CiA 303

Recommendation

Part 2: Representation of SI units and prefixes

Version 1.5.0

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HISTORY

Date	Changes
2001-07-01	*Publication of Version 1.0* as draft recommendation
2004-12-30	*Publication of Version 1.3* as draft recommendation
2006-08-14	*Publication of Version 1.4* as draft recommendation
2012-04-27	*Publication of Version 1.5* as public recommendation
	- minor editorial changes
	- added a reference to the valid SI-units standard ISO 80000, removed a reference to the withdrawn SI-units standard ISO 1000:1992
	- added Annex A. An example of recommended practice to assign the SI units and prefixes is moved to Annex A.

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CONTENTS

1 Scope

This document provides recommendation on how to represent the international system of units and prefixes in CANopen device, interface and application profiles.

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.

/CiA301/ CiA 301, CANopen application layer and communication profile

/ISO 80000/ ISO 80000, Quantities and units

3 Terms and definitions

For the purpose of this document, the following terms and definitions and those given in /CiA301/ and /ISO 80000/ apply.

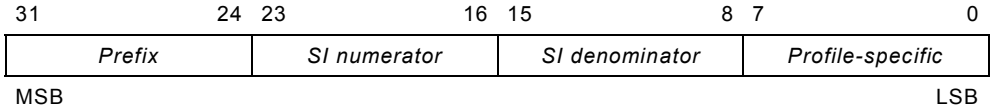
4 Symbols and abbreviated terms

For the purpose of this document, the following symbols and abbreviated terms and those given in /CiA301/ and /ISO 80000/ apply.

5 Representation of SI units and prefixes

5.1 General

This clause provides notation indexes, which represent physical units and prefixes in CANopen device, interface and application profiles. The notation indexes are arranged in the SI unit groups as it is given in /ISO 80000/. The parameter definition of the application objects (see /CiA301/), which specify physical units, shall contain a notation index for SI prefix and notation indexes for SI unit as SI unit numerator and denominator. It is recommended to specify this parameter definition in CANopen device profiles, interface profiles and application profiles. The notation indexes, which shall be used in these objects, are specified in the tables given in clause 5 and 6. The description, name and international symbol of the units are provided for informative purposes. The description is given in quantities of the international system of quantities. For details, see /ISO 80000/. The parameter definition, illustrated in Figure 1, is a recommended practice to assign SI unit and prefix to an I/O object.



NOTE In case, SI base unit is used, the bit field SI numerator shall contain the notation index of the base unit. The SI denominator is not used and its bit field is equal to 1. If SI derived units are used, the SI numerator bit field shall contain the notation index corresponding to the numerator of the unit and the SI denominator shall contain the notation index corresponding to the denominator of the unit. Additionally, the parameter definition may contain notation index for profile specific units.

Figure 1 – Parameter definition

5.2 Notation index for SI dimensionless unit

Table 1 specifies notation index for SI dimensionless unit.

Table 1 – SI dimensionless unit

Description	Name of unit	International symbol	Notation index (hex)
dimensionless	none	dimensionless	00

5.3 Notation indexes for SI base units

Table 2 specifies notation indexes for SI base units.

Table 2 – SI base units

Description of unit	Name of unit	International symbol	Notation index (hex)
length	metre	m	01
mass	kilogram	kg	02
time	second	s	03
electric current	ampere	A	04
thermodynamic. temperature	kelvin	K	05
amount of substance	mole	mol	06
luminous intensity	candela	cd	07
reserved			08 ... 0F

5.4 Notation indexes for SI derived units with special names and symbols

Table 3 specifies notation indexes for SI derived units with special names.

Table 3 – SI derived units with special names and symbols

Description of unit	Name of unit	International symbol	Notation index (hex)
plane angle	radian	rad	10
solid angle	steradian	sr	11
reserved			12 ... 1F
frequency	hertz	Hz	20
force	newton	N	21
pressure, stress	pascal	Pa	22
energy, work, quantity of heat	joule	J	23
power, radiant flux	watt	W	24
electric charge, quantity of electricity	coulomb	C	25
electric potential difference, electromotive force	volt	V	26
capacitance	farad	F	27
electric resistance	ohm	Ω	28
electric conductance	siemens	S	29
magnetic flux	weber	Wb	2A
magnetic flux density	tesla	T	2B
inductance	henry	H	2C

Description of unit	Name of unit	International symbol	Notation index (hex)
celsius temperature	degree celsius	°C	2D
luminous flux	lumen	lm	2E
illuminance	lux	lx	2F

5.5 Notation indexes for SI derived units with special names and symbols admitted for reasons of safeguarding human health

Table 4 specifies notation indexes for SI derived units with special names and symbols admitted for reasons of safeguarding human health.

Table 4 – SI derived units with special names and symbols admitted for reasons of safeguarding human health

Description of unit	Name of unit	International symbol	Notation index (hex)
activity (of a radionuclide)	becquerel	Bq	30
absorbed dose, specific energy (imparted), kerma	gray	Gy	31
dose equivalent, ambient dose equivalent, directional dose equivalent, personal dose equivalent	sievert	Sv	32
catalytic activity	katal	kat	33
reserved			34 … 3F

5.6 Notation indexes for units used with the SI

Table 5 specifies notation indexes for units used with the SI.

Table 5 – Units used with the SI

Description	Name of unit	International symbol	Notation index (hex)
plane angle	grade	g*	40
plane angle	degree	°*	41
plane angle	minute	'*	42
plane angle	second	''*	43
volume	litre	l**	44
area	are	a	45
area	hectare	ha	46
time	minute	min	47
time	hour	h	48
time	day	d	49
time	year	a	4A
mass	gram	g	4B
mass	tonne***	t	4C
pressure	bar	bar	4E
poise	poise	P	4F
stokes	stokes	St	50
electric charge	electron-volt	eV	51
atomic mass unit	atomic mass unit	u	52
astronomic unit	astronomic unit	AU	53

Description	Name of unit	International symbol	Notation index (hex)
parsec	parsec	pc	54
acceleration	meter per square second	m/s^2	55
moment of force, torque	newton metre	Nm	56
square second	square second	s^2	57
area	square metre	m^2	58
volume	cubic metre	m^3	59
dynamic viscosity	pascal second	Pa·s	5A
specific heat capacity, specific entropy	joule per kilogram kelvin	J/(kg·K)	5B
thermal conductivity	watt per meter kelvin	W/(m·K)	5C
molar heat capacity, molar entropy	joule per mole kelvin	J/(mol·K)	5D
radiance	watt per square meter steradian	$W/(m^2 \cdot sr)$	5E
catalytic (activity) concentration	katal per cubic meter	kat/m^3	5F
reserved			60 … 9F
* The symbol shall be used in the right superscript position (in the position of an exponent).			
** The capital L may be used instead of l in symbolic representation of litre.			
*** This "metric ton" unit is mainly used in the USA.			

5.7 Code table for SI-based specific units used in CANopen device, interface and application profiles

Table 6 specifies the representation of the SI-based specific units used in CANopen device, interface and application profiles.

Table 6 – CANopen profile specific SI-based units

Description	Name of unit	International symbol	Notation index (hex)
profile-specific		-	A0 … FF

6 Prefix representation

6.1 General

This clause specifies the representation of prefixes for physical units in CANopen device, interface and application profiles. The description, name and international symbol of the units are provided for informative purposes. For details on prefixes, see /ISO80000/.

6.2 Code table for prefixes

Table 7 specifies the representation of the prefixes for SI units.

Table 7 – Prefixes for SI units

Prefix	Factor	Symbol	Notation index (hex)
reserved			13 … 7F
exa	10^{18}	E	12
-	10^{17}	-	11
-	10^{16}	-	10
peta	10^{15}	P	0F

Prefix	Factor	Symbol	Notation index (hex)
-	10^{14}	-	0E
-	10^{13}	-	0D
tera	10^{12}	T	0C
-	10^{11}	-	0B
-	10^{10}	-	0A
giga	10^{9}	G	09
-	10^{8}	-	08
-	10^{7}	-	07
mega	10^{6}	M	06
-	10^{5}	-	05
-	10^{4}	-	04
kilo	10^{3}	k	03
hecto	10^{2}	h	02
deca	10^{1}	da	01
-	10^{0}	-	00
deci	10^{-1}	d	FF
centi	10^{-2}	c	FE
milli	10^{-3}	m	FD
-	10^{-4}	-	FC
-	10^{-5}	-	FB
micro	10^{-6}	µ	FA
-	10^{-7}	-	F9
-	10^{-8}	-	F8
nano	10^{-9}	n	F7
-	10^{-10}	-	F6
-	10^{-11}	-	F5
pico	10^{-12}	p	F4
-	10^{-13}	-	F3
-	10^{-14}	-	F2
femto	10^{-15}	f	F1
-	10^{-16}	-	F0
-	10^{-17}	-	EF
atto	10^{-18}	a	EE
reserved			ED to 80

Annex A Implementation example for SI units and prefixes representation in CANopen device, interface and application profiles.

A.1 Implementation example for velocity sensor

Figure 2 illustrates parameter definition for an application object, which describe SI unit for velocity sensor value. The value is given in km/h. Table 8 specifies the object description for an object for SI unit of the velocity sensor value. In Table 9 the recommended entry description for an object is given.

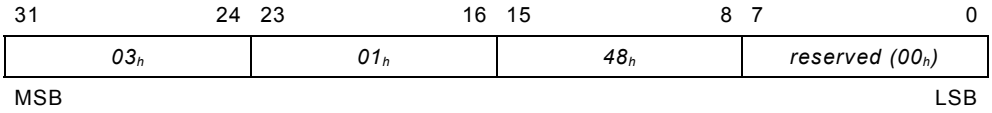


Figure 2 – Parameter definition for SI unit of the velocity sensor value

Table 8 – Object description

Index	(NOTE)
Name	(NOTE)
Object Code	VAR
Data Type	UNSIGNED32
Category	(NOTE)

Table 9 – Entry description

Sub-index	00_h
Access	(NOTE)
PDO Mapping	No or Optional
Value Range	See parameter definition (Figure 2)
Default Value	(NOTE)

NOTE The parameter properties shall be defined in the corresponding CANopen device, interface and application profiles.

