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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Controllers with analogue signals for use in industrial-process control systems – Part 2: Guidance for inspection and routine testing

Régulateurs à signaux analogiques utilisés pour les systèmes de conduite des processus industriels – Partie 2: Recommandations pour les essais d'inspection et les essais individuels de série

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CONTROLLERS WITH ANALOGUE SIGNALS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS –

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60546-2 has been prepared by subcommittee 65B: Devices and process analysis, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition, published in 1987. This second edition constitutes a minor technical revision made to bring some terms, measurement units and references up to date.

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

CDV	Report on voting
65B /660/CDV	65B /718A/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 of the IEC 60546 series, under the general title: *Controllers with analogue signals for use in industrial-process control systems*, 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.

CONTROLLERS WITH ANALOGUE SIGNALS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS –

Part 2: Guidance for inspection and routine testing

1 Scope

This International Standard applies to pneumatic and electrical industrial-process controllers using analogue signals which are in accordance with IEC 60381-1 and IEC 60381-2. The provisions of this standard are applicable in principle to controllers having different, but continuous signals.

This standard is intended to provide technical guidance for inspection and routine testing of controllers, for instance, as acceptance tests or after repair. For a full evaluation, IEC 60546-1 should be used. Quantitative criteria for acceptable performance are established by agreement between manufacturer and user. The requirements of this standard are effective when agreed upon by the manufacturer and the user.

2 Normative references

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

IEC 60546-1:___, *Controllers with analogue signals for use in industrial-process control systems – Part 1: Methods of evaluating the performance*[1]

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in IEC 60546-1 apply.

3.1 Symbols used in this standard

t time

y output signal (see Figure 1)

y_0 output signal at time $t = 0$

x measured value (see Figure 1)

w set point value (see Figure 1)

X_p proportional band

T_I reset time

T_D rate time

K_P proportional action factor

K_I integral action factor

K_D derivative action factor

[1] To be published.

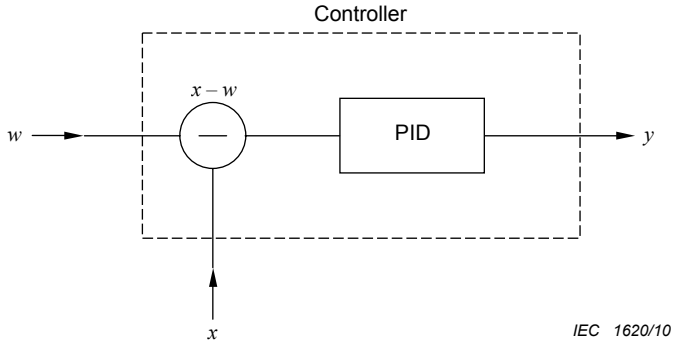


Figure 1 – Basic signals to/from an idealized controller

4 Sampling for test

If, by agreement between manufacturer and user, tests are to be performed on a sample lot, it is recommended that a sampling method such as presented in IEC 60410 be selected. When sampling is used, controllers to be tested may be chosen by the user's inspector.

5 Performance tests

5.1 General

Environmental conditions at the location of testing shall be recorded. Recommended conditions can be found in 5.1.1 of IEC 60546-1.

The following tests shall be performed.

5.2 **Tests of controller action** (only functions provided by test specimen need consideration)

5.2.1 **Offset** (full test: see Clause 6 of IEC 60546-1)

This test applies only to controllers with integral action.

a) Initial conditions

Closed loop according to Figure 2, switch position B. Reverse action.

X_p = 100 %, proportional band

T_I = minimum reset time

T_D = witched off, if possible, or at minimum rate time

b) Test procedure

Measure and record the offset, on the differential measuring device, for set point w = 50 %. Note x and w indications, and check corresponding scale indications, if existing. Repeat the measurement with w = 10 % and then w = 90 %.

5.2.2 **Proportional action** (full test: see 7.2 of IEC 60546-1)

The open loop circuit arrangement in Figure 2 is used with the switch in position A.

a) Initial conditions

Open loop according to Figure 2, switch position A.

X_p = 100 %, proportional band

Stabilize output y at 50 %.

T_I = switched off, if possible, or at maximum reset time after stabilization

T_D = switched off, if possible, or at minimum rate time

X = w = 50 %

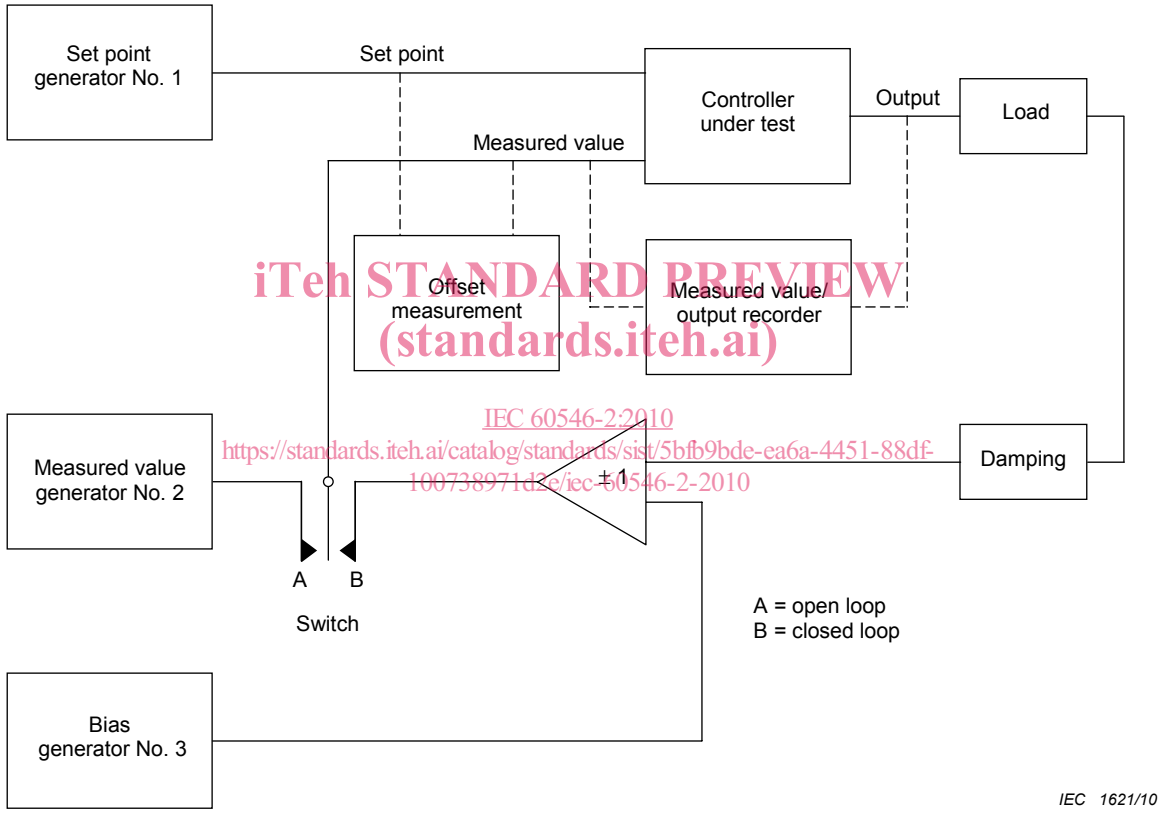
b) Test procedure

Introduce a step change of 20 % of input signal from generator No. 2.

Record corresponding change (Δy %) of output y.

$$X_p = \left(\frac{\Delta x\ \%}{\Delta y\ \%}\right) 100 = \left(\frac{\Delta x}{\text{Measured value span}} / \frac{\Delta y}{\text{Output span}}\right) 100$$

NOTE 1 If integral action cannot be made negligible, Δy should be determined in accordance with Figure 3.



Generator No. 1 – D.C. or pressure for steady-state input

Generator No. 2 – Step for proportional and integral action tests

Generator No. 3 – D.C. or pressure for fixed bias levels for test in closed loop

Figure 2 – Arrangement for open loop or closed loop tests

b) Test procedure

Introduce a step change of 20 % of input signal from generator No. 2.

Record corresponding change (Δy %) of output y.

$$X_p = \left(\frac{\Delta x\ \%}{\Delta y\ \%}\right) 100 = \left(\frac{\Delta x}{\text{Measured value span}} / \frac{\Delta y}{\text{Output span}}\right) 100$$

NOTE 2 If integral action cannot be made negligible, Δy should be determined in accordance with Figure 3.

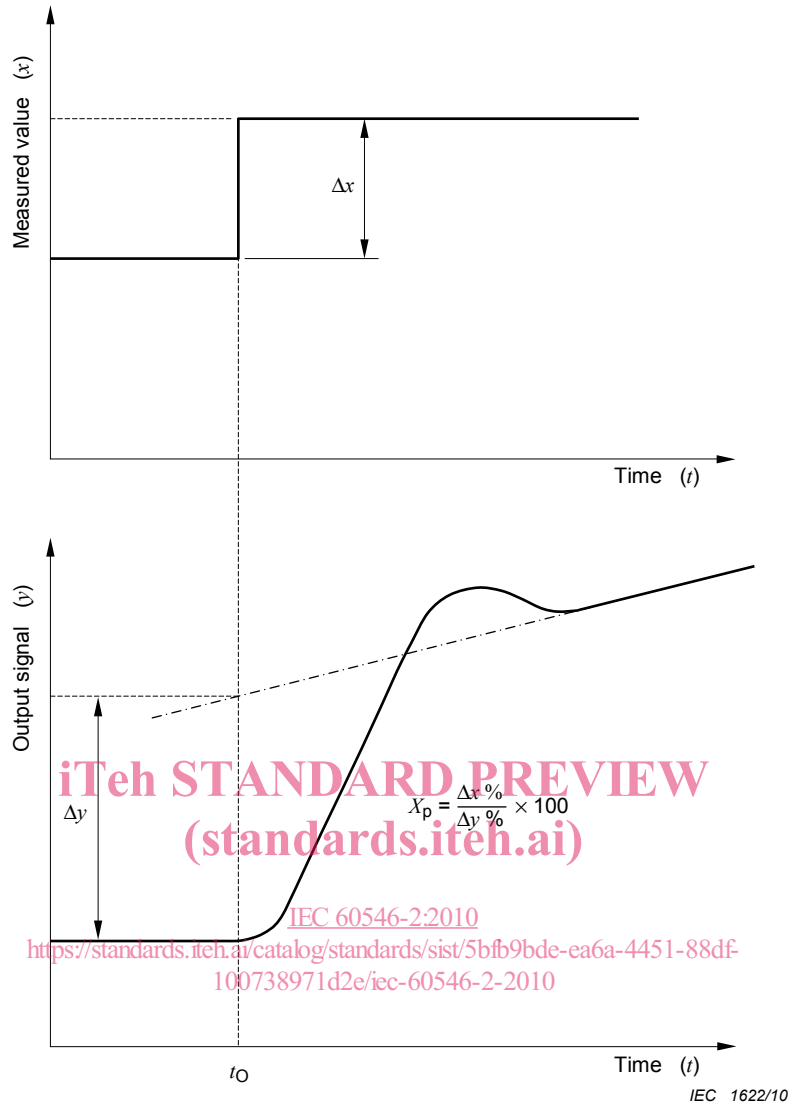


Figure 3 – Recorded characteristics of proportional action

5.2.3 **Integral action** (full test: see 7.3 of IEC 60546-1)

The open loop circuit arrangement in Figure 2 is used with the switch in position A.

a) Initial conditions

Open loop according to Figure 2, switch position A.

X_p = 100 %, proportional band

T_D = switched off, if possible, or at minimum rate time

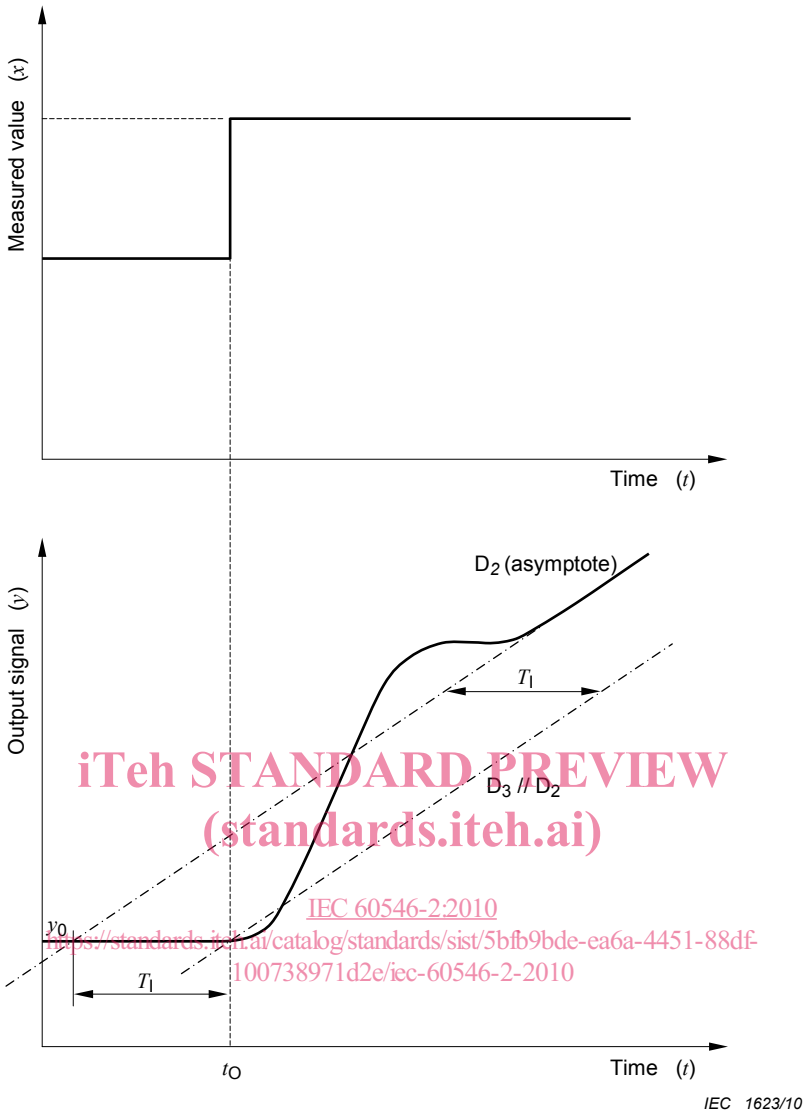
T_I = 1 min or at nearest marking of its scale

X = w = 50 %

b) Test procedure

Stabilize output y at 50 % then introduce ±20 % step of input signal, by generator No. 2.

Record the corresponding output change, Δy. Determine reset time T_I as shown in Figure 4.



T_I = time interval between D_2 and D_3

Figure 4 – Recorded characteristics of integral action

5.2.4 Derivative action (for a more accurate test: see 7.4 of IEC 60546-1)

Applicable to controllers with derivative action on $x - w$ and not on those with derivative action on x only.

a) Initial conditions

Open loop according to Figure 2, switch position B.

X_p = 100 %, proportional band

Stabilize output y at 50 %.

T_I = switched off, if possible, or at maximum reset time after stabilization

T_D = 1 min

w = 50 %

b) Test procedure

Introduce step change of 10 % to 20 % of set point span from generator No. 1. Record corresponding change of output signal y. Determine rate time T_D as shown in Figure 5.

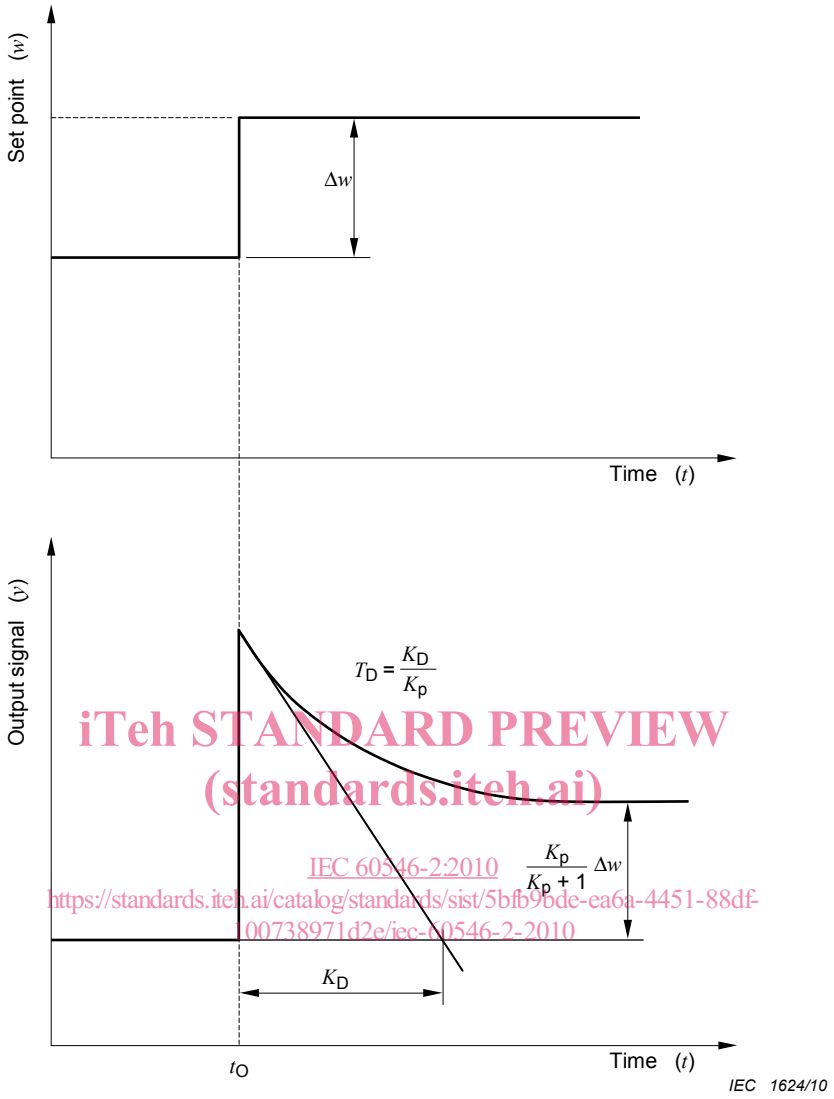


Figure 5 – Recorded characteristics of derivative action

5.3 Power supply variations (full test: see 8.5.1 of IEC 60546-1)

Routine testing of power supply variations can be made under the following.

a) Initial conditions

See 5.1.1 of IEC 60546-1 and with controller connected to maximum rated load.

b) Test procedure

Measure the effect on offset of the following variations in power supply or the manufacturer's stated limits, if smaller.

Voltage variation: $^{+10}_{-15}$ % of nominal a.c. or d.c. voltage.

Air pressure variation: ±10 % of nominal pressure.