IEC 62343-5-1

Edition 2.0   2014-11

INTERNATIONAL
STANDARD

colour
inside

Dynamic modules –
Part 5-1 Test methods – Dynamic gain tilt equalizer – Gain tilt settling time
measurement

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**Part 5-1 Test methods – Dynamic gain tilt equalizer –
Gain tilt settling time measurement**

FOREWORD

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International Standard IEC 62343-5-1 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2009. It constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

a) change in the title

b) changes in performance parameter names.

The text of this standard is based on the following documents:

CDV	Report on voting
86C/1249/CDV	86C/1277/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62343 series, published under the general title *Dynamic Modules*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

DYNAMIC MODULES –

Part 5-1 Test methods – Dynamic gain tilt equalizer – Gain tilt settling time measurement

1 Scope

This part of IEC 62343 contains the measurement method of gain tilt settling time for a dynamic gain tilt equalizer (DGTE) to change its gain tilt from an arbitrary initial value to a desired target value.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62343, *Dynamic modules – General and guidance*

IEC 62343-1-3, *Dynamic modules – Part 1-3: Performance standards – Dynamic gain tilt equalizer (non-connectorized)*

3 Terms, definitions, abbreviations and response waveforms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62343 and IEC 62343-1-3 and the following apply.

3.1.1
T_c
convergence time
time to converge from the first hit at the target $\pm Y$ % to the stay within the deviation $\pm Y$ % in the optical power from the output port of DGTE at pre-determined wavelength

3.1.2
T_l
latency time
<direct and analogue control types> time between the application of control signal and the change in output optical power by $\pm X$ % of the initial power of DGTE at pre-determined wavelength

3.1.3
T_p
processing time
<digital control type> time between the application of control command and the change in output optical power by $\pm X$ % of the initial power of DGTE at pre-determined wavelength

3.1.4
gain tilt settling time
$(T_l$ or $T_p) + T_r + T_c$

3.1.5

T_r

rise time

time to change from the initial $\pm X$ % to the target $\pm Y$ % in the optical power from the output port of DGTE at pre-determined wavelength

3.1.6

T_s

settling time

time to be suppressed from the first hit at the target $\pm Y$ % to the final stay at the target within a required resolution of the optical power from the output port of DGTE at pre-determined wavelength

3.2   Abbreviations

CPU	central processing unit
DGTE	dynamic gain tilt equalizer
DUT	device under test
LCD	liquid crystal display
O/E	optical-to-electrical
PDL	polarization dependent loss
TLS	tuneable laser source
WDM	wavelength division multiplexing

3.3   Response waveforms

The definitions and symbols defined in 3.1 are shown in Figure 1, Figure 2 and Figure 3.
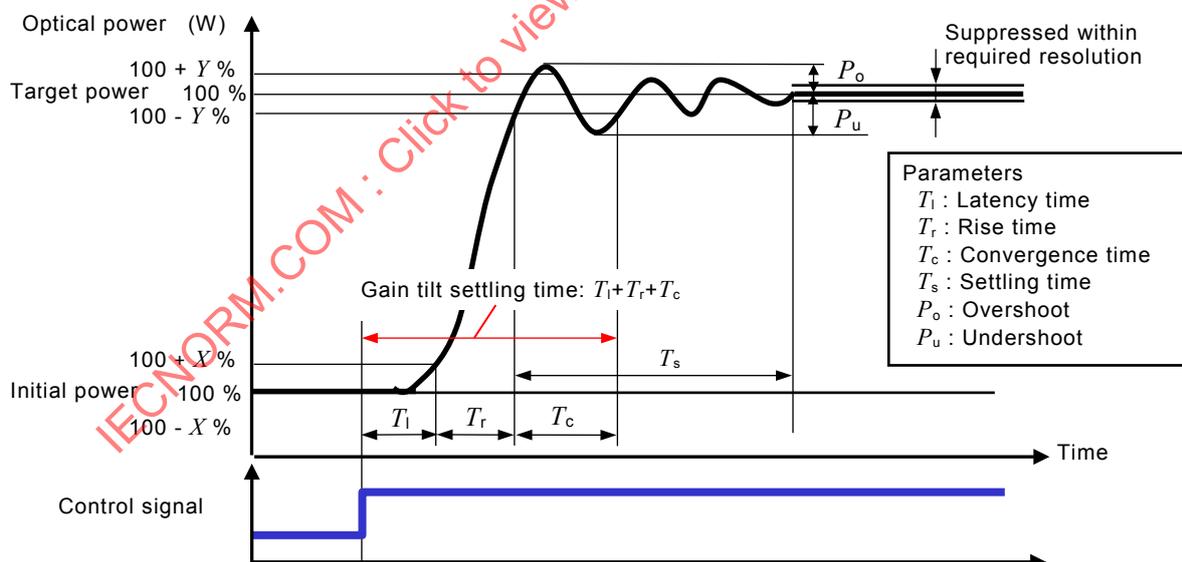
Figure 1 – Response waveforms for direct control DGTEs

Optical power (W)

100 + Y %
Target power   100 %
100 - Y %

Suppressed within required resolution

P_o

P_u

Parameters
T_p : Processing time
T_r : Rise time
T_c : Convergence time
T_s : Settling time
P_o : Overshoot
P_u : Undershoot

Gain tilt settling time: $T_\text{p}+T_\text{r}+T_\text{c}$

T_s

100 + X %
Initial power   100 %
100 - X %

T_p T_r T_c

Time

Command

Figure 2 – Response waveforms for digital control DGTEs

Optical power (W)

100 + Y %
Target power   100 %
100 - Y %

Suppressed within required resolution

P_o

P_u

Parameters
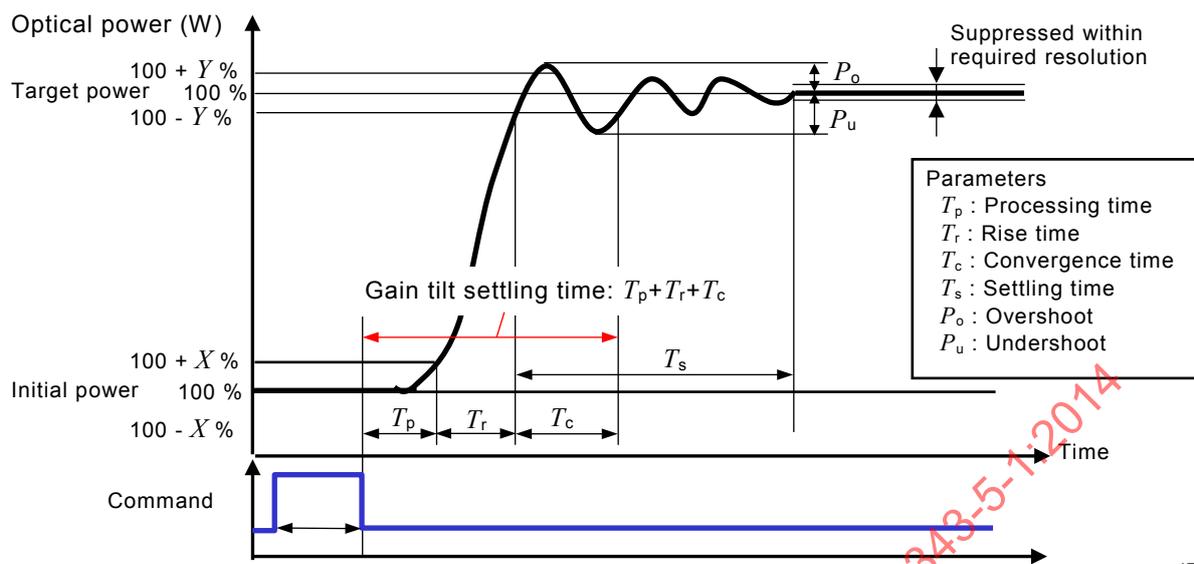T_l : Latency time
T_r : Rise time
T_c : Convergence time
T_s : Settling time
P_o : Overshoot
P_u : Undershoot

Gain tilt settling time: $T_l+T_\text{r}+T_\text{c}$

T_s

100 + X %
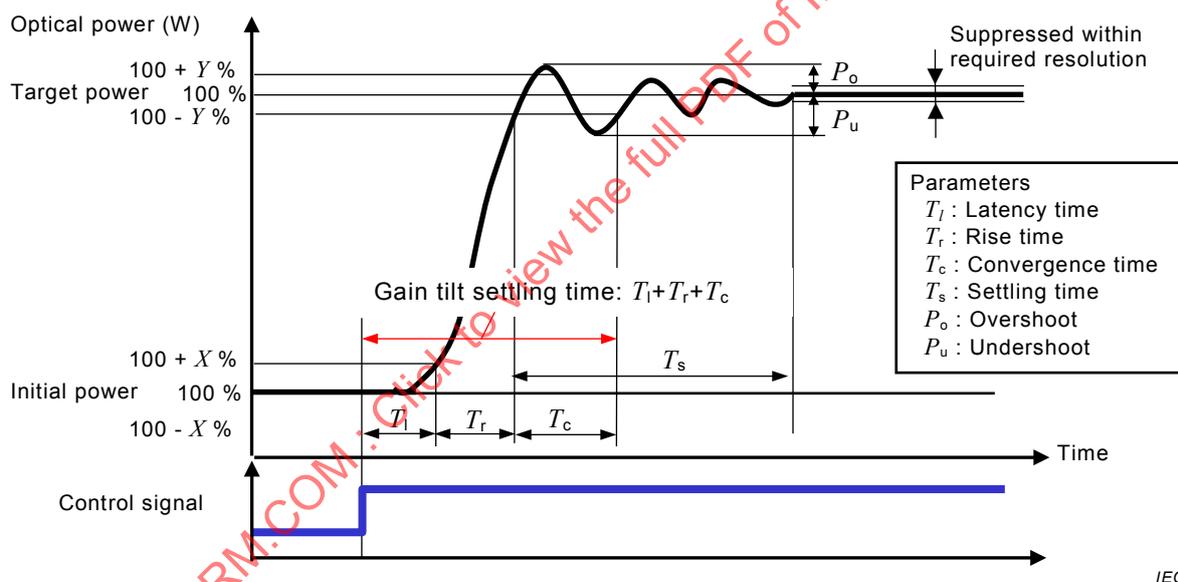Initial power   100 %
100 - X %

T_l T_r T_c
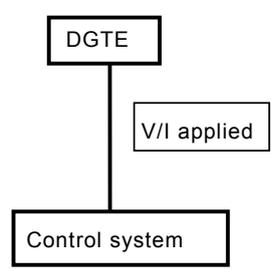
Time

Control signal

Figure 3 – Response waveforms for analogue control DGTEs

4   General information

The DGTE is categorized into three control methods as shown in Table 1. The direct control type is driven directly by voltage or current; the digital control type is operated by digital control system with digital signals; and the analogue control type is operated by analogue signals. The definition and the measurement method of gain tilt settling time for DGTE are different for the three control types. Table 1 also shows the configuration of operating systems and the correction for temperature dependency for three control types of DGTE. When the gain tilt settling time for the DGTE has temperature dependency, users may need to calibrate the temperature effect. The bottom row in Table 1 indicates the typical methods of the correction for temperature dependency (refer to Annex D).

Table 1 – Categorization of DGTE by the control method

	Direct control	Digital control	Analogue control
Control	By voltage or current directly	By command through digital circuit	By voltage or current through analogue circuit
Configurations	DGTE — V/I applied — Control system	DGTE w/digital circuit — Command (Rs232c, I2C, etc.) — Control system	DGTE w/analogue circuit — V/I control (ex.0~+5V) — Control system
Correction for temperature dependency	By control system	By digital circuit or control system	By analogue circuit or control system
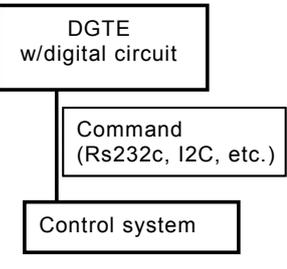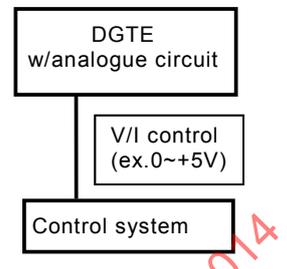
5 Apparatus

5.1 Light source

A tuneable wavelength device is used as the light source. A tuneable laser source (TLS) or a combination of a broadband light source and tuneable filter is the typical equipment of tuneable wavelength light source. The tuning range of the tuneable wavelength light source shall be enough to cover the operating wavelength of DGTE to be measured.

In order to minimise the measurement uncertainty caused by the linewidth of the light source, the linewidth multiplied by the maximum value of the gain tilt slope of DGTE shall be smaller than one tenth of the dynamic gain tilt range. Typical value of operating wavelength range and dynamic gain tilt range of DGTE are 35 nm and ±4 dB respectively. For example, the error for the linewidth of 1 nm is calculated as:

$$1 \times \left\{ \frac{4/35}{[+4-(-4)]} \right\} = 1,4\% \tag{1}$$

The output power of the light source shall remain stable during the measurement. The stability of the output power during the gain tilt settling time of DGTE to be measured shall be smaller than one tenth of dynamic gain tilt range of DGTE.

If the polarization dependent loss (PDL) of DGTE to be measured is larger than 0,5 dB, a depolarized light source shall be used.

5.2 Pulse generator

A pulse generator is used to drive DGTE to be measured. The shape of the pulse shall be rectangular to change the gain tilt. The intensity and width of the pulse shall be such to make the maximum tilt change defined as the specification of DGTE. The rise time/fall time of the rectangular pulse shall be shorter than 10 ns or one tenth of the rise time/fall time to be measured.

5.3 O/E converter

An O/E converter is used to convert the optical output power of DGTE to be measured to the electrical power to be observed by an oscilloscope. The bandwidth of O/E converter shall be from DC to greater than $10(1/T_r)$ Hz, where T_r is the rise time to be measured.

The maximum power input to the O/E converter before compression shall be 10 times more than the optical power to be measured.

5.4 Temperature and humidity chamber

The test setup shall include an environmental chamber capable of producing and maintaining the specified temperature and/or humidity.

5.5 Oscilloscope

The oscilloscope shall have a storage function and sufficient bandwidth and accuracy. It shall have at least two traces.

5.6 Temporary joints

This is a method, device, or mechanical fixture for temporarily aligning two fibre ends into a reproducible, low loss joint. It may be, for example, a precision V-groove vacuum chuck, micromanipulator or a fusion or mechanical splice. The stability of the temporary joint shall be compatible with the measurement precision required.

5.7 Control system

For the digital and the analogue control types, the control system is used to drive the DGTE. The specification is defined individually.
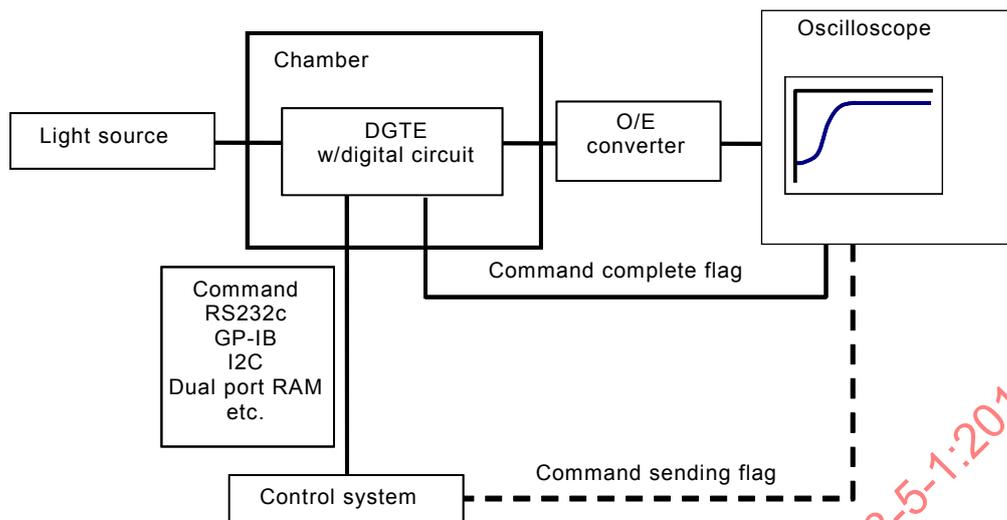
5.8 Measurement setup

The measurement setups for the three types of DGTE in Table 1 are shown in Figure 4, Figure 5 and Figure 6, respectively. For each type of control, a correction signal from the O/E converter output is applied to the DGTE.
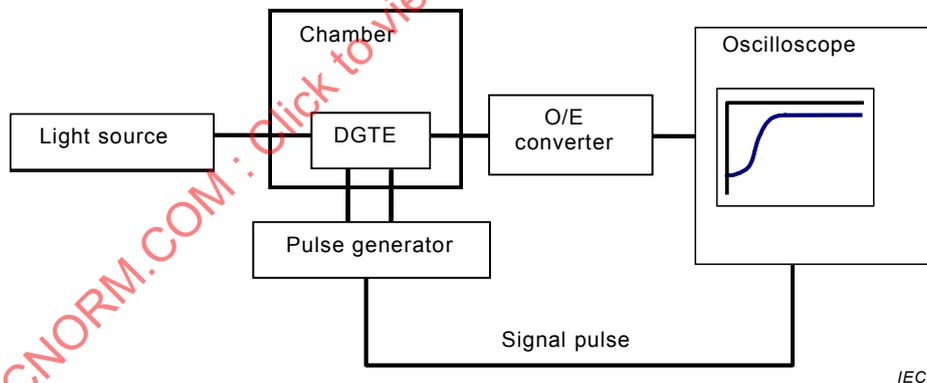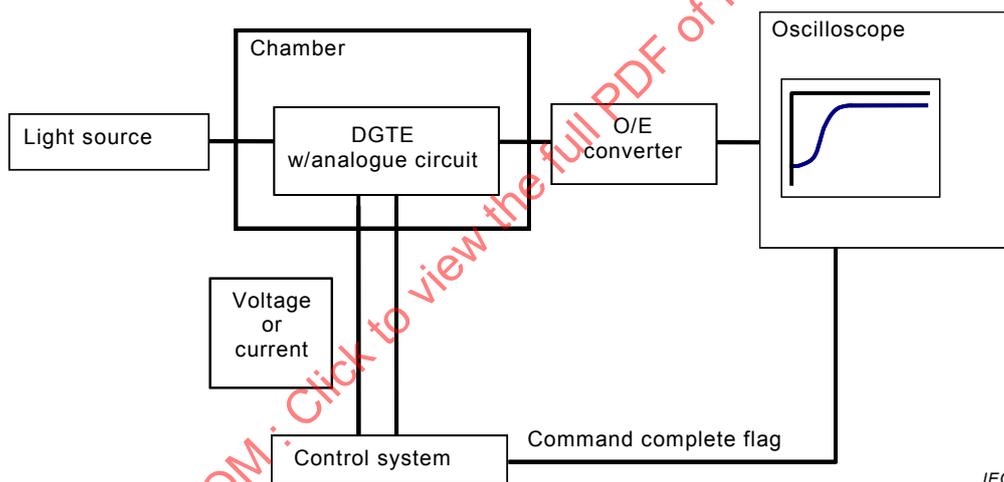

IEC

Figure 4 – Measurement setup for direct control

NOTE   Either command complete flag or command sending flag can be used

Figure 5 – Measurement setup for digital control

NOTE   The control system provides a step signal to the DGTE.

Figure 6 – Measurement setup for analogue control

6   Procedure

6.1   Direct control type

6.1.1   Setup

The measurement setup is shown in Figure 4. The temperature after setting shall be kept stabilized and uniform in the chamber for the stable measurement. The light source, the pulse generator, the O/E converter and the oscilloscope shall be turned on for the measurement.

6.1.2   Preparation

Before starting the measurement, the setup shall be held constant for more than 1 h for stabilization.

6.1.3 Wavelength setting

The wavelength of the light source shall be set at the measuring wavelength. The measurement shall take place at three wavelengths: shortest, centre and longest wavelengths in the operating wavelength range. An alternative method is to measure at the wavelength at the maximum deviation in insertion loss.

6.1.4 Pulse generator setting

The voltage or current to drive from the minimum (maximum) tilt to maximum (minimum) shall be set. The minimum and the maximum states of tilt occur when the deviation in insertion loss takes the maximum value at the shortest or the longest wavelength within the operating wavelength.

6.1.5 Applying the driving pulse

The driving pulse shall be applied to the DGTE to be measured by the pulse generator.

6.1.6 Monitoring and recording the output signal from DGTE under test (DUT)

The output signal from the O/E converter shall be monitored by the oscilloscope and the data shall be recorded. In addition, the signal pulse from the pulse generator shall be monitored and recorded.

6.1.7 Calculation of the gain tilt settling time

After the measurement at three wavelengths, the gain tilt settling time shall be calculated according to Figure 1. Generally, the gain tilt settling time is defined as the maximum value among the three gain tilt settling times.

6.2 Digital control type

6.2.1 Setup

The measurement setup is shown in Figure 5. The temperature after setting shall be kept stabilized and uniform in the chamber for the stable measurement. The light source, the digital control system, the O/E converter and the oscilloscope shall be turned on for the measurement.

6.2.2 Preparation

Before starting the measurement, the setup shall be turned on for more than 1 h for stabilization.

6.2.3 Wavelength setting

The wavelength of the light source shall be set at the measuring wavelength. The measurement shall take place at three wavelengths: shortest, centre and longest in the operating wavelength range. An alternative method is to measure at the wavelength at the maximum deviation in insertion loss.

6.2.4 Sending command

The command to operate from the minimum (maximum) tilt to maximum (minimum) shall be set. The minimum and the maximum states of tilt are given when the deviation in insertion loss takes the maximum value at the shortest or the longest wavelength within the operating wavelength. After the setting, the command shall be sent from the control system.

6.2.5 Monitoring and recording the command complete flag

The output signal from the O/E converter and the command complete flag from the DUT shall be monitored by the oscilloscope and the data shall be recorded. The command sending flag from the control system, which may be substituted for the command complete flag from DUT if not available, shall also be monitored and recorded.

6.2.6 Calculation of the gain tilt settling time

After the measurement at three wavelengths, the gain tilt settling time is calculated according to Figure 2. Generally, the gain tilt settling time is defined as the maximum value among the three gain tilt settling times.

6.3 Analogue control type

6.3.1 Setup

The measurement setup is as shown in Figure 5. The temperature shall be kept stabilized and constant in the chamber for the measurement. The light source, the analogue control system, O/E converter and oscilloscope shall be turned on for the measurement.

6.3.2 Preparation

Before starting the measurement, the setup shall be turned on for more than 1 h for stabilization.

6.3.3 Wavelength setting

The wavelength of the light source shall be set at the measuring wavelength. The measurement shall take place at three wavelengths: shortest, centre and longest wavelengths in the operating wavelength range. An alternative method is to measure at the wavelength at the maximum deviation in insertion loss.

6.3.4 Applying the control signal

The control signal to operate from the minimum (maximum) tilt to maximum (minimum) tilt shall be set. The minimum and the maximum states of tilt occur when the deviation in insertion loss takes the maximum value at the shortest or the longest wavelength within the operating wavelength. After the setting, the signal shall be sent from the control system.

6.3.5 Monitoring and recording the command complete flag

The output signal from the O/E converter shall be monitored by the oscilloscope and the data recorded. Also, the command complete flag from the control system shall be monitored and recorded.

6.3.6 Calculation of the gain tilt settling time

The gain tilt settling time is calculated according to Figure 3. After the measurement at three wavelengths, the gain tilt settling time is calculated. Generally, the gain tilt settling time is defined as the maximum value among the three gain tilt settling times.

7 Details to be specified

7.1 Apparatus

7.1.1 Light source

These characteristics of the light source shall be specified:

– spectral width

– state of polarization

– output power

7.1.2   Pulse generator

These characteristics of the pulse generator shall be specified:

– rising time

– pulse width

– pulse intensity

7.1.3   O/E converter

These characteristics of the O/E convertor shall be specified:

– response frequency

– dynamic range

7.1.4   Control system

These characteristics of the control system shall be specified:

– type of control system

– type of interface

7.2   Measurement conditions

These measurement conditions shall be specified:

– wavelength

– deviation of tilt

– insertion loss deviation at the measuring wavelength

– temperature of chamber

– tolerance of target insertion loss deviation

Annex A
(informative)

Convergence criterion

A DGTE used in an optical amplifier converts input signals with time-varying gain tilt into output signals in which gain tilt is nominally flat. A required flatness for multichannel EDFAs for WDM systems is typically $\pm 0,5$ dB for each spectral band. Therefore, the gain tilt settling time of the DGTE is recommended to be defined as the convergence to $\pm 0,5$ dB [$\cong(\pm 10\ \%)$] from target attenuation.