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INTERNATIONAL STANDARD

Dynamic modules – Test methods –
Part 5-1: Dynamic gain tilt equalizer – Response time measurement

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

FDIS	Report on voting
86C/883/FDIS	86C/899/RVD

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 of IEC 62343 series, published under the general title *Dynamic modules – Test methods,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn,
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- amended.

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

DYNAMIC MODULES – TEST METHODS –

Part 5-1: Dynamic gain tilt equalizer – Response time measurement

1 Scope and general information

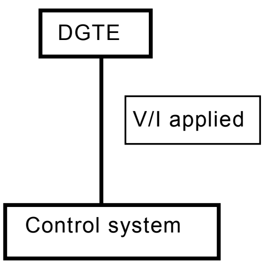
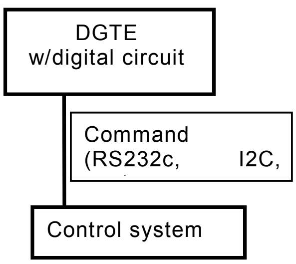
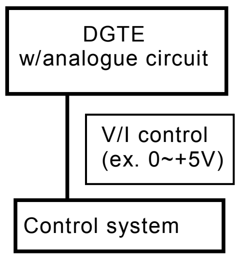
1.1 Scope

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

1.2 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 response time for DGTE are different for the three control types. Table1 also shows the configuration of operating systems and the correction for temperature dependency for three control types of DGTE. When the response 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			
Correction for temperature dependency	By control system	By digital circuit or control system	By analogue circuit or control system

2 Terms, definitions, abbreviations and response waveforms

2.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1.1
convergence time
T_c
time to converge from the first hit at the target ±Y % to the stay within the deviation ±Y % in the optical power from the output port of DGTE at pre-determined wavelength

2.1.2
latency time
T_l
for the direct and the analogue control types, time between the application of control signal and the change in optical power by ±X % from the output port of DGTE at pre-determined wavelength

2.1.3
processing time
T_p
for the digital control type, time between the application of control command and the change in optical power by ±X % from the output port of DGTE at pre-determined wavelength

2.1.4
response time
(T_l or T_p) + T_r + T_c

2.1.5
rise time
T_r
time to change from the initial ±X % to the target ±Y % in the optical power from the output port of DGTE at pre-determined wavelength

2.1.6
setting time
T_s
time to be suppressed from the first hit at the target ±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

2.2 Abbreviations

CPU	Central processing unit
DGTE	Dynamic gain tilt equalizer
DUT	Device under test
O/E	Optical-to-electrical
PDL	Polarization dependent loss
TLS	Tunable laser source
WDM	Wavelength division multiplexing

2.3 Response waveforms

The definitions and symbols defined in 2.1 are shown in Figures 1 through Figure 3.

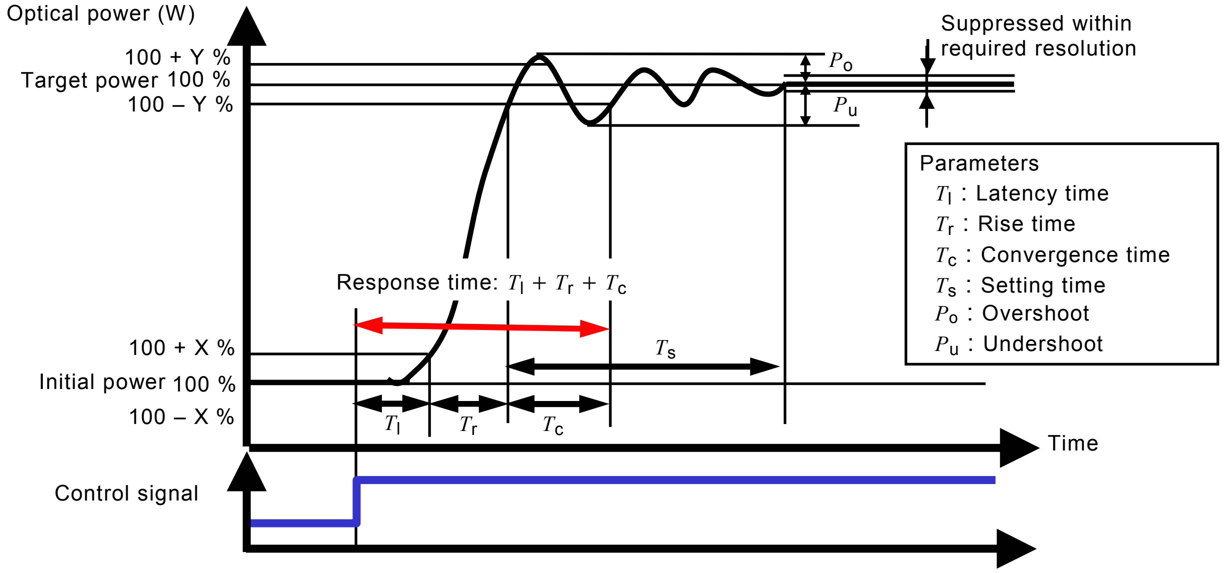


Figure 1 – Response waveforms for direct control DGTEs

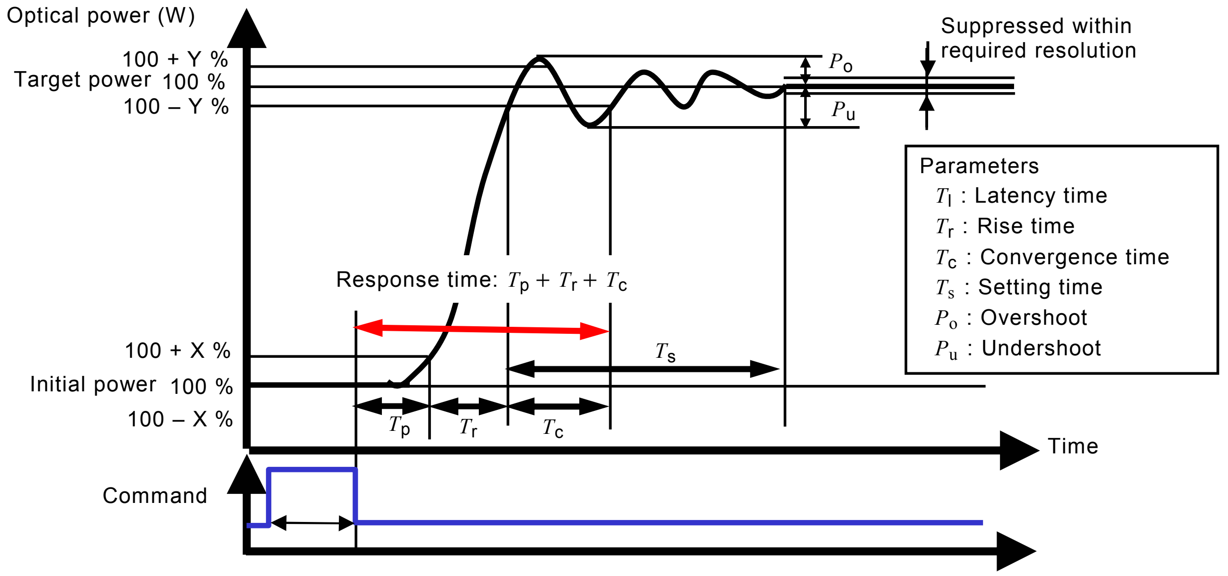


Figure 2 – Response waveforms for digital control DGTEs

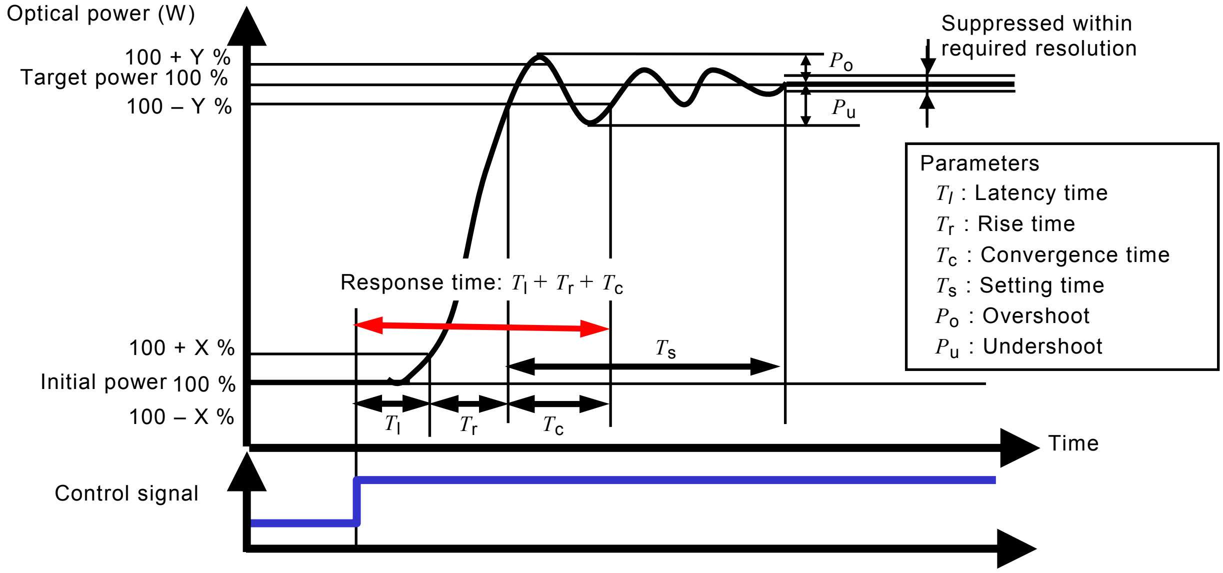


Figure 3 – Response waveforms for analogue control DGTEs

3 Apparatus

3.1 Light source

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

In order to minimize 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 values 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:

$$(1)\frac{4/35}{(+4-(-4))}) = 1{,}4\ \%$$

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

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

3.2 Pulse generator

A pulse generator is used to drive the 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.

3.3 O/E converter

An O/E converter is used to convert the optical output power of the 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 more than 10 times the optical power to be measured.

3.4 Temperature and humidity chamber

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

3.5 Oscilloscope

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

3.6 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.

3.7 Control system

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

3.8 Measurement set-up

The measurement set-up for the three control types is shown in Figures 4 to Figure 6.

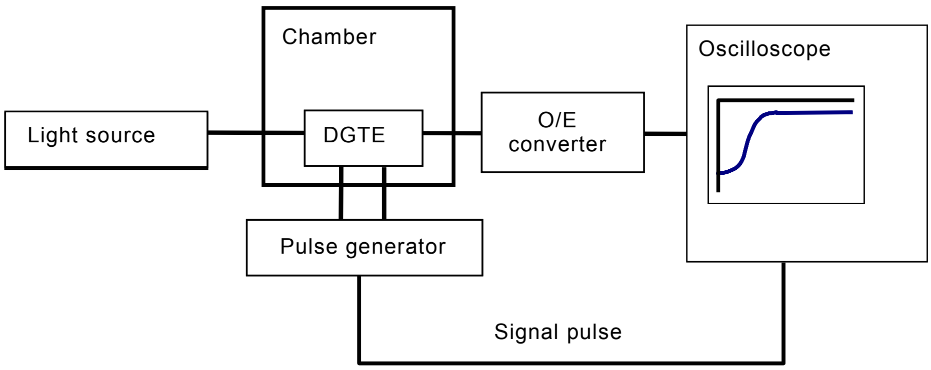
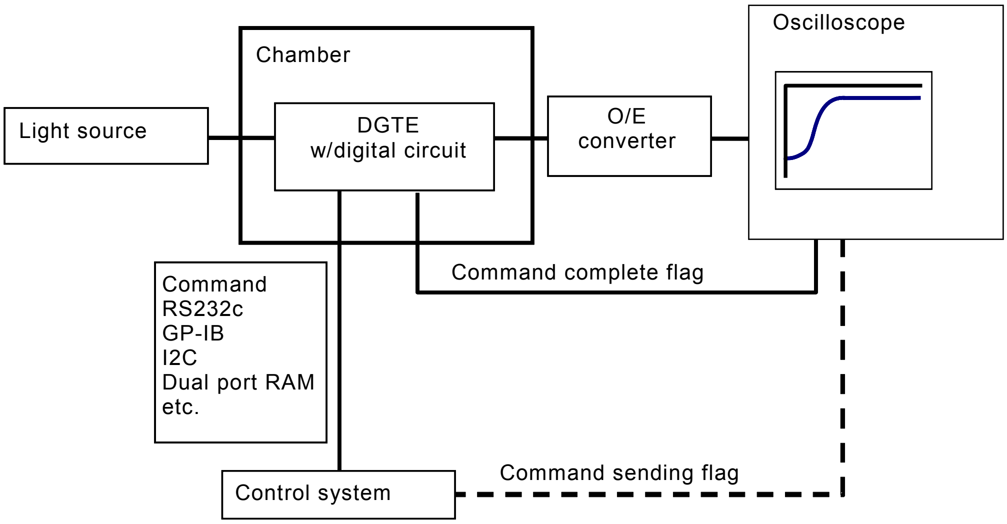
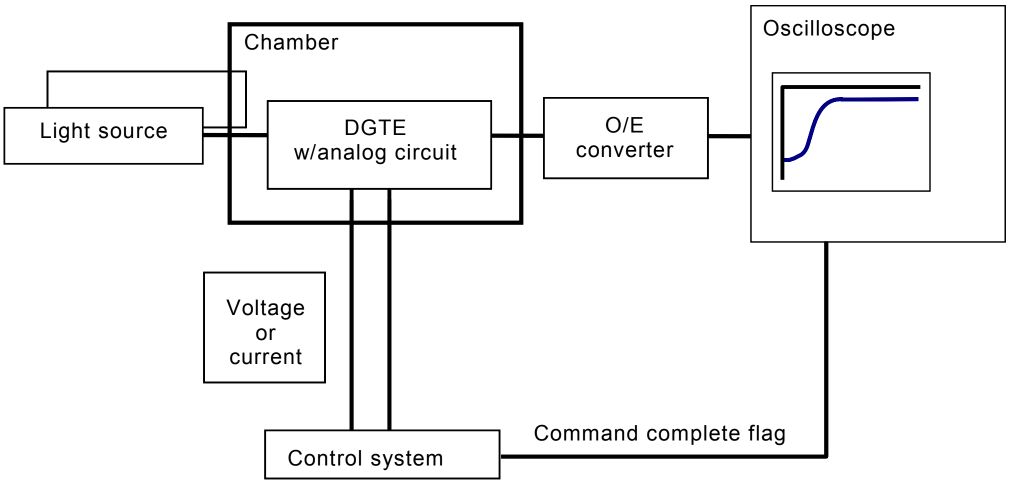


Figure 4 – Measurement set-up for direct control



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

Figure 5 – Measurement set-up for digital control



NOTE It should be driven by a step signal from the control system.

Figure 6 – Measurement set-up for analogue control

4 Procedure

4.1 Direct control type

4.1.1 Set-up

The measurement set-up shall be made up as shown in Figure 1. The temperature in the chamber after setting shall be kept constant and uniform in order to achieve stable measurement. The light source, the pulse generator, the O/E converter and the oscilloscope shall be turned on for the measurement.

4.1.2 Preparation

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

4.1.3 Wavelength setting

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

4.1.4 Pulse generator setting

The voltage or current needed to drive from minimum (maximum) tilt to maximum (minimum) shall be set. The minimum and 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.

4.1.5 Applying the driving pulse

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

4.1.6 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.

4.1.7 Calculation of the response time

After the three wavelengths have been measured, the response time shall be calculated according to Figure 1. Generally, the response time is defined as the maximum value among the three response times.

4.2 Digital control type

4.2.1 Set-up

The measurement set-up is shown in Figure 2. The temperature in the chamber after setting shall be kept constant and uniform for stable measurement. The light source, the digital control system, the O/E converter and the oscilloscope shall be turned on for the measurement.

4.2.2 Preparation

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

4.2.3 Wavelength setting

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

4.2.4 Sending command

The command to operate from minimum (maximum) tilt to maximum (minimum) shall be set. The minimum and 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.

4.2.5 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.

4.2.6 Calculation of the response time

After the measurement at three wavelengths, the response time is calculated according to Figure 1. Generally, the response time is defined as the maximum value among the three response times.

4.3 Analogue control type

4.3.1 Set-up

The measurement set-up is as shown in Figure 2. 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.

4.3.2 Preparation

Before starting the measurement, the set-up shall be stabilized for more than 1 h.

4.3.3 Wavelength setting

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

4.3.4 Applying the control signal

The control signal to operate from 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 setting, the signal shall be sent from the control system.

4.3.5 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. The command complete flag from the control system shall also be monitored and recorded.

4.3.6 Calculation of the response time

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

5 Details to be specified

5.1 Apparatus

5.1.1 Light source

These characteristics of the light source shall be specified:

– spectral width;
– state of polarization;
– output power.

5.1.2 Pulse generator

These characteristics of the pulse generator shall be specified:

– rising time;
– pulse width;
– pulse intensity.

5.1.3 O/E converter

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

– response frequency;
– dynamic range.

5.1.4 Control system

These characteristics of the control system shall be specified:

– type of control system;
– type of interface.

5.2 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 ± 0,5 dB for each spectral band. Therefore, the response time of the DGTE is recommended to be defined as the convergence to ± 0,5 dB (≅±10 %) from target attenuation.

Annex B
(informative)

Measurement examples

Two examples are shown below. In the case where the insertion loss change is small and the target power is within ± 10 % of the initial power at the measured wavelength, the response time cannot be defined as in Figure B.2.

Initial optical power: 0 dBm (1,0 mW)

Target optical power: –3 dBm (0,5 mW) -> Target attenuation: –3 dB

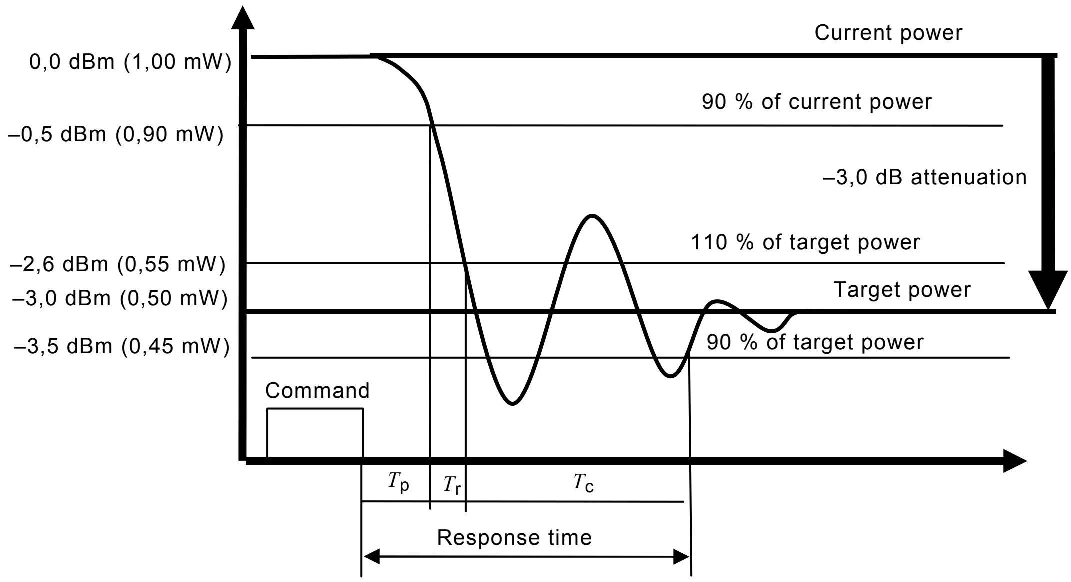


Figure B.1 – Where insertion loss change is sufficient

Initial optical power: –5,0 dBm (0,32 mW)

Target optical power: –5,3 dBm (0,30 mW) Target attenuation: –0,3 dB

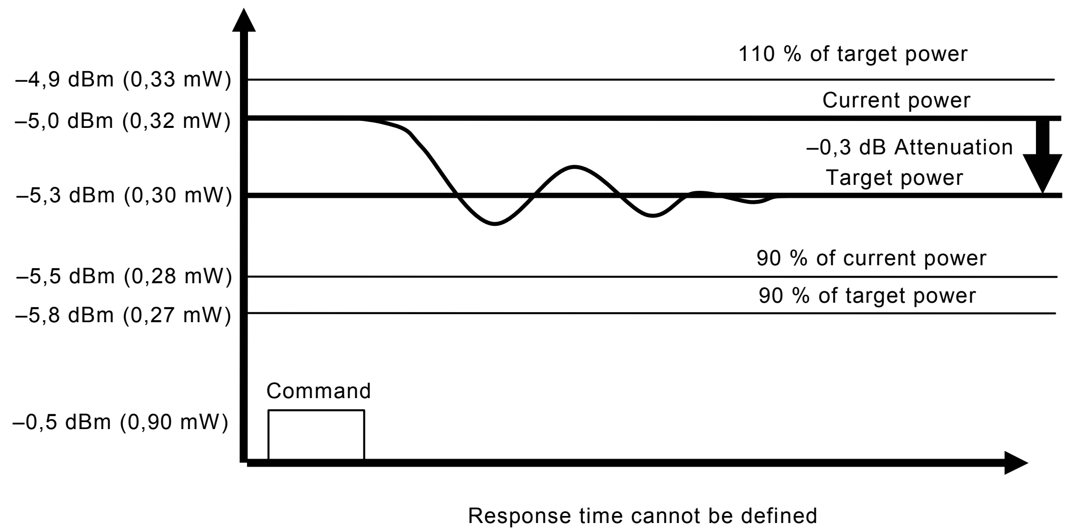


Figure B.2 – Where insertion loss change is small

Annex C
(informative)

Response time for specific DGTEs

Response time is defined as the maximum value over operating temperature range. An LCD (liquid crystal device) may show longer response time at low temperature.

Annex D
(informative)

Necessity for the correction of temperature dependency

The response time of the DGTE may depend on ambient temperature. Some devices have a temperature controller in the package. Some devices have a temperature compensation function to compensate the temperature dependence by tuning the applied voltage or the current according to an ambient temperature. The correction for the direct control type shall be carried out by a control system at a higher level. The digital control type of a DGTE has a CPU and monitors an ambient temperature to correct the temperature effect by itself. The analogue control type also has an analogue circuit and monitors an ambient temperature to correct the temperature effect by itself.

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