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Test methods of Nx40Gbit/s optical wavelength division multiplexing (WDM) systems

Nx40Gbit/s 光波分复用（WDM）系统测试方法

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Foreword

This standard is formulated with reference to YD/T 1159-2001 “Test methods of optical wavelength division multiplexing (WDM) systems” AND combining with the actual conditions in China.

This standard is used in conjunction with YD/T 1991-2009 “Technical requirements for Nx40Gbit/s optical wavelength division multiplexing (WDM) system”.

Appendix A and Appendix B of this standard are informative.

This standard was proposed by AND shall be under the jurisdiction of the China Communications Standardization Association.

The drafting organizations of this standard: Ministry of Industry and Information Technology Telecommunications Research Institute, ZTE Corporation, Wuhan Institute of Posts and Telecommunications, Shanghai Bell Co., Ltd., Huawei Technologies Co., Ltd.

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Test methods of Nx40Gbit/s optical wavelength division multiplexing (WDM) systems

1 Scope

This standard specifies the test methods of the open N×40Gbit/s optical wavelength division multiplexing (WDM) system, including: system configuration and reference point definition, main optical channel test, optical wavelength converter test, optical wavelength division multiplexer/demultiplexer test, optical amplifier test, dispersion compensator test, FEC test, dynamic power control and gain equalization test, OADM test, monitoring channel test, transmission function and performance test, network management system function verification, APR function verification and so on.

This standard is applicable to the open Nx40Gbit/s optical wavelength division multiplexing (WDM) system. The integrated Nx40Gbit/s optical wavelength division multiplexing (WDM) systems and Nx10Gbit/s optical wavelength division multiplexing (WDM) systems using non-NRZ code patterns may also make reference with this standard.

2 Normative references

The provisions in following documents become the provisions of this Standard through reference in this Standard. For the dated references, the subsequent amendments (excluding corrections) or revisions do not apply to this Standard; however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB/T 20440-2006 Technical requirements of dense wavelength division multiplexer/demultiplexer

YD/T 1159-2001 Test methods of optical wavelength division multiplexing (WDM) system

YD/T 1259-2003 Technical specification for optical safe procedure for wavelength division multiplexing (WDM) system

YD/T 1339-2005 Test methods of metropolitan optical transport network WDM ring

YD/T 1383-2005 Technical requirements for WDM element management system

YD/T 1991-2009 Technical requirements for Nx40Gbit/s optical wavelength division multiplexing (WDM) system

ITU-T G783 Characteristics of synchronous digital hierarchy (SDH)

ITU-T G825 The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)

ITU-T G8251 The control of jitter and wander within the optical transport networks (OTN)

ITU-T G959.1 (2009) Optical transport network physical layer interfaces

3 Symbols and abbreviations

The following symbols and abbreviations apply to this standard.

AIS: Alarm Indication Signal

APR: Automatic Power Reduction

ASE: Amplified Spontaneous Emission

BBE: Background Block Error

BBER: Background Block Error Ratio

BDI: Backward Defect Indication

BER: Bit Error Ratio

BIAES: Backward Incoming Alignment Error Second

DEG: Degraded

DFB: Distributed Feedback

DGD: Differential Group Delay

DPSK: Differential Phase Shift Keying

DP-QPSK: Dual Polarization Quadrature Phase Shift Keying

DQPSK: Differential Quadrature Phase Shift Keying

S: Client Interface Receive Reference Point

SDH: Synchronous Digital Hierarchy

SESR: Severely Errored Second Ratio

SM: Section Monitoring

S_M: Multichannel Source Reference Point

S_n: The n-th Channel Source Reference Point

SQM: Sequence Number Mismatch

SSF: Server Signal Fail

TCM: Tandem Connection Monitor

TTI: Trail Trace Identifier

UAS: Unavailable Second

VCAT: Virtual Concatenation

VcPLM: Virtual Concatenation Payload Mismatch

WDM: Wavelength Division Multiplexing

4 System configuration and reference point definition

The reference configuration of the Nx40Gbit/s WDM system is as shown in Figure 1, wherein the OTU is the optical wavelength converter to achieve 3R function, that is, re-amplification, re-shaping and re-timing; the OMU is the optical multiplexer unit to achieve multiple wavelength multiplexing function; the OA is the optical amplification unit to achieve the signal light field amplification (including dispersion compensation function); the ODU is the optical demultiplexer unit to achieve multiple wavelength demultiplexing function; AND the Tx/Rx is the customer side optical interface.

5.1.1.4 Precautions

It shall pay attention to the following matters during the test:

a) The tested power value is composed of the ASE noise power;

b) Spectral analyzer shall be calibrated by power meter before testing the power.

5.1.2 MPI-S_M Maximum path power difference

5.1.2.1 Definitions

It refers to the difference between the maximum value and the minimum value of the average transmitted optical power of all paths at the reference point MPI-S_M at a given light resolution at the same time.

5.1.2.2 Test configuration

The test configuration is as shown in Figure 2. Test instrument is the spectrum analyzer.

5.1.2.3 Test procedure

FOLLOW the procedures below to conduct test:

a) TEST the output optical power per path in accordance with 5.1.1.3;

b) The difference between the maximum value and the minimum value of the output optical power per path is the maximum path power difference.

5.1.2.4 Precautions

None.

5.1.3 MPI-S_M/S_M total transmit power

5.1.3.1 Definitions

It refers to the total average transmit optical power of all paths at the reference point MPI-S_M/S_M.

5.1.3.2 Test configuration

The test configuration is as shown in Figure 3. Test instrument is the optical power meter.

a) CONNECT the test configuration as shown in Figure 3; SET the spectrum analyzer resolution bandwidth less than 0.1nm;

b) ADJUST the displayed wavelength range of the spectrum analyzer to display the path wavelength to be tested in the middle of the screen;

c) POSITION the cursor at the peak of the wavelength pulse; SELECT this wavelength optical power integration bandwidth as the current path interval; in accordance with the digital display of the instrument, RECORD the optical power value of this wavelength as P_1 (mW); TURN off the light source of the current test path; under the same optical power integration bandwidth, in accordance with the digital display of the instrument to record the optical power value of this wavelength as P_2 (mW);

d) SET the optical power integration bandwidth of the current test path to 0.1 nm; in accordance with digital display of the instrument, RECORD the optical path power value as P_A (mW), then the calculated value of OSNR of this path is OSNR = 10lg ((P_1- P_2) / PA), in the unit of dB;

e) TURN on the light source of the current test path, SELECT the next path successively; PERFORM the steps b) ~ c).

5.1.4.4 Precautions

It shall pay attention to the following matters during the test:

a) The use of signal source turn-off will result in a certain test deviation (ASE power changes after turning off the light source), especially when the wavelength of the initial configuration is less AND at the edge of the band. As for the corresponding change, RECORD, CORRECT and TEST the calculated value during the actual test, with the specific method as shown in Appendix A;

b) For online OSNR test or system concatenation ROADM for the available services, it may also use the spectrometer which supports the 40Gbit/s WDM signal in-band OSNR test function to conduct direct test, with the specific method as shown in Appendix B.

c) For the case where the path interval or the signal spectrum shape does not affect the single path signal power calculation, it may directly use the spectral analyzer which supports the signal integration power automatic calculation to directly and automatically scan the optical signal to noise ratio.

It refers to the polarization mode dispersion value between the reference point MPI-S_M and MPI-R_M, which is expressed by the DGD average value or maximum value, wherein the maximum value is generally taken as 3 times the average value (that is, the probability of the appearance of DGD maximum value is 4.2×10^{-5}).

5.2.2.2 Test configuration

The test configuration is as shown in Figure 5. The test instrument is a modulated broad spectrum light source and a PMD analyzer.

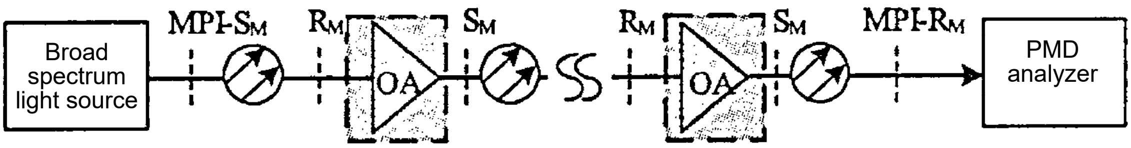


Figure 5 -- Test configuration of MPI-S_M ~ MPI-R_M polarization mode dispersion

5.2.2.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 5; in accordance with the tested band requirements, SET the light source and the band parameters of the CD analyzer;

b) ADJUST the MPI-R_M point power to comply with the PMD analyzer's receiving range; START the PMD analyzer to start the test; RECORD the tested PMD results.

5.2.2.4 Precautions

It shall pay attention to the following matters during the test:

a) For PMD analyzers that do not support the punch-through optical amplifiers, TEST in sections each span line optical fiber and dispersion compensation optical fiber, SQUARE each tested value, directly ADD them together, and SQUARE root it;

b) For the PMD values between the reference points S_n ~ R_n, it may square respectively the PMD value of such elements as the OMU/ODU, optical power amplifiers, and optical preamplifiers AND the PMD value between MPI-S_M and MPI-R_M; directly ADD them together, and SQUARE root it;

b) ADJUST the displayed wavelength range of the spectrum analyzer to display the path wavelength to be tested in the middle of the screen;

c) POSITION the cursor at the peak of the wavelength pulse; SELECT this wavelength optical power integration bandwidth as the current path interval; in accordance with the digital display of the instrument, RECORD the optical power value of this wavelength;

d) In accordance with the step b) and c), TEST and RECORD the input optical power of each optical path.

5.3.1.4 Precautions

It shall pay attention to the following matters during the test:

a) The tested power value is composed of the ASE noise power;

b) Spectral analyzer shall be calibrated by power meter before testing the power.

5.3.2 MPI-R_M maximum path power difference

5.3.2.1 Definitions

It refers to the difference between the maximum value and the minimum value of the average received optical power of all paths at the reference point MPI-R_M at a given light resolution at the same time.

5.3.2.2 Test configuration

The test configuration is as shown in Figure 8. Test instrument is the spectrum analyzer.

5.3.2.3 Test procedure

FOLLOW the procedures below to conduct test:

a) TEST the input optical power per path in accordance with 5.3.1.3;

b) The difference between the maximum value and the minimum value of the input optical power per path is the maximum path power difference.

5.3.2.4 Precautions

None.

5.3.3 MPI-R_M/R_M total received power

a) CONNECT the test configuration as shown in Figure 8; SET the spectrum analyzer resolution bandwidth less than 0.1nm;

b) ADJUST the displayed wavelength range of the spectrum analyzer to display the path wavelength to be tested in the middle of the screen;

c) POSITION the cursor at the peak of the wavelength pulse; SELECT this wavelength optical power integration bandwidth as the current path interval; in accordance with the digital display of the instrument, RECORD the optical power value of this wavelength as P_1 (mW); TURN off the light source of the current test path; under the same optical power integration bandwidth, in accordance with the digital display of the instrument to record the optical power value of this wavelength as P_2 (mW);

d) SET the optical power integration bandwidth of the current test path to 0.1 nm; in accordance with digital display of the instrument, RECORD the optical path power value as P_A (mW), then the calculated value of OSNR of this path is OSNR = 10lg ((P_1- P_2) / PA), in the unit of dB;

e) TURN on the light source of the current test path, SELECT the next path successively; PERFORM the steps b) ~ c).

5.3.4.4 Precautions

It shall pay attention to the following matters during the test:

a) The use of signal source turn-off will result in a certain test deviation (ASE power changes after turning off the light source), especially when the wavelength of the initial configuration is less AND at the edge of the band. As for the corresponding change, RECORD, CORRECT and TEST the calculated value during the actual test, with the specific method as shown in Appendix A;

b) For online OSNR test or system concatenation ROADM for the available services, it may also use the spectrometer which supports the 40Gbit/s WDM signal in-band OSNR test function to conduct direct test, with the specific method as shown in Appendix B.

c) For the case where the path interval or the signal spectrum shape does not affect the single path signal power calculation, it may directly use the spectral analyzer which supports the signal integration power automatic calculation to directly and automatically scan the optical signal to noise ratio.

5.3.5 Optical path OSNR cost

b) ADJUST the adjustable optical attenuator A, so that the error indication of the error analyzer is at about 10^{-7};

c) ADJUST the adjustable optical attenuator A; respectively TEST the optical power corresponding to the reference point S when the error indication is 10^{-8}, 10^{-9}, 10^{-10}, and 10^{-11};

d) In accordance with the extrapolation method (such as least squares method), DRAW the curve corresponding to the received optical power - error rate on the double logarithmic coordinate paper (the ordinate shall take two logarithms AND the abscissa is linear), AND the optical power as corresponding to BER = 1×10^{-12} is the receiving sensitivity.

6.1.1.1.5 Precautions

6.1.1.1.6 It shall pay attention to the following matters during the test:

a) For the case that the service interface is Ethernet, the general relationship between the error rate and the packet loss rate under the uniform distribution of error may be used for the purposes of conversion, that is, the packet loss rate = $1 - (1 - BER)^n$, wherein n is the bit number of the Ethernet frame;

b) Under certain conditions (such as high-volume test, etc.), it may also directly record the optical power value when the error rate of the instrument is 10^{-12} (or critical error-free, observation time for more than 4 min).

6.1.1.2 Overload power

6.1.1.2.1 Definitions

It refers to the maximum acceptable value of the average received optical power at the reference point S when the error rate reaches 10^{-12}.

6.1.1.2.2 Test configuration

The test configuration is as shown in Figure 11. Test instruments include the error analyzer, optical power meter and optical adjustable attenuator, wherein the error analyzer may be of SDH, OTN or data network analyzer based on the business interface.

6.1.1.2.3 Test procedure

6.1.1.2.4 FOLLOW the procedures below to conduct test:

6.1.1.5 Transmission pulse shape (eye pattern template)

6.1.1.5.1 Definitions

The transmitted signal waveform specifies the optical pulse shape characteristics of the transmitter in the form of an eye pattern template, including rise time, fall time, pulse overshoot, and oscillation, etc.

6.1.1.5.2 Test configuration

The test configuration is as shown in Figure 14. Test instruments include the signal generator and communication signal analyzer, wherein the signal generator may be of SDH, OTN or data network analyzer based on the business interface.

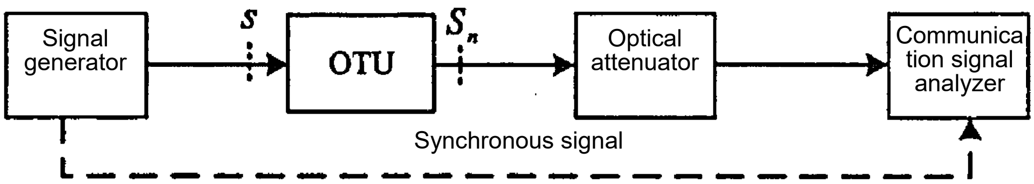


Figure 14 -- Transmitting end eye pattern template/extinction ratio test configuration

6.1.1.5.3 Test procedure

6.1.1.5.4 FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 14;

b) ADJUST the optical attenuator so that the input optical power of the communication signal analyzer is within its dynamic range;

c) ADJUST the communication signal analyzer to turn on the filter corresponding to the tested signal. After the waveform stable, CALL out the corresponding eye pattern template as stored in the communication signal analyzer; ADJUST it to align with the waveform;

d) WAIT for the waveform sample point to accumulate for at least 1000 times; SAVE and RECORD the results.

6.1.1.5.5 Precautions

6.1.1.5.6 It shall pay attention to the following matters during the test:

a) This parameter does not apply to eye pattern templates based on phase modulated signals (e.g. DPSK, P-DPSK, RZ-DQPSK and DP-QPSK, etc.);

b) The communication signal analyzer generally does not support the clock recovery function of the 40Gbit/s optical interface. AND its synchronization signal is provided by the electrical interface of the tested equipment OR the dedicated 40Gbit/s clock recovery module.

6.1.1.6 Extinction ratio

6.1.1.6.1 Definitions

It refers to, under the worst-case reflection conditions, the ratio of the average optical power of logic “1” to the average optical power of logic “0” under the full modulation condition.

6.1.1.6.2 Test configuration

The test configuration is as shown in Figure 14. The test instruments include a signal generator and a communication signal analyzer, wherein the signal generator may be of SDH, OTN or data network analyzer based on the business interface.

6.1.1.6.3 Test procedure

6.1.1.6.4 FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 14;

b) ADJUST the optical attenuator so that the input optical power of the communication signal analyzer is within its dynamic range;

c) ADJUST the communication signal analyzer; after the waveform stable, READ out the extinction ratio value from the instrument.

6.1.1.6.5 Precautions

6.1.1.6.6 It shall pay attention to the following matters during the test:

a) During the test, the filter of the internal reference receiver of the communication signal analyzer is turned off;

b) This parameter does not apply to the signal based on phase modulation (e.g. DPSK, P-DPSK, RZ-DQPSK and DP-QPSK, etc.).

6.1.1.7 Chromatic dispersion tolerance

6.1.1.7.4 FOLLOW the steps below to conduct the test:

a) CONNECT the test configuration as shown in Figure 15 (a);

b) ADJUST the adjustable optical attenuator A and B; TEST the OSNR value of the test path (test method is as shown in Clause 5.3.4.3) when the error display of the error analyzer is 10^{-12} (or critical error-free, observation time for more than 4min); RECORD it as $OSNR_B$;

c) CONNECT the test configuration as shown in Figure 15 (b); SET the polarization mode dispersion as the known tolerance; ADJUST the polarization controller to make the input optical polarization of the PMD simulator as its main polarization;

d) ADJUST the adjustable optical attenuator A and B; TEST the OSNR value of the test path (test method is as shown in Clause 5.3.4.3) when the error display of the error analyzer is 10^{-12} (or critical error-free, observation time for more than 4min); RECORD it as $OSNR_P$;

e) The OSNR cost of the currently set polarization mode dispersion is $OSNR_C$ - $OSNR_B$; AND if the value is greater than or less than the indicator requirement, it shall reduce or increase the set polarization mode dispersion value AND repeat steps d) and e); otherwise, RECORD the polarization mode dispersion value corresponding to this cost value; and MARK it as the polarization mode dispersion test tolerance;

f) SET the chromatic dispersion as the negative threshold of the known tolerance; REPEAT steps d) and e).

6.1.1.7.5 Precautions

6.1.1.7.6 It shall pay attention to the following matters during the test:

a) The specific requirements for the reference bandwidth filter are as shown in Chapter B.3 in ITU-T G959.1 (2009); AND during the actual test, it may also directly use the ODU corresponding to the current path center wavelength to conduct test;

b) Adjustable CD simulator is composed of the optical fiber or other CD devices, AND the chromatic dispersion value can be increased or decreased as required by the test;

c) For the case where the transmitter includes pre-compensation such as electronic dispersion compensation, the test method is to be studied.

6.1.1.8 Polarization mode dispersion tolerance

6.1.1.8.1 Definitions

It refers to the polarization mode dispersion value corresponding to the OSNR cost derived from the first-order polarization mode dispersion at the reference point S_n or between S_n ~ R_n reaching to a specific value (e.g., 1dB), expressed as the average value or the maximum value of DGD, wherein the maximum value is usually taken as 3 times the average value (that is, the probability of occurrence of DGD maximum value is 4.2×10^{-5}).

6.1.1.8.2 Test configuration

The test configuration is as shown in Figure 16. Test instruments include the error analyzer, ASE noise source, light coupler, adjustable attenuator, spectrum analyzer and reference bandwidth filter (realized through ODU), etc., wherein the error analyzer may be of SDH, OTN or data network analyzer based on the business interface.

6.1.1.8.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 16 (a);

b) ADJUST the adjustable optical attenuator A and B; TEST the OSNR value of the test path (test method is as shown in Clause 5.3.4.3) when the error display of the error analyzer is 10^{-12} (or critical error-free, observation time for more than 4min); RECORD it as $OSNR_B$;

c) CONNECT the test configuration as shown in Figure 16 (b); SET the polarization mode dispersion as the known tolerance; ADJUST the polarization controller to make the input optical polarization of the PMD simulator as its main polarization;

d) ADJUST the adjustable optical attenuator A and B; TEST the OSNR value of the test path (test method is as shown in Clause 5.3.4.3) when the error display of the error analyzer is 10^{-12} (or critical error-free, observation time for more than 4min); RECORD it as $OSNR_P$;

e) The OSNR cost of the currently set polarization mode dispersion is $OSNR_P$ - $OSNR_B$; AND if the value is greater than or less than the indicator requirement, it shall reduce or increase the set polarization mode dispersion value AND repeat steps d) and e); otherwise, RECORD the polarization mode dispersion value corresponding to this cost value; and MARK it as the polarization mode dispersion test tolerance;

6.1.1.9.4 Precautions

None.

6.1.1.10 Side-mode suppression ratio

6.1.1.10.1 Definitions

It refers to the ratio of the average optical power of the main longitudinal mode to the optical power of the most significant side mode under the full modulation condition at the worst emission condition.

6.1.1.10.2 Test configuration

The test configuration is as shown in Figure 17. Test instruments include the error analyzer and spectrum analyzer, wherein the error analyzer may be of SDH, OTN or data network analyzer based on the business interface.

6.1.1.10.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 17; SET the operating mode of the spectrum analyzer as DFB; SET the resolution bandwidth as the 0.1nm or less;

b) SET the wavelength range displayed by the spectrometer; ADJUST the amplitude scale of the spectrometer; MAKE the waveform display in the middle of the screen in an appropriate amplitude, in order to facilitate observation and reading;

c) ADJUST the vertical cursor to read the average peak optical power of the main longitudinal mode and the maximum side mode, respectively; CALCULATE the difference of the two powers (in dBm) to obtain the side mode suppression ratio (in dB). For a spectrometer that supports automatic measurement of the side mode suppression ratio, it may directly read out the result.

6.1.1.10.4 Precautions

For some of the modulation pattern spectrums of double (multi) peaks, for the peak at left and right side, respective TEST the SMSR and TAKE the minimum value.

6.1.1.11 Center frequency (wavelength) and offset

6.1.1.11.1 Definitions

The center frequency (wavelength) refers to the actual center frequency (wavelength) of the optical signal emitted at the reference point S_n. The center frequency (wavelength) offset refers to the difference between the nominal center frequency and the actual center frequency (wavelength), which includes the light source shirp, signal bandwidth, SPM broadening, and the effects of temperature and aging.

6.1.1.11.2 Test configuration

The test configuration is as shown in Figure 18. The test instrument is multi-wavelength meter.

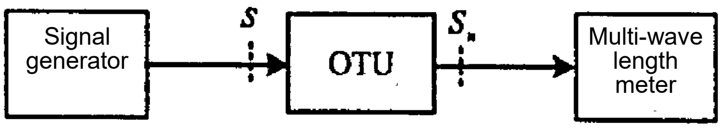


Figure 18 -- Transmitting end center frequency test configuration

6.1.1.11.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 18;

b) SET the frequency (wavelength) range displayed by the multi-wavelength meter; READ out and RECORD the center frequency (wavelength) value at the peak;

c) The difference between the test center frequency (wavelength) and the nominal center frequency (wavelength) is the center frequency (wavelength) offset.

6.1.1.11.4 Precautions

6.1.1.11.5 It shall pay attention to the following matters during the test:

a) It may select the wavelength (nm) or frequency (THz) as the dimension to conduct the test;

b) Wavelength/frequency may also be used to test the center frequency (wavelength) after passing the spectrum analyzer as calibrated by the multi-wavelength meter (the spectrum meter test frequency is at least one order higher above the accuracy as required by the test result), AND the test method is same as the use of the multi-wavelength meter;

recommended for 15 ~ 25 test points); START the instrument to start automatic test;

d) COMPARE the jitter tolerance curve obtained from test with the corresponding jitter tolerance template, to determine if the result is qualified and store it.

6.1.1.12.4 Precautions

For STM-256 or OTU-3 signals, the instruments manufactured earlier may not have built-in jitter tolerance templates that comply with the ITU-T G825 or ITU-T G8251, at this time it requires manual edit of the template complying with standard.

6.1.1.13 Jitter generation

6.1.1.13.1 Definitions

It refers to the inherent jitter of the optical interface output at the reference point S_n when there is no input jitter, AND it is generally observed or measured for a period of 60s.

6.1.1.13.2 Test configuration

The test configuration is as shown in Figure 20. The test instrument is an OTN jitter analyzer.

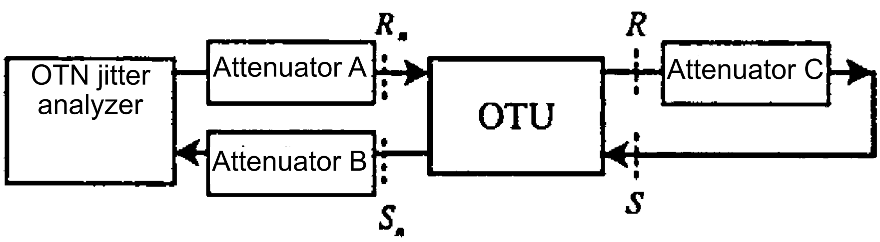


Figure 20 -- Transmitting end jitter generation test configuration

6.1.1.13.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 20;

b) ADJUST the attenuation of the optical attenuators A, B and C, so that the signal power of the jitter analyzer and the OTU is within the dynamic range of the jitter test; SELECT the PRBS of the test signal as 2^{23}-1 or longer; SELECT the path signal structure as ODU3;

c) SET the jitter analyzer to the internal timing mode; ACTIVATE the test item of the jitter tolerance on the jitter analyzer; SELECT the jitter measurement filter as corresponding to ITU-T G8251;

d) TEST the values of B1 and B2, respectively, continuously for not less than 60s; READ and RECORD the maximum peak-to-peak values.

6.1.1.13.4 Precautions

The OTU's S_n/R_n side OTN frame structure is set to the standard FEC mode, AND the instrument shall support the same transmission pattern as that at the S_n/R_n side of the OTU.

6.1.1.14 Jitter transfer function

6.1.1.14.1 Definitions

It refers to the relationship that the ratio between the equipment output signal jitter and the applied input signal jitter changes with the jitter frequency.

6.1.1.14.2 Test configuration

The test configuration is as shown in Figure 21. The test instrument is a jitter analyzer, which may be of SDH or OTN analyzer that supports jitter function analysis based on the service interface.

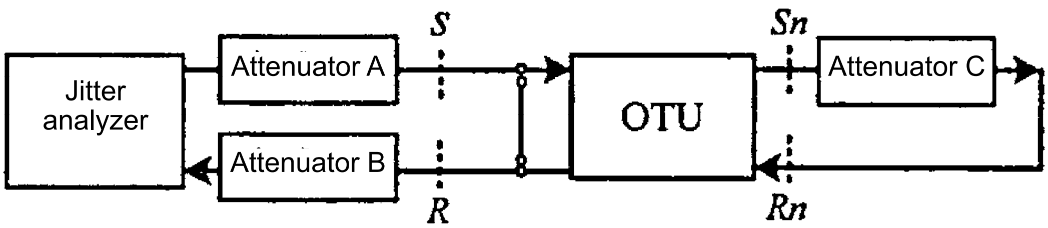


Figure 21 -- Transmitting end jitter transfer function test configuration

6.1.1.14.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 21;

b) SET the jitter analyzer at internal timing mode; SELECT the PRBS of the test signal as 2^{23}-1 or longer; SELECT the path signal structure as VC-4-256C (for SDH signal) or ODU3 (for OTN signal); SELECT the test items of the jitter transfer function on the jitter analyzer; SELECT the jitter tolerance template of ITU-T G783 (for SDH signal) or ITU-T G8251 (for

Figure 22 -- Receiving end receiver sensitivity/overload test configuration

6.1.2.1.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 22; CONFIRM that the error analyzer and R_n point receive the appropriate optical power;

b) ADJUST the adjustable optical attenuator A, so that the error indication of the error analyzer is at about 10^{-7};

c) ADJUST the adjustable optical attenuator A; respectively TEST the optical power corresponding to the reference point S when the error indication is 10^{-8}, 10^{-9}, 10^{-10}, and 10^{-11};

d) In accordance with the extrapolation method, DRAW the curve corresponding to the received optical power - error rate on the double logarithmic coordinate paper (the ordinate shall take two logarithms AND the abscissa is linear), AND the optical power as corresponding to BER = 10^{-12} is the receiving sensitivity.

6.1.2.1.4 Precautions

Same as 6.1.1.1.4.

6.1.2.2 Overload power

6.1.2.2.1 Definitions

It refers to the maximum acceptable value of the average received optical power at the reference point R_n when the bit error rate reaches 10^{-12}.

6.1.2.2.2 Test configuration

The test configuration is as shown in Figure 22. Test instruments include the error analyzer, optical power meter and optical adjustable attenuator, wherein the error analyzer may be of SDH, OTN or data network analyzer based on the business interface.

6.1.2.2.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 22; CONFIRM that the error analyzer and R_n point receive the appropriate optical power;

b) ADJUST the adjustable optical attenuator A, so that the optical power value at the R_n point reaches to the overload power value; if the error analyzer at this time has no error or its error rate is less than or equal to 10^{-12}, RECORD that the overload power is less than the current set power value;

c) If it is required to test the exact value of the overload power, it may further reduce the attenuation value of the adjustable optical attenuator A, until the error rate is close to but less than 10^{-12}.

6.1.2.2.4 Precautions

Same as 6.1.1.2.4.

6.1.2.3 Reflection coefficient

6.1.2.3.1 Definitions

It refers to the ratio of the reflective optical power to the incident optical power at the reference point R_n.

6.1.2.3.2 Test configuration

The test configuration is as shown in Figure 23. The test instrument is a light reflection (return loss) tester.

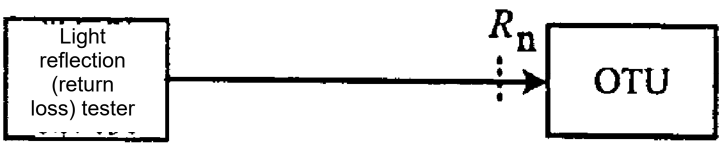


Figure 23 -- Receiving end light reflection coefficient test configuration

6.1.2.3.3 Test procedure

FOLLOW the procedures below to conduct test:

a) SET the wavelength of the light reflection (return loss) tester at the 1550nm window; CALIBRATE the light reflection (return loss) tester;

b) CONNECT the test configuration as shown in Figure 23; SET the OTU as in non-powered state; after the instrument reading is stable, READ and RECORD the reflection coefficient from the light reflection (return loss) tester.

6.1.2.3.4 Precautions

a) The specific requirements of the reference bandwidth filter is as shown in Chapter B.3 of ITU-T G959.1 (2009); AND during the actual test, it may also directly use the ODU as corresponding to the current path center wavelength to conduct test;

b) The R_n point power must be in the normal operating range during the test.

6.1.2.5 Average transmit power

6.1.2.5.1 Definitions

It refers to the average power coupled from the transmitter to the optical fiber at the reference point R.

6.1.2.5.2 Test configuration

The test configuration is as shown in Figure 25. Test instruments include the signal generator and optical power meter, wherein the signal generator may be of SDH, OTN or data network analyzer based on the business interface.

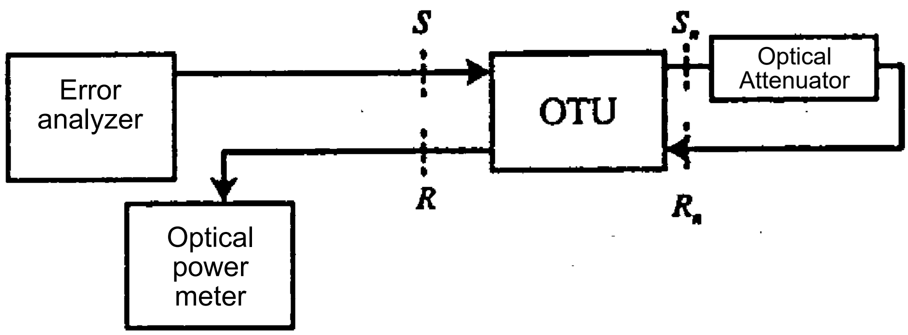


Figure 25 -- Receiving end average transmit power test configuration

6.1.2.5.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 25; SET the OTU to normal operation state;

b) After the reading of the optical power meter is stable, READ and RECORD the power value from the optical power meter.

6.1.2.5.4 Precautions

SELECT correct wavelength window of the power meter.

6.1.2.6 Transmission pulse shape (eye pattern template)

6.1.2.7 Extinction ratio

6.1.2.7.1 Definitions

It refers to, under the worst-case reflection conditions, the ratio of the average optical power of logic “1” to the average optical power of logic “0” under the full modulation condition.

6.1.2.7.2 Test configuration

The test configuration is as shown in Figure 26. The test instruments include a signal generator and a communication signal analyzer, wherein the signal generator may be of SDH, OTN or data network analyzer based on the business interface.

6.1.2.7.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 14;

b) ADJUST the optical attenuator so that the input optical power of the communication signal analyzer is within its dynamic range;

c) ADJUST the communication signal analyzer; after the waveform stable, WAIT for the waveform sample point to accumulate for at least 1000 times; SAVE and RECORD the extinction ratio value.

6.1.2.7.4 Precautions

During the test, the filter of the internal reference receiver of the communication signal analyzer is turned off.

6.1.2.8 Chromatic dispersion tolerance

6.1.2.8.1 Definitions

It refers to the range of chromatic dispersion values corresponding to the OSNR cost at the reference point R that reaches a specific value (e.g., 1dB).

6.1.2.8.2 Test configuration

The test configuration is shown in Figure 27. Test instruments include the OTN error analyzer, adjustable CD simulator and so on.

6.1.2.8.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 27 (a); SET the optical interface at S_n/R_n side as the standard OTN frame format;

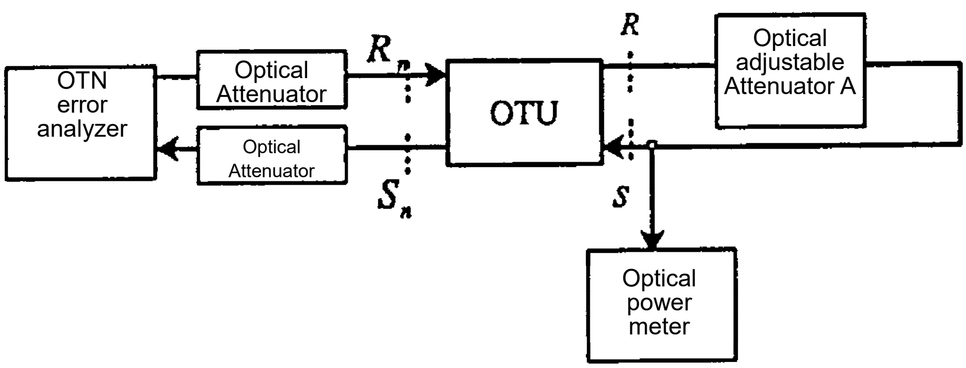
b) ADJUST the adjustable optical attenuator A, so that the error indication of the error analyzer is at about 10^{-7}; respectively TEST the optical power value at the reference point S when the error indication of the error analyzer is 10^{-8}, 10^{-9}, 10^{-10}, and 10^{-11}; then in accordance with the relationship between the optical power and the error rate, EXTRAPOLATE the optical power value as corresponding to the error rate of 10^{-12}; RECORD it as P_1 (dBm);

c) CONNECT the test configuration as shown in Figure 27 (b); SET the chromatic dispersion as the positive critical value of known tolerance;

d) ADJUST the adjustable optical attenuator A, so that the error indication of the error analyzer is at about 10^{-7}; respectively TEST the optical power value at the reference point S when the error indication of the error analyzer is 10^{-8}, 10^{-9}, 10^{-10}, and 10^{-11}; then in accordance with the relationship between the optical power and the error rate, EXTRAPOLATE the optical power value as corresponding to the error rate of 10^{-12}; RECORD it as P_2 (dBm);

e) The power cost as lead in by the currently set chromatic dispersion is P_1 - P_2 (dB); if this cost value is more than or less than the indicator, it may reduce or increase the set chromatic dispersion value; REPEAT the steps d) and e); otherwise, RECORD the dispersion value corresponding to this cost value; IDENTIFY it as the chromatic dispersion test zero critical value;

f) SET the chromatic dispersion as the negative threshold of the known tolerance; REPEAT steps d) and e).



(a) Test configuration of optical receiving sensitivity without chromatic dispersion

The test configuration is as shown in Figure 28. Test instruments include the error analyzer and spectrum analyzer, wherein the error analyzer may be of SDH, OTN or data network analyzer based on the business interface.

6.1.2.10.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 28; SET the operating mode of the spectrum analyzer as DFB; SET the resolution bandwidth as the 0.1nm or less;

b) SET the wavelength range displayed by the spectrometer; ADJUST the amplitude scale of the spectrometer; MAKE the waveform display in the middle of the screen in an appropriate amplitude, in order to facilitate observation and reading;

c) ADJUST the vertical cursor to read the average peak optical power of the main longitudinal mode and the maximum side mode, respectively; CALCULATE the difference of the two powers (in dBm) to obtain the side mode suppression ratio (in dB). For a spectrometer that supports automatic measurement of the side mode suppression ratio, it may directly read out the result.

6.1.2.10.4 Precautions

None.

6.1.2.11 Input jitter tolerance

6.1.2.11.1 Definitions

It refers to the lowest level of phase noise that is tolerable by the optical interface at the reference point R_n, which shall comply with three conditions, that is, it shall be free from alarm, loss of lock and slip code, it shall be free from error, AND its power cost is less than 1 dB.

6.1.2.11.2 Test configuration

The test configuration is as shown in Figure 29. The test instrument is an OTN jitter analyzer.

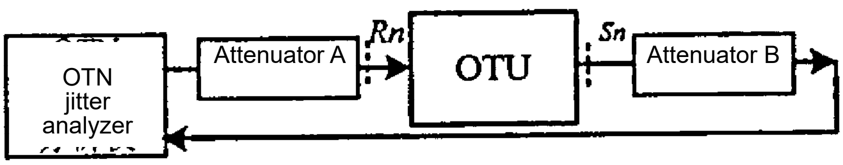


Figure 29 -- Receiving end jitter test configuration

6.1.2.11.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 29;

b) ADJUST the attenuation of the optical attenuators A and B, so that the signal power of the jitter analyzer and the OTU is within the dynamic range of the jitter test; SELECT the PRBS of the test signal as 2^{23}-1 or longer; SELECT the path signal structure as ODU3;

c) SET the jitter analyzer to the internal timing mode; ACTIVATE the test item of the jitter tolerance on the jitter analyzer; SELECT the jitter tolerance template of ITU-T G825; SET appropriate number of test frequency points (it is recommended for 15 ~ 25 test points); START the instrument to start automatic test;

d) COMPARE the jitter tolerance curve obtained from test with the corresponding jitter tolerance template, to determine if the result is qualified and store it.

6.1.2.11.4 Precautions

6.1.2.11.5 It shall pay attention to the following matters during the test:

a) SET the OTN frame structure at the S_n/R_n side of the OTU at the standard FEC mode; AND the instrument shall support the same transmission pattern as the S_n/R_n side of the OTU.

b) For OTU3 signals, the instruments manufactured earlier may not have built-in jitter tolerance templates that comply with the ITU-T G8251, at this time it requires manual edit of the template complying with standard.

c) This applies only to relay type OTU.

6.1.2.12 Jitter generation

6.1.2.12.1 Definitions

It refers to the inherent jitter of the optical interface output at the reference point R when there is no input jitter, AND it is generally observed or measured for a period of 60s.

6.1.2.12.2 Test configuration

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 29;

b) SET the jitter analyzer at internal timing mode; SELECT the PRBS of the test signal as 2^{23}-1 or longer; SELECT the path layer signal structure as ODU3; SELECT the test items of the jitter transfer function on the jitter analyzer; SELECT the jitter tolerance template of ITU-T G8251 (for OTN signal); SET appropriate number of test frequency points (it is recommended for 15 ~ 25 test points);

c) Firstly, DISCONNECT the tested OTU; USE the short-circuit fiber to make the jitter analyzer loopback; ADJUST the optical attenuator so that the receiving signal power of the jitter analyzer is within the range of the jitter test; START the automatic calibration of the jitter transfer function;

d) After calibration, CONNECT the tested OTU; ADJUST the optical attenuator A and B so that the receiving signal power of the jitter analyzer and OTU in the range of jitter test; START the automatic test of the jitter transfer function;

e) COMPARE the jitter tolerance curve obtained from test with the corresponding jitter transfer function template, to determine if the result is qualified and store it.

6.1.2.13.4 Precautions

6.1.2.13.5 It shall pay attention to the following matters during the test:

a) SET the OTN frame structure at the S_n/R_n side of the OTU at the standard FEC mode; AND the instrument shall support the same transmission pattern as the S_n/R_n side of the OTU.

b) For OTU3 signals, the instruments manufactured earlier may not have built-in jitter tolerance templates that comply with the ITU-T G8251, at this time it requires manual edit of the template complying with standard.

c) This applies only to relay type OTU.

6.2 Sub-rate multiplexer optical parameter test

6.2.1 Transmitting end interface parameter test

SEE clause 6.1.1.

6.2.2 Receiving end interface parameters test

SEE clause 6.1.2.

6.3 relay OTU optical parameters test

S_n interface parameters are as shown in clause 6.1.1 AND the R_n interface parameters are as shown in clause 6.1.2.

7 Optical wavelength division multiplexer / demultiplexer test

OMU and ODU tests are as shown in Chapter 8 of the YD/T 1159-2001 and Chapter 5 of the GB/T 20440-2006; AND the comb filter tests shall follow OMU/ODU.

8 Optical amplifier test

SEE Chapter 9 of YD/T 1159-2001,

9 Dispersion compensator test

9.1 CD compensator

9.1.1 Fixed dispersion compensator

The chromate dispersion value test is performed as described in clause 5.2.1, AND the other parameters are tested in accordance with the optical wavelength division multiplexer/Demultiplexer requirements.

For a CD fixed dispersion compensator that does not provide an external accessible interface, the test method is to be studied.

9.1.2 Adaptive dispersion compensator

The compensation range test is as shown in clause 6.1.1.7 (CONNECT the adaptive dispersion compensator after R_n Point). The insertion loss and reflection coefficient are performed in accordance with the requirements of the optical wavelength division multiplexer/demultiplexer. Other parameters are to be studied.

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 24;

b) TURN off the FEC function; TEST the OSNR tolerance in accordance with the clause 6.1.2.4; RECORD it as $OSNR_{OFF}$; RECORD the line rate as B_{OFF};

c) TURN on the FEC function; TEST the OSNR tolerance in accordance with the clause 6.1.2.4; RECORD it as $OSNR_{ON}$; RECORD the line rate as B_{ON}; RECORD the error rate before error correction as ERR_{ON};

d) The FEC coding gain is $OSNR_{OFF}$ - $OSNR_{ON}$ + 10lg (B_{OFF}/B_{ON}), in the unit of dB; AND the error rate critical value before error correction is ERR_{ON}.

10.2.4 Precautions

None.

11 Dynamic power control and gain equalization test

11.1 Path power dynamic control

The specific path power dynamic control test process is determined in accordance with the specific realization method.

During the test, the path power dynamic control process shall not affect the normal operation of the online services of the tuned path and other paths. At the same time, the dynamic adjustment of the path power supports the automatic start and manual start method.

11.2 Line power dynamic control

The specific path power dynamic control test process is determined in accordance with the specific realization method.

During the test, the line power dynamic control shall not affect the normal operation of all path services.

11.3 Dynamic gain equalization

The specific dynamic gain testing process is determined in accordance with the specific realization method.

During the test process, the increase of the number of paths carried in circuits shall not affect the performance of other paths; when the multiple paths are added simultaneously, the system shall not be affected. When the number of paths is increased or decreased during operation, the parameters of the system shall be adjusted automatically AND no other hardware or software changes are required. In the extreme case, for the N-path WDM system, if N-1 multiple paths are lost at the same time, the remaining paths shall restore normal error-free operation within 10ms (specific test may select the monitored path which is respectively the first wave and the last wave).

The adjustment of the gain for optical amplifiers (including EDFA + Raman amplifiers) may be made based on a single optical amplifier or the entire optical multiplexing section. The overall optical signal adjustment completion time of the entire optical multiplexing section shall be less than 5 ~ 10min, including the transmit power of each wavelength, pre-equalization, and the gain adjustment time of all optical amplifiers.

Dynamic gain equalization during the test shall not affect the normal operation of all path services.

12 OADM test

For the FOADM test, SEE Chapter 5 ~ 11 of YD/T 1339-2005.

For the ROADM test, it is to be studied.

13 Supervisory channel test

For the optical supervisory channel (OSC), SEE chapter 10 of YD/T 1159-2001.

For the electrical supervisory channel (ESC), it is to be studied.

14 Transmission function and performance test

14.1 1+1 Protection switching function verification

14.1.1 Definitions

14.3 Error rate test before error correction

14.3.1 Definitions

It refers to the error rate of the system after transmission BUT before FEC error correction, with the monitoring time at least more than 4min.

14.3.2 Test configuration

The test configuration is as shown in Figure 31. Test instrument is the error analyzer, which may be of SDH or OTN analyzer based on the business interface.

14.3.3 Test procedure

FOLLOW the procedures below to conduct test:

a) SELECT the test path; CONNECT the test configuration as shown in Figure 31; CHECK whether the receiving power of each reference point of the instrument and WDM system is within the normal range; AND the error analyzer shall have no warning or error;

b) TURN off the FEC error correction function; START the error analyzer to test the error performance before FEC error correction (the payload bit error is temporarily used for statistics, with the statistical time at least more than 4min); meanwhile START the performance statistics of the network management FEC before error correction;

c) When the FEC performance statistics time before error correction is greater than the set time, RECORD and COMPARE the error rate difference before FEC error correction as counted by the error analyzer and the network management.

14.3.4 Precautions

For different paths, it may conduct random sampling for the test.

14.4 System jitter test

14.4.1 System input jitter tolerance

14.4.1.1 Definitions

It refers to the lowest level of phase noise that is tolerable by the optical interface at the reference point S, which shall comply with three conditions, ITU-T G8251, at this time it requires manual edit of the template complying with standard.

14.4.2 System output jitter

14.4.2.1 Definitions

It refers to the inherent jitter of the optical interface output at the reference point R when there is no input jitter at the point S of WDM system, AND it is generally observed or measured for a period of 60s.

14.4.2.2 Test configuration

Test configuration is as shown in Figure 32. The test instrument is a jitter analyzer, which may be of SDH or OTN analyzer that supports jitter function analysis based on the service interface.

14.4.2.3 Test procedure

FOLLOW the procedures below to conduct test:

a) CONNECT the test configuration as shown in Figure 32; CHECK whether the receiving power of each reference point of the instrument and WDM system is within the jitter test normal range; SELECT the PRBS of the test signal as 2^{23}-1 or longer; SELECT the path layer signal structure as VC-4-256C (for SDH signal) or ODU3 (for OTN signal);

b) SET the jitter analyzer to the internal timing mode; ACTIVATE the test item of the jitter on the jitter analyzer; SELECT the jitter measurement filter corresponding to ITU-T G825 (for SDH signal) or ITU-T G8251 (for OTN signal);

c) TEST the values of B1 and B2, respectively, continuously for not less than 60s; READ and RECORD the maximum peak-to-peak values.

14.4.2.4 Precautions

None.

14.5 Uninterrupted service monitoring function verification

14.5.1 Definitions

It refers to, under the conditions allowing uninterrupted service, that the wavelength division multiplexing terminal station and the line amplifier relay

	- OPUk VCAT sequence number mismatch (OPUk_VCAT_SQM); - OPUk multiplex structure identifier mismatch (OPUk_MSIM)
ODUk sub-layer TCMi alarm	- ODUk TCMi alarm indication signal (ODUk_TCMi_AIS); - ODUk TCMi locked defect (ODUk_TCMi_LCK); - ODUk TCMi open connection indication (ODUk_TCMi_OCI); - ODUk TCMi trace identifier mismatch (ODUk_TCMi_TIM); - ODUk TCMi signal degradation (ODUk_TCMi_DEG); - ODUk TCMi backward defect indication (ODUk_TCMi_BDI); - ODUk TCMi loss of tandem connection (ODUk_TCMi_LTC); - ODUk TCMi server signal fail (OUUk_TCMi_SSF)
ODUk sub-layer PM alarm	- ODUk PM alarm indication signal (ODUk_PM_AIS); - ODUk PM locked defect (ODUk_PM_LCK); - ODUk PM open connection indication (ODUk_PM_OCI); - ODUk PM trace identifier mismatch (ODUk_PM_TIM); - ODUk PM signal degradation (ODUk_PM_DEG); - ODUk PM backward defect indication (ODUk_PM_BDI); - ODUk PM server signal failure (ODUk_PM_SSF)
OTUk sub-layer alarm	- OTUk loss of frame (OTUk_LOF); - OTUk loss of multi-frame (OTUk_LOM); - OTUk alarm indication (OTUk_AIS); - OTUk trace identifier mismatch (OTUk_TIM); - OTUk signal degradation (OTUk_DEG); - OTUk backward defect indication (OTUk_BDI); - OTUk server signal fail (OTUk_SSF); - Excessive error alarm before FEC error correction; - Excessive error alarm after FEC error correction;
OCh sub-layer alarm	- OCh layer payload loss of signal (OCH_LOS_P) (optional); - OCh layer payload forward defect indication (OCH_FDI_P) (optional); - OCh layer overhead forward defect indication (QCH_FDI_O) (optional); - OCh layer open connection indication (OCH_OCI) (optional); - OCh layer forward defect indication (OCH_FDI) (optional); - OCh layer server signal fail (OCH_SSF) (optional); - OCh layer payload server signal failure (OCH_SSF_P) (optional); - OCh layer overhead server signal failure (OCH_SSF_O) (optional); - Input optical power excessive; - Output optical power excessive; - Laser transmission failure; - Laser life pre-alarm (optional); - Laser backlight power alarm (optional); - Laser temperature excessive (optional); - Laser cooling current excessive (optional);

Table 3 (continued)

OTN management sub-layer	Alarm and maintenance signal parameter
OMS layer alarm	- OMS layer payload loss of signal (OMS_LOS_P) (optional); - OM overhead backward defect indication (OMS_BDI_O) (optional); - MS payload backward defect indication (OMS_ BDI_P) (optional); - OMS overhead forward defect indication (OMS_ FDI_O) (optional); - OMS payload forward defect indication (OMS_FDI_P) (optional); - OMS backward defect indication (OMS_BDI) (optional); - OMS forward defect indication (OMS_FDI) (optional);

section performance	- SM background block error ratio (SM-BBER) (optional): - SM backward input alignment error second (SM-BIAES); - SM errored second (SM-ES); - SM severely errored second (SM-SES); - SM severely errored second ratio (SM-SESR) (optional); - SM unavailable second (SM-UAS); - SM far end background block error (SM-FEBBE); - SM far end background block error ratio (SM-FEBBER) (optional); - SM input alignment errored second (SM-IAES); - SM far end errored second (SM-FEES); - SM far end severely errored second (SM-FESES); - SM far end severely errored second ratio (SM-FESESR) (optional); - SM far end unavailable second (SM-FEUAS); - Error rate before FEC error correction (support FEC's OTU); - Error rate after FEC error correction (support FEC's OTU);
OCh sub-layer performance	- Input optical power: - Output optical power; - Laser bias current; - Laser cooling current; - Laser operating current; - laser temperature;

16 APR function verification

SEE Chapter 6 of YD/T 1259-2003.

Appendix A

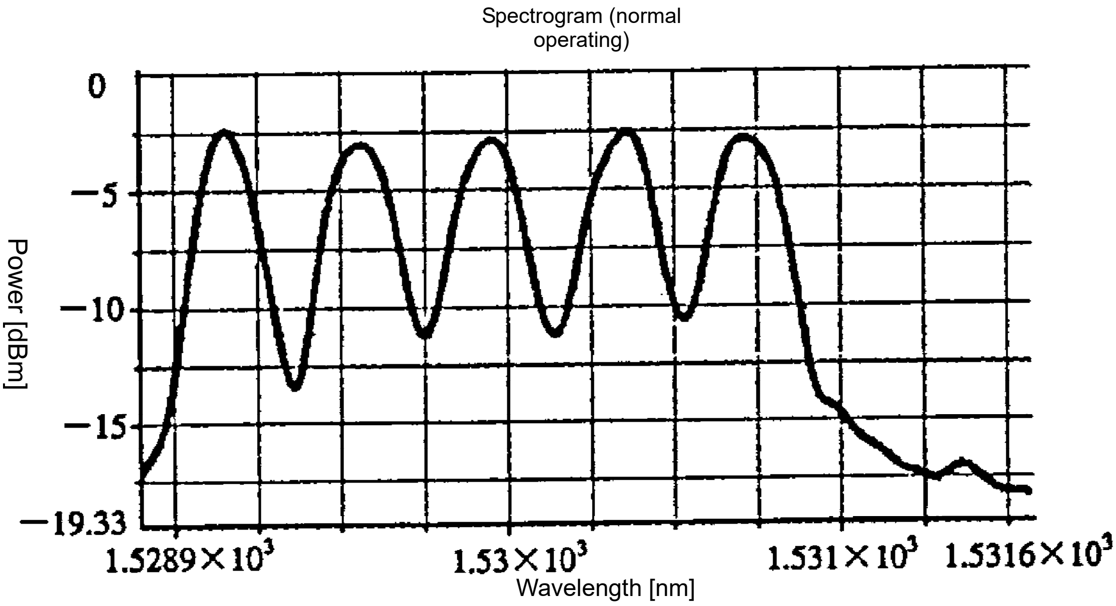
(Informative)

Deviation calibration of OSNR test by light source turning off method

A.1 Deviation analysis of OSNR test by light source turning off method

When the OSNR is tested with the light source turning off method, since after turning off the light source of the current test path, the distribution of ASE noise spectrum of the optical amplifier will change slightly, as shown in Figure A.1, AND this change is especially apparent when the number of wavelengths configured for the current optical path is less (less than 10 waves) OR when it is located at the edge of C band. Therefore, the noise power measured in accordance with the methods of 5.1.4 and 5.3.4 is generally greater than the actual noise power before the light source of the measured path is turned off, resulting in a deviation of the OSNR test value from the actual value.

This Appendix provides two methods for correcting the OSNR test deviation, that is, the absolute correction method and the relative correction method.



(a) Spectrogram when the 3rd wave of the tested path in normal operation

Figure A.3 -- Correction power test after turning off the light source

A.3 Correction by relative method

The relative correction method refers to the correction of OSNR value by correcting the noise power through using the noise relative change amount.

The specific calibration steps are as follows:

a) Before turning off the light source of the tested path, respectively TEST the power value of the point A and point B at the center wavelength ± a (a is 0.3 for the 50 GHz path interval; AND a is 0.5 for the 100GHz path interval) nm wavelength of the tested path; RECORD them as P_A and P_B, in the unit of mW, as shown in Figure A.2.

b) After turning off the light source of the tested path, respectively TEST the power value of the point A' and point B' at the center wavelength ± a (a is 0.3 for the 50 GHz path interval; AND a is 0.5 for the 100GHz path interval) nm wavelength of the tested path; RECORD them as P_A' and P_B', in the unit of mW, as shown in Figure A.3.

c) The absolute change R of the ASE reference noise (0.1 nm bandwidth) of the tested path before and after turning off the light source is as shown in Equation (A.3):

$$R = \frac{P_A + P_B}{P_A^{'} + P_B^{'}} \tag{A.3}$$

The calibration of the OSNR calculation equation in 5.1.4 and 5.3.4 based on the ASE change amount R is as shown in equation (A.4):

$$OSNR = 10 \times \lg\left((P_1 - P_2) / ((P_A/2) \times R)\right) \tag{A.4}$$

In order to further improve the accuracy of OSNR calculation, it is recommended to take the geometric mean of the R value after several tests.

extinction. The commercially available spectrum analyzer, which supports in-band OSNR test, mainly solves the impact of PMD and PDL on OSNR test accuracy by means of narrowband optical filtering techniques.

The disadvantage of the polarization extinction in-band OSNR measurement method is the need to adjust the polarization controller for many times AND traverse the input signal polarization state, in order to achieve polarization extinction, AND the number of adjustment of the polarization state may reach tens to hundreds of times, so the measurement time is longer, AND the accuracy and measurement repeatability are relatively poor.

B.3 Polarization extinction in-band OSNR measurement method

The basic steps of the polarization extinction in-band OSNR measurement method are as follows:

a) CONNECT the test configuration as shown in Figure 7; SET the operating mode of the spectrum analyzer as in-band OSNR;

b) ADJUST the display wavelength range of the spectrum analyzer; DISPLAY all the path wavelengths to be tested on the screen;

c) PERFORM the in-band OSNR test function of the spectrum analyzer; SCAN all the paths to be tested in turn; DISPLAY the wavelengths of each tested path, the signal power, the noise power and the OSNR value on the spectrum analyzer;

d) RECORD the OSNR value of each path to be tested.

__________ END __________

------ The End ------