Application Note

Anritsu envision : ensure

Ideal Remote Sequence

BERTWave Series MP2110A/MP2100B

Contents

1. Introduction

The BERTWave series (Figure 1) has been designed for manufacturing applications to help hold-down initial equipment capital costs and cut running costs. In addition, it makes effective use of remote commands to cut measurement times on production lines.

This note introduces standard remote sequences making use of the BERTWave functions and speed to measure optical modules and devices. The remote sequences described in this note can be used to configure a simple test system for manufacturing optical modules and devices by selecting the best commands from remote commands built into the BERTWave.

Fig. 1 BERTWave Series

2. Optical Module Test System

This note explains methods for evaluating both the optical and electrical characteristics of an optical module using the measurement system shown in Figure 2. Although Figure 2 shows the setup for evaluating a 4ch optical module, the setup is similar for evaluating a 1ch optical module.

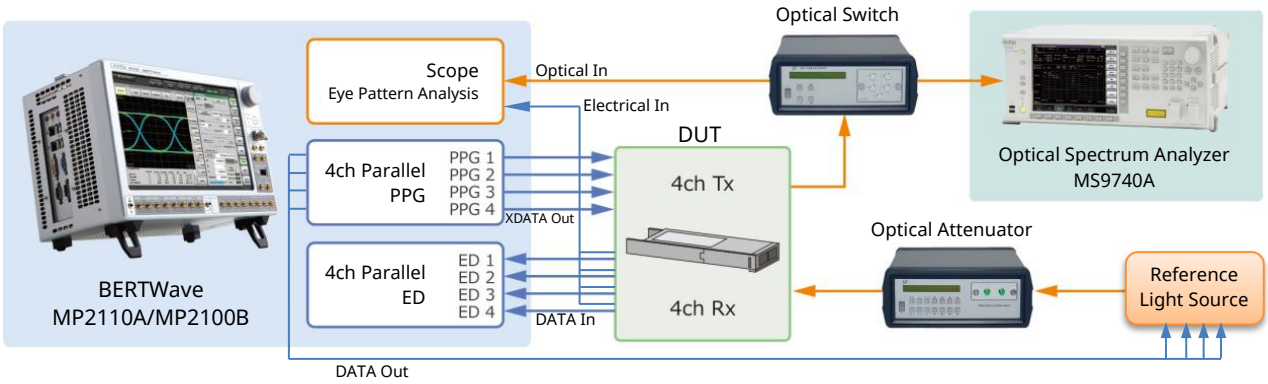

Fig. 2 BERTWave Measurement System (using MP2100B/MP2110A with Opt-014 and Opt-023 installed)

The BERTWave in this measurement system is connected as follows:

- Connect BERTWave PPG XDATA Out to DUT (optical module).
- Connect BERTWave PPG DATA Out to reference light source.
- Connect DUT Rx Electrical Out to BERTWave ED Data In and oscilloscope electrical channel input connector.
- Connect DUT Tx Optical Out to BERTWave oscilloscope optical channel input connector.
- Connect BERTWave Clk Out* to BERTWave Trigger Clk In.
  *Clk Out for MP2110A and Sync Out for MP2100B

Table 1 lists the test items using this measurement system and the BERTWave modules required by the test.

Table 1 Test Items

Test Item		Module
Optical IF	Extinction Ratio, Average Power Adjustment Value	Optical Scope, PPG
	Crosspoint, Average Power, Extinction Ratio, OMA, etc.	
	Mask Margin	
Electrical IF	Jitter (p-p, rms), Rise/Fall Times, etc.	Electrical Scope, PPG
Rx Optical Sensitivity		PPG, ED

2.1. Hardware Configuration

Table 2 lists the options required to make the measurements using the system shown in Figure 2.

Table 2 Options Required for Sequence Execution

Module	MP2110A	MP2100B
BERT (PPG, ED)	014/012/011	014/012/011
Optical Scope	023/022/025/026	023*
Electrical Scope	023/021	023/021

*Requires separate filter option

011: 1CH BERT
012: 2CH BERT
014: 4CH BERT
021: Dual Electrical Scope
022: Dual Optical Scope
023: Optical and Single-ended Electrical Scope
025: Optical Scope for Single Mode
026: Optical Scope for Multi-mode

2.2. Software Configuration

The command sequence explained in this note assumes use of software version 3.02 or later. Using an earlier version may cause errors due to changes in command specifications and may result in abnormal operation.

3. Measurement Sequence

Figure 3 shows the overall sequence for the test items in Table 1. This note explains the remote sequence for performing these tests.

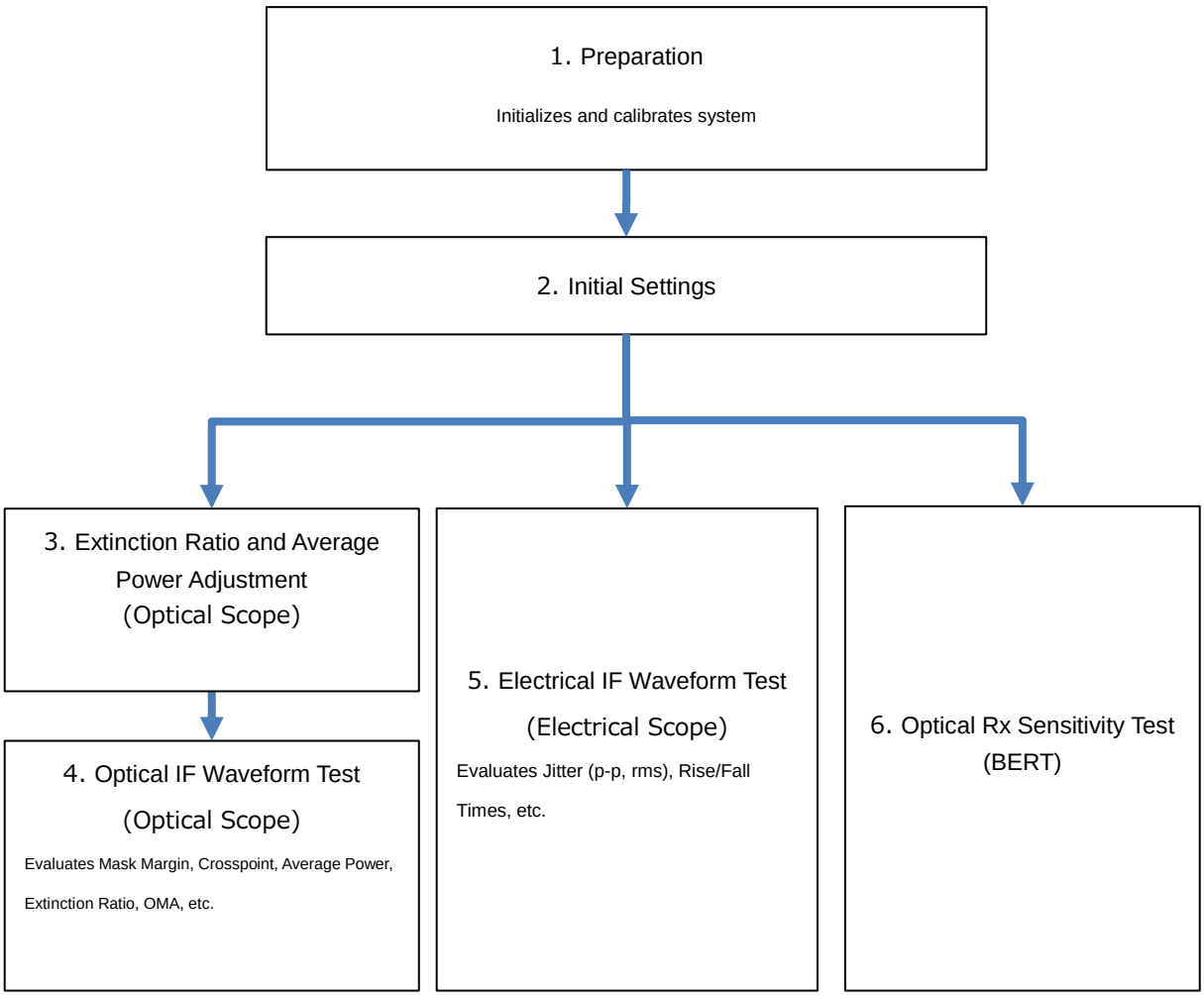

Fig. 3 Overall Sequence of Optical Module Evaluation

4. Command Sequences

4.1. Preparations

Initialize and calibrate the system before use by following the procedure in Table 3.

Table 3　Setting Sequence Before Use

Module	Remote Command	Explanation
Common	*CLS;*IDN? *OPT?	Captures BERTWave serial number, firmware version and option configuration
Common	*RST	Initializes settings

Scope	// Before sending this command,
	// confirm that there is NO signal input to input connectors,
	// and set the response timeout to 60 s or more.
	
	:SCOPe:CALibrate:AMPLitude?
		Calibrate oscilloscope amplitude and returns calibration result
		
		*At calibration, confirm that there is NO signal input to input connectors (Ch A/B In, Trigger Clk In).
		
		*Since calibration requires about 50 s in the Eye mode, set the response wait timeout to 60 s or more.

4.2. Initial Settings

Initialize the system settings by setting the optical module bit rate, electrical signal parameters (amplitude and test pattern), optical signal wavelength, filter, etc., as shown in Table 4.

Table 4 Initial Setting Sequence

Module	Remote Command	Explanation
BERT	:DISPlay:ACTive 1	Displays PPG/ED Ch1 screen

	// with MP2110A
	:BERT:OUTPut:BITRate:STANdard "100GE_4"
	
	// with MP2100B
	:BERT:OUTPut:BITRate:STANdard "10G_LAN"
	:BERT:SOURce:PATTern:TYPE PRBS31
	:BERT1:OUTPut:DATA:AMPLitude DATA,0.5
	:BERT2:OUTPut:DATA:AMPLitude DATA,0.5
	:BERT3:OUTPut:DATA:AMPLitude DATA,0.5
	:BERT4:OUTPut:DATA:AMPLitude DATA,0.5
		Sets PPG/ED (bit rate, test pattern, amplitude)
		
		If the MP2110A/MP2100B Channel Tracking function is used, setting Ch1 sets the same basic settings at all PPG/ED channels.

	:SOURce:OUTPut:ASET ON	Sets PPG output to ON To set ON at each channel, use the command :BERT<ch>::OUTPut:DATA:OUTPut

Optical Scope (O/E)	// with MP2110A
	:OE:FILTer "100GE_4"
	
	// with MP2100B
	:OE:INPut:FILTer 6 //10GbE
	:OE:INPut:WAVLength 1310
	
	:OE:CONFigure:EXRCorrection 1
	:OE:CONFigure:EXRCorrection:FACTor 3.00
		Sets optical input (filter, wavelength, correction factor*)
		
		*Set as necessary so that the Correction Factor becomes the reference Extinction Ratio
		
		Using the MP2110A, the :OE part also operates as :SCOPe

Scope	:DISPlay:ACTive 5	Displays Scope screen

	// with MP2110A
	:SCOPe:TIME:TRACking PPG_CLOCKOUT
	// For more accurate Jitter performance
	// use the :BERT:OUTPut:CLOCk:SOURce:CHANnel command
	// to set the PPG channel used to the same as
	// the Clk Out channel.
	
	// with MP2100B
	:SCOPe:CONFigure:TRACking:DRATe ON
	:SCOPe:CONFigure:TRACking:DRATe:MASTer 0
		[using BERTWave PPG]
		
		Sets so bit rate and trigger clock rate tracked by PPG. For details, refer to section 5.1. AUTOscale.
		
		*Using the MP2110A, for more accurate Jitter performance set the Clk Out channel setting to the same as the PPG channel used.

	// with MP2110A
	:SCOPe:TIME:DATRate 25.78125 Gbps
	:SCOPe:TIME:DIVRatio 4,CLKR
	
	// with MP2100B
	:SCOPe:TIME:DATRate 10.3125 Gbps
	:SCOPe:TIME:DIVRatio 4,CLKR
		[not using BERTWave PPG]
		
		Sets input bit rate and trigger divide ratio. For details, refer to section 5.1. AUTOscale.

4.3. Extinction Ratio and Average Power Adjustment (Optical Scope)

Adjust the Extinction Ratio and Average Power. The Extinction Ratio and Average Power ranges are determined by each standard and ensuring that the settings are within these ranges requires adjustment to the best position while varying the Extinction Ratio and Average Power as described in Table 5.

Table 5 Extinction Ratio and Average Power Adjustment Sequence

Module	Remote Command	Explanation
Optical Scope	:SCOPe:INPut:CHA OFF :SCOPe:INPut:CHB ON :SCOPe:CONFigure:MEASure:CHANnel B	Sets measurement channel to B
	:SCOPe:OPTion:MAX:SAMPles:NUMber 1350 :SCOPe:ACCUmulation:TYPe PERSistency	Sets sampling conditions (Sample Number: 1350, and Persistency)
	:SCOPe:DISPlay:WINDow:Y:DIVision:CHB 200	Sets Y-axis scale to best value
	:SCOPe:CONFigure:MEASure:TYPe AMPTIME	Sets test mode to Amplitude/Time
	:SCOPe:CONF:MEAS:AMPTIME1 CHB, 6 :SCOPe:CONF:MEAS:AMPTIME2 CHB, 8	Selects items displayed on measurement screen (Average Power, Extinction Ratio)
	:SCOPe:SAMPling:STATus RUN	Starts sampling

	// Adjusts DUT and repeats over until
	// measurement result is expected value
	:SCOPe:FETCh:AMPLitude:AVEPower?
	:SCOPe:FETCh:AMPLitude:EXTRatio?
	:SCOPe:DISPlay:WINDow:GRAPhics:CLEar
		Captures measurement results (Average Power, Extinction Ratio) and clears results
		
		Adjusts DUT and repeats over until measurement result is expected value

	:SCOPe:SAMPling:STATus HOLD	Stops sampling

4.4. Optical IF Waveform Test (Optical Scope)

Run the waveform test on the signal output from the optical module optical IF. This is the most important test for confirming the optical module characteristics; it indicates the transceiver connection compatibility in a network and the performance superiority. To confirm that the output optical signal quality meets the standards, evaluate the Mask Margin, Crosspoint, Average Power, Extinction Ratio, and OMA.

Table 6 Optical IF Waveform Test Sequence

Module	Remote Command	Explanation
Optical Scope	:SCOPe:OPTion:MAX:SAMPles:NUMber 1350 :SCOPe:ACCUmulation:TYPe LIMited :SCOPe:ACCUmulation:LIMit WAVeform,100	Sets sampling conditions Sample Number, Limited mode, Captured waveform)
	:SCOPe:CONFigure:MEASure:TYPe AMPMask	Sets measurement items to Amplitude/Time & Mask

	// with MP2110A
	:SCOPe:CONFigure:MASK:RECall "100GbE-LR4_Tx.txt"
	// with MP2100B
	:SCOPe:CONFigure:MASK:TYPe 11 // 10 GbE LAN/PHY
		Specifies Mask file

	// with one channel (B) set as measurement channel
	:SCOPe:INPut:CHA OFF;:SCOPe:INPut:CHB ON
	// with two channels (A and B) set as measurement channels
	:SCOPe:INPut:CHA ON;:SCOPe:INPut:CHB ON
		Sets measurement channel
		*2ch simultaneous measurement requires the phase to be the same at screen copying.

	:SCOPe:DISPlay:WINDow:SCALe:AUTOscale BOTH	Sets AUTOscale Specifying parameters using the AUTOscale command can shorten execution times (about 1 s at BOTH). For details, refer to section 5.1. AUTOscale.
	:SCOPe:SAMPling:STATus RUN // Repeats over until response to STATe? Command is HOLD :SCOPe:SAMPling:STATus?	Runs sampling and waits until completed
	(At 2ch measurement, repeats following over at ChA and ChB) (:SCOPe:INPut:CHA OFF;:SCOPe:INPut:CHB ON)	
	:SCOPe:CONFigure:MEASure:CHANnel B	Sets channel for capturing measurement results
	(:SCOPe:CONFigure:MEASure:AMPTIME 1 CHB, 4 // Crossing) (:SCOPe:CONFigure:MEASure:AMPTIME 2 CHB, 6 // Avg Pow dBm) (:SCOPe:CONFigure:MEASure:AMPTIME 3 CHB, 8 // ExR) (:SCOPe:CONFigure:MEASure:AMPTIME 4 CHB, 15 // OMA mW)	Select the items to display the measurement results (Crosspoint, Average Power (dBm), Extinction Ratio, OMA (mW))
	:SCOPe:CONFigure:MASK:UPDate :SCOPe:MEASure:MASK:MARGin? :SCOPe:FETCh:AMPLitude:CROSsing? :SCOPe:FETCh:AMPLitude:AVEPower? :SCOPe:FETCh:AMPLitude:EXTRatio? :SCOPe:FETCh:AMPLitude:OMA:MW?	Queries measurement results (Mask Margin, Crosspoint, Average Power, Extinction Ratio, OMA)

	// Set COPY command file name to same file name
	// (so as not to compress to BERTWave disk).
	:SCOPe:EYEPulse:PRINt:COPY "screen_data","C:/screen_copy"
	
	// Special read processing is required because the DATA?
	// command response (image data) is binary data.
	// For details, refer to the DATA? command explanation in the Operation Manual.
	:SYSTem:DISPlay:DATA?
		Copies screen and captures image data
		
		*Software versions prior to V3.03/V4.01.01 require specification of :MODule:ID 5 before the COPY command.

4.5. Electrical IF Waveform Test (Electrical Scope)

Run the waveform test on the signal output from the optical module electrical IF. To confirm that the output signal quality meets the standards, evaluate the Jitter, Rise/Fall Times, etc., as described in Table 7.

Table 7　Electrical IF Waveform Test Sequence

Module	Remote Command	Explanation
Electrical Scope	:SCOPe:OPTion:MAX:SAMPles:NUMber 1350 :SCOPe:ACCUmulation:TYPe LIMited :SCOPe:ACCUmulation:LIMit WAVeform,100	Sets sampling conditions (Sample Number: 1350, and Captured Waveform Number)
	:SCOPe:CONFigure:MEASure:TYPe AMPTIME	Sets test mode to Amplitude/Time
	:SCOPe:INPut:CHA ON :SCOPe:INPut:CHB OFF :SCOPe:CONFigure:MEASure:CHANnel A	Sets measurement channel to A
	:SCOPe:DISPlay:WINDow:SCALe:AUTOscale BOTH	Executes AUTOscale Specifying parameters using the AUTOscale command can shorten execution times (about 1 s at BOTH).
	:SCOPe:SAMPling:STATus RUN // Repeats over until response to STATe? Command is HOLD :SCOPe:SAMPling:STATus?	Runs sampling and waits until completed
	(:SCOPe:CONFigure:MEASure:AMPTIME 1 CHA, 9 // Jitter pp) (:SCOPe:CONFigure:MEASure:AMPTIME 2 CHA, 10 // Jitter rms) (:SCOPe:CONFigure:MEASure:AMPTIME 3 CHA, 11 // Tr) (:SCOPe:CONFigure:MEASure:AMPTIME 4 CHA, 12 // Tf)	Select the items to display the measurement results (Jitter (p-p), Jitter (rms), Rise/Fall Times)
	:SCOPe:FETCh:TIME:JITTer:PPeak? :SCOPe:FETCh:TIME:JITTer:RMS? :SCOPe:FETCh:TIME:TRISe? :SCOPe:FETCh:TIME:FTIMe?	Queries measurement results (Jitter (p-p), Jitter (rms), Rise/Fall Times)

	// Set COPY command file name to same file name
	// (so as not to compress to BERTWave disk).
	:SCOPe:EYEPulse:PRINt:COPY "screen_data","C:/screen_copy"
	
	// Special read processing is required because the DATA?
	// command response (image data) is binary data.
	// For details, refer to the DATA? command explanation in the Operation Manual.
	:SYSTem:DISPlay:DATA?
		Copies screen and captures image data
		
		*Software versions prior to V3.03/V4.01.01 require specification of :MODule:ID 5 before the COPY command.

4.6. Optical Rx Sensitivity Test (BERT)

The optical Rx sensitivity test is one of the most important tests for quantifying optical receiver durability; it confirms the minimum optical signal power that can be recognized. In concrete terms, the test measures the BER using the BERT while the optical power is reduced using a variable attenuator. Generally, it is the error-free power at a bit rate of 1 x 10^{-12}. The test procedure is described in Table 8.

Table 8 Optical Rx Sensitivity Test Sequence

Module	Remote Command	Explanation

BERT	// Lowers optical input level to DUT using optical attenuator
	// and repeats following measurement over until no error
	:BERT:ALL:SENSe:MEASure:IMMediate? 10,"ER:TOTal"
		[When estimating BER curve]
		
		MP2110A/MP2100B captures measurement results from measurement start using IMMediate? Command
		
		Fast if measurement time is 10 ms to 3 s

	// Sets measurement time to Single measurement of 100 seconds (1 minute 40 seconds)
	:BERT:SENSe:MEASure:EALarm:MODE SINGle
	:BERT:SENSe:MEASure:EALarm:PERiod 0,0,1,40
	
	// Lowers optical input level to DUT using optical attenuator
	// and repeats following measurement over until no error
	:BERT:ALL:SENSe:MEASure:STARt
	:BERT:ALL:SENSe:MEASure:EALarm:STATe?', '0'
	:BERT:ALL:CALCulate:DATA:EALarm? "CURRent:ER:TOTal"
		[When measuring BER for 3 or more seconds]
		
		Repeats specified Single measurement for measurement time
		
		Using the MP2110A/MP2100B, appending the keyword :ALL to the command executes the same operation for all channels.

5. Speed-up Tips

5.1. AUTOscale

The AUTOscale function built into the BERTWave sampling oscilloscope is the easiest method for displaying the waveform on the screen. As well as automatically adjusting the scale to display the waveform, the AUTOscale function can automatically detect the input signal rate and trigger signal division ratio. However, the following cases partly omit the AUTOscale processing for fast operation speeds.

5.1.1. When using BERTWave PPG

When using the all-in-one PPG as the oscilloscope input signal, the shortest AUTOscale processing is supported by setting the input signal rate and trigger signal division ratio settings to track the PPG settings. In addition, since the rate and division ratio settings are also made only at the PPG side, settings at the oscilloscope side can be omitted, which is a time-saving merit.

Table 9 Scope Tracking Setting Commands

With MP2110A	:SCOPe:TIME:TRACking
With MP2100B	:SCOPe:CONFigure:TRACking:DRATe ON :SCOPe:CONFigure:TRACking:DRATe:MASTer 0

5.1.2. When Input Signal Rate and Trigger Signal Division Ratio Known

When the oscilloscope input signal rate and trigger signal division ratio are already known, the shortest AUTOscale processing is supported by specifying the BOTH parameter at the command to set the bit rate and division ratio and execute AUTOscale so the bit rate and division ratio automatic detection function is not used.

Table 10 Commands when Bit Rate and Trigger Division Ratio Known

Set bit rate	:SCOPe:TIME:DATRate
Set trigger division ratio	:SCOPe:TIME:DIVRatio
Execute AUTOscale	:SCOPe:DISPlay:WINDow:SCALe:AUTOscale BOTH

5.1.3. When Trigger Signal Division Ratio Known

When the oscilloscope input trigger signal division ratio is already known, setting the division ratio automatic detection function to OFF shortens the AUTOscale processing time.

Table 11 Commands when Division Ratio Known

Set division ratio auto-detect function to OFF	:SCOPe:TIME:AUTodetect OFF
Execute AUTOscale	:SCOPe:DISPlay:WINDow:SCALe:AUTOscale

6. Conclusion

This note explains the optimum measurement sequence using the BERTWave for stable and fast measurement of optical modules on production lines. Anritsu provides the best measurement methods to improve customers' manufacturing quality and product competitiveness.

The sample program for actually running the command sequences described in this note is saved at the following path in the BERTWave storage memory. Please use it in conjunction with this note and the Operation Manual.

C:¥Program Files¥Anritsu¥MP2100A¥MX210000A¥Examples¥C#_SCPI_Sample

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Specifications are subject to change without notice.

● **United States**
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 Eletronica Ltda.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 - Bela Vista - Sao Paulo - SP
Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

● **Mexico**
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

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

● **France**
Anritsu S.A.
12 avenue du Québec, Bâtiment Iris 1- Silic 612,
91140 VILLEBON SUR YVETTE, 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.r.l.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

● **Sweden**
Anritsu AB
Kistagången 20B, 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
Kay Fiskers Plads 9, 2300 Copenhagen S, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

● **Russia**
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Moscow, 125009, Russia
Phone: +7-495-363-1694
Fax: +7-495-935-8962

● **Spain**
Anritsu EMEA Ltd.
Representation Office in Spain
Edificio Cuzco IV, Po. de la Castellana, 141, Pta. 5
28046, Madrid, Spain
Phone: +34-915-726-761
Fax: +34-915-726-621

● **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
902, Aurora Tower,
P O Box: 500311- Dubai Internet City
Dubai, United Arab Emirates
Phone: +971-4-3758479
Fax: +971-4-4249036

● **India**
Anritsu India Private Limited
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage,
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

● **Singapore**
Anritsu Pte. Ltd.
11 Chang Charn Road, #04-01, Shriro House
Singapore 159640
Phone: +65-6282-2400
Fax: +65-6282-2533

● **P.R. China (Shanghai)**
Anritsu (China) Co., Ltd.
Room 2701-2705, Tower A,
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, 200233, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

● **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P.R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

● **Japan**
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi, Kanagawa, 243-0016 Japan
Phone: +81-46-296-6509
Fax: +81-46-225-8359

● **Korea**
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, 13494 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

● **Australia**
Anritsu Pty. Ltd.
Unit 20, 21-35 Ricketts Road,
Mount Waverley, Victoria 3149, 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

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