Application Note

Anritsu

MP1800A

Signal Quality Analyzer

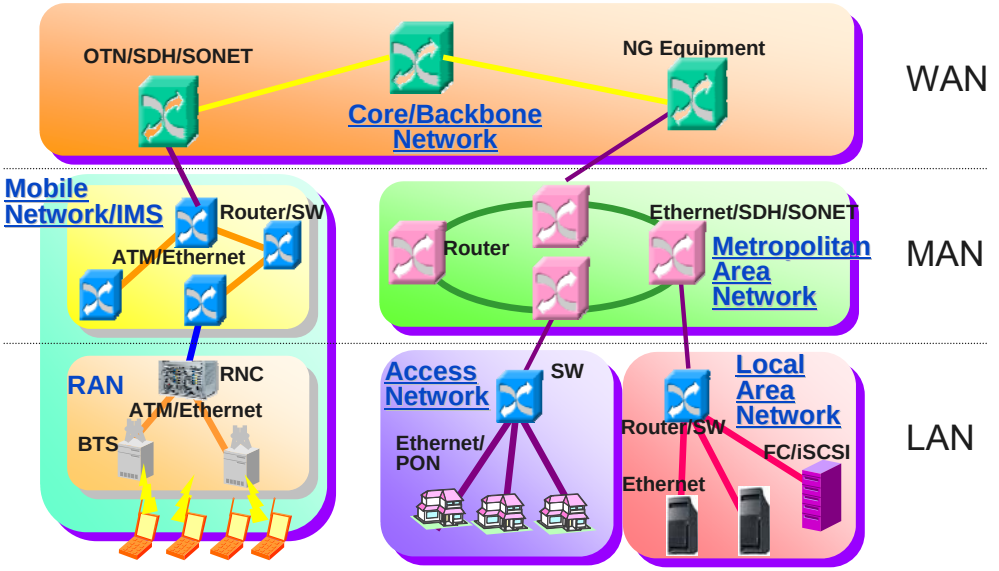
Optical Module Testing

MP1800 Series Signal Quality Analyzer Application Note Optical Module Testing

Anritsu Corporation
Measurement Business Group
IP Network Measurement Division

Contents

Network Overview



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Slide 3

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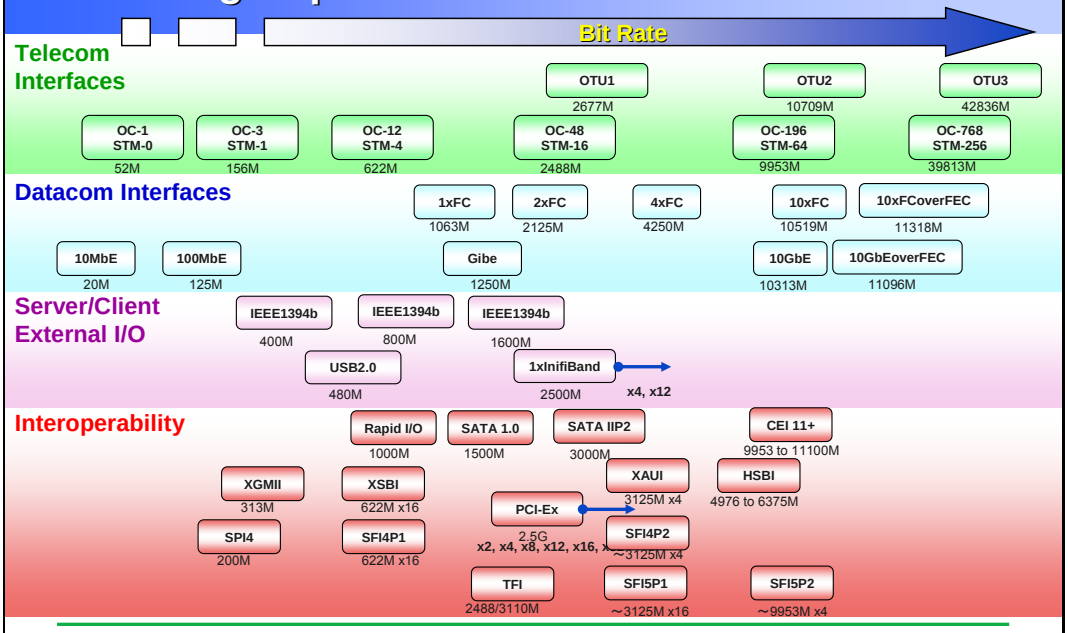
Various High-Speed Interfaces



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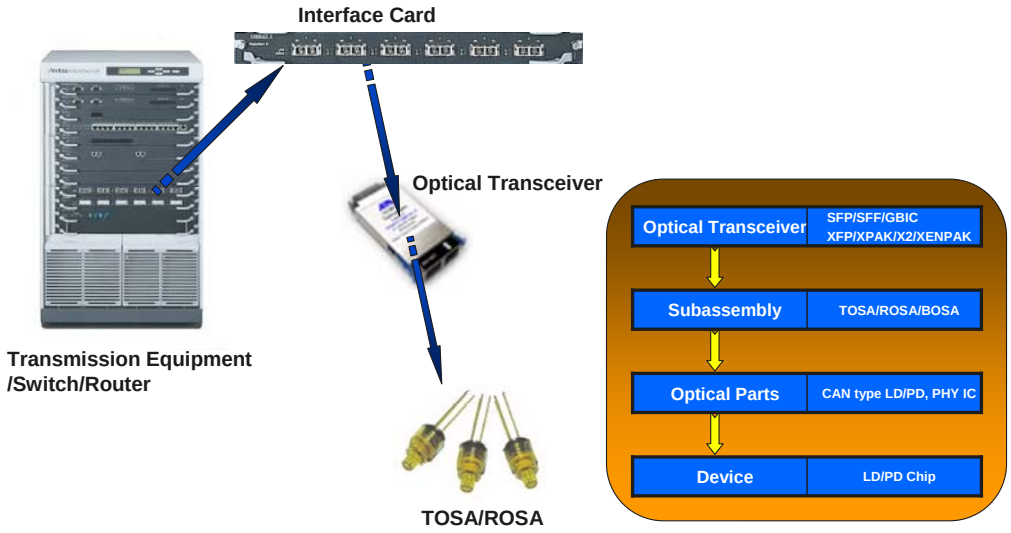
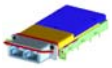
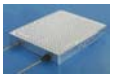
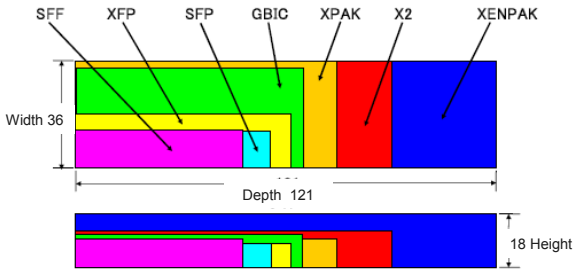
Network Equipment Composition

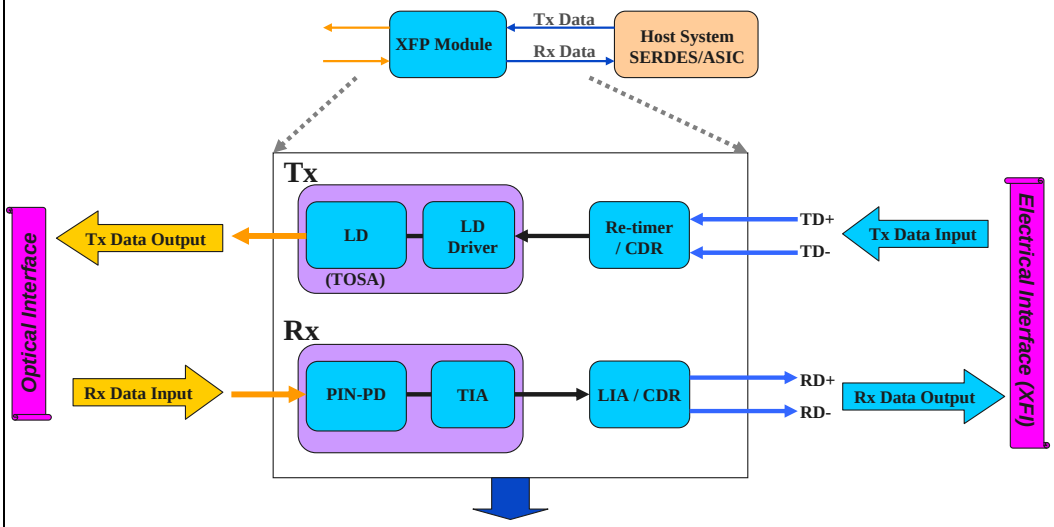


Optical Transceivers (MSA Modules)

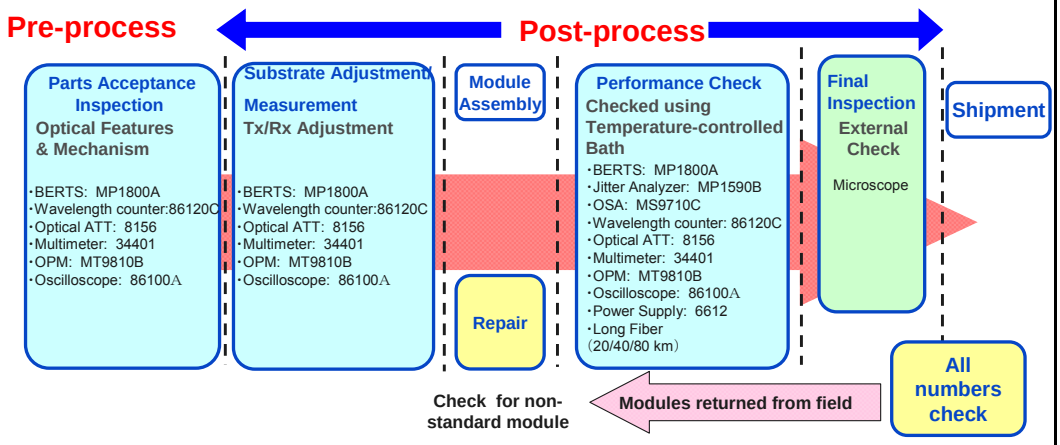
	SFF / SFP	XFP (Ziffy)	XENPAK	X2	XPAK	300pin
Form						
Bit Rate	100M to 4G	9.95 to 10.75G	10.3G	10.3G	9.95 to 11.2G	10G/40G
Electrical I/F	Serial	Serial	x4 (XAUI)	x4 (XAUI/SFI-4P2)	x4 (XAUI/SFI-4P2)	x16 (SFI-4P1) x16 (SFI-5P1)
Application	ATM/FDDI/FC/Gibe SDH/SONET	SDH/SONET 10GbE/10GFC	10GbE	10GbE	SDH/SONET 10GbE/FEC	SDH/SONET
Features	Small	Small	Small, XAUI support	SFI-4P2/PCI Card	Small, SFI-4P2	10G/40G



XFP Block Diagram



Optical Transceiver Manufacturing Process



Key Measurement Parameters

	Tx Measurement Parameters	ITU-T G.957 SDH/SONET	IEEE 802.3ae 10GbE	IEEE 802.3z GbE	ANSI FC-PI FC 1G/2G
Optical Output	Center Wavelength	◎	◎	◎	◎
	Average Launch Power	◎	◎	◎	◎
	RMS Spectrum Width	◎	◎	◎	◎
	-20 dB Spectrum	◎			
	Side-mode Suppression Ratio	◎			◎
	Extinction Ratio	◎	◎	◎	
	Optical Modulation Amplitude		◎		◎
	Mask of Eye Diagram	◎	◎		◎
	Rise Time/Fall Time			◎	◎
	Transmitter and Dispersion Penalty		◎		
	Jitter Generation				◎
	Relative Intensity Noise		◎	◎	◎
	Optical Return Loss Tolerance		◎		

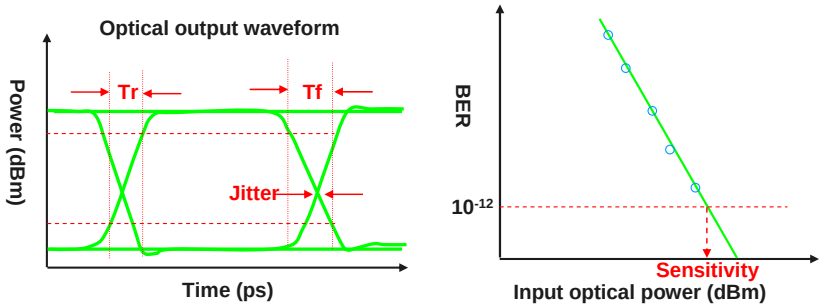
	Rx Measurement Parameters	ITU-T G.957 SDH/SONET	IEEE 802.3ae 10GbE	IEEE 802.3z GbE	ANSI FC-PI FC 1G/2G
Optical Input	Wavelength	◎	◎	◎	◎
	Average Receive Power	◎	◎	◎	◎
	Receiver Sensitivity	◎	◎	◎	◎
	Receiver Reflectance		◎		
	Return Loss	◎		◎	◎
	Min. Overload	◎			
	Stressed Receiver Sensitivity		◎	◎	◎
	Vertical Eye Closure Penalty		◎	◎	◎
	Stressed Eye Jitter		◎		
	Receive Electrical 3 dB Upper Cut Off Frequency		◎	◎	◎
	Stressed Receiver DCD Component of DJ				◎

Key Measurement Parameters

	Transmitter Section			
	Measurement Parameter	Symbol	Unit	Explanation
Optical Output	Average Optical Output Power	Pout	dBm	Average Optical Output Power
	Center Wavelength	λ	nm	Center Wavelength
	Spectral Width	σ	nm	Spectral width of -20dB down from the peak level of optical signal
	Sidemode Suppression Ratio	SSR	dB	Ratio between the peak and Side mode
	Extinction Ratio	ER	dB	Ratio between Data "1" and "0" of Optical power using PRBS pattern
	Optical Modulation Amplitude	OMA	μW	It is difference in optical power for "1" and "0" levels of the optical signal using Square pattern
	Optical Rise/Fall Time	Tr	ps	Time to rise/fall between 20% and 80% of Signal level
	Jitter P-P/RMS		ps	peak to peak / RMS value at cross point of Optical waveform
	Transmitter Eye Mask			Good/NG test which the required pulse shape characteristics are specified in the form of a mask of the transmitter eye diagram.
Electrical Input	Data Input Swing	Vin	Vpp	Electrical Input level for Optical output
	Transmit Enable/Disable Voltage	V_{EN}/V_D	V	Power-on / Shut-downVoltage of Optical signal
	Transmit Disable Assert Time		us	Transmit Disable Assert Time of Optical signal

	Receiver Section			
	Measurement Parameter	Symbol	Unit	Explanation
Optical Input	Minimum Sensitivity	Rsens	dBm	Minimum Optical power which measured at 10^{-12} (or 10^{-10})BER
	Overload	Pmax	dBm	Maximum Input Power
	LOS Assert/De-Assert	LOS_A/LOS_D	dBm	Optical input power which LOS is detected
	LOS Hysteresis		dB	Difference power between detction and removal of LOS detection
Electrical Output	Data Output Swing	Vout	Vpp	Electrical Output Amplitude level for Single end
	Data Output Rise/Fall Time	Tr	ps	Time to rise/fall between 20% and 80% of Signal level
	LOS Signal Level		V	High/Low Voltage of LOS indicate signal output

Key Measurement Parameters



Rise Time	Time to rise from 20% to 80% of signal level
Fall Time	Time to fall from 80% to 20% of signal level
Extinction ratio	Ratio of optical power of “0” and “1” data
Jitter	Time variation of rising or falling edge of optical waveform
Min. Sensitivity	Optical power of input signal to achieve 10^{-10} or 10^{-12} BER

Test procedure described in IEC61280-2-1, 61280-2-2

Measurement Procedures

1. Center Wavelength
2. Spectral Width
3. Average Optical Output Power
4. Transmitter Eye-Diagram
5. Extinction Ratio & OMA
6. Minimum Sensitivity
7. Jitter

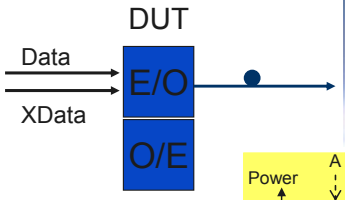
∗ Reference ITU-T G.957 and IEEE802.3z/ae

Measurement Procedures

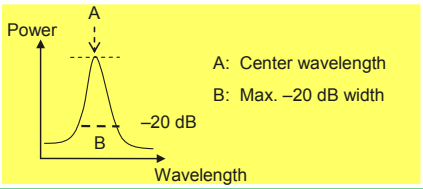
1. Center Wavelength
2. Spectral Width

The maximum spectral width is specified as the maximum full width of the center wavelength peak, measured –20 dB down from the maximum amplitude of the center wavelength.

System Setup
MP1800A
SQA (PPG)



MS9710C
Optical Spectrum Analyzer



Measurement Procedures

3. Average Optical Output Power

The mean launched power at point S is the average power of the transmitter. It is given as a range to allow for some cost optimization and to cover allowances for operation under standard operating conditions, Tx connector degradations, measurement tolerances, and aging effects. These values allow calculation of values for the sensitivity and overload point for the Rx at point R.

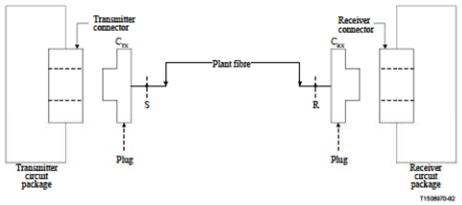
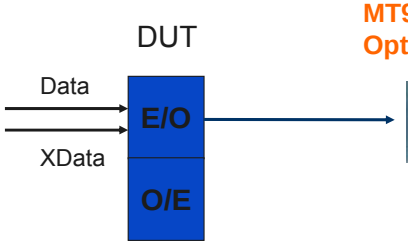


Figure 1/G.957 – Representation of optical line system interface

*Point S: The reference point on the optical fiber just after the transmitter optical connector
*Point R: The reference point on the optical fiber just before the receiver optical connector.

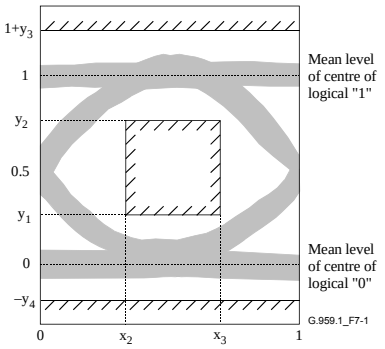
System Setup
MP1800A
SQA (PPG)



MT9810B
Optical Power Meter

Measurement Procedures

4. Transmitter Eye-Diagram



Transmitter pulse shape characteristics, including rise/fall times, pulse overshoot/undershoot, and ringing—all of which should be controlled to prevent excessive degradation of the Rx sensitivity—are specified in the form of a mask for the Tx eye-diagram at point S.

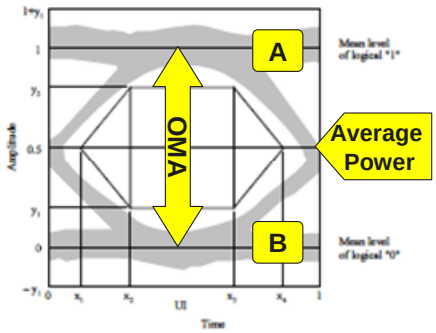
The parameters specifying the mask for the Tx eye-diagram are shown in ITU-T G.959 Fig. 7-1.

	NRZ 2.5G	NRZ 10G 1310-nm region	NRZ 10G 1550-nm region	NRZ 10G Amplified	NRZ 40G
x_3-x_2 (#2)	0.2	0.2	0.2	0.2	0.2
y_1	0.25	0.25	0.25	Δ + 0.25 (#1)	0.25
y_2	0.75	0.75	0.75	Δ + 0.75 (#1)	0.75
y_3	0.25	0.4	0.25	0.25	0.25
y_4	0.25	0.25	0.25	0.25	0.25

#1 – Δ is a variable –0.25 < Δ < +0.25.
#2 – x_2 and x_3 of the rectangular eye mask need not be equidistant with respect to the vertical axes at 0 UI and 1 UI.

Measurement Procedures

5. Extinction Ratio & OMA



The convention for the optical logic level is:
Light emission = logical "1"
No emission = logical "0"

EX is defined as: ER = 10 log10(A/B)

OMA is defined as: OMA = A – B

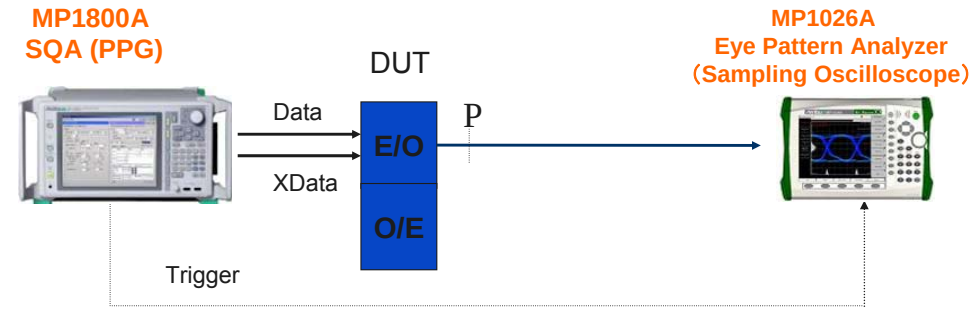
Where, *A* is the average optical power level for logical "1" and *B* is the average optical power level for logical "0".

OMA: Optical Modulation Amplitude
ER: Extinction Ratio

Measurement Procedures

4. Transmitter Eye-Diagram
5. Extinction Ratio & OMA

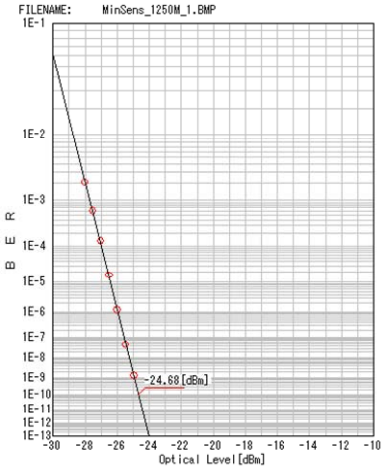
System Setup



Measurement Procedures

6. Minimum Sensitivity

Receiver sensitivity is defined as the minimum acceptable value of average received power at point R to achieve BER 1E–10 (or 1E–12).



*It takes into account power penalties caused by use of a transmitter under standard operating conditions with worst-case values for extinction ratio, pulse rise/fall times, optical return loss at point S, Rx connector degradations and measurement tolerances.

Average optical power (or OMA) vs. BER

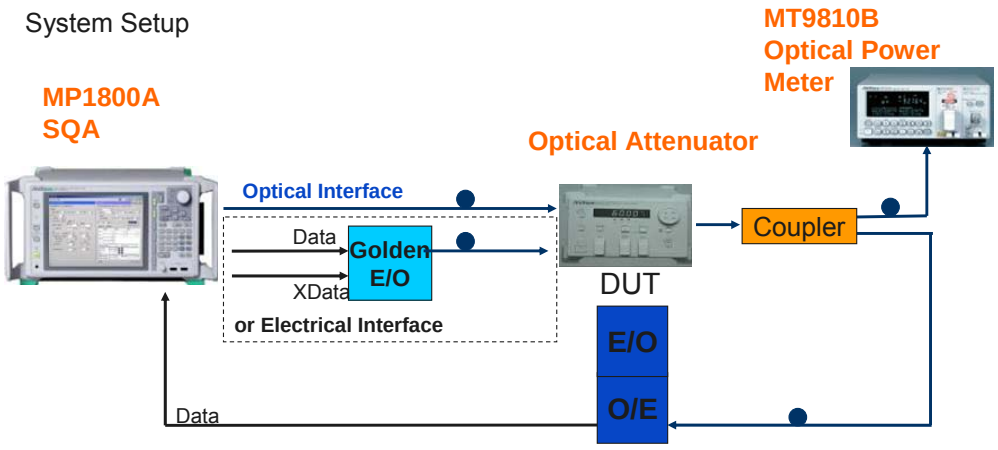
The minimum sensitivity level for receiver section is obtained from this graph.

Min Sensitivity: –24.68 dBm at BER 1E-10

Measurement Procedures

6. Minimum Sensitivity

System Setup



Measurement Procedures

7. Jitter measurement

Type of Jitter measurement

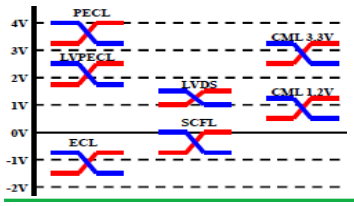
- ✓ **General**
  - ➢ **Measure Mask of Eye Diagram and time variation of the rising/falling edge of signal using Oscilloscope.**
- ✓ **ITU-T base**
  - ➢ **Measure Jitter Generation/Tolerance/Transfer and Output Jitter using Jitter Analyzer**
- ✓ **IEEE base (Stressed Eye)**
  - ➢ **Stressed Receiver Conformance Test**

Appendix

- High-Speed Electrical Interfaces
- Coaxial Connectors
- References

High-Speed Electrical Interfaces

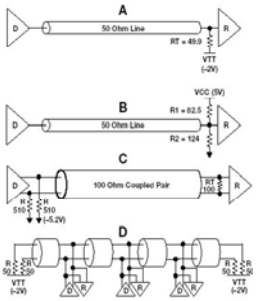
	ECL	PECL (+5 V)	LVPECL (+3.3 V)	LVDS	CML	SCFL
Bus	Point to Point, Multipoint	Point to Point, Multipoint	Point to Point, Multipoint	Point to Point, Multipoint	Point to Point	Point to Point
Operating Bit rate	DC to >10 Gbit/s	DC to >10 Gbit/s	DC to >10 Gbit/s	DC to >2 Gbit/s	DC to >10 Gbit/s	DC to >40 Gbit/s
Coupling	DC or AC	DC or AC	DC or AC	DC	DC or AC	DC or AC
Tx Voh [V]	–0.90	4.00	2.40	1.425	Vcc	0.00
Tx Vcenter [V]	–1.30	3.60	2.00	1.250	Vcc –0.40	–0.45
Tx Vol [V]	–1.70	3.20	1.60	1.075	Vcc –0.80	–0.90
Tx Vod [mVp-p] Typ	800	800	800	350	800	900
Rx Vin [mVp-p] min	200	200	200	100	400	-
Impedance Termination	50 Ω to -2 V	50 Ω to +3 V	50 Ω to +1.3 V	100 Ω between Diff. ports	50 Ω	50 Ω to GND



Signal swing comparisons showing differential output voltage and driver offsets of ECL, PECL, LVPECL, LVDS, CML and SCFL

High-Speed Electrical Interfaces

Termination for ECL/PECL/LVPECL



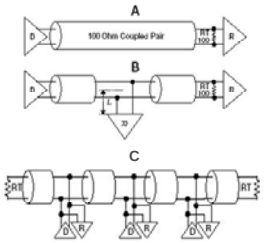
A: ECL terminated by 50 Ω to VTT; –2 V (ECL), +3.0 V (PECL), +1.3 V (LVPECL)

B: PECL terminated by Thevenin network, R1/R2 = 50 Ω

C: Differential ECL terminated by 100 Ω parallel termination

D: Differential ECL Multipoint bus terminated by 50 Ω to VTT at each end of bus

Termination for LVDS



A: LVDS terminated by 100 Ω parallel termination

B: Multidrop LVDS terminated by 100 Ω parallel termination at far end only; stubs off main line should be shortest possible length

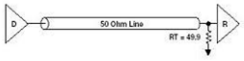
C: Multipoint LVDS bus terminated by two parallel terminations equal to 100 Ω or effective load impedance of bus—typically in 54 to 100 Ω range

Termination for CML

A: Point-to-Point CML with internal source and load terminations—50 Ω pull-ups to positive rail

B: AC coupled Point-to-Point CML with internal source and load terminations—driver and receiver may be powered from different rails

Termination for SCFL



SCFL terminated by 50 Ω to GND

Reference: National Semiconductor

Coaxial Connectors

Coaxial Connector		Frequency Range	Type	Impedance	Comment
SMA		DC–18.5 GHz	3.5 mm	50 Ω	
APC-3.5		DC–26.5 GHz	3.5 mm	50 Ω	Compatible with SMA
K		DC–40 GHz	2.92 mm	50 Ω	Compatible with SMA
APC-2.4		DC–50 GHz	2.4 mm	50 Ω	
V		DC–65 GHz	1.85 mm	50 Ω	Compatible with APC-2.4
W1		DC–110 GHz	1.0 mm	50 Ω	

References

MSA	http://
SFP	http://schelto.com/SFP/index.html
SFF	http://schelto.com/SFP/SFF/sff.htm
XFP	http://www.xfpmsa.org/cgi-bin/home.cgi
XPAK	http://www.xpak.org/
X2	http://www.x2msa.org/
XENPAK	http://www.xenpak.org/
QSFP	http://www.qsfpmsa.org/
300pin	http://www.300pinmsa.org

END

Anritsu

Specifications are subject to change without notice.

Anritsu Corporation
5-1-1 Onna, Atsugi-shi, Kanagawa, 243-8555 Japan
Phone: +81-46-223-1111
Fax: +81-46-296-1264

● **U.S.A.**
Anritsu Company
1155 East Collins Blvd., Suite 100, Richardson,
TX 75081, U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

● **Canada**
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

● **Brazil**
Anritsu Eletrônica Ltda.
Praca Amadeu Amaral, 27 - 1 Andar
01327-010-Paraiso-São Paulo-Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

● **U.K.**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire, LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

● **France**
Anritsu S.A.
9 Avenue du Québec, Z.A. de Courtabœuf
91951 Les Ulis Cedex, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

● **Germany**
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

● **Italy**
Anritsu S.p.A.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

● **Sweden**
Anritsu AB
Borgafjordsgatan 13, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

● **Finland**
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

● **Denmark**
Anritsu A/S
Kirkebjerg Allé 90, DK-2605 Brøndby, Denmark
Phone: +45-72112200
Fax: +45-72112210

● **Spain**
Anritsu EMEA Ltd.
Oficina de Representación en España
Edificio Veganova
Avda de la Vega, n° 1 (edf 8, pl 1, of 8)
28108 ALCOBENDAS - Madrid, Spain
Phone: +34-914905761
Fax: +34-914905762

● **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suit 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

● **Singapore**
Anritsu Pte. Ltd.
10, Hoe Chiang Road, #07-01/02, Keppel Towers,
Singapore 089315
Phone: +65-6282-2400
Fax: +65-6282-2533

● **India**
Anritsu Pte. Ltd.
India Branch Office
Unit No. S-3, Second Floor, Esteem Red Cross Bhavan,
No. 26, Race Course Road, Bangalore 560 001, India
Phone: +91-80-32944707
Fax: +91-80-22356648

● **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Units 4 & 5, 28th Floor, Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong
Phone: +852-2301-4980
Fax: +852-2301-3545

● **P.R. China (Beijing)**
Anritsu Company Ltd.
Beijing Representative Office
Room 1515, Beijing Fortune Building,
No. 5, Dong-San-Huan Bei Road,
Chao-Yang District, Beijing 10004, P.R. China
Phone: +86-10-6590-9230
Fax: +86-10-6590-9235

● **Korea**
Anritsu Corporation, Ltd.
8F Hyunjuk Building, 832-41, Yeoksam Dong,
Kangnam-ku, Seoul, 135-080, Korea
Phone: +82-2-553-6603
Fax: +82-2-553-6604

● **Australia**
Anritsu Pty. Ltd.
Unit 21/270 Ferntree Gully Road, Notting Hill,
Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

● **Taiwan**
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

Please Contact:

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