Lenze

Manual

Global Drive

Drive PLC Developer Studio

Introduction to
IEC 61131-3 programming

Important note:

The software is supplied to the user as described in this document. Any risks resulting from its quality or use remain the responsibility of the user. The user must provide all safety measures protecting against possible maloperation.

We do not take any liability for direct or indirect damage, e.g. profit loss, order loss or any loss regarding business.

All information given in this online documentation has been carefully selected and tested for compliance with the hardware and software described. Nevertheless, discrepancies cannot be ruled out. We do not accept any responsibility or liability for any damage that may occur. Required corrections will be included in updates of this documentation.

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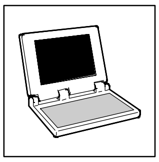

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1 Preface and general information

This Manual informs about the standard IEC 61131-3.

The IEC 61131-3 standard is the basis for uniform PLC programming that enables the user

- to use already tested and standardized software components again.
- to apply software engineering methods for the generation of these components.
- to consider problem solutions from a complex point of view.
- to abstract complex tasks in smaller modules.
- to define interfaces unambiguously.
- to transfer progams more easily to other systems.

The programming languages used in the Drive PLC Developer Studio meet the requirements of the IEC 61131-3 standard.

In many cases, the Introduction also lists the international terms (*in italics in brackets*) in addition to the German terms.

1.1 For further information on IEC 61131-3 programming

- see the Manual **Drive PLC Developer Studio**
- see the homepage of **PLCopen**: www.plcopen.org

2 The software model

The software model of IEC 61131-3 describes the concepts of configuration, resource, task, program, function block and function and their connection.

For the definition of these terms, the standard is based on a maximum powerful PLC providing the following features:

- Mulit-processor can be used
- Multi-tasking is possible
- Unlimited number of analog and digital inputs and outputs
- Communication with other PLCs and PCs is possible

2.1 Resources within a configuration

The highest level in the software model is the **configuration** (*configuration*), which defines the unit structure. This unit can be, for instance, a PLC with several CPUs connected.

A configuration contains one or several **resources** (*resources*), which form a CPU.

The programs of the resource are controlled by **tasks** which represent an executable program unit.

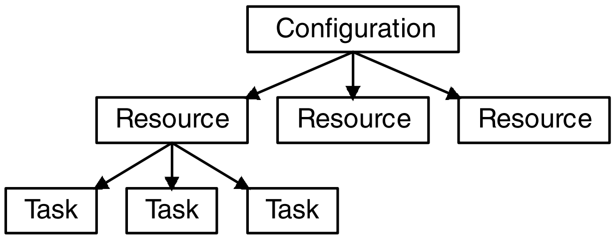


Fig. 1 A configuration with several resources which can contain independent tasks.

2.1.1 Tasks

Tasks can be processed periodically or because of a certain event. They have a priority which defines the assignment of CPU times within the resource.

There are several task types:

- Cyclic tasks
- Time-controlled tasks (*INTERVAL tasks*)
- Event-controlled tasks (*EVENT tasks*)
- Interrupt tasks

A task declaration consists of the task name, its priority, and a condition on which the task is to be executed.

The condition can be a time interval, an event (rising signal at a digital input or `FALSE`/`TRUE` transition of a global variable) or an interrupt.

Every task can be assigned to several programs which are to be activated by the task. The programs are processed in the sequence indicated.

The following rules apply to the execution of a task:

- The task with the condition that has been met will be executed when, for instance, the interval time indicated is over or the variable addressed changes from `FALSE` to `TRUE`.

- If several tasks fulfill the condition, the task with the highest priority will be executed.
- It is not possible to assign the same priority to several tasks.
(Exception: Priority 0 = Task inhibited)
- If a task with a higher priority meets the condition while another task is being processed, the task with the lower prority will be interrupted and only be processed after the other task has been completed.

2.2 Program Organization Units, POUs

IEC1131-3 defines programs (*programs*), function blocks (*function blocks*) and functions (*functions*) as program organization units or POUs (*Program Organization Units, POUs*).

The features of a POU enable a wide modularization of user programs and the reuse of software modules already implemented and tested. At least the declaration of the request interface is required to enable program modules to access a POU. After its declaration, a POU is available to all other POUs.

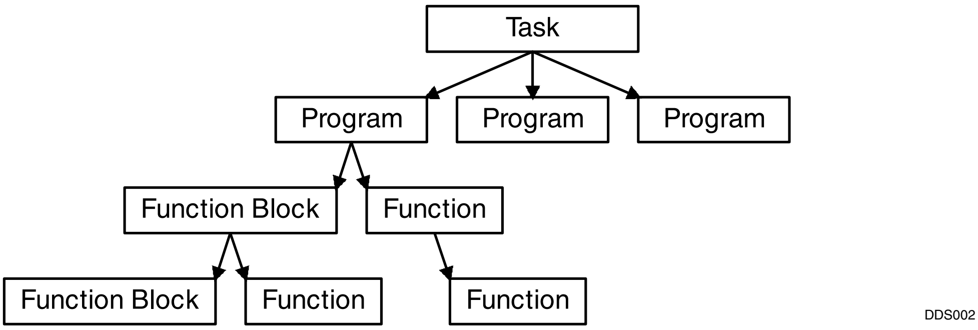


Fig. 2 Structuring of program organization units (POUs) in programs, function blocks and functions

2.2.1 Programs

The run-time features of the entire program, which can run in a CPU, are determined by the assignment of programs to a task. A program can be assiged to several tasks, i.e. several instances of the program are generated with different run-time features. One of the programs is the main program and is assigend to the PLC periphery, global variables and access paths.

2.2.2 Function blocks

The IEC 61131-3 standard uses standard functions and function blocks to standardize typical PLC functions. This "Standard library" is an important basis for uniform, manufacturer-independent programming of PLC systems.

Function blocks (FBs) can be compared with integrated circuits, which include a certain control function. They are used to set inputs/outputs and internal variables. The status of a function block request is saved from cycle to cycle. Only the input and output variables of the function can be addressed by the request program. A function block can also be called by another function block.

Instancing of function blocks

IEC 61131-3 provides the instancing of function blocks. An instance is a structure which saves all internal input and output variables when a function block is called.

A program which calls FB1 three times has three instances of FB1, one for each call. The program can thus be evaluated precisely on request and without any side effects. Please observe that all instances use the same program code, i.e. changes of the program code have the same effect on al three requests.

Software tools like the **Drive PLC Developer Studio** help instancing by means of an automatic declaration: An instance name is specified for an FB call. This name manages the data structure of the call.

Overview: IEC 61131-3 standard function blocks

Bistable function blocks	
SR/RS	Bistable function block (dominant set/reset)
SEMA	Software semaphore (interruptable)
Signal detection	
R_TRIG/F_TRIG	Detector of rising/falling signals
Counters	
CTU/CTD	Up-counter/down-counter
CTUD	Up and down counter
Timers	
TP	Pulse encoder
TON/TOF	Timer on-delay/timer off-delay

2.2.3 Functions

Unlike FBs, functions cannot buffer their internal values. Thus, they cannot use global variables, access function blocks and declare directly addressable variables. All functions have in common that they return the same output parameters if the input parameters are the same.

Overview: IEC 61131-3 standard functions

Type conversion functions	
..._TO_...	Conversion between integers
BOOL_TO	BOOL ⇒ Type X
TO_BOOL	Type X ⇒ BOOL
TIME_TO / TIME_OF_DAY	TIME / TIME_OF_DAY ⇒ Type X
DATE_TO / DT_TO	DATE / DATE_AND_TIME ⇒ Type X
STRING_TO	STRING ⇒ Type X
TRUNC	REAL ⇒ INT
Numeric functions	
ABS	Absolute value
SQRT	Square root
LN	Natural logarithm
LOG	Logarithm to the base 10
EXP	Exponential function
SIN	Sine calculation in rad
COS	Cosine calculation in rad
TAN	Tangent calculation in rad
ASIN	Arcus sine calculation in rad
ACOS	Arcus cosine calculation in rad
ATAN	Arcus tangent calculation in rad
EXPT	Exponentiation of one variable with another
STRING functions	
LEN	Indicates the string length
LEFT	Shows a left initial string
RIGHT	Shows a right initial string
MID	Shows a part of a string
CONCAT	Concatenation (connection) of two strings
INSERT	Inserts a string at a certain position into another string
DELETE	Deletes a part of a string
REPLACE	Replaces a part of a string by another part
FIND	Finds a part of a string

Overview: IEC 61131-3 standard operators

Arithmetic operators	
ADD	Addition
MUL	Multiplication
SUB	Subtraction
DIV	Division
MOD	Remainders
EXP	Exponentiation
MOVE	Assignment
Bit-shift operators	
SHL	Shift to LHS
SHR	Shift to RHS
ROR	CW rotation
ROL	CCW rotation
Bit-string operators	
AND	Bit-by-bit AND of bit operands
OR	Bit-by-bit OR of bit operands
XOR	Bit-by-bit XOR of bit operands
NOT	Bit-by-bit NOT of bit operands
Selection operators	
SEL	Binary selection
MAX	Maximum
MIN	Minimum
LIMIT	Limit
MUX	Multiplexer
Comparison operators	
GT	Higher than
LT	Lower than
LE	Lower or equal
GE	Higher or equal
EQ	Equal
NE	Not equal

2.3 Control restart

The software model of IEC 61131-3 also defines the restart behaviour of the control.

Cold start

With cold starts, the program is loaded again. All variables are reset to their initial value. They either use a standard initial value (e.g. 0 or `FALSE`) or the initial value indicated in the variable declaration (optionally). All tasks of the resource are started.

Warm start

With warm starts (restarts), variables are not set to their inital value but continue with the value saved before the interruption.

3 The communication model

The communication model of IEC 61131-3 describes the data exchange of configuration elements by means of

- access paths
- global variables
- call parameters
- communication organization units (IEC 61131-5)

These unambiguously defined interfaces support the modularization and thus the reuseability of program parts.

3.1 Access paths

Defined access paths enable the configuration elements to communicate with each other and PLC systems.

3.2 Global variables

Global variables enable easy communication between programs. They can be declared and used in a configuration, resource and program.

3.3 Call parameters

Within a program, data is exchanged by means of call parameters, i.e. input and output variables. Call parameters define interfaces for value transfers.

3.4 Communication organization units

Communication organization units provide communication services which are defined in part 5 of IEC 61131 (in preparation).

4 General language elements

General language elements of IEC 61131-3 are identifiers, keywords, comments, literals, data types and variables. They are described in detail in the following sub-sections:

4.1 Identifiers

Identifiers are used to address variables, functions, programs, etc. They are elements and can support the readability of programs.

- Identifiers are a sequence of letters, digits and underscores starting with a letter or an underscore.

Identifiers must not

- include spaces and umlaute.
- be declared twice in the same way.
- be identical with keywords.(🕮Chapter 4.2)

Tip!

The conventions used for the variable identifiers of Lenze system blocks, function blocks and functions are described in the appendix. (🕮 20)

4.2 Keywords

Keywords are unambiguous character combinations which are used as individual syntax elements.

- Keywords must not be used as identifiers.

Examples of keywords to IEC 61131-3

ABS, **SIN**, **BOOL**, **FALSE**, **TRUE**, **FOR**, **NEXT**, **IF**, **THEN**, **VAR**, **GLOBAL**, **DATE**, **TIME**, **FUNCTION**

4.3 Comments

Comments or program parts help to understand the program and are important communication means. Comments are allowed in all text editors at any place and must start and end with a special character sequence (* and *). Every network can be commmented to document its functionality.

4.4 Literals

IEC 61131-3 describes literals as a sequence of characters, digits or times.

Character sequences

Character sequence literals have 0 or more characters and start and end with inverted commas (e.g. `'Character sequence'`).

Digits

There are two different numerical literals: integers and reals.

Integers can be defined with a basis, decimal numbers can also have a sign (+ or -). Reals can also be indicated with exponents.

	Identification	Example
Integers		
decimal		10
binary	2#	2#1010
octal	8#	8#12
hexadecimal	16#	16#A
Reals		
without exponent		-12.50
with exponent	E	15.7E4

Times

There are two different time literals: Duration and time of day/date.

	Identification	Example
Duration	T# or TIME#	T#10ms
Time of day/date		
Date	D# or #DATE	D#1999-08-29
Time of day	TOD# or #TIME_OF_DAY	TOD#15:36:30
Date and time of day	DT# or #DATE_AND_TIME	DT#1999-08-29-15:36:30

4.5 Data types

IEC 61131-3 defines different standard data types. They help to compile derived and user-defined data types. Each identifier is assigned to a data type. The type determines how much memory is to be reserved and which values correspond to the memory contents.

Standard data types

- `BOOL` (truth values `TRUE`/`FALSE`)
- `BYTE`, `WORD`, `DWORD`, `SINT`, `USINT`, `INT`, `UINT`, `DINT`, `UDINT` (integer data types)
- `REAL` (floating point data type)
- `STRING` (character string)
- `TIME`, `TIME_OF_DAY`, `DATE`, `DATE_AND_TIME` (time data types)

Defined data types:

- `ARRAY` (one, two, three-dimensional field)
- `POINTER` (contains addresses of variables/function blocks for the run-time of the program)
- Enumeration (*enumerated*, consists of many string constants)
- `STRUCT` (structure)
- Reference (generates an alternative name for a variable/constant/function block)

4.6 Variables

IEC 61131-3 defines five different variable classes:

- Global variables
- Local variables
- Input variables
- Output variables
- Input and output variables

Local variables do not have a connection to the outside, i.e. they can only be addressed from within a program part; global variables can be addressed from all POUs.

Input, output and input/output variables are related to a program, function or function block. They can be changed by reading and writing within the assigned POU; outside the POU, the change must be defined (input, output and input/output).

The variables are declared between the keywords **VAR** and **END_VAR** in the source text. In general, every variable is initialized after a cold restart. The default value is usually 0 or **FALSE**. A user-specific initialization with another value is possible with the sign ":=" in the declaration.

Variable attributes

The following attributes can be used additionally when declaring a variable:

- **RETAIN**: These variables remain the same even after a power failure. The program continues with the values saved when being restarted.
- **CONSTANT**: Variable values cannot be changed.
- **AT**: Variables have a fixed location in the memory map (fixed address).

Example: Declaration of an output variable with initialization value

```
VAR_OUTPUT
  par_out1 : INT := 10;     (* Output parameter 1 with start value 10
*)
END_VAR
```

Fixedly addressed variables

Variables can be assigned to a physical memory location (PLC) by means of the keyword **AT** when being declared.

The address is indicated as a special character sequence. The character sequence starts with a percentage sign "%" followed by a range prefix and a prefix (data type) for size and ends with a digit sequence which indicates the memory location.

Range prefixes: **I** (Input), **Q**(Output), **M**(Marker, internal memory range)

Size prefix: **X** (Single bit), **B**(Byte, 8 bits), **W**(Word, 16 bits), **D**(Double word, 32 bits)

Examples:	`%QX1.0.2`	Output bit 2
	`%IW1.0.1`	Input bit 1
	`%MB7`	Marker byte 7
	`%MW1`	Marker word 1
	`%MD3`	Marker double word 3
	`%MX1.2`	Third marker bit in marker word 1

5 Programming languages

IEC 61131-3 defines the following five programming languages:

- IL: Instruction List (*Instruction List, IL*)
- ST: Structured Text (*Structured Text*)
- SFC: Sequential Function Chart (*Sequential Function Chart, SFC*)
- FBD: Function Block Diagram (*Function Block Diagram, FBD*)
- LD: Ladder Diagram (*Ladder Diagram, LD*)

Each of these languages is used for special applications which are particularly suited to solve certain problems.

5.1 Instruction List (IL)

(Instruction List, IL)

Instruction List can be compared with Assembler and consists of a sequence of instructions.

- Every instruction starts with a new line, contains an operator and, depending on the operation, one or several operands separated by commas.
- An identifier marker followed by a colon (:) can be in front of an instruction.
- Comments can be entered additionally.
- It is possible to insert empty lines between the instructions.

Example:

```
LD   17
ST   lint            (* Comment*)
GE   5
JMPC next
LD   idword
EQ   istruct.sdword
STN  test
next:
```

5.2 Structured Text (ST)

(Structured Text)

Structured Text consists of instructions which can be executed like in high languages with conditions (**IF..THEN..ELSE**) or in loops (**WHILE..DO**).

Structured Text is an easily readable and understandable programming language that does not only offer powerful loop programming and the possibility of conditioned commands but also imaging mathematical functions.

Example:

```
IF value < 7 THEN
  WHILE value < 8 DO
        value := value + 1;
  END_WHILE;
END_IF;
```

Instructions (overview)

Type of instruction	Example

Assignment by assignment operator	`A:=B;`
	`CV:=CV + 1;`
	`C:=SIN(X);`

Call of a function block, use of an FB	`CMD_TMR(IN:=%IX5, PT:=300);` `A:=CMD_TMR.Q`
RETURN	`RETURN;`

IF condition	`D:=B*B;`
	`IF D<0.0 THEN`
	`  C:=A;`
	`ELSIF D=0.0 THEN`
	`  C:=B;`
	`ELSE`
	`C:=D;`
	`END_IF;`

CASE selection	`CASE INT1 OF`
	`  1: BOOL1:=TRUE;`
	`  2: BOOL2:=TRUE;`
	`ELSE`
	`  BOOL1:=FALSE;`
	`  BOOL2:=FALSE;`
	`END_CASE;`

FOR loop	`J:=101;`
	`FOR I:=1 TO 100 BY 2 DO`
	`  IF ARR[I]=70 THEN`
	`    J:=I;`
	`    EXIT;`
	`  END_IF;`
	`END_FOR;`

WHILE loop	`J:=1;`
	`WHILE J<=100 AND ARR[J]<>70 DO`
	`  J:=J+2;`
	`END_WHILE;`

REPEAT loop	`J:=-1;`
	`REPEAT`
	`  J:=J+2;`
	`UNTIL J= 101 OR ARR[J]=70`
	`END_REPEAT;`

EXIT	`EXIT;`
Empty instruction	`;`

5.3 Sequential Function Chart (SFC)

(Sequential Function Chart, SFC)

Sequential Function Chart is a graphically oriented language that enables the description of a time sequence of different actions within a program.

An organization unit written in SFC consists of steps which are linked by means of directed connections (transitions).

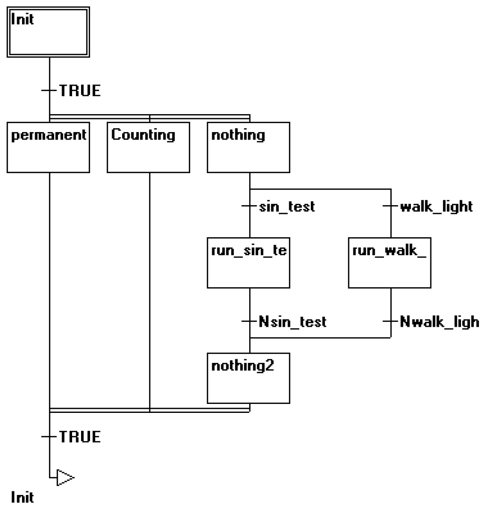


Fig. 3 Example of a network in SFC

The graphical representation of transitions and steps reminds of a flow chart, is easily readable and perfectly suitable for programming higher level status sequences.

Steps

Steps consist of flags and one or several actions or Boolean variables.

- The actions of steps are separated from the steps and can be used repeatedly in an organization unit.
- Qualifiers activate and deactivate actions and Boolean variables (sometimes with time delay).
- Concurrences are possible because an action can still be active when the next step is already being processed, e.g. the qualifier S (set).

Actions

Actions can contain instructions in IL or ST, networks in FBD or LD, or a sequential function (SFC).

Transitions

Transitions are between steps. A step that follows a transition is activated if the transition condition is **TRUE**.

The following transition conditions are possible:

- Boolean variable
- Boolean address
- Boolean constant (**TRUE**)
- A sequence of instructions with a Boolean result in ST syntax (`(i<=100) AND b`)
- A sequence of instructions programmed in any language

Alternative branches

In SFC, two or more branches can be defined as alternative branches.

- Every alternative branch must start and end with a transition.
- Alternative branches can contain parallel branches and other alternative branches.
- An alternative branch starts with a horizontal line (alternative start) and ends with a horizontal line (alternative end) or a jump.
- If the step before the alternative start line is active, the first transition of every alternative branch is evaluated from left to right. The first transition from the left that meets the transition condition **TRUE** is opened and all following steps are activated.

Parallel branches

In SFC, two or more branches can be defined as parallel branches.

- Every parallel branch must start and end with a step.
- Parallel branches can contain alternative branches or other parallel branches.
- A parallel branch starts with a double line (parallel start) and ends with a double line (parallel end) or a jump.
- If the step before the parallel start line is active and the transition condition after this step is **TRUE**, then the first steps of all parallel branches are activated. These branches are processed in parallel.
- The steps after the parallel end line are activated if all steps before are active and the transition condition of this step is **TRUE**.

Jumps

A jump is a connection with the step whose name is indicated under the jump symbol.

Jumps are necessary because it is not allowed to create upwards or crossing connections.

5.4 Function Block Diagram (FBD)

(Function Block Diagram, FBD)

Function Block Diagram is a graphically oriented programming language.

It works with a list of networks. Each network has a structure which represents a logic or arithmetics, a function block request, jump or a return instruction. Function block outputs are connected with inputs of following function blocks. Jumps facilitate programming.

Based on defined function blocks, the Function Block Diagram enables the user to implement any program sequence by means of connection elements. Furthermore, the schematic representation of the data flow helps to understand program sequences.

As known from the **9300 Servo PLC** and **Drive PLC**, many hardware components are offered with the corresponding function blocks. That means that there are corresponding modules for both levels, hardware and software.

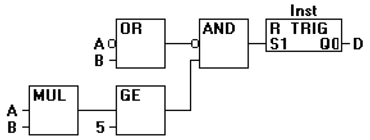


Fig. 4 Example of a network in FBD

5.5 Ladder Diagram (LD)

(Ladder Diagram, LD)

Ladder Diagram is a graphically oriented programming language, similar to the principle of an electric circuit.

On the one hand, Ladder Diagrams are used to build up logic circuits, on the other hand, they can also be used to create networks (like in FBD). Thus, the Ladder Diagram is perfectly suitable to control the request of organization units.

Ladder Diagrams consist of several networks.

A network is limited by vertical current leads on both ends. In between, there is a circuit diagram consisting of contacts, coils and connection lines which transmit the status ”ON” and ”OFF” from left to right (**TRUE** or **FALSE**):

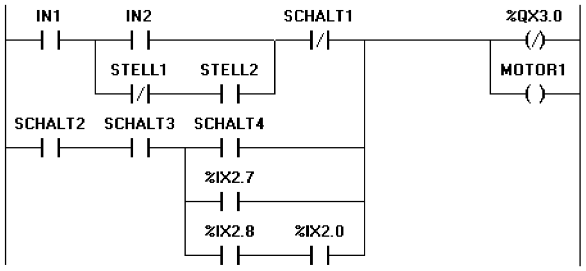


Fig. 5 Example of a network in LD

Contacts

If a Boolean variable of a contact has the value **TRUE**, the status "ON" is transmitted via the connection line from left to right. Otherwise, the right connection is set to "OFF".

- Contacts can be switched in parallel. For this, one of the parallel branches must transmit the value "ON".
- Contacts can also be switched in series. For this, all contacts must transmit the status "ON".
- Contacts can also be negated (indicated by a slash in the contact symbol). The contact transmits the input status if its status is "OFF" (**FALSE**) ist.

Coils

In LD, an unlimited number of coils is available on the right side of a network (indicated by brackets).

- A coil transmits the connection value from left to right and copies the value to the corresponding Boolean variable.
- The start line can be set to "ON" or "OFF" (depending on the Boolean values **TRUE** or **FALSE**).
- Coils can only be connected in parallel.
- Coils can also be negated (indicated by a slash in the contact symbol). They then copy the negated value to the corresponding Boolean variable.

Set/reset coils

Coils can also be defined as set or reset coils.

A set coil (indicated by the letter "S" in the coil symbol) can have the status "ON", but cannot be reset to "OFF".

- If the Boolean variable of the set coil has been set to **TRUE**, it cannot be reset to **FALSE**.

A reset coil (indicated by an "R" in the coil symbol) can have the status "OFF", but cannot be reset to "ON".

- If the Boolean variable of the reset coil has been set to **FALSE**, it cannot be reset to **TRUE**.

Function blocks in LD

In addition to contacts and coils, it is also possible to enter function blocks and programs in LD.

Function blocks and programs must have an input and output with Boolean values in the network. They can be used at the same locations as the contacts, i.e. on the left side of the LD network.

6 Appendix

6.1 IEC keywords

Keywords are unique character combinations used as individual syntax elements.

- Keywords must not be used as identifiers.
- Keywords under the **Drive PLC Developer Studio** also include the names of Lenze function blocks, that always start with "L_" (`L_ABS` , `L_ADD` , ...).

Keywords reserved for IEC 61131-3 programming languages:

ABS	ACOS	ACTION	ADD	AND	ANDN
ANY	ANY_BIT	ANY_DATE	ANY_INT	ANY_NUM	ANY_REAL
ARRAY	ASIN	AT	ATAN		
BOOL	BY	BYTE			
CAL	CALC	CALCN	CASE	CD	CDT
CLK	CONCAT	CONFIGURATION	CONSTANT	COS	CTD
CTU	CTUD	CU	CV		
DATE	DATE_AND_TIME	DELETE	DINT	DIV	DO
DS	DT	DWORD			
ELSE	ESIF	END_ACTION	END_CASE	END_CONFIGURATION	END_FOR
END_FUNCTION	END_FUNCTION_BLOCK		END_IF	END_PROGRAM	END_REPEAT
END_RESOURCE	END_STEP	END_STRUCT	END_TRANSITION	END_TYPE	END_VAR
END_WHILE	EN	ENO	EQ	ET	EXIT
EXP	EXPT				
FALSE	F_EDGE	F_TRIG	FIND	FOR	FROM
FUNCTION	FUNCTION_BLOCK				
GE	GT				
IF	IN	INITIAL_STEP	INSERT	INT	INTERVAL
JMP	JMPC	JMPCN			
L	LD	LDN	LE	LEFT	LEN
LIMIT	LINT	LN	LOG	LREAL	LT
LWORD					
MAX	MID	MIN	MOD	MOVE	MUL
MUX					
N	NE	NEG	NOT		
OF	ON	OR	ORN		
P	PRIORITY	PROGRAM	PT	PV	

Q	Q1	QU	QD		
R	R1	R_TRIG	READ_ONLY	READ_WRITE	REAL
RELEASE	REPEAT	REPLACE	RESOURCE	RET	RETAIN
RETC	RETCN	RETURN	RIGHT	ROL	ROR
RS	RTC	R_EDGE			
S	S1	SD	SEL	SEMA	SHL
SHR	SIN	SINGLE	SINT	SL	SQRT
SR	ST	STEP	STN	STRING	STRUCT
SUB					
TAN	TASK	THEN	TIME	TIME_OF_DAY	TO
TOD	TOF	TON	TP	TRANS	TRUE
TYPE					
UDINT	UINT	ULINT	UNTIL	USINT	
VAR	VAR_ACCESS	VAR_EXTERNAL	VAR_GLOBAL	VAR_INPUT	VAR_IN_OUT
VAR_OUTPUT					
WHILE	WITH	WORD			
XOR	XORN				

6.2 Conventions for Lenze variable identifiers

This chapter describes the conventions used for the variable identifiers of Lenze system blocks, function blocks and functions. The conventions ensure uniform and universal labelling and make reading the PLC program easier.

Tip!

The conventions used by Lenze are based on the "Hungarian Notation". This ensures that the most significant characteristics of a variable (e.g. the data type) can be instantly recognized from its identifier.

An identifier consists of

- a **system block designation** (only for identifiers of system block variables)
- a **variable type entry** (optional)
- a **data type entry**
- an **identifier** (the "proper" name of the variable)
- a **signal type entry** (optional)

6.2.1 System block designation

(only for identifiers of system block variables)

The inputs/outputs of a system block are directly accessed via the corresponding I/O variables.

To indicate to which system block the I/O variables are assigned, the name of the corresponding system block followed by an underscore is written before the identifier.

Examples of system block designations:

*AIN_*

*CAN1_*

*DIGIN_*

6.2.2 Indication of the variable type

The indication of the variable type is optional. It can be used to indicate the variable type in the identifier:

Variable type entry (optional)	Meaning
I_	VAR_INPUT
Q_	VAR_OUTPUT
IQ_	VAR_IN_OUT
R_	VAR RETAIN
C_	VAR CONSTANT
CR_	VAR CONSTANT RETAIN
g_	VAR_GLOBAL
gR_	VAR_GLOBAL RETAIN
gC_	VAR_GLOBAL CONSTANT
gCR_	VAR_GLOBAL CONSTANT RETAIN

6.2.3 Indication of the data type

The data type entry provides information about the data type of a variable:

Data type entry	Meaning
b	Bool
by	Byte
n	Integer
w	Word
dn	Double Integer
dw	Double Word
s	String
f	Real (Float)
sn	Short Integer
t	Time
un	Unsigned Integer
udn	Unsigned Double Integer
usn	Unsigned Short Integer

If the variable is an array or a pointer, this will be indicated **before** the data type entry:

Data type entry (optional)	Meaning
a	Array (combined type), field
p	Pointer

Examples of data type entries:

aby (Array of data type Byte)

dn (Double Integer)

pdn (Pointer to Double Integer)

6.2.4 Identifier

The identifier is the proper name of a variable and should indicate the application or function of the variable.

- Identifiers always start with a capital letter.
- If an identifier is assembled from several "words", then each "word" must start with a capital letter.
- All other letters are written in lower case.

Examples of identifiers:

JogValue

NumberOfValues

CurrentSelectedJogValue

6.2.5 Indication of the signal type

In general, it is possible to assign a certain signal type to the inputs and outputs of Lenze function blocks/system blocks. There are digital, analog, position and speed signals.

A corresponding ending (preceded by an underscore) is added to the identifier of the input/output variable to indicate the signal type.

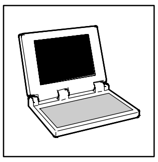
Signal type	Ending	Memory	Normalization (external value ≡ internal value)	Previous designation
analog	_a (analog)	16 bits	100 % ≡ 16384	○
digital	_b (binary)			□
Phase-angle difference or speed	_v (velocity)	16 bits	15000 rpm ≡ 16384	△
Phase-angle or position	_p (position)	32 bits	1 motor revolution ≡ 65535	▲

6.2.6 Examples of variable identifiers

Variable identifier	Assigned system block	Variable type	Data type	Signal type	Application/function
g_anFixSetSpeedValue_a	-	VAR_GLOBAL	Array (Integer)	analog	Array for fixed setpoints
CAN2_nOutW1_a	CAN2_IO	-	Integer	analog	Output word 1 of CAN2_OUT
AOUT1_nOut_a	AOUT1	-	Integer	analog	Output analog signal
bQSP_b	-	-	Bool	binary (TRUE/FALSE)	Activation of quick stop
byFunction	-	-	Byte	-	Function selection
dnIn1_p	-	-	Double Integer	position	Phase input signal 1
nVp	-	-	Integer	-	Gain

6.3 Glossary

Sequential Function Chart	Sequential Function Chart SFC (*Sequential Function Chart - SFC*) is a programming language to describe sequential and parallel control processes with time and event control.
Action	Boolean variable or instructions which can be controlled through an action block (in SFC).
Action block	Activation description of actions in SFC.
Current event	Intermediate result in IL of any data type.
Instruction List	Instruction List (*Instruction List - IL*) is a common programming language for PLC systems similar to Assembler.
SFC	Abbreviation for Sequential Function Chart
IL	Abbreviation for Instruction List
Organization unit	(Sub-)program unit which is part of a PLC program. Often organization units can be loaded into the PLC independently of each other. Compare POU.
CPU	Central processing unit (*Central Processing Unit*) of, e.g., a PLC.
Declaration	Indication of variables and FB instances in a declaration block by also indicating the identifier, data type and FB type as well as initial values, ranges and field features.
Declaration block	Summary of declarations for a variable type at the beginning of a POU.
Elementary data type	A standard data type predefined by IEC 61131-3.
Function extensions	A function can have a variable number of inputs.
FB	Abbreviation for Function Block (*Function Block*), often, function blocks are also called "Function organization units".
FB instance	See Instance
FB type	Name of a function block with request interface.
FBD	*Function Block Diagram*, see Function Block Diagram
Function	A POU of type `Function`
Function organization unit	See Function block
Function block	A POU of type `Function_Block`
Function Block Diagram	The Function Block Diagram (*Function Block Diagram*) consists of a list of networks which enable the user to create graphics that show any program process by means of connection elements.
FBD	See Function Block Diagram
IL	*Instruction List*, see Instruction List
Indirect FB call	Call of an FB instance whose name has been transferred to a POU as `VAR_IN_OUT` parameter.
Instance	Structured data set of an FB by declaration of a function block plus indication of the FB type.
LD	Abbreviation for Ladder Diagram
Configuration	The configuration (*Configuration*) defines the PLC structure and represents the highest level in the IEC 61131-3 software model.
Ladder Diagram	Ladder Diagram (*Ladder Diagram - LD*) is a programming language to describe networks with simultaneously operating Boolean and electromechanical elements such as contacts and coils.
LD	*Ladder Diagram*, see Ladder Diagram
POU	Abbreviation for Program Organization Unit (*Program Organization Unit - POU*)
POU	*Program Organization Unit*, see Program Organization Unit
Program Organization Unit	The Program Organization Unit is an organization unit in IEC 61131-3 of type function, function block or program. It builds up user programs hierarchically.
Resource	A resource (*Resource*) is a central unit (CPU) of a configuration.
Step	Status node in an SFC program. Actions referring to a step are started here.
SFC	*Sequential Function Chart*, see Sequential Function Chart
PLC	Programmable Logic Controller (*Programmable Controller*).



Introduction to IEC 61131-3 programming

Appendix

ST	Abbreviation for Structured Text.
Standard functions	All functions predefined by IEC 61131-3 to implement PLC typical functionality.
Standard organization units	See Standard function blocks
Standard function blocks	All function blocks (*Function Blocks*) predefined by IEC 61131-3 to implement PLC typical functionality.
Structured Text	Structured Text (*Structured Text*) is a programming language to describe algorithms and execution control by means of the latest high languages.
Task	Definition of run time features of a program.
Transition	Transition from one SFC step to the next by evaluation of the transition condition.
Type definition	Definition of a user-specific data type based on already existing data types.
Variable	Name of a data memory which can contain values determined by the data type or variable declaration.
Cycle	The cycle of a (periodically called) user program.
Cycle time	The cycle time is the time needed by the user progam for a cycle.