.17	Transmitter transition time(ps)		17	10~12	11/11
	Average launch power of OFF(dBm)		-16	<-16	11/11
5.2	Rx Sensitivity (OMA _{outer}), per lane (dBm) ³		-4.6	-12.3 ~ -7.9	11/11
5.3	Difference in receive power between any two lanes (OMA _{outer}) (dB)		4.3	0.1 ~ 1.9	11/11
5.4	LOS Assert (dBm) ⁵	-15		-14.0 ~ -10.6	11/11
5.5	LOS De-assert (dBm) ⁵		-8.4	-13.1 ~ -9.5	11/11
5.6	LOS Hysteresis (dB)	0.5		0.9 ~ 1.6	11/11
5.9	Rx DDMI Accuracy(dB)	-3	+3	-1.73~0.71	11/11
	Stressed receiver sensitivity (OMA _{outer}) ¹⁵ (dBm)		-2.6	-8.9~-7.2	Note15
6.2	Tx Return Loss (dB)		-26	-48.2 ~ -34	11/11

Section	Parameter ¹	Min	Max	Measured Range	Pass/Total
6.3	Rx Return Loss (dB)		-26	-50.1 ~ -34.6	11/11
7	400GAUI-8 Tests ¹⁶				note 16
7.2	Signaling rate per lane ⁴ (ppm)		26.5625 ± 100	26.5625	11/11
7.3	Near-end Eye Height ⁴ (mV)	70		74.8 ~ 128.2	11/11
7.4	Near-end ESMW ⁴ (UI)	0.265		0.287 ~ 0.409	11/11
7.5	Far-end Eye Height ⁴ (mV)	30		40.5 ~ 65.6	11/11
7.6	Far-end ESMW ⁴ (UI)	0.2		0.249 ~ 0.343	11/11
7.7	Differential Output Voltage Test ⁴ (mV)		900	620 ~ 806	11/11
7.8	AC Common Mode Output Voltage Test ⁴ (mV)		17.5	2.78~ 16.29	11/11
7.9	DC Common Mode Output Voltage Test ⁴ (mV)	-350	2850	-32.2 ~ -3.2	11/11
7.10	Rise time ⁷ (ps)	9.5		19.3 ~ 26.7	11/11
7.11	Fall time ⁷ (ps)	9.5		18.4 ~ 26.8	11/11
7.12	TP4 Near-end Eye Diagram ⁸				note 8
7.13	TP4 Far-end Eye Diagram ⁸				note 8
7.14	Far-end pre-cursor ISI ratio ¹⁰ (%)	-4.5	2.5	-0.8 ~ 2.1	11/11
8.2	Power consumption (W)		10	7.35 ~ 8.78	11/11
9.2	VCC DDMI Accuracy(%)	-3	3	1.09~1.6	11/11
9.3	Module RMS noise output 10 Hz - 10 MHz(mV) ^{11,12}		15	0.46~0.51	11/11
10.2	TEMP DDMI Accuracy(°C)	-3	+3	0.37~1.38	11/11
11.2	Jitter Tolerance(TP1a) ¹⁴			Pass	Note14

Note:

The optical power is launched into 9/125µm SMF.

Test patterns

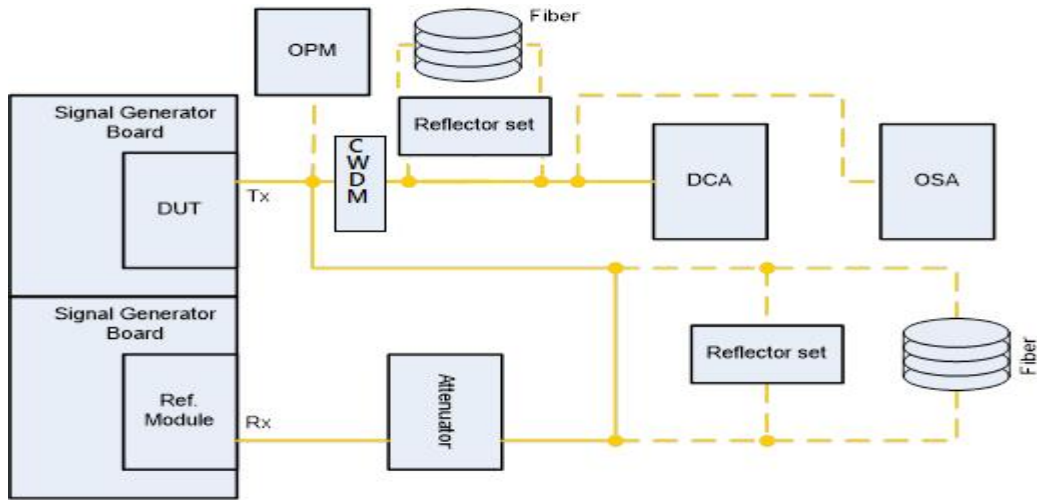
Pattern	Pattern description
Square wave	Square wave (8 threes, 8 zeros)
3	PRBS31Q
4	PRBS13Q
5	Scrambled idle
6	SSPRQ

Test-pattern definitions and related subclauses

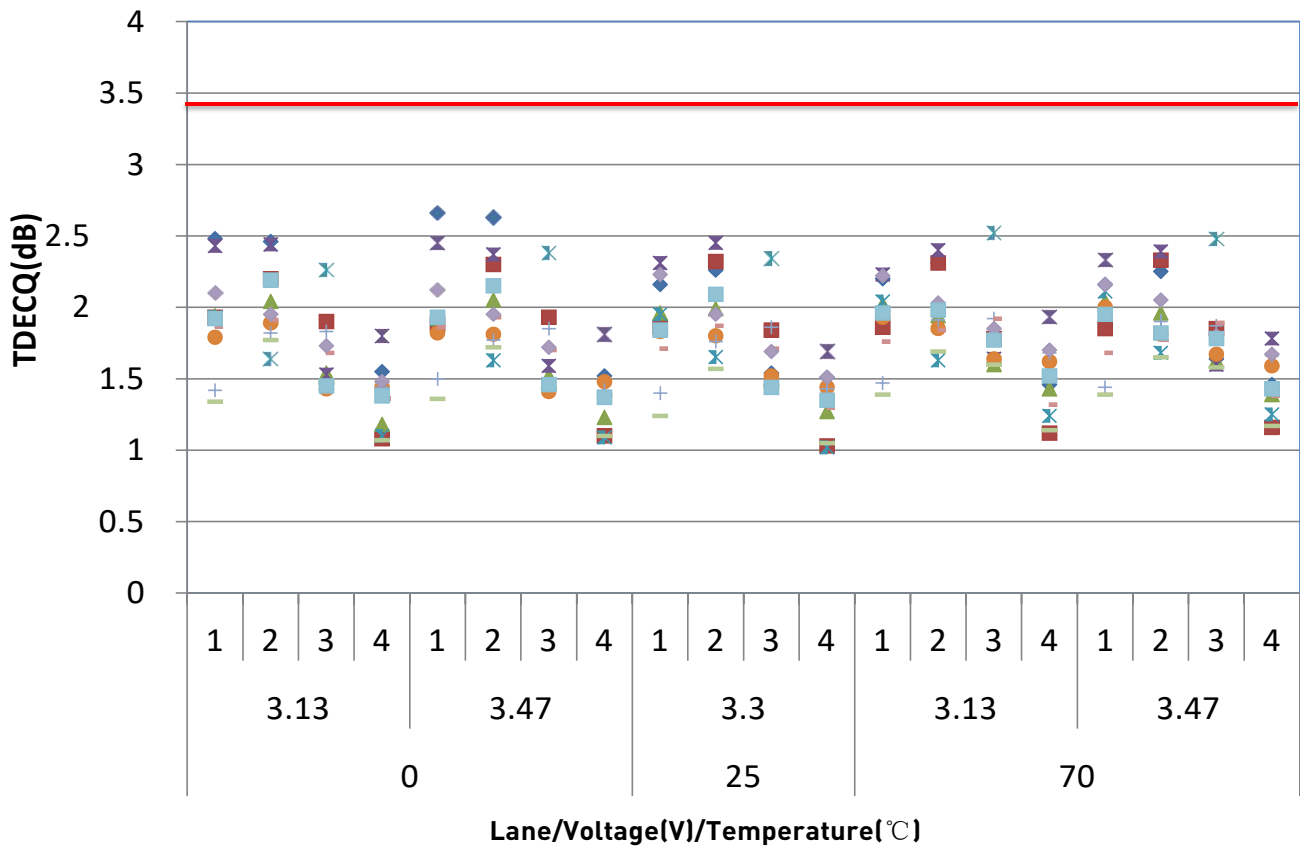
Parameter	Pattern
Wavelength	Square wave, 3, 4, 5, 6 or valid 200GBASE-R or 400GBASE-R signal
Side mode suppression ratio	3, 5, 6 or valid 200GBASE-R or 400GBASE-R signal
Average optical power	3, 5, 6 or valid 200GBASE-R or 400GBASE-R signal
Outer Optical Modulation Amplitude (OMA _{outer})	4 or 6
Transmitter and dispersion eye closure for PAM4 (TDECQ)	6
Extinction ratio	4 or 6
RIN _{15,1} OMA and RIN _{16,5} OMA	Square wave

1. Measured with a PRBS31Q test pattern @53.125Gb/s.
2. Measured with a PRBS13Q test pattern @53.125Gb/s.
3. Measured with a PRBS31Q test pattern @53.125Gb/s, BER \leftarrow $2.4e-4$ optical input power whose range is from -3.5dBm to -22.5dBm.
4. DDMI value.
5. The test pattern used is PRBS13Q, the transitions within sequences of three zeros and three threes, and three threes and three zeros, respectively, are measured @53.125Gb/s.
6. Picture excerpts from «Keysight 400GAUI-8 for one channel at normal temperature & Voltage test Report for Photonics» .
7. 9. See 802.3-2015 (68.6.7).
8. Measured by N1091BSCB.
9. Measured at room temperature and 3.3V. 12. See SFF-8431 REV4.1(D.17.2).
10. Test fiber is G.652 2km fiber.
11. Table excerpts from «400G FR4&LR4, DR4 TP1a Jitter Tolerance Result» .
12. Measured by Central Calibration and Services. For details see Report: «400G-FR4 Stressed Receiver Test Report» .
13. Rx Output Eq control setting: pre-cursor code=2, post-cursor code=1, Amplitude code=2.

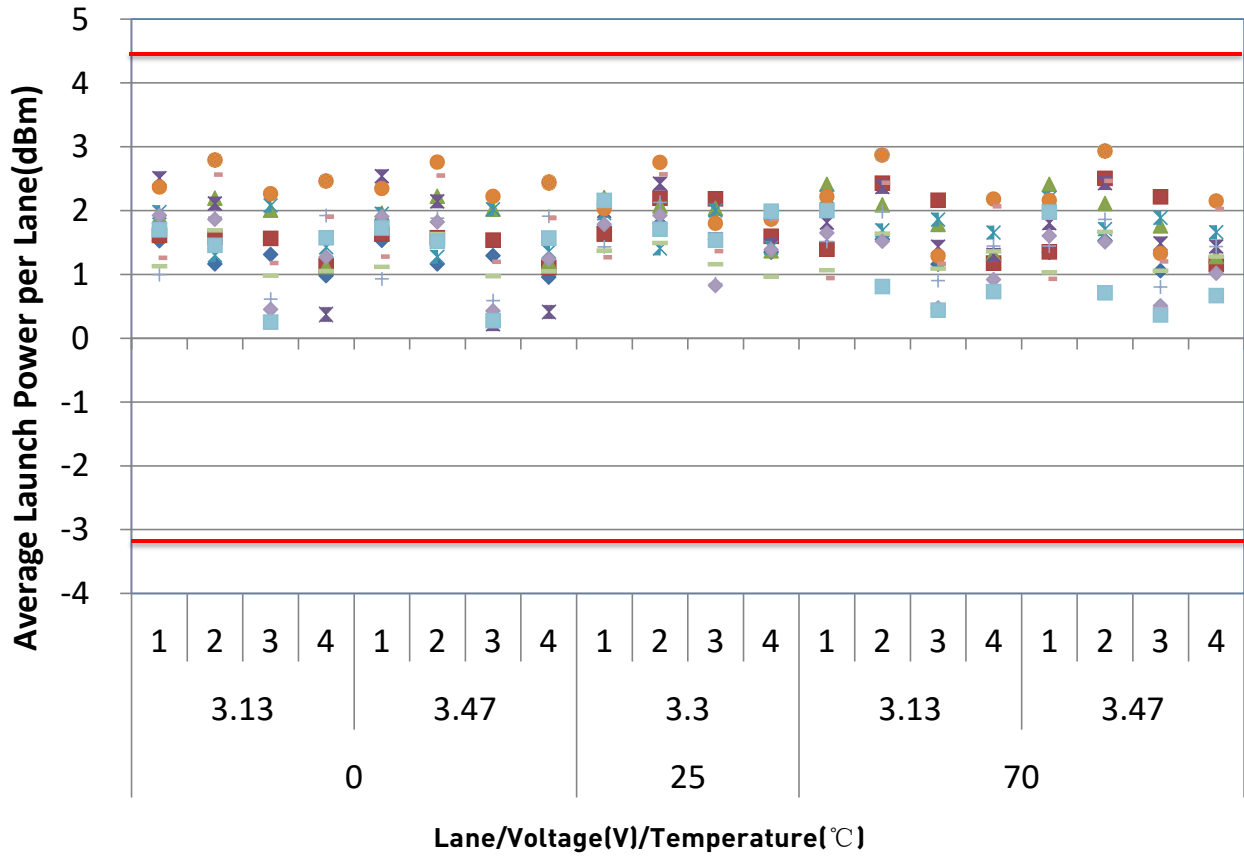
4. Transmitter Tests



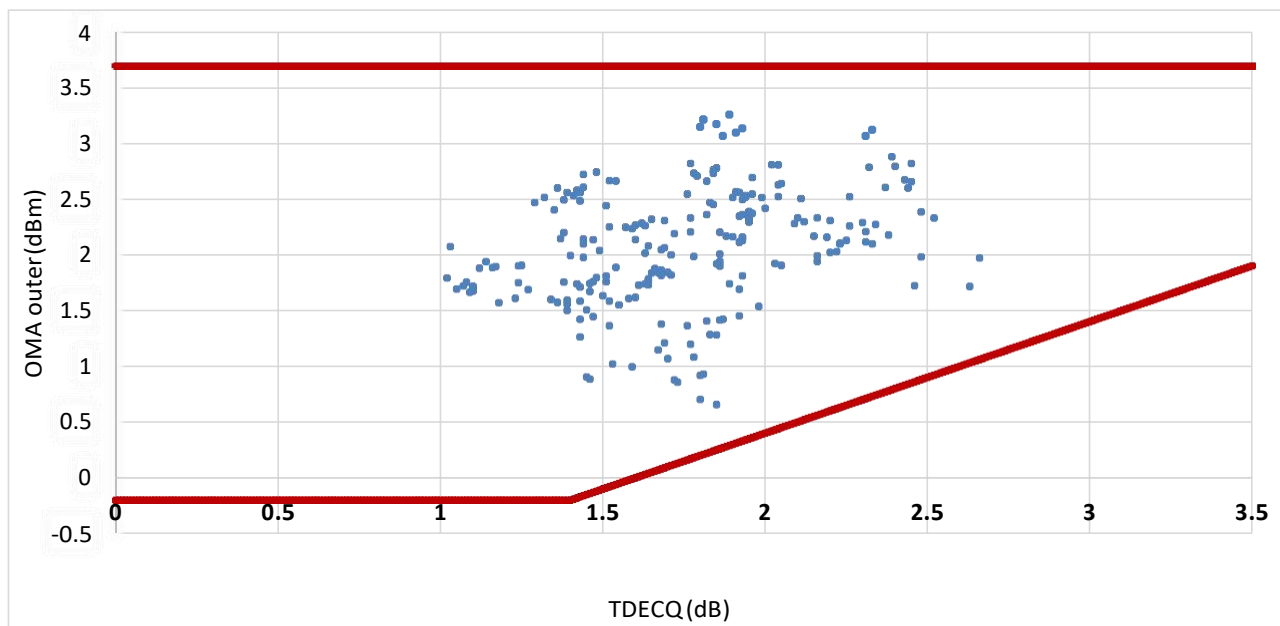
4.1 TDECQ Testing Results



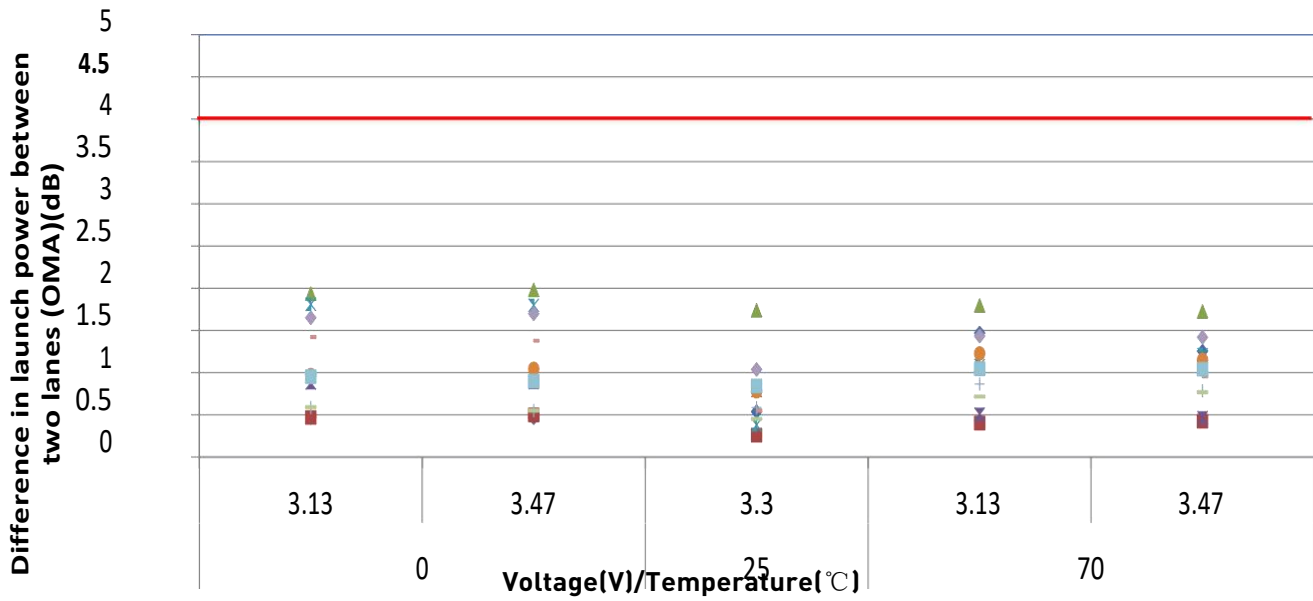
4.2 Average Launch Power per Lane Testing Results



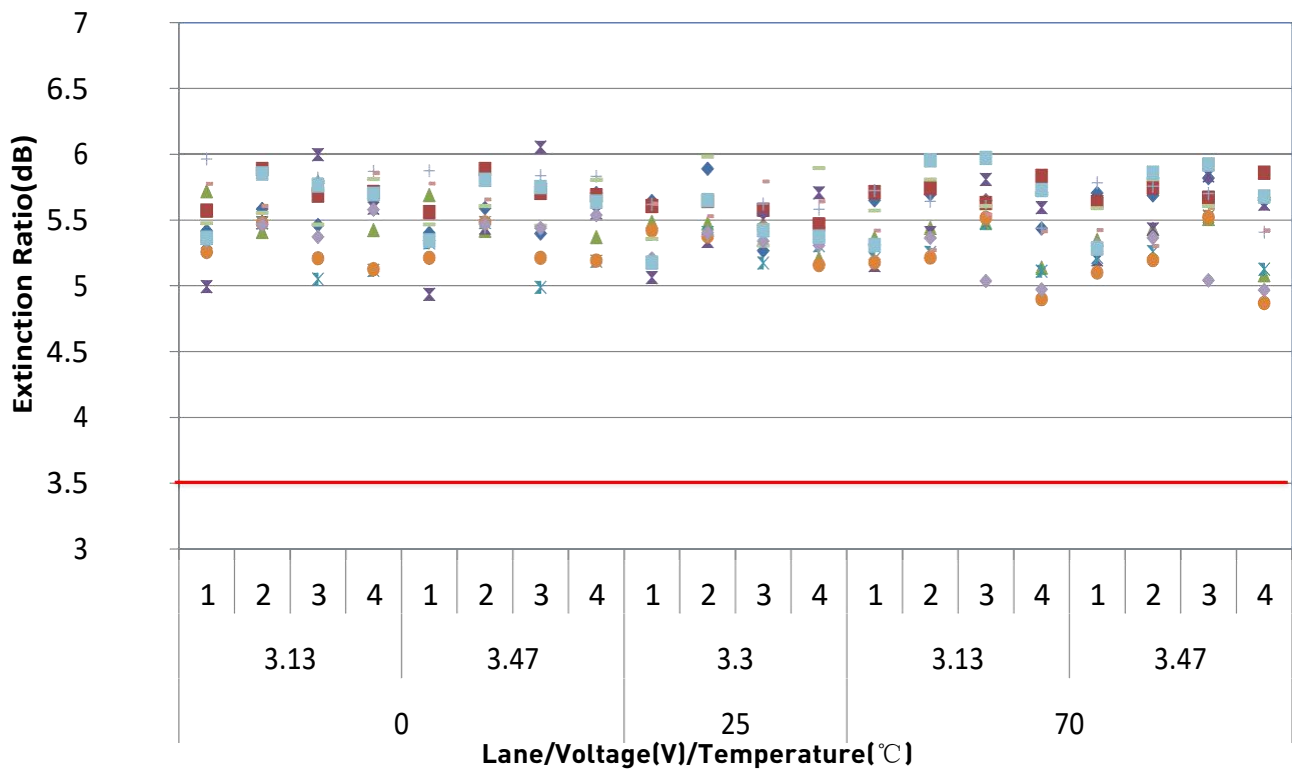
4.3 Optical Modulation Amplitude@5corner Testing Results



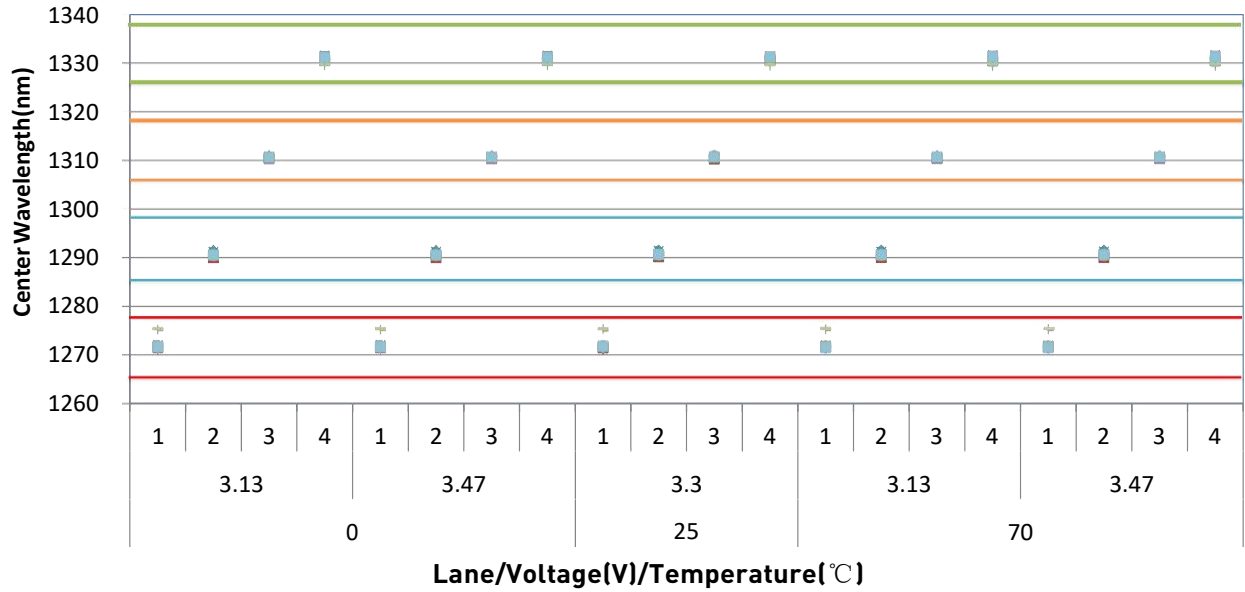
4.4 Difference in launch power between two lanes (OMA) Testing Results



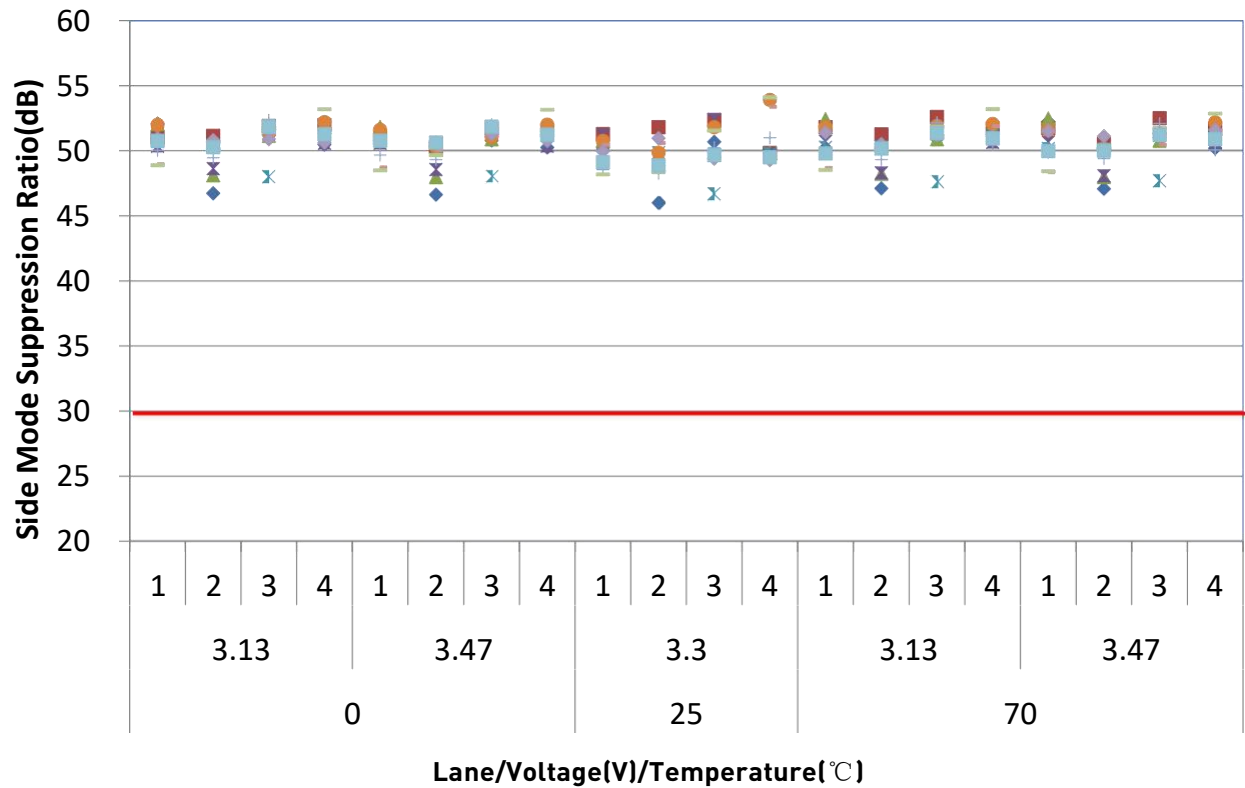
4.5 Extinction Ratio Testing Results



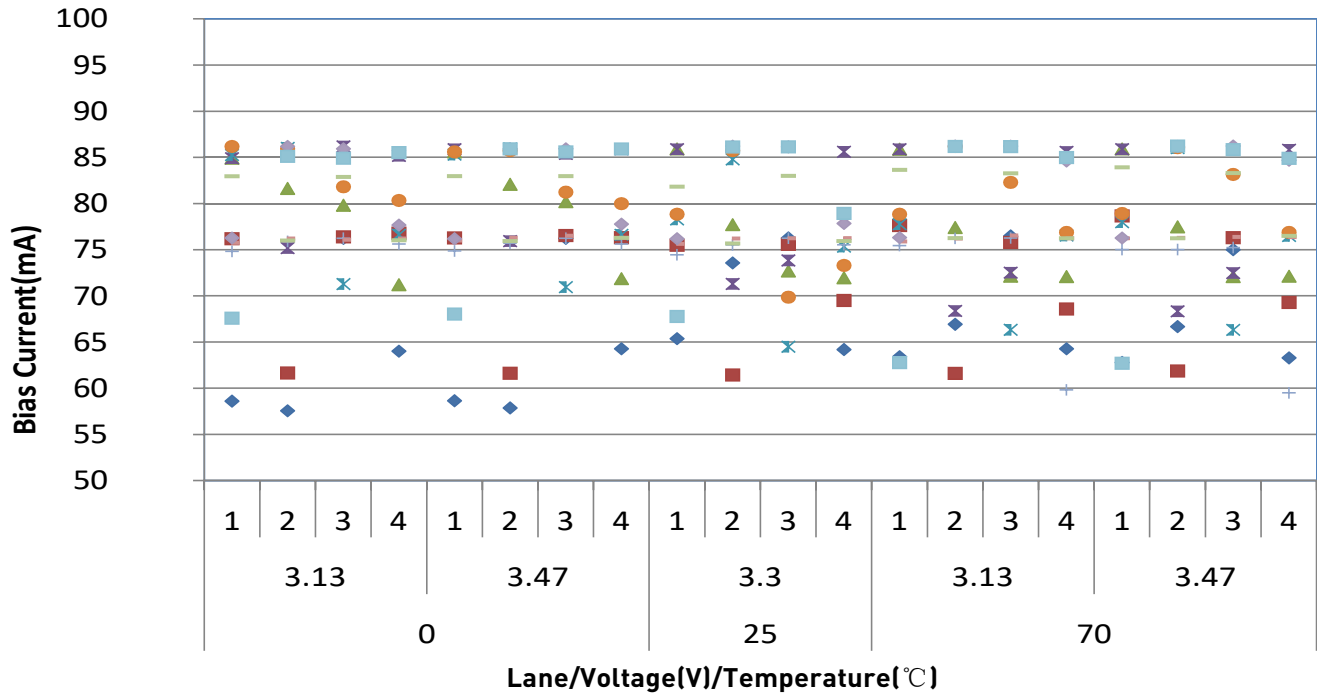
4.6 Center Wavelength Testing Results



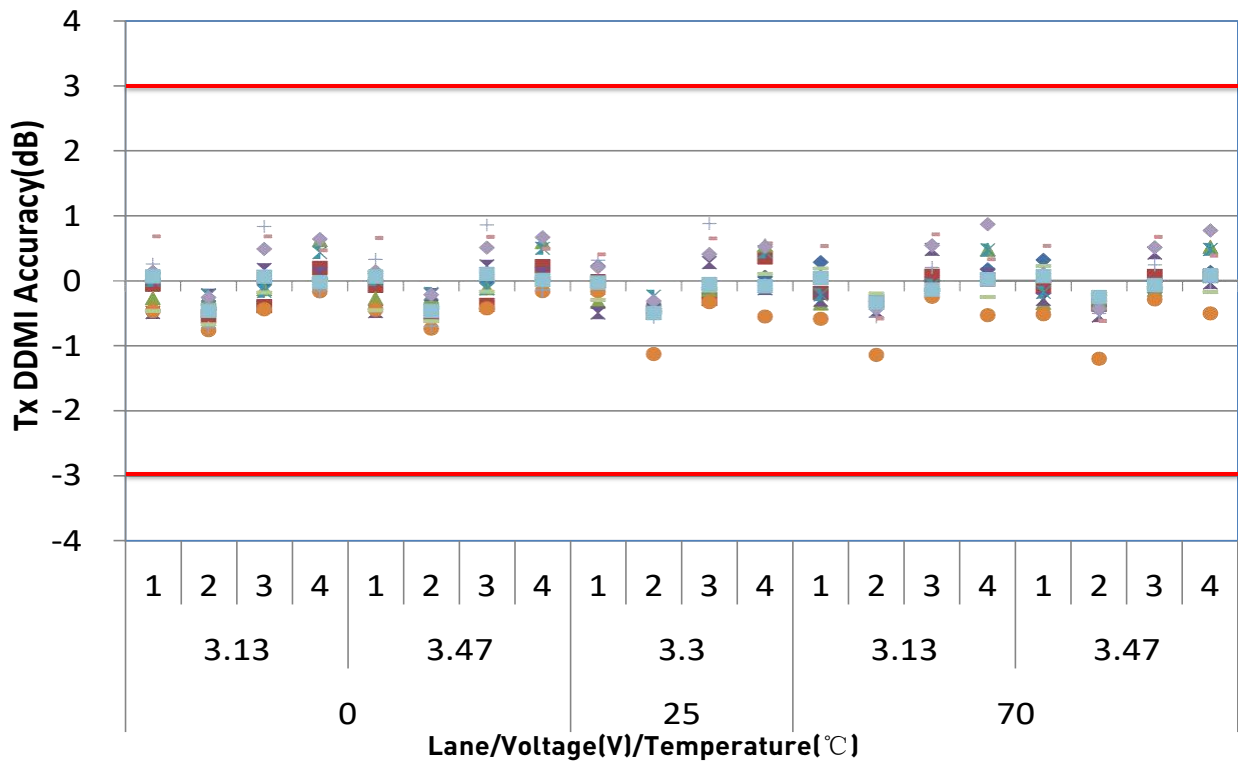
4.7 Side Mode Suppression Ratio Results



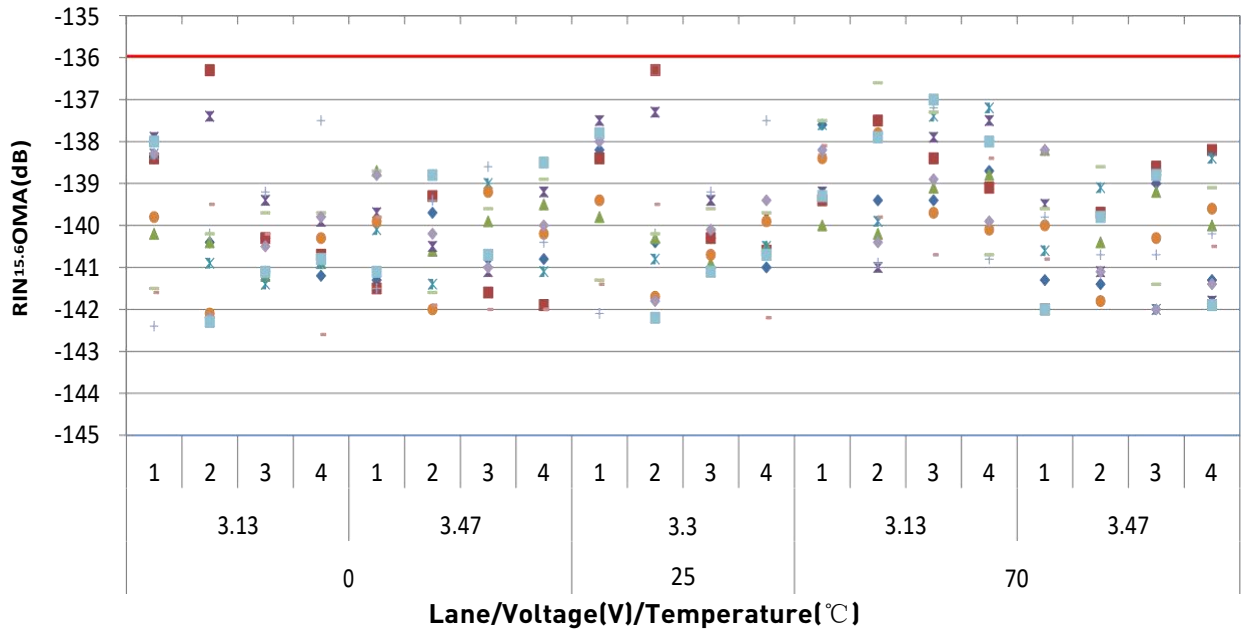
4.8 Bias Current Testing Results



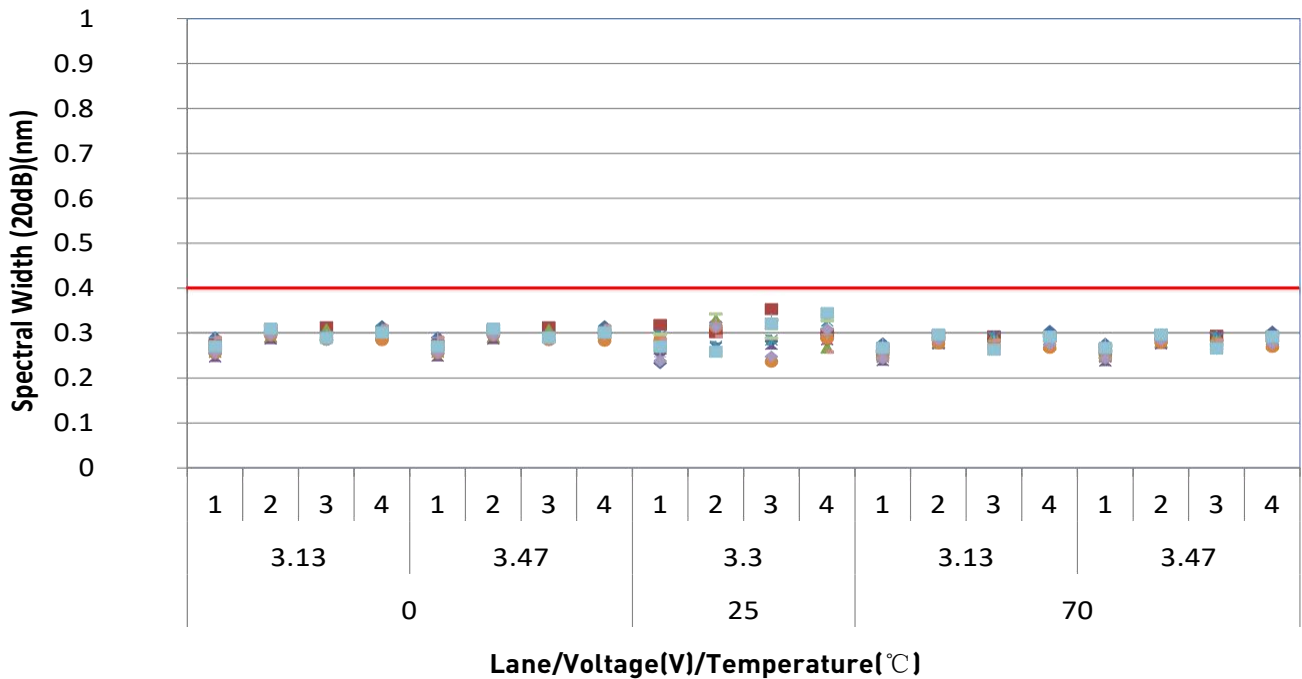
4.9 Tx DDMI Accuracy Testing Results



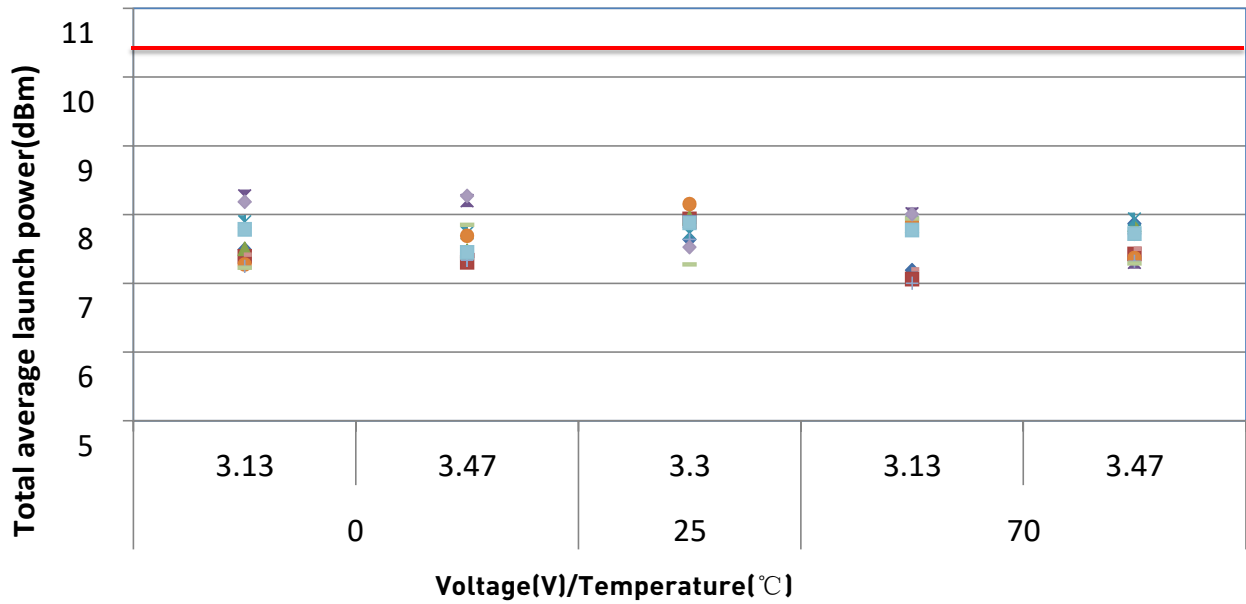
4.10 RIN15.6OMA Testing Results



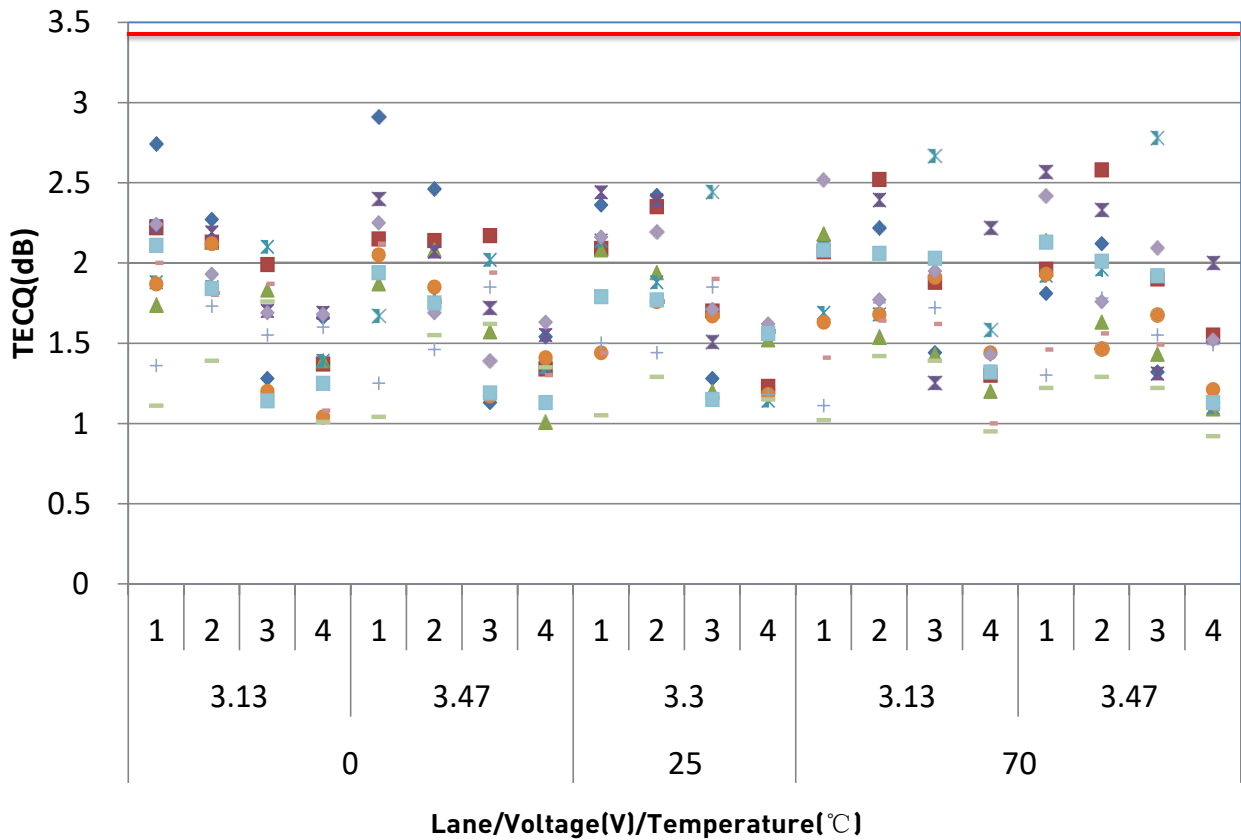
4.11 Spectral Width (20dB) Testing Results



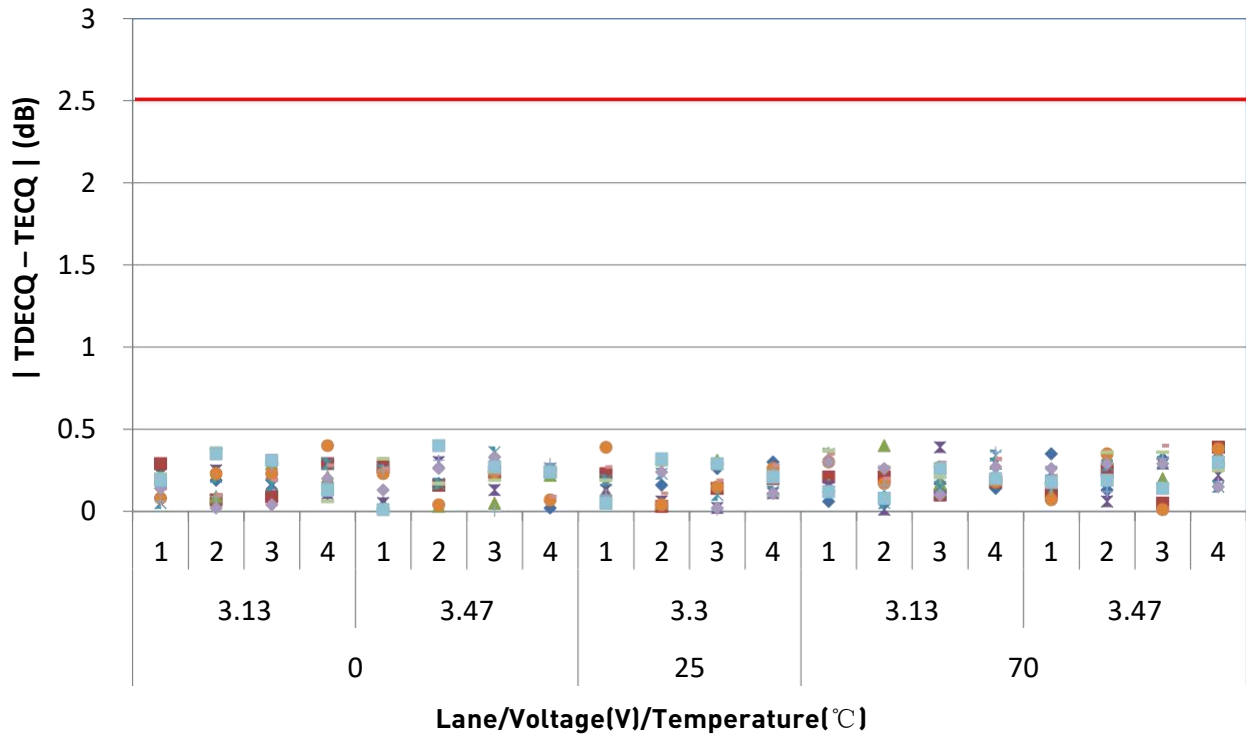
4.12 Total average launch power Testing Results



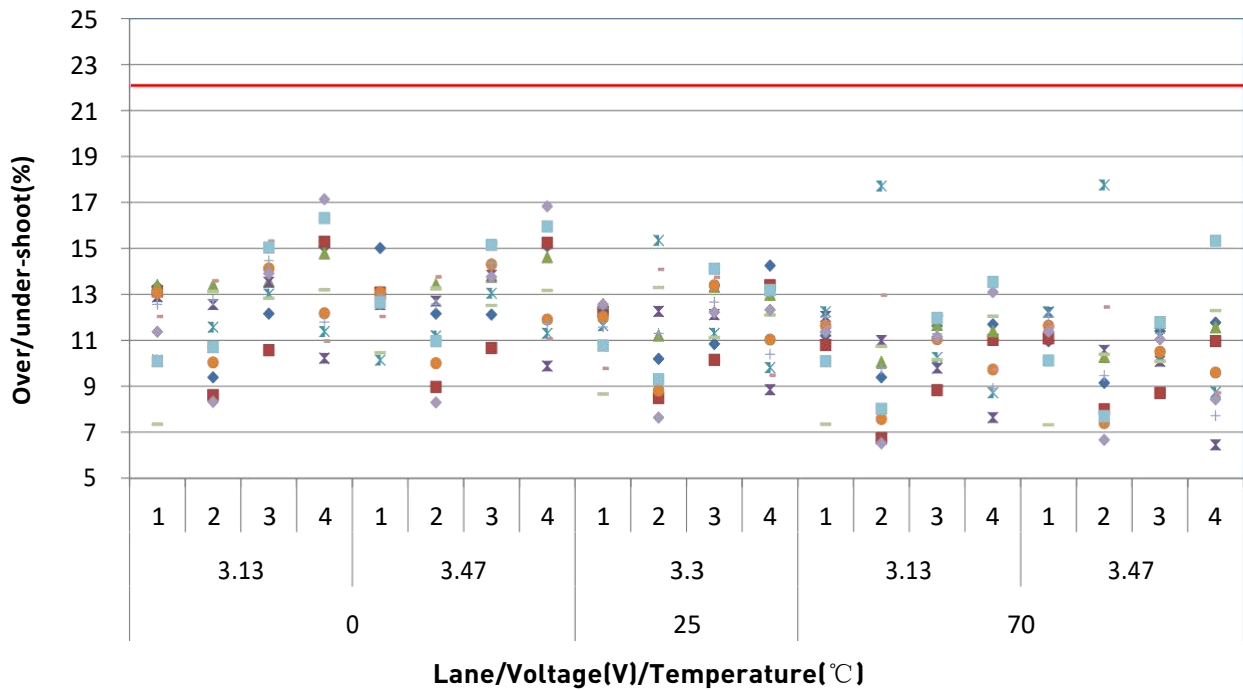
4.13 TECQ Testing Results



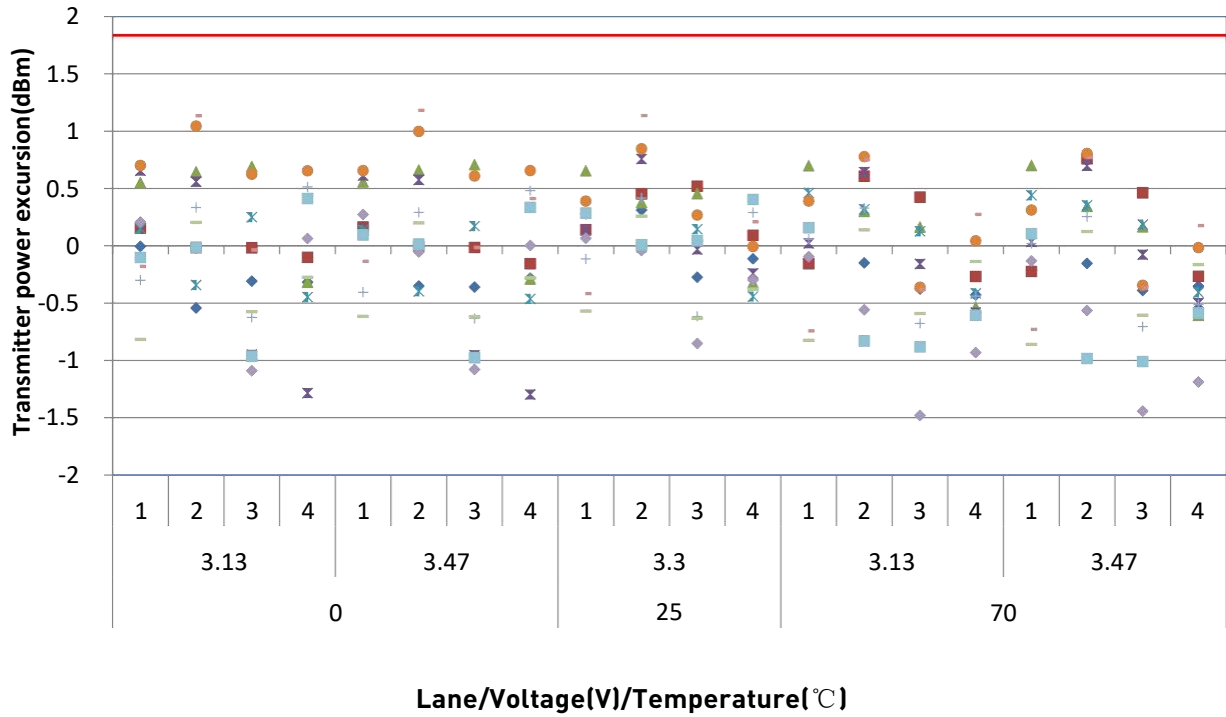
4.14 | TDECQ – TECQ | Testing Results



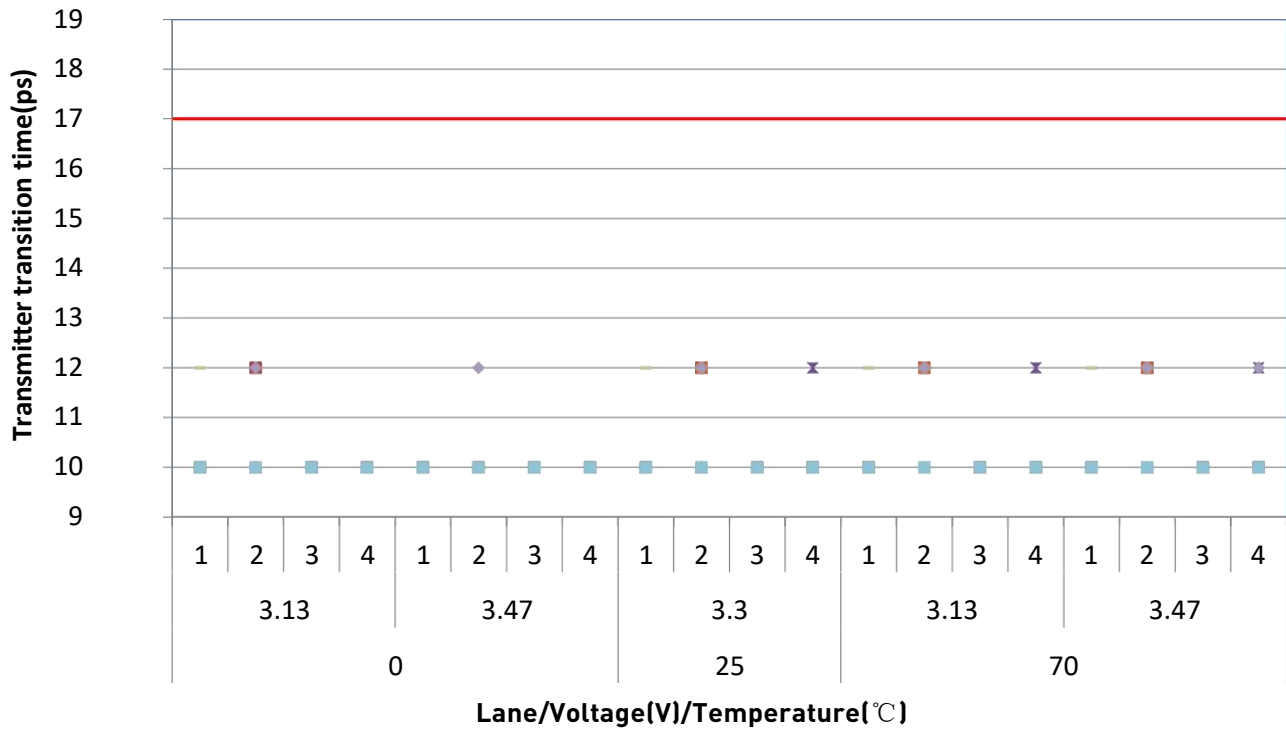
4.15 | Over/under-shoot Testing Results



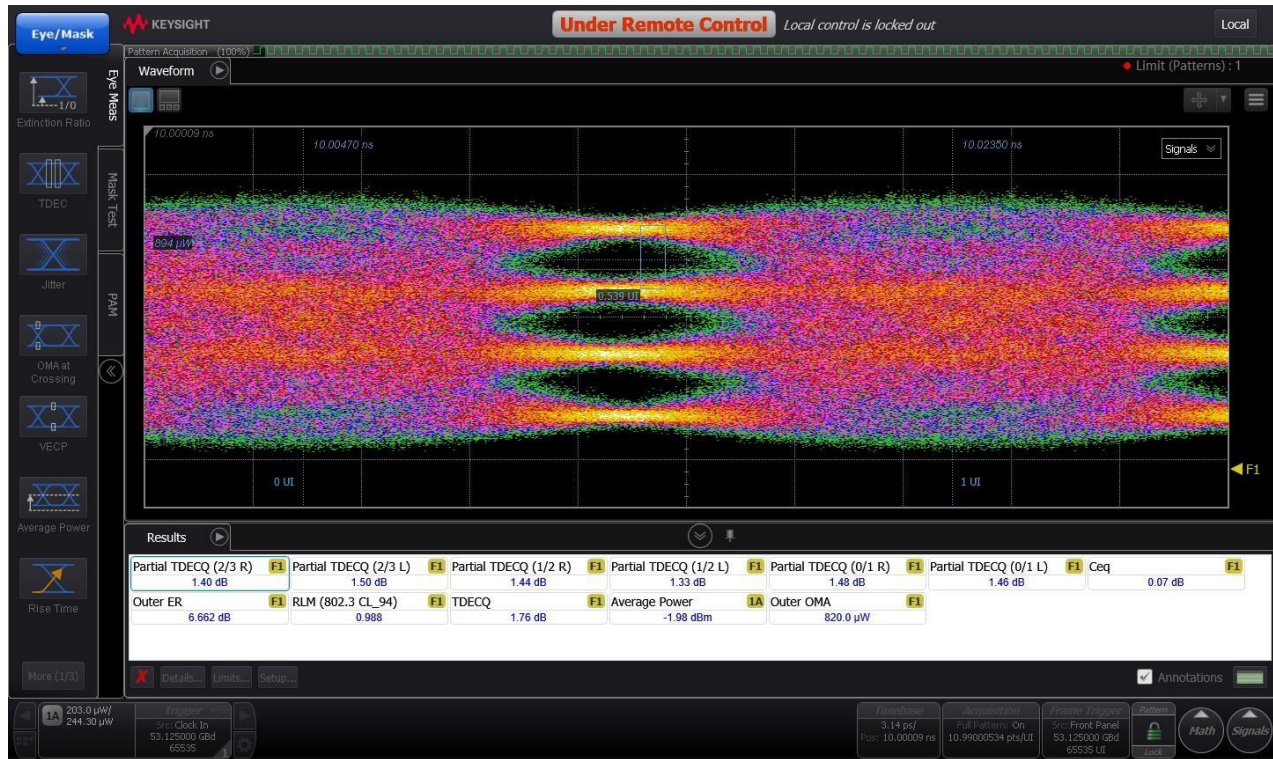
4.16 Transmitter power excursion Testing Results



4.17 Transmitter transition time Testing Results

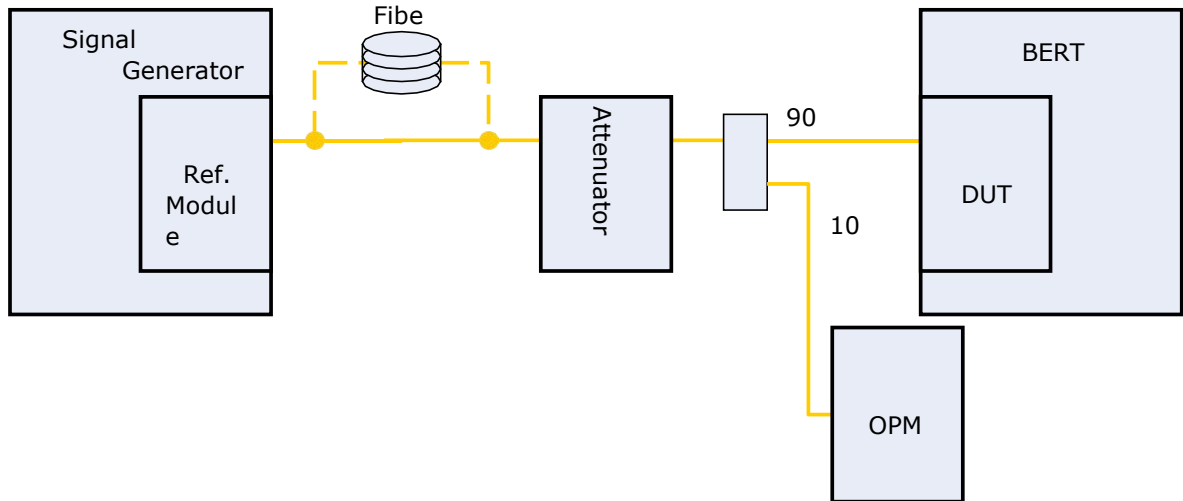


4.18 TX Eye Diagram



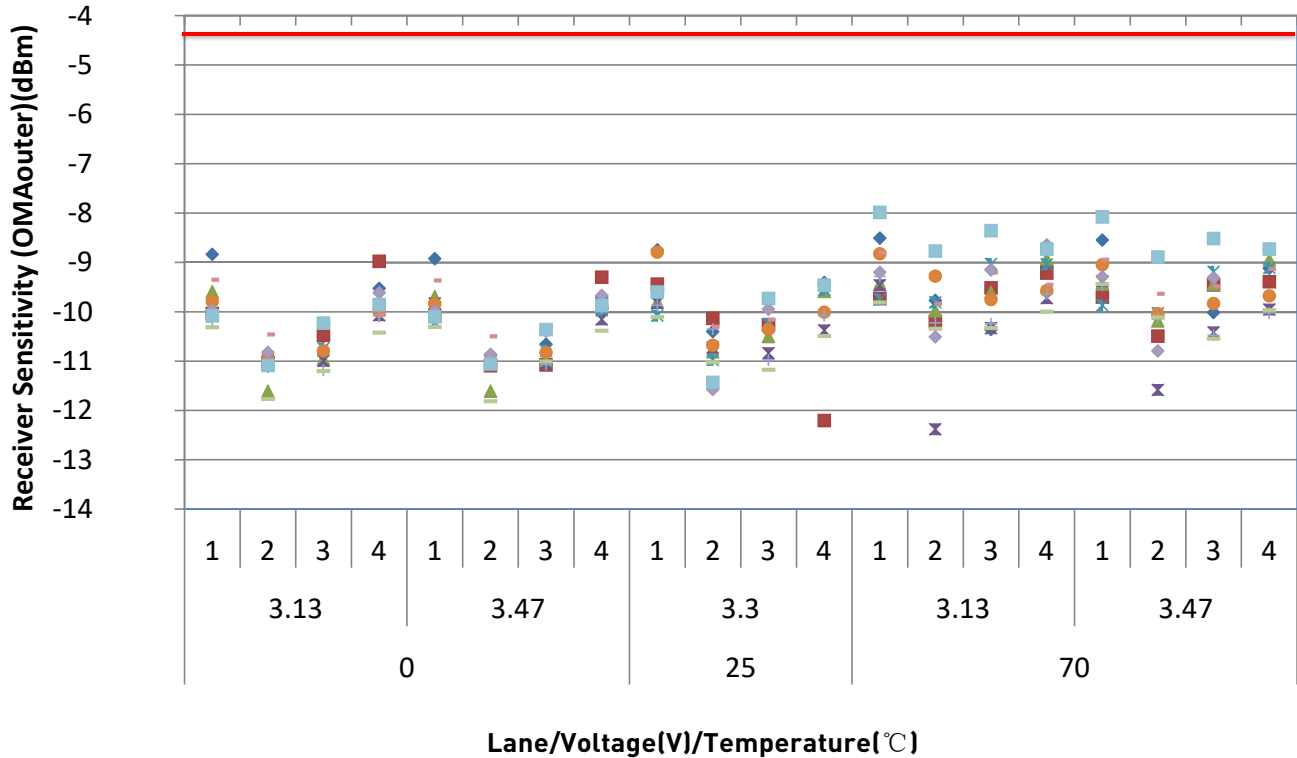
5. Receiver Tests

5.1 Testing Setup

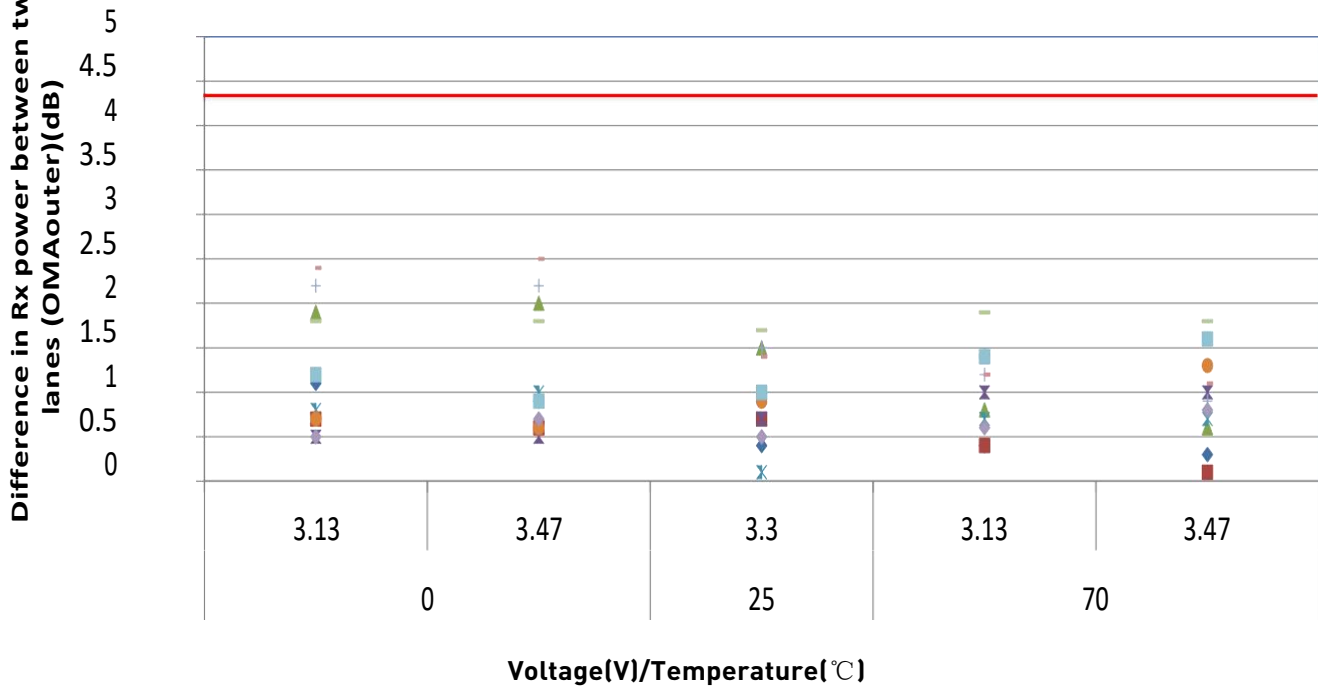


5.2 Receiver Sensitivity (OMA_{outer}) Testing Results

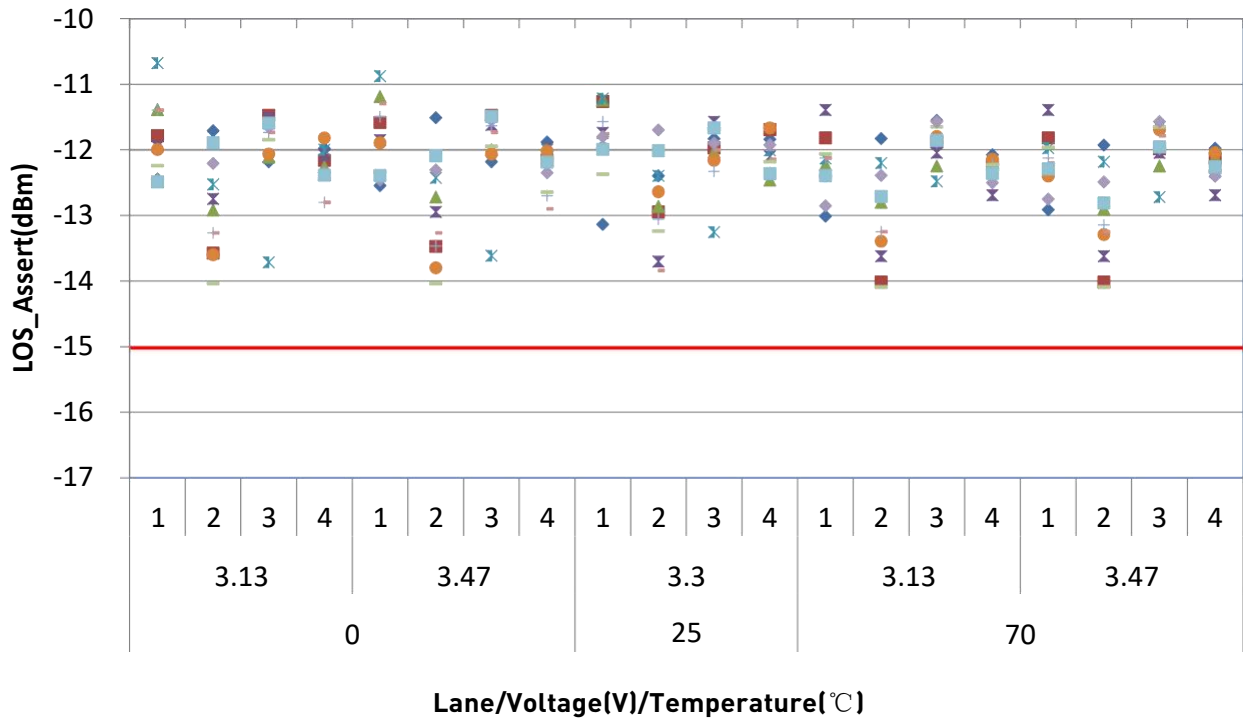
Receiver Sensitivity with power supply noise and 15.6dB optical return loss added:



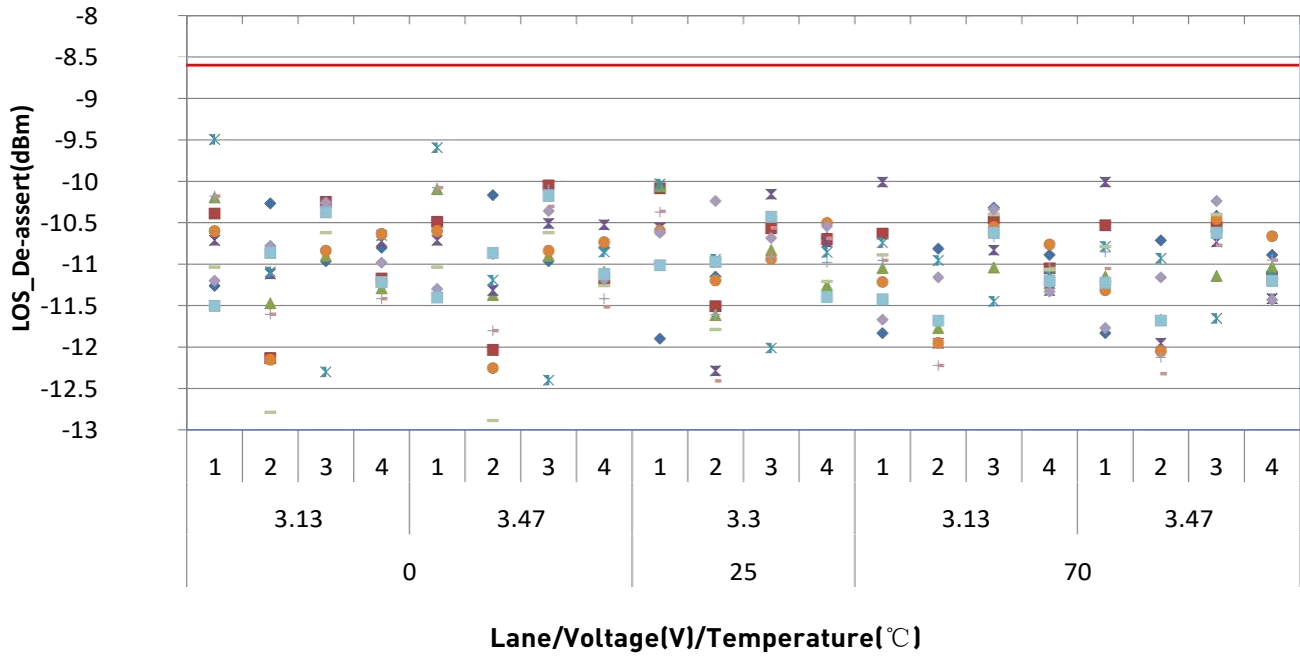
5.3 Difference in Rx power between two lanes (OMAouter) Testing Results



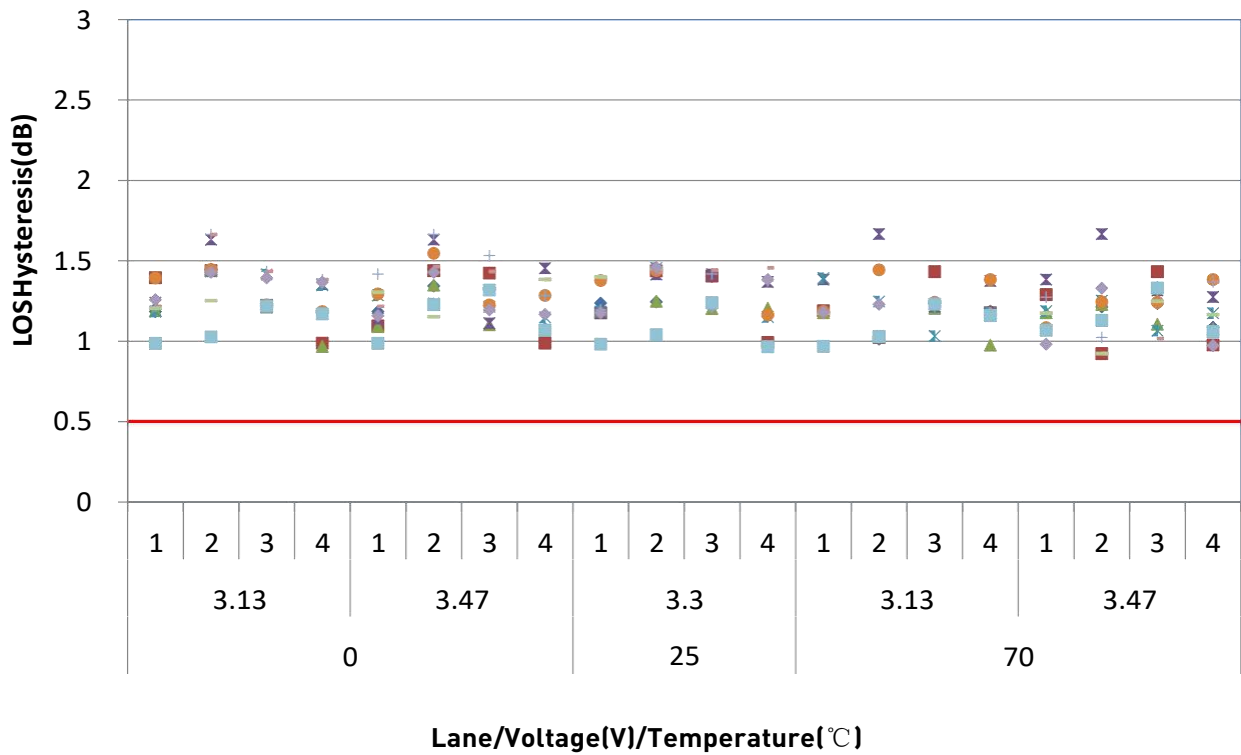
5.4 LOS_Assert Testing Results



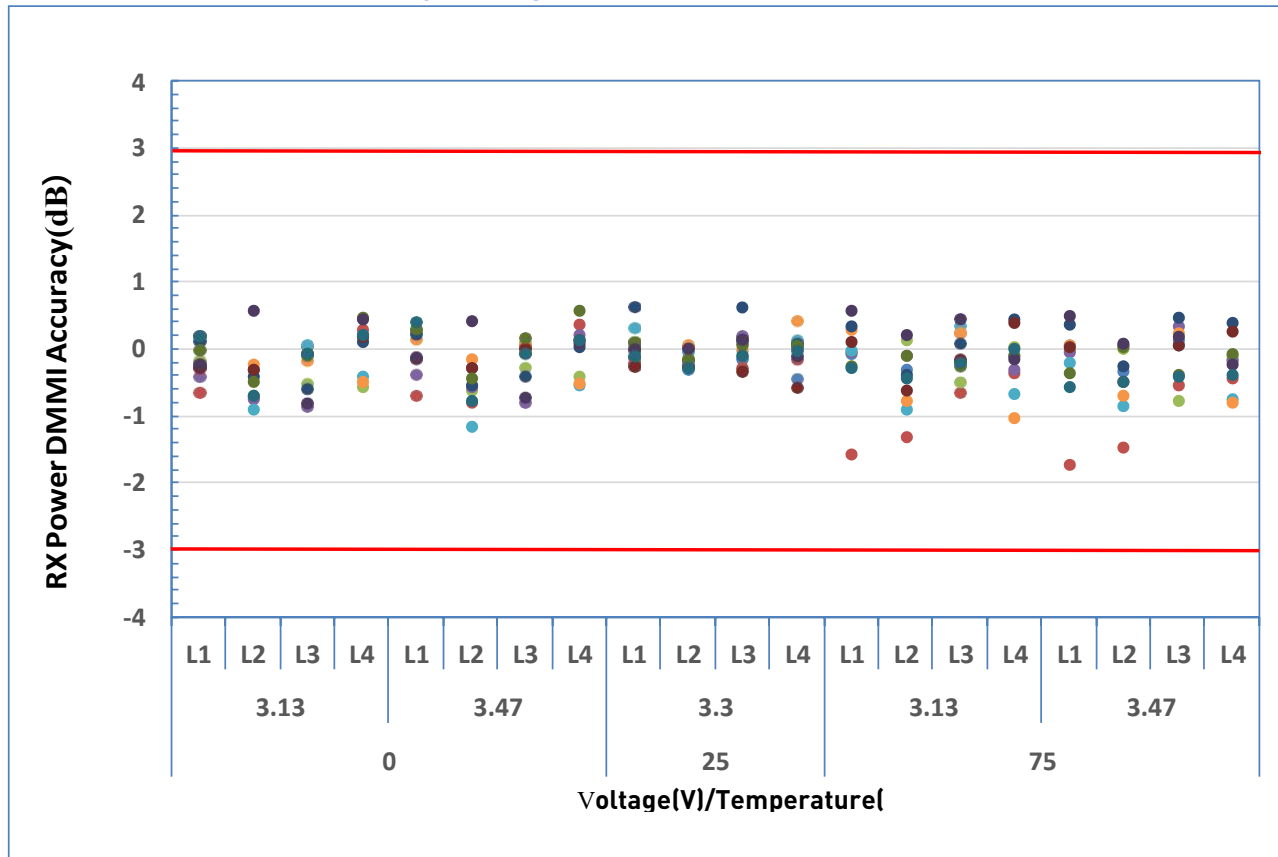
5.5 LOS_De-assert Testing Results



5.6 LOS Hysteresis Testing Results

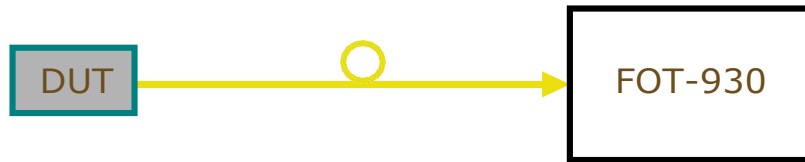


5.7 RX Power DMMI Accuracy Testing Results

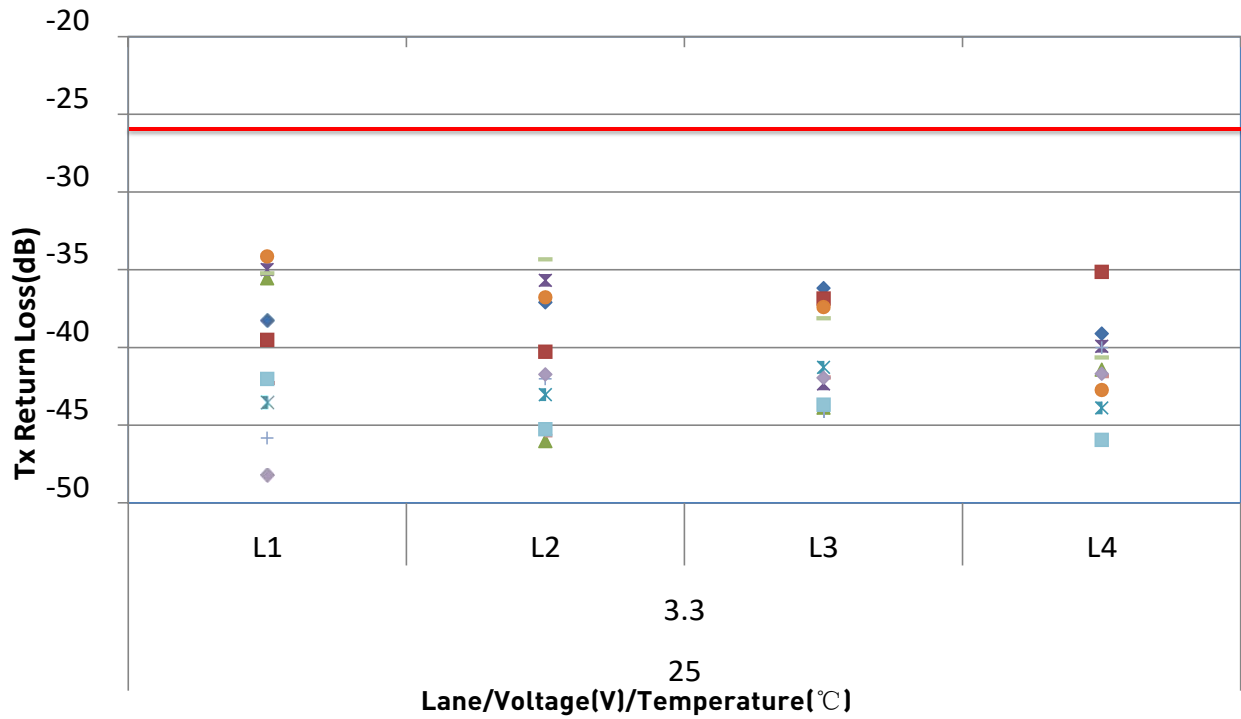


6. Return Loss Tests

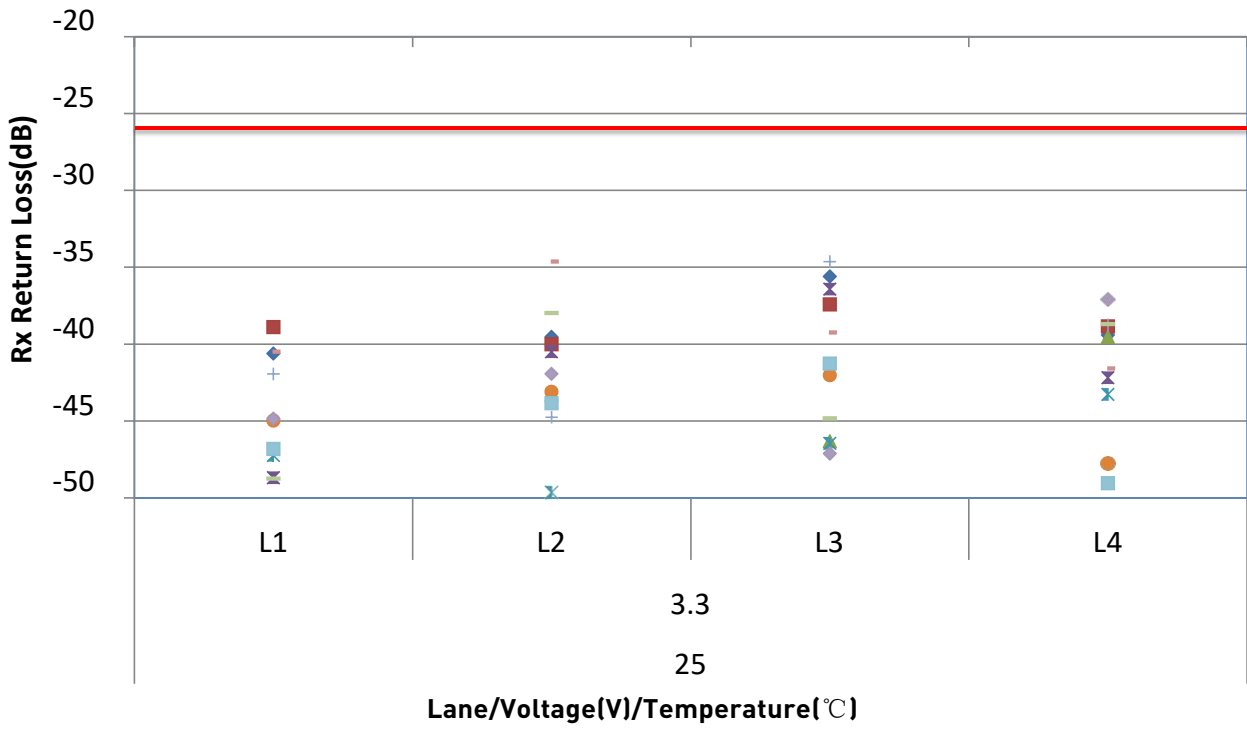
6.1 Testing Setup



6.2 Tx Return Loss Testing Results



6.3 Rx Return Loss Testing Results



7. 400GAUI-8 Tests

7.1 TP4 Testing Setup

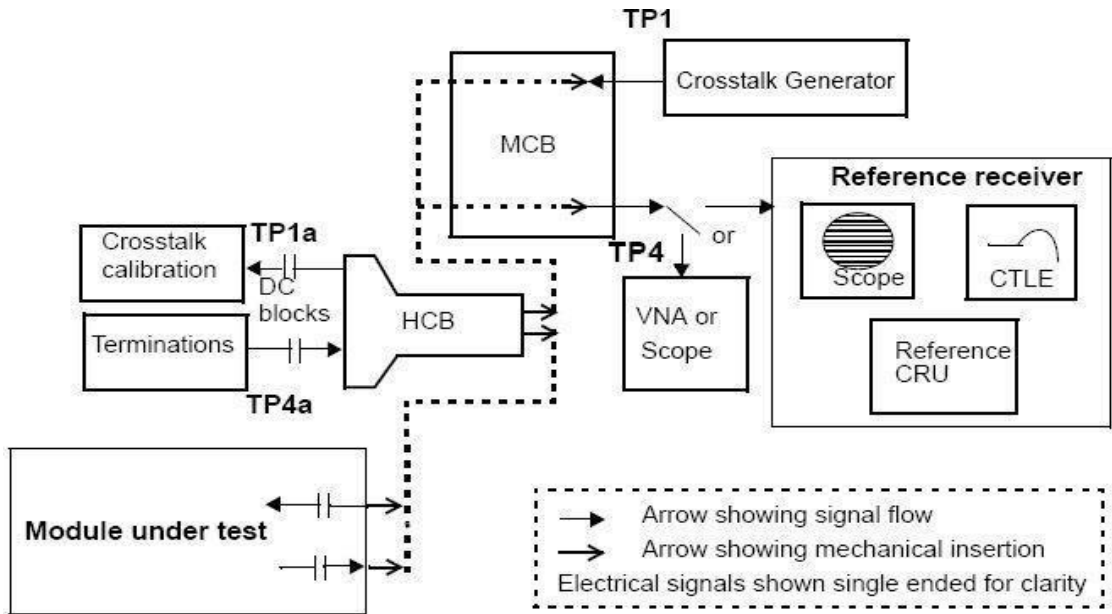
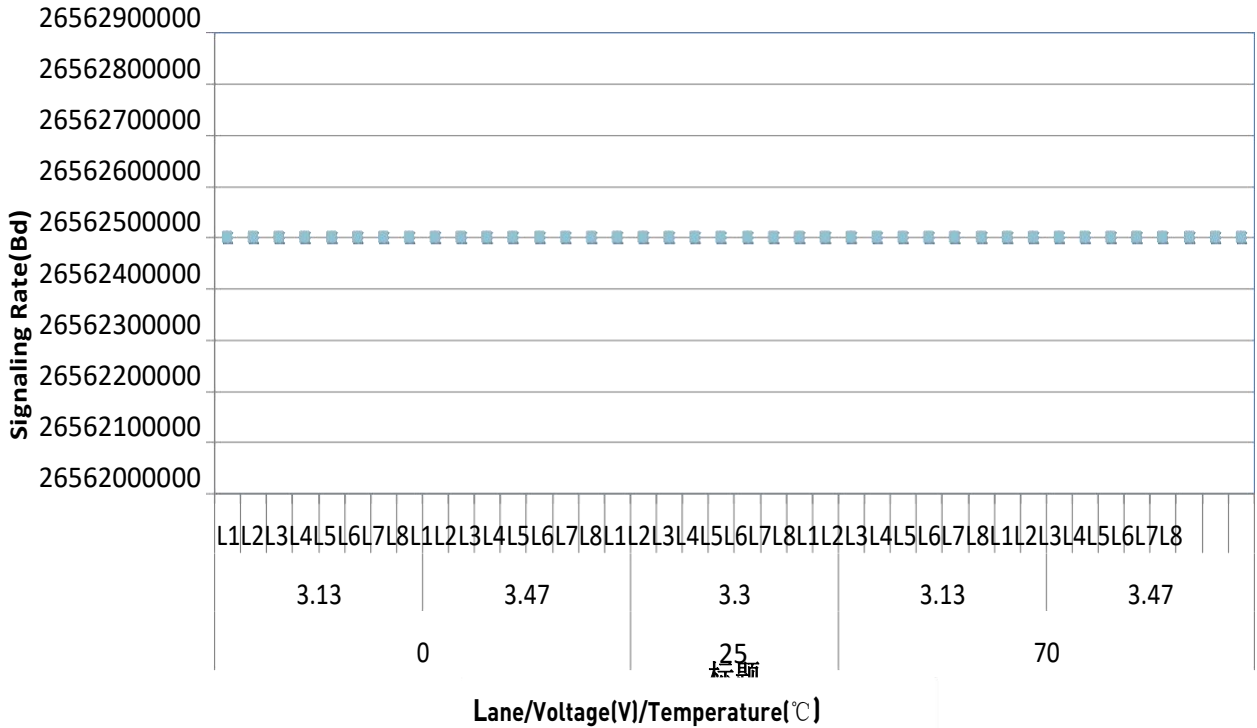


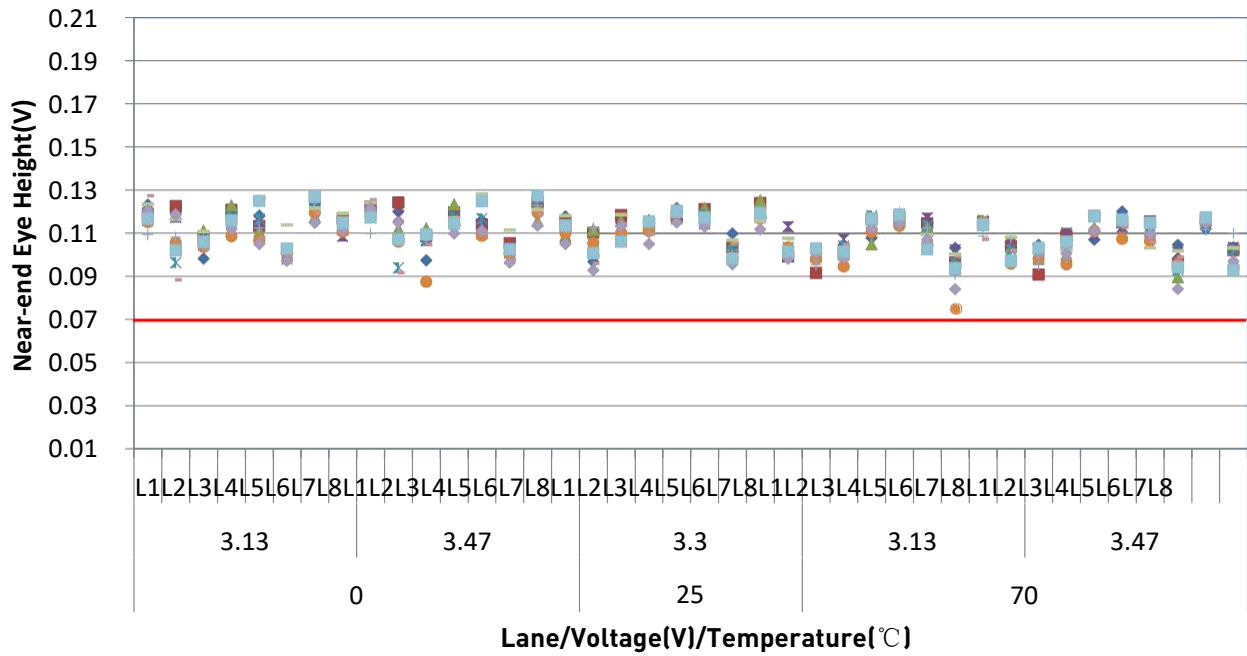
Figure 83E-11—Example module output test configuration

Note: Rx Output Eq control setting: pre-cursor code=2, post-cursor code=1, Amplitude code=2

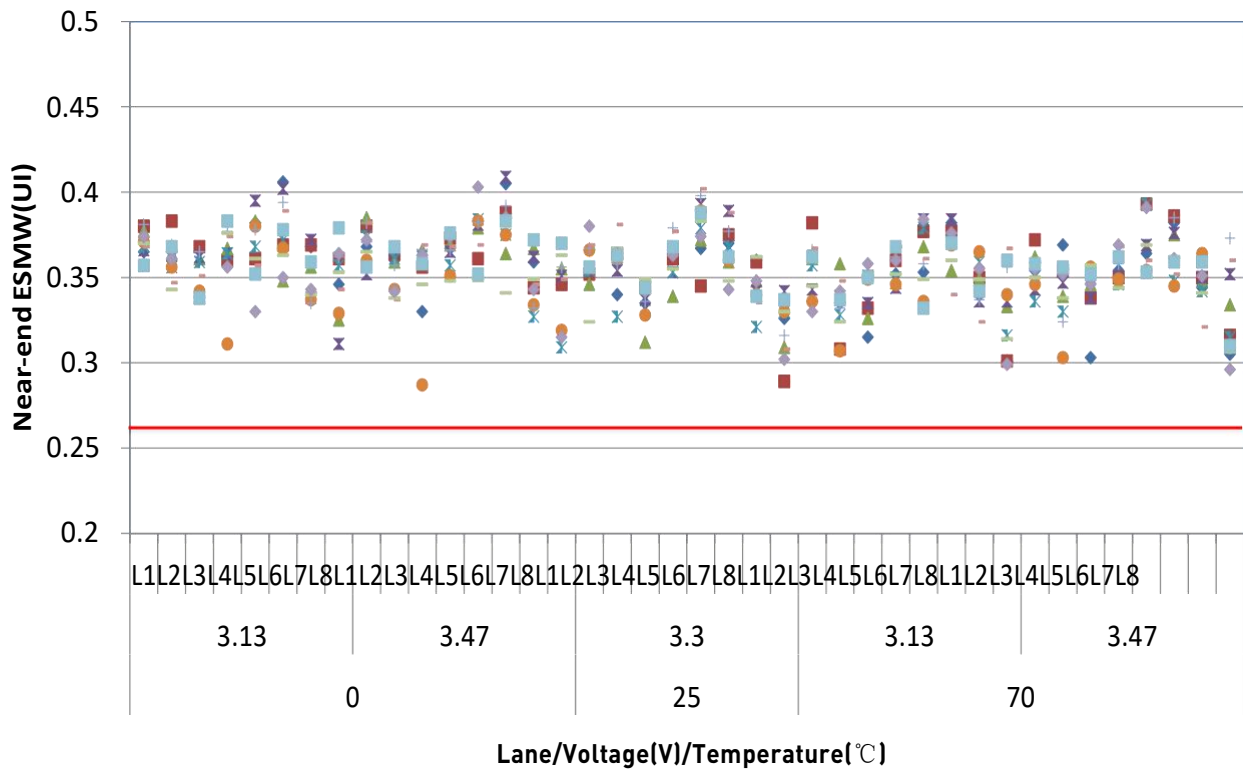
7.2 Signaling Rate Testing Results



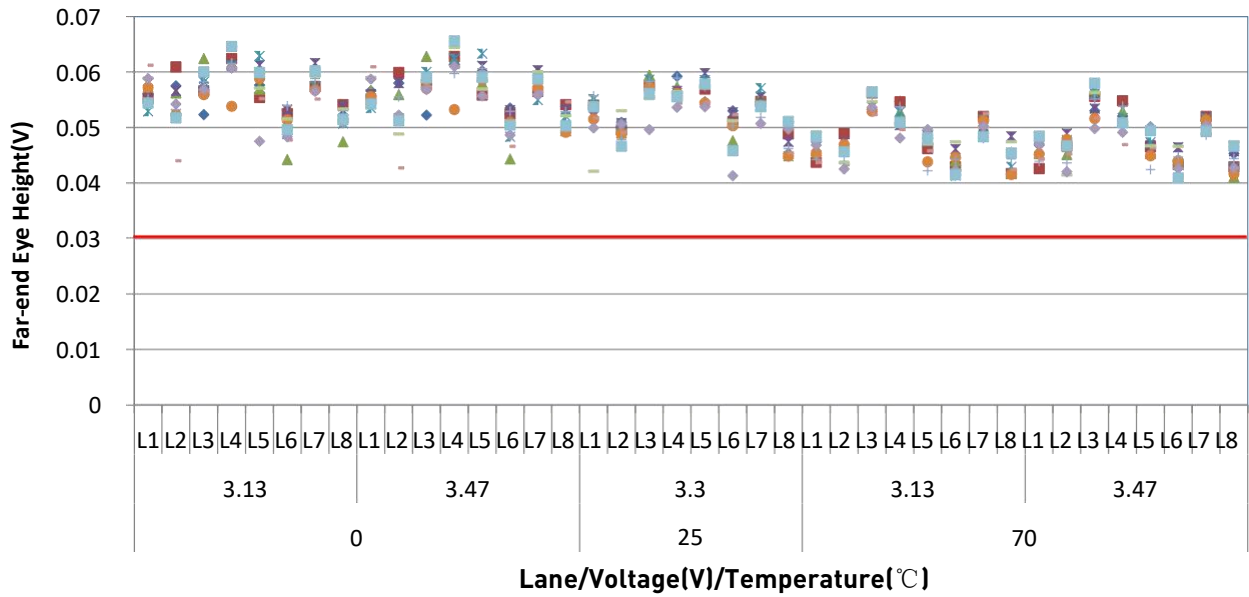
7.3 Near-end Eye Height Testing Results



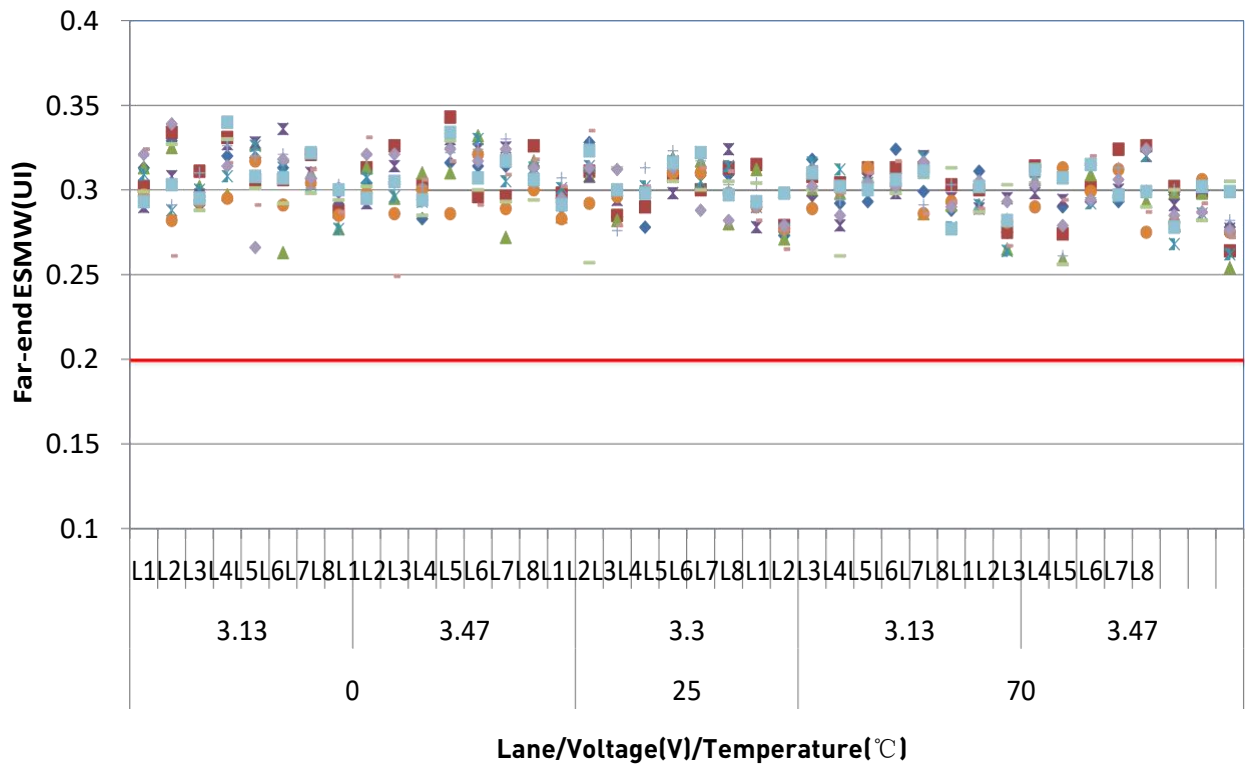
7.4 Near-end ESMW Testing Results



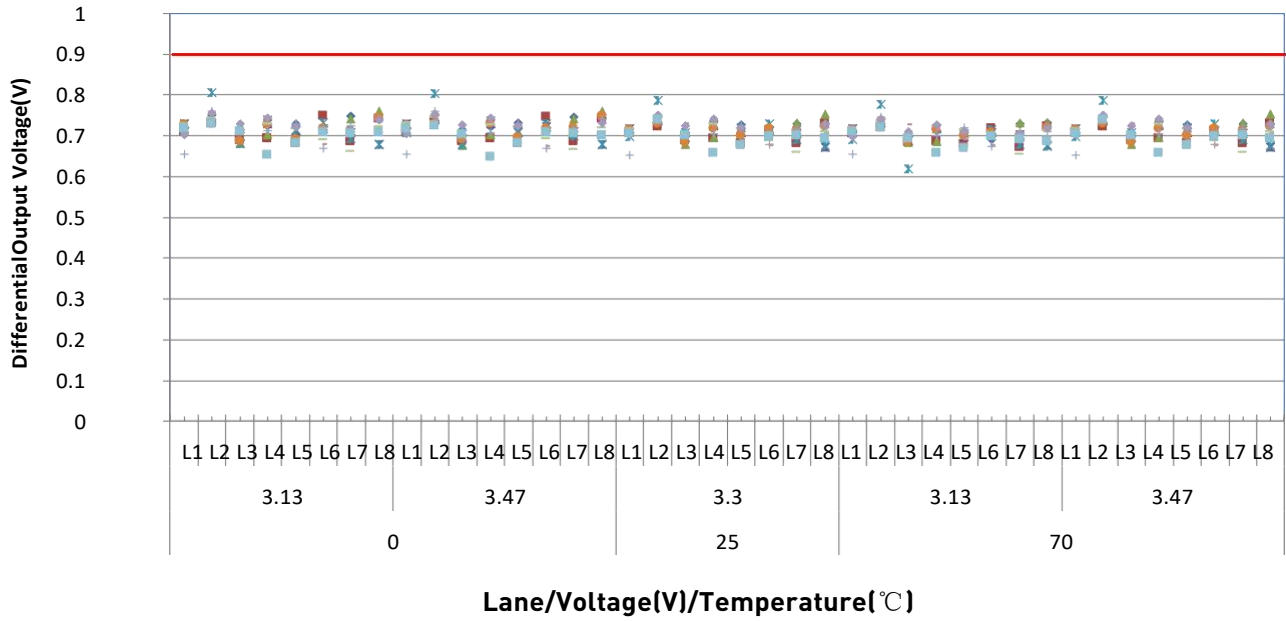
7.5 Far-end Eye Height Testing Results



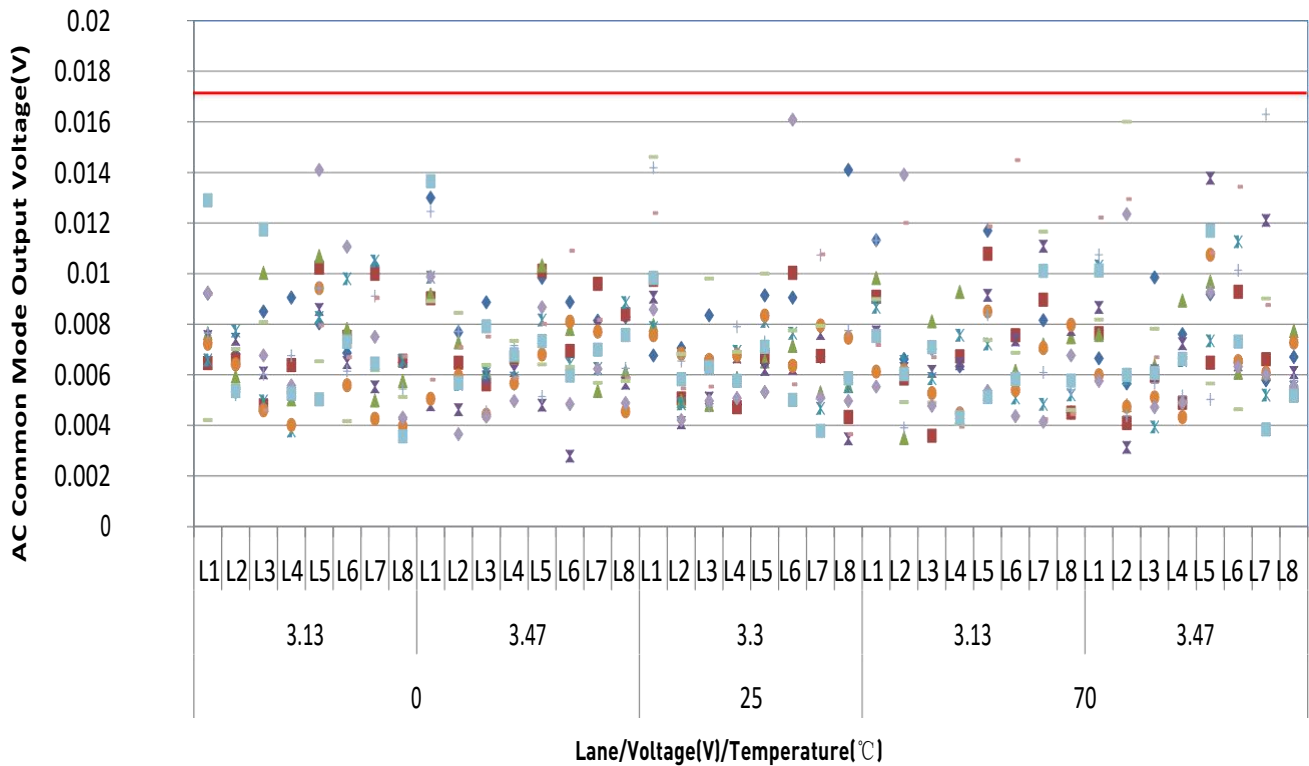
7.6 Far-end ESMW Testing Results



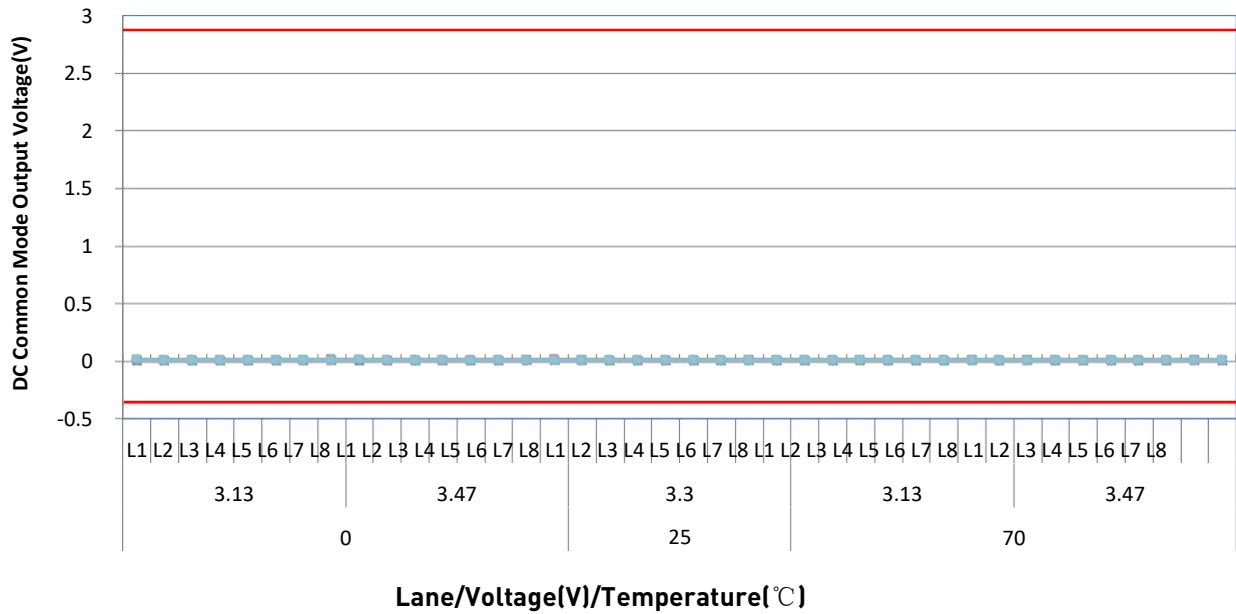
7.7 Differential Output Voltage Testing Results



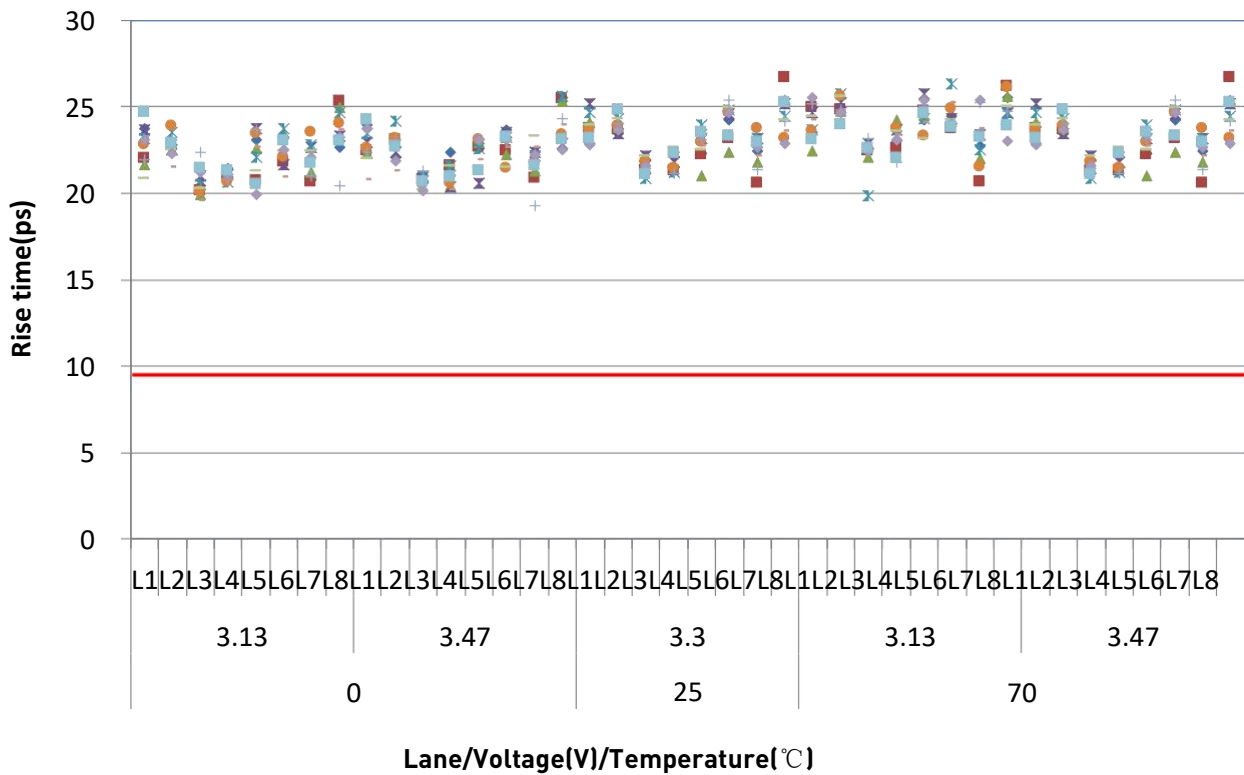
7.8 AC Common Mode Output Voltage Testing Results



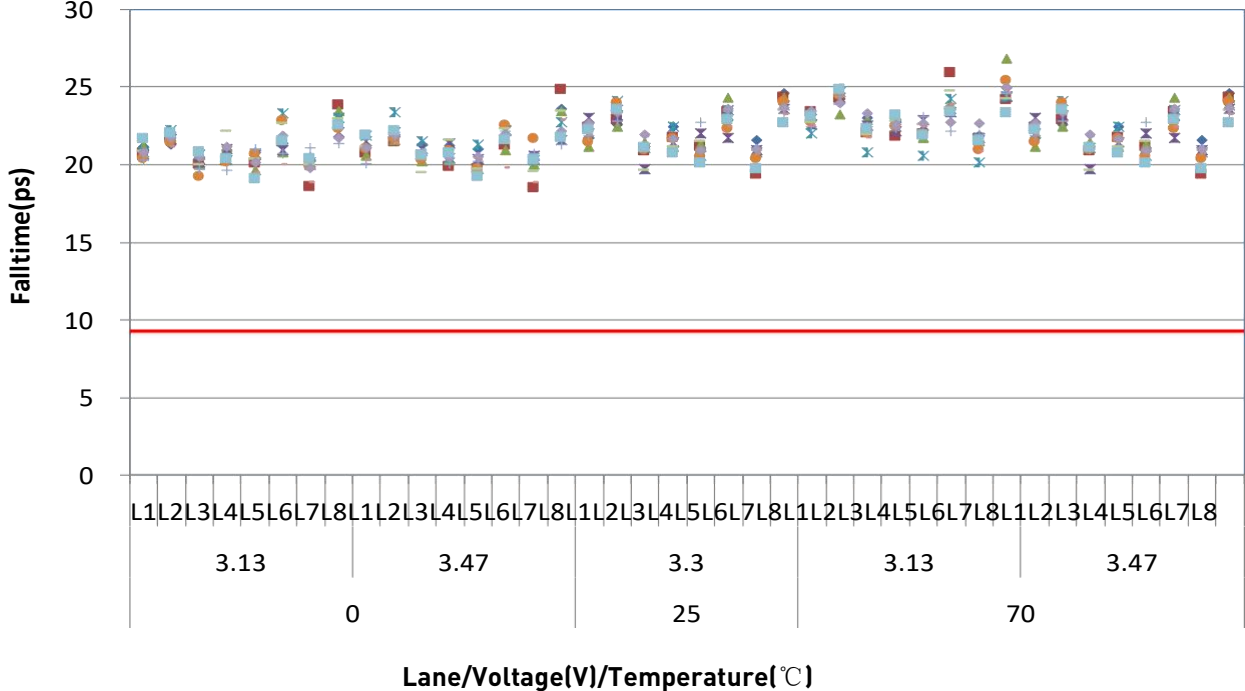
7.9 DC Common Mode Output Voltage Testing Results



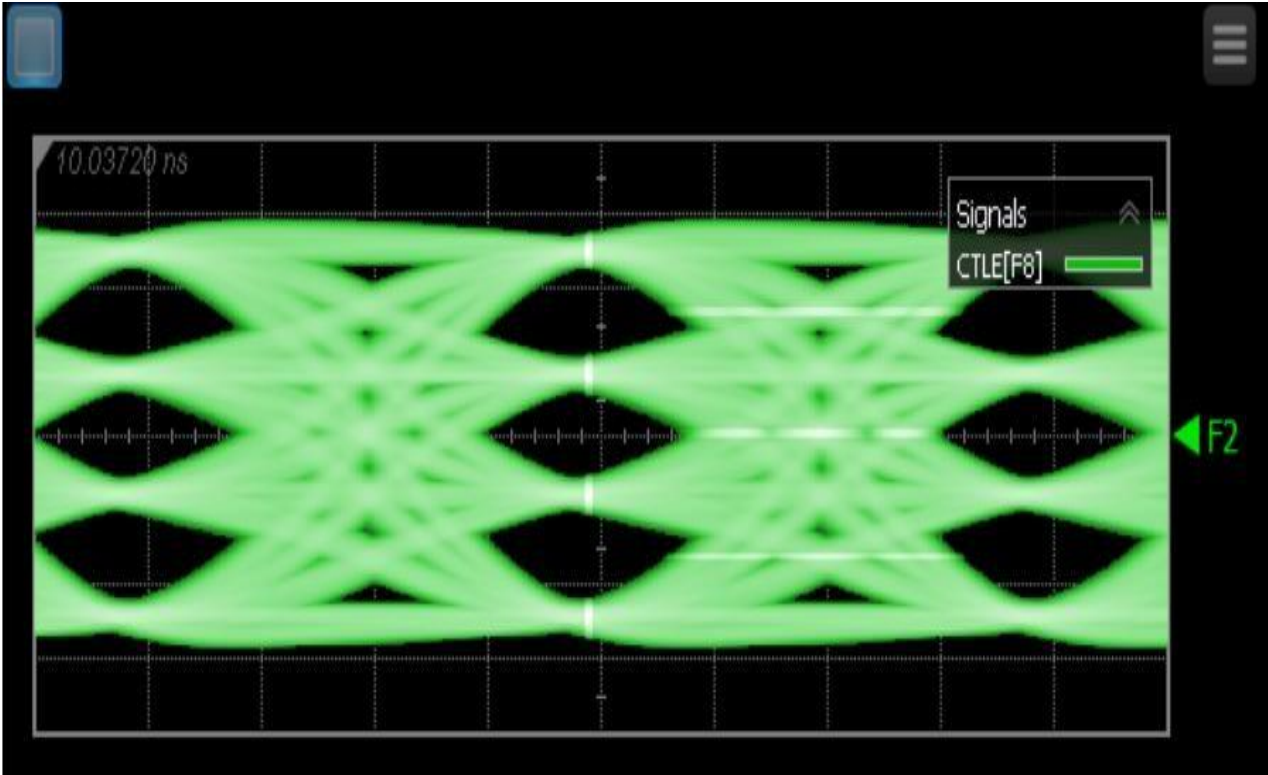
7.10 Rise time Testing Results



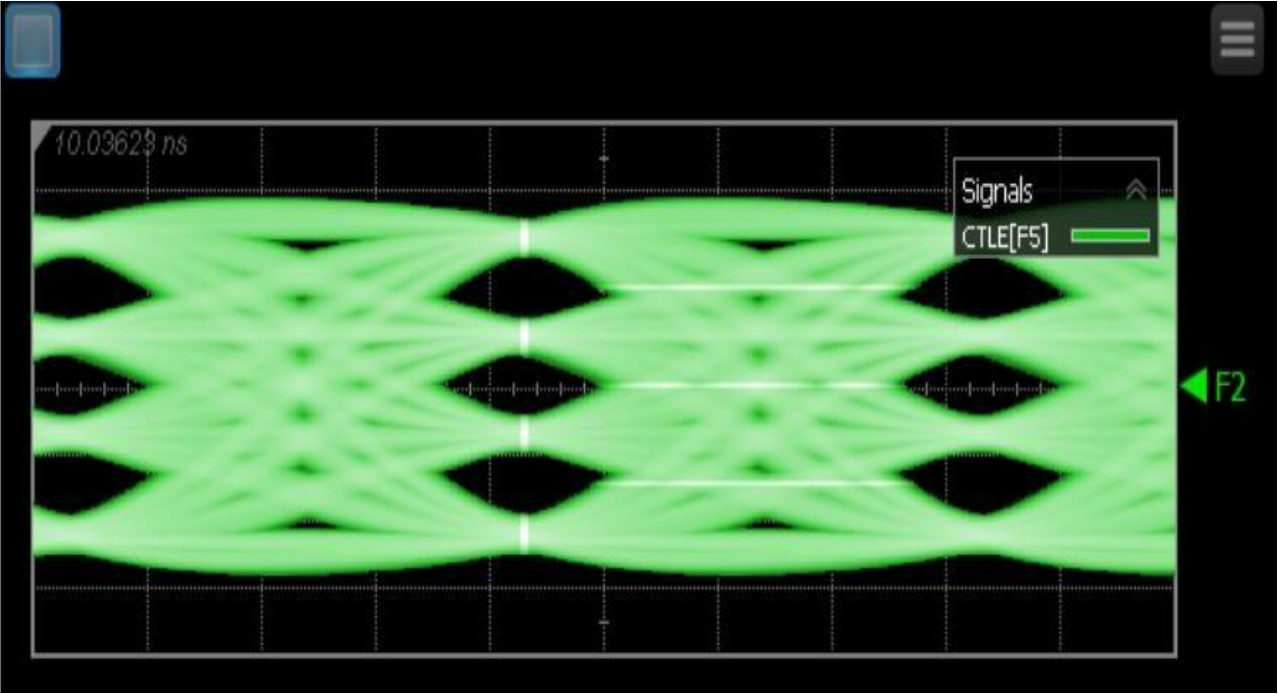
7.11 Fall time Testing Results



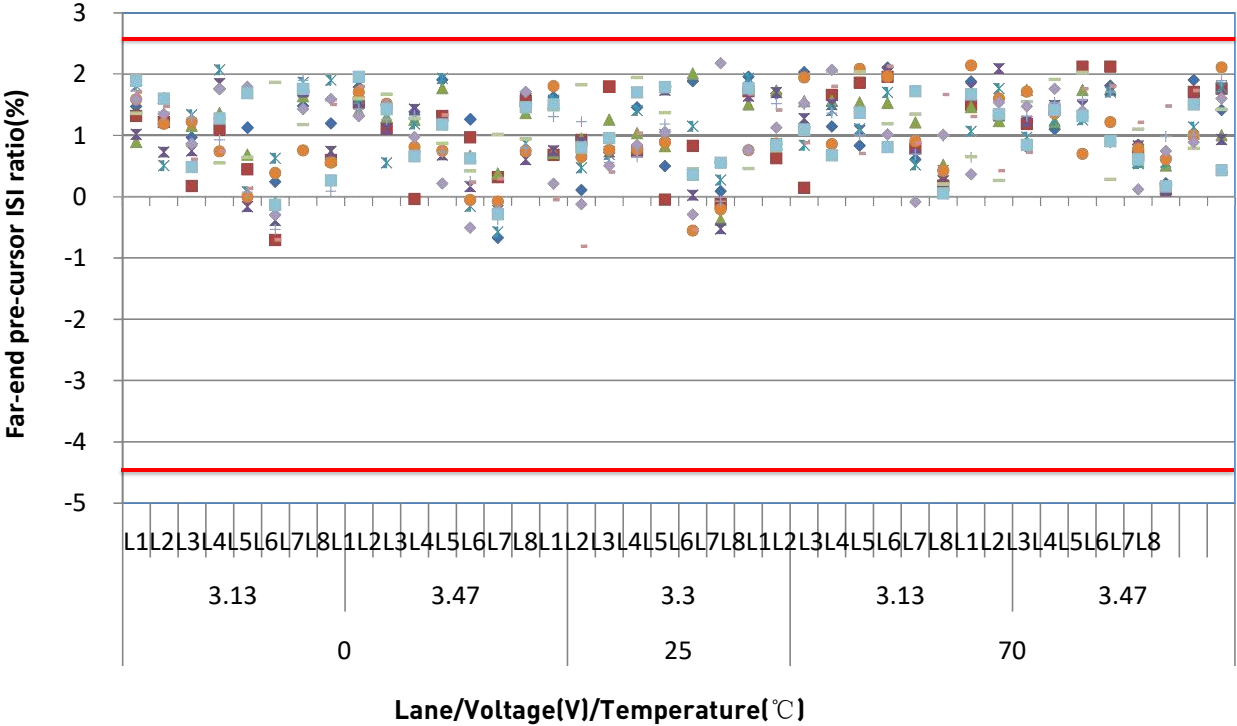
7.12 TP4 Near-end Eye Diagram



7.13 TP4 Far-end Eye Diagram

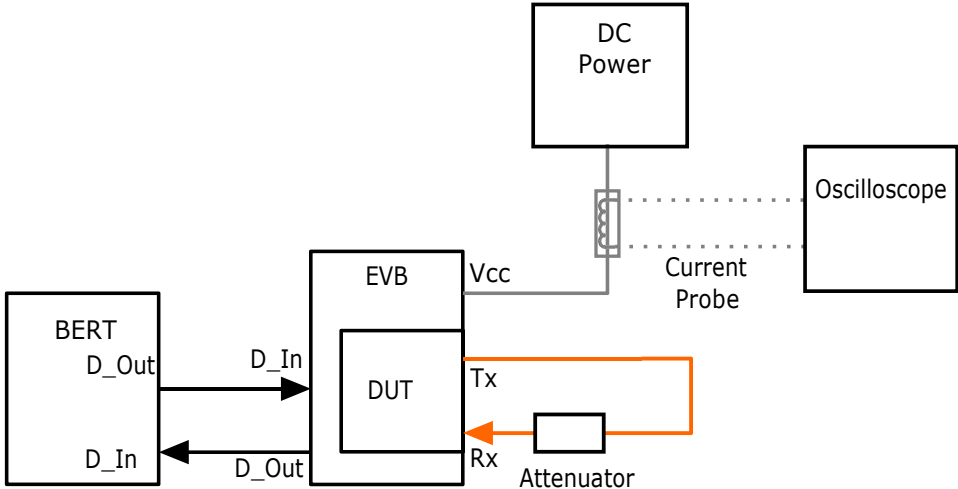


7.14 Far-end pre-cursor ISI ratio Testing Results

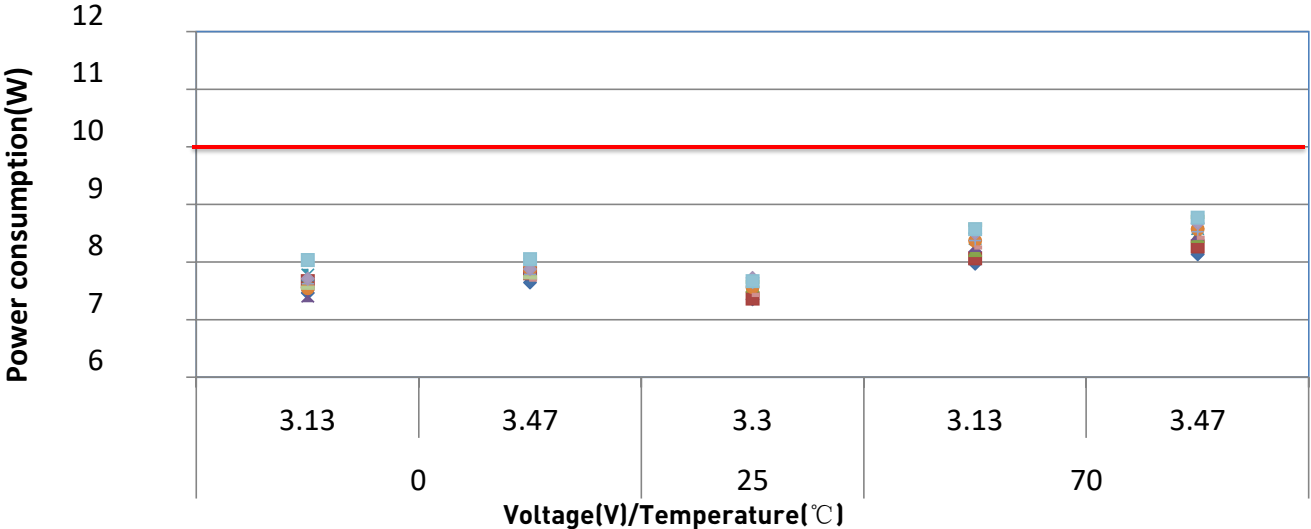


8. Power consumption Tests

8.1 Testing Setup

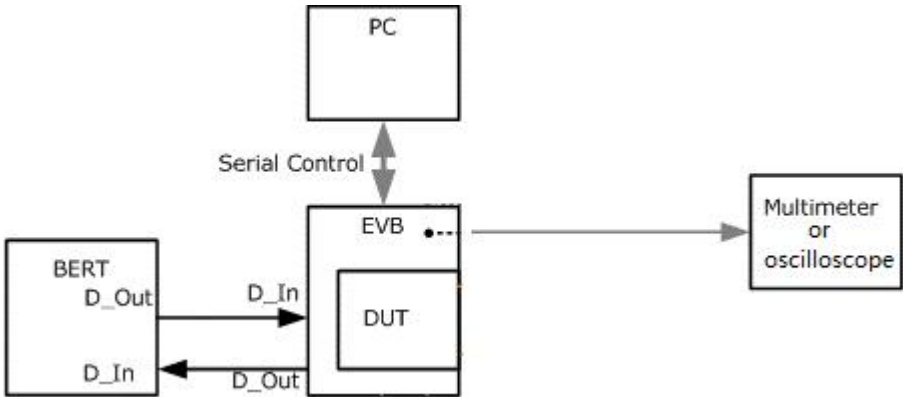


8.2 Power consumption Testing Results

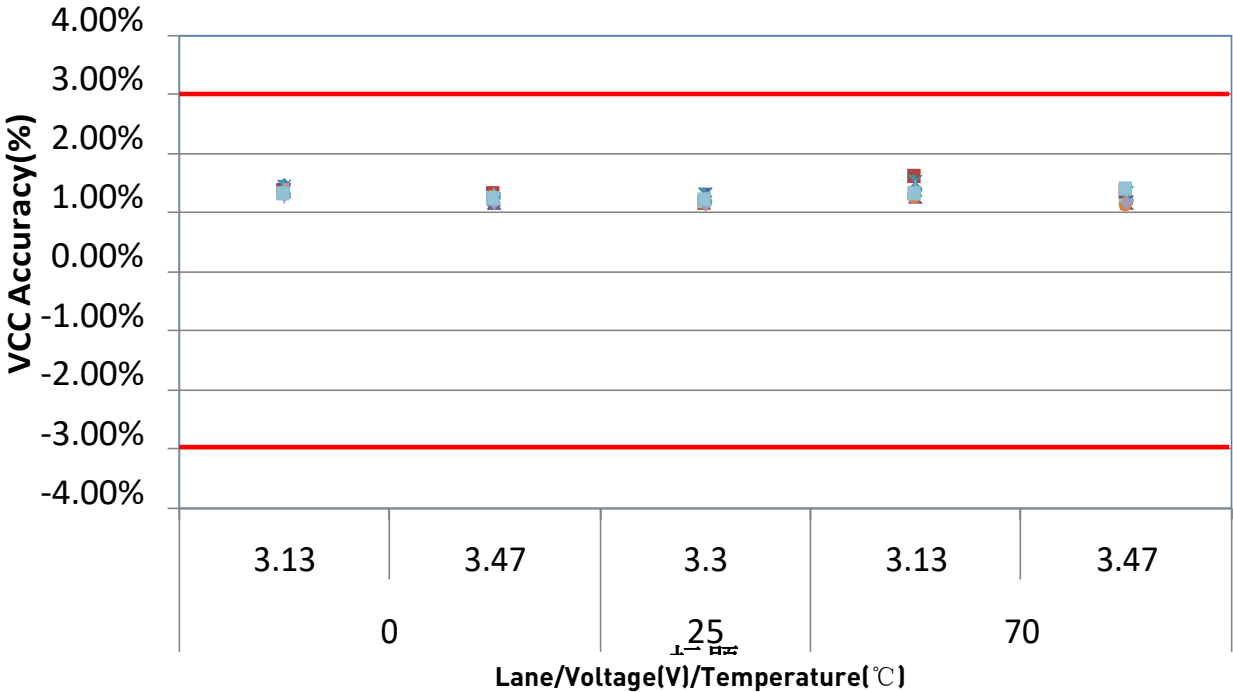


9. Voltage Tests

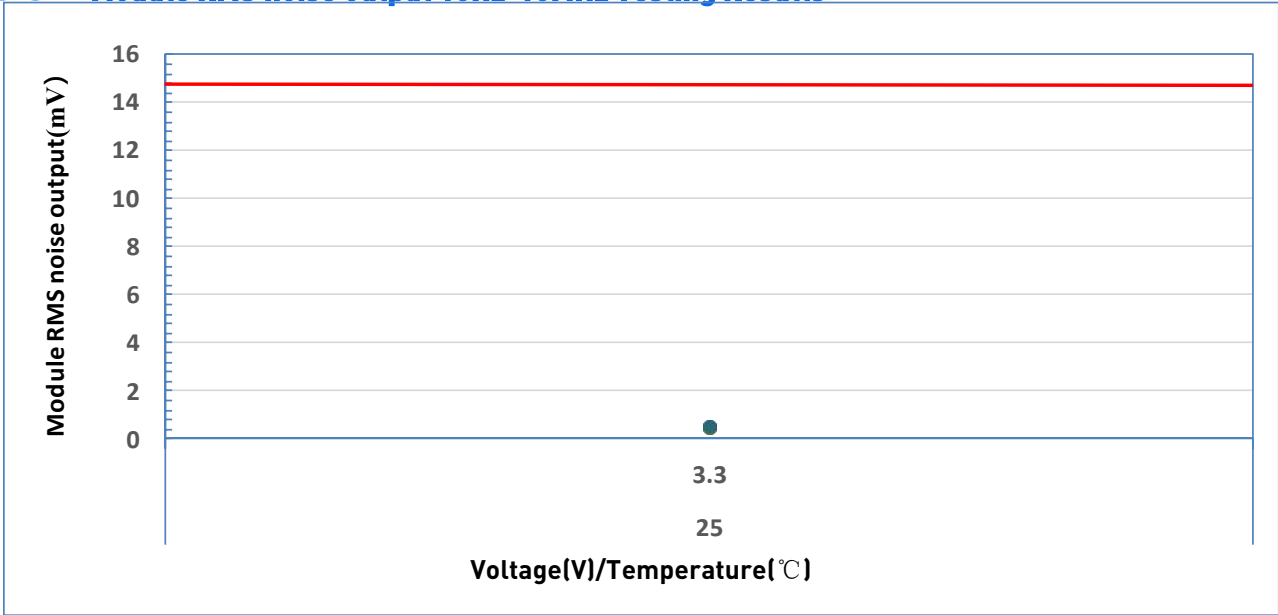
9.1 Voltage Testing Setup



9.2 VCC Accuracy Testing Results

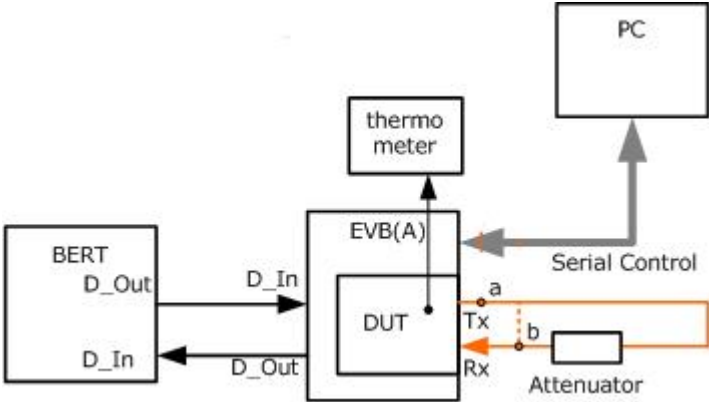


9.3 Module RMS noise output 10Hz-10MHz Testing Results

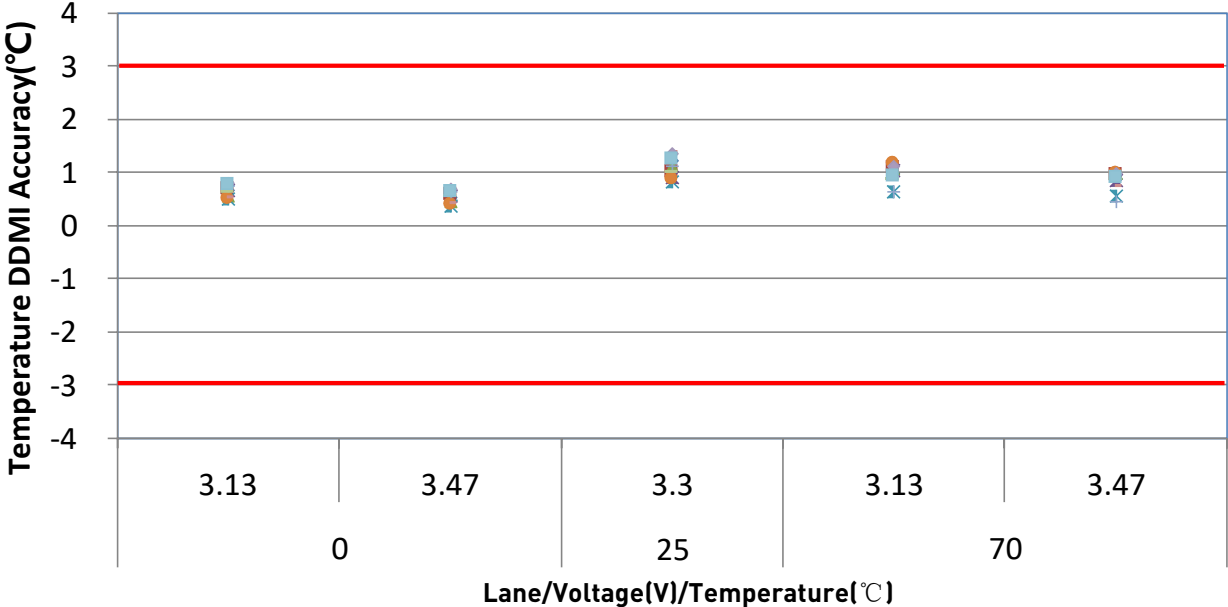


10. Temperature DDMI Accuracy Tests

10.1 Temperature DDMI Accuracy Testing Setup



10.2 Temperature DDMI Accuracy Testing Results



11. Jitter Tolerance(TP1a) Tests

11.1 TP1a Testing Setup

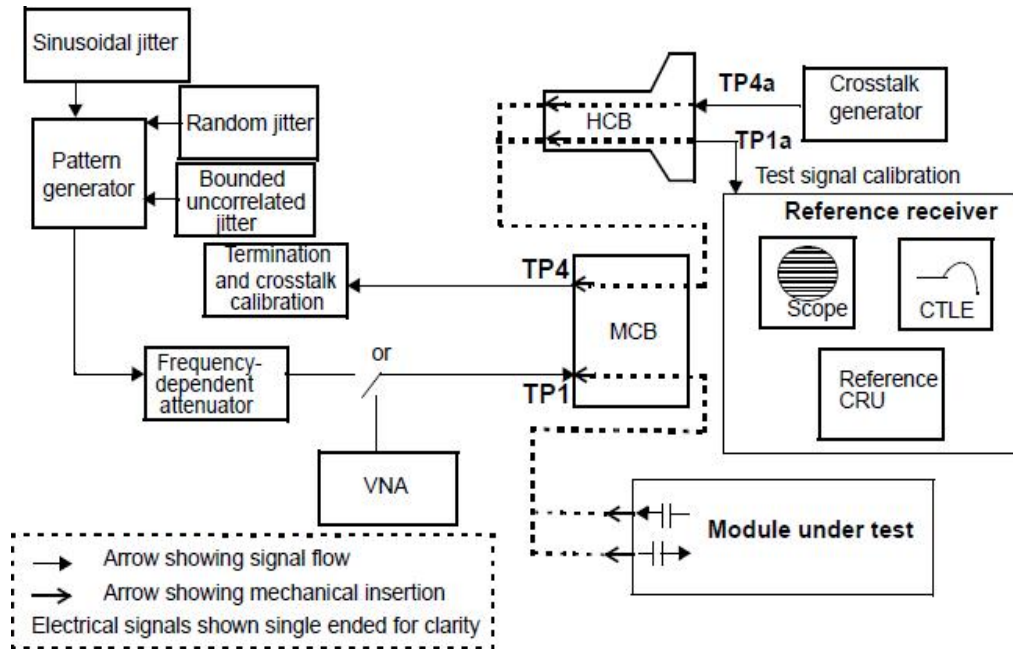
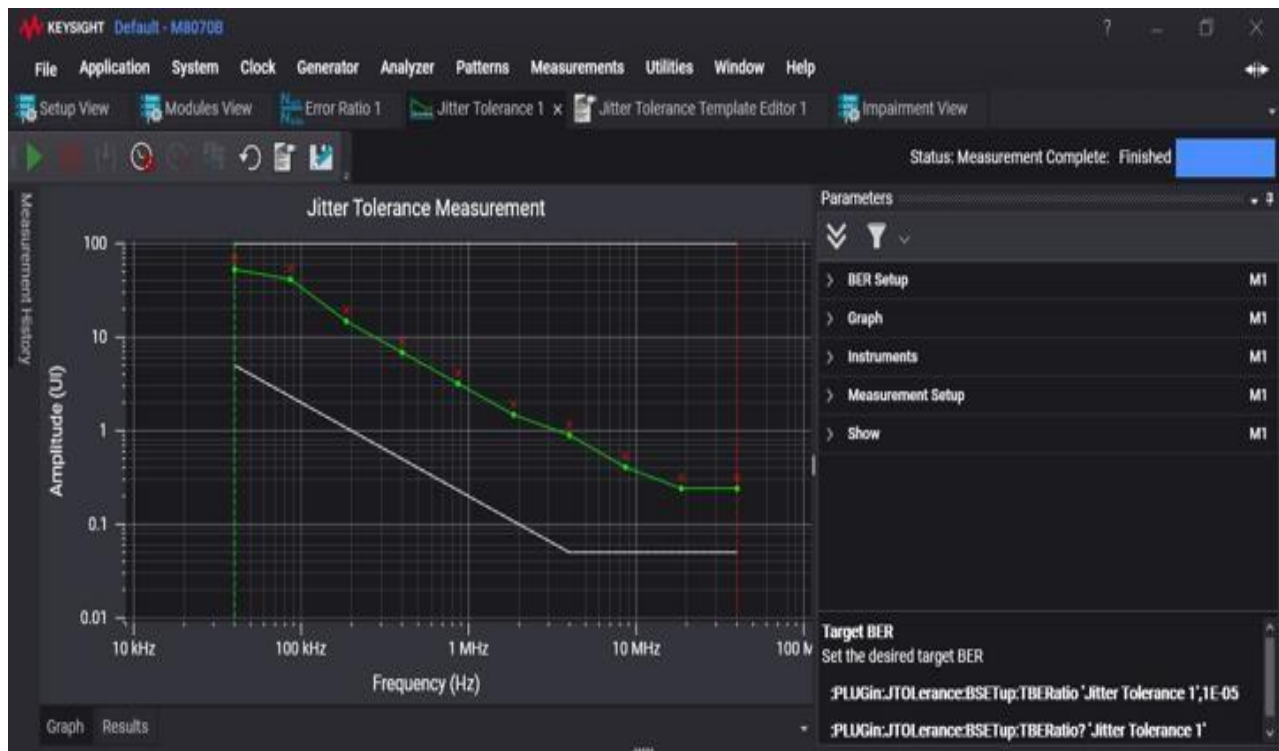


Figure 120E-12—Example module stressed input test

11.2 TP1a jitter tolerance 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	TEMPERATURE MONITOR	HH509R	12000446	OMEGA	Temperature monitor
12	SIGNAL GENERATOR	8648D	4108A01122	AGILENT	CLOCK
13	OPTICAL SWITCH	1x4	14S4214-3007	LIGHTWAVELINK	CHANGE CHANNEL

Further Information :

Web www.naddod.com

Email For order requirements: sales@naddod.com

For customer service: support@naddod.com

For technical support: tech@naddod.com

For cooperation: agency@naddod.com

For technical support: tech@naddod.com

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