

**PUBLICLY
AVAILABLE
SPECIFICATION**

**IEC
PAS 60027-6**

First edition
2004-09

**Letter symbols to be used
in electrical technology –
Control technology**



Reference number
IEC/PAS 60027-6:2004(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/online_news/justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch

Tel: +41 22 919 02 11

Fax: +41 22 919 03 00

PUBLICLY
AVAILABLE
SPECIFICATION

IEC
PAS 60027-6

First edition
2004-09

**Letter symbols to be used
in electrical technology –
Control technology**

© IEC 2004 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

K

For price, see current catalogue

CONTENTS

FOREWORD.....	3
1 Scope	4
2 Normative references	4
3 Principles.....	5
4 General quantities and functions.....	6
5 Characteristic quantities of the step response	7
6 Parameters of transfer elements and control loops.....	7
7 Variable quantities of the control loop	8
8 Mapping functions and their variable quantities	9
9 Functional diagrams.....	10

Withdrawing
IECNORM.COM: Click to view the full PDF of IEC PAS 60027-6:2004

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY –
CONTROL TECHNOLOGY****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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

A PAS is a technical specification not fulfilling the requirements for a standard but made available to the public.

IEC-PAS 60027-6 has been processed by IEC technical committee 25: Quantities and units, and their letter symbols.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
25/271/NP	25/283/RVN

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming it into an International Standard.

LETTER SYMBOLS TO BE USED IN ELECTRICAL TECHNOLOGY – CONTROL TECHNOLOGY

Introductory note

This Publicly Available Specification (PAS) is intended to replace section 11 of IEC 60027-2:2000.

In comparison to section 11 of IEC 60027-2:2000 the following has been altered.

- The number of physical quantities and of their symbols listed in this PAS has been increased significantly. New sections for general quantities and functions, for characteristic quantities of the step response, for parameters of transfer elements and control loops, and for mapping functions and their quantities have been included.
- The hitherto existing series of reserve symbols has been deleted. Four symbols out of this series have been used as new symbols for main quantities.
- The presentation of the denotation of some mathematical concepts specific to the field formerly given in 11.4 has been removed to the column “remarks” of the relevant tables.

1 Scope

This PAS is applicable to control technology. It gives names and symbols for quantities, signals and functions, and their units.

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 60027-1:1992, *Letter symbols to be used in electrical technology - Part 1: General*.

IEC 60027-2:2000, *Letter symbols to be used in electrical technology – Part 2: Telecommunications and electronics*

IEC 60050-101:1998, *International Electrotechnical Vocabulary – Part 101: Mathematics*

IEC 60050-351:1998, *International Electrotechnical Vocabulary – Part 351: Automatic control*

ISO 31-2:1992, *Quantities and units – Part 2: Periodic and related phenomena*

ISO 31-5:1992, *Quantities and units – Part 5: Electricity and magnetism*.

3 Principles

3.1 This PAS presents a coherent body of letter symbols for the most important physical quantities and functions used in control technology science and technology, particularly for important variable quantities and (without distinction) the signals representing them.

3.2 Signals and quantities may have any physical form; it is the control engineering design function which characterizes them. Therefore, for most of the quantities and functions listed in this PAS, it is not possible to appoint a special unit to them. For those quantities and functions for which this is possible (1.04 to 1.16, 2.01 to 2.05, 3.04 to 3.15, 5.01, 5.02, and 5.06) any user of this PAS knows the inherent unit.

3.3 The names of quantities, functions and signals, their definitions, their 7-digit reference numbers and the names of functional blocks within the functional diagrams are based on IEC 60050-351.

3.4 In IEC 60050-101 and IEC 60050-351, letter symbols are just used but not standardized. International standardization of letter symbols and units is to be found in the different parts of ISO 31 and IEC 60027 only.

3.5 Any of the basic symbols listed in sections 1 to 5 may be supplemented by the signs and subscripts to be found in IEC 60027-1.

3.6 Symbols for time-dependent quantities are covered by IEC 60027-1.

3.7 Some entries in the column “remarks” give the notation of some mathematical concepts specific to the field.

3.8 Vector quantities are represented by the same symbols as the corresponding scalar quantities, but by bold type letters.

3.9 The list of recommended letter symbols in sections 1 to 5 is followed in section 6 by functional block diagrams intended to show typical applications.

4 General quantities and functions

Table 1

Item number	Entry number in IEC ¹⁾	Item number in IEC 60027-1	Item number in ISO 31	Name of quantity or function	Symbol	Remarks
4.01	351-21-06			input variable	u	
4.02	351-21-07			output variable	v ²⁾	
4.03	351-21-08			state variable	x_j	Arabic numeral subscripts for components $j = 1, 2, 3, \dots, n$
4.04	101-14-08	18	2-3.1	frequency	f	
4.05	351-24-24	24	2-2	time constant	τ, T	
4.06	101-14-36	13	2-4	angular frequency; pulsance	ω	$\omega = 2\pi f$
4.07	351-28-14			characteristic angular frequency	ω_0	
4.08	351-24-18			damping ratio	g	
4.09	351-24-18			eigen angular frequency; angular frequency of damped oscillation	ω_d	$\omega_d = \omega_0 \sqrt{1 - g^2}$
4.10	101-14-20	26	2-11	damping coefficient	δ	$\delta = g\omega_0$
4.11		19	2-3.2	rotational frequency	f_r	
4.12	351-24-37	103	5-43	phase angle	φ	
4.13	101-13-06	953		Dirac function; unit pulse; unit impulse (US)	$\delta(t)$	
4.14	101-13-02	952		unit-step function; Heaviside function	$\varepsilon(t)$	
4.15	351-24-21			unit-step response	$h(t)$	
4.16	351-24-19			unit-pulse response; unit-impulse response (US); weighting function	$g(t)$	

¹⁾ As far as the entry number starts with 351, this is the term number in edition 3 of IEC 60050-351 (to be published).

²⁾ The symbol v is a Latin “vee”, not a Greek “nu”.

5 Characteristic quantities of the step response

Table 2

Item number	Entry number in IEC ³⁾	Name of quantity	Symbol
5.01	351-24-27	equivalent time constant	T_b
5.02	351-24-26	equivalent dead-time	T_e
5.03	351-24-28	step response time	T_{sr}
5.04	351-24-29	settling time	T_s
5.05	351-24-30	overshoot	v_m ⁴⁾

6 Parameters of transfer elements and control loops

Table 3

Item number	Entry number in IEC ⁵⁾	Name of quantity	Symbol	Remarks
6.01	351-28-17	proportional action coefficient	K_P	Equation of an ideal PID control element: $y(t) = K_P u(t) + K_I \int_0^t u(\tau) d\tau + K_D \dot{u}(t)$
6.02	351-28-20	integral action coefficient	K_I	
6.03	351-28-25	derivative action coefficient	K_D	
6.04	351-28-23	reset time	T_i	$T_i = K_P / K_I$
6.05	351-28-28	rate time	T_d	$T_d = K_D / K_P$
6.06	351-28-41	dead-time	T_t	
6.07	351-25-01	control rise time	T_{cr}	
6.08	351-25-02	control settling time	T_{cs}	
6.09	351-24-40	corner angular frequency	ω_i	$i = 1, 2, 3, \dots$
6.10	351-25-08	loop gain	K_o	
6.11	351-25-08	control factor	R	

³⁾ The entry number is the term number in edition 3 of IEC 60050-351 (to be published).

⁴⁾ For the symbol v see footnote 2. This entry should only determine the index. The main symbol should always be that of the quantity, the overshoot of which is meant.

⁵⁾ See footnote 3.

Item number	Entry number in IEC ⁵⁾	Name of quantity	Symbol	Remarks
6.12	351-25-04	gain crossover angular frequency	ω_c	
6.13	351-25-06	phase crossover angular frequency	ω_π	
6.14	351-25-05	phase margin	φ_m	
6.15	351-25-07	gain margin	G_m	
6.16	351-21-17	system matrix	A	General description of a linear system using state variables: $\dot{x} = Ax + Bu$ $y = Cx + Du$
6.17	351-21-15	input matrix	B	
6.18	351-21-16	output matrix	C	
6.19	351-21-19	direct input-output matrix	D	
6.20	351-21-18	transition matrix	Φ	

7 Variable quantities of the control loop⁶⁾

Table 4

Item number	Entry number in IEC ⁷⁾	Name of quantity	Symbol	Remarks
7.01	351-27-01	controlled variable	x	
7.02	351-27-02	reference variable	w	
7.03	351-27-03	feedback variable	r	
7.04	351-27-04	error variable	e	$e = w - r$
7.05	351-27-06	controller output variable	m	
7.06	351-27-07	manipulated variable	y	
7.07	351-27-08	disturbance variable	z	
7.08	351-27-09	command variable	c	
7.09	351-27-10	final controlled variable	q	

⁶⁾ Instead of “variable quantities”, normally the shorter designation “variables” is used (see IEC 60050-351).

⁷⁾ See footnote 3.

8 Mapping functions and their variable quantities⁸⁾

Table 5

Item Number	Entry number in IEV ⁹⁾	Name of quantity or function	Symbol	Remarks
8.01		mapping variable (quantity) of Laplace transformation	p, s	$p = \sigma + j\omega = -\delta + j\omega = s$
8.02		mapping variable (quantity) of Z transformation	z	
8.03	351-24-31	transfer function	G, F	A function of p or s . In telecommunication, H is used
8.04	351-24-33	frequency response	$G(j\omega)$ $F(j\omega)$	
8.05	351-24-36	gain response; amplitude response	$ G(j\omega) $ $ F(j\omega) $	
8.06	351-24-38	phase response	$\arg G(j\omega)$ $\arg F(j\omega)$	
8.07	351-24-42	describing function	$B(\hat{u})$	A function of the amplitude of the sinusoidal input variable u
NOTE The quantities and functions listed in this table are complex ones. Their symbols may be underlined. If underlined symbols are used for these quantities and functions, the function symbol included in vertical lines has to be used for the gain response.				

⁸⁾ See footnote 6.

⁹⁾ See footnote 3.

9 Functional diagrams

NOTE The arrows show the direction of action.

9.1 Open-loop control system; guidance system

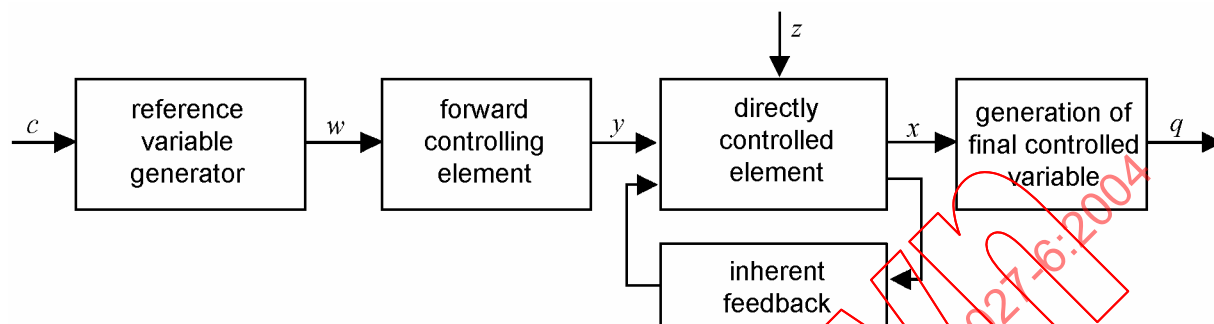


Figure 1 – Open-loop control system; guidance system

9.2 Closed-loop control system; feedback control system

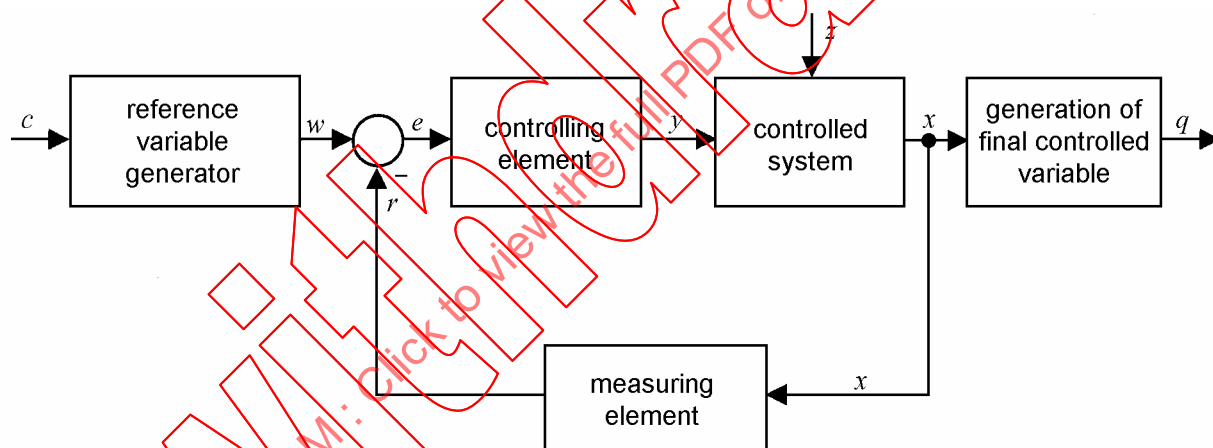


Figure 2 – Closed-loop control system; feedback control system

9.3 System description using state variables

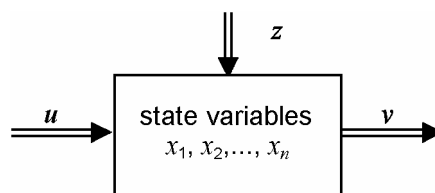


Figure 3 – System description using state variables¹⁰⁾

¹⁰⁾ See footnote 2.