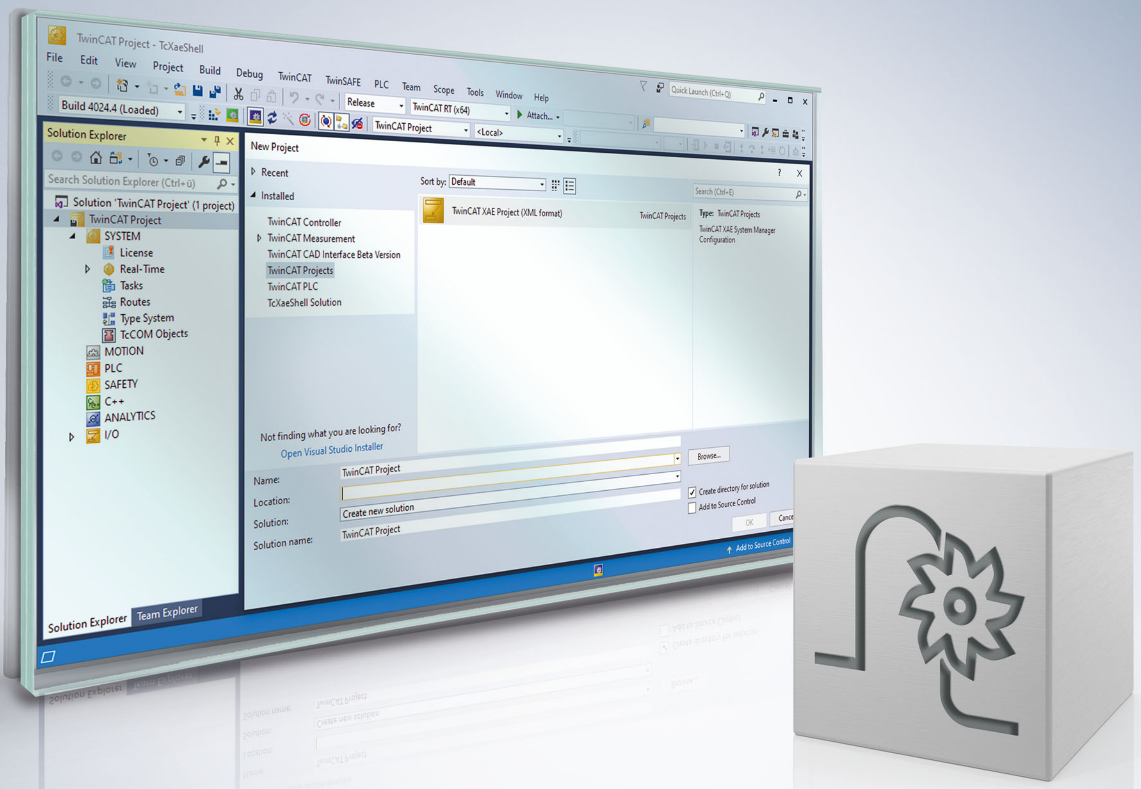
BECKHOFF New Automation Technology

Functional description | EN

TF5200 | TwinCAT 3 CNC

Exporting V.E. variables



6/10/2025 | Version: 1.24

Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

Beckhoff®, TwinCAT®, TwinCAT/BSD®, TC/BSD®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered trademarks of and licensed by Beckhoff Automation GmbH.
Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

Patent Pending

The EtherCAT technology is patent protected, in particular by the following applications and patents:
EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702
with corresponding applications or registrations in various other countries.

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

Copyright

General and safety instructions

Icons used and their meanings

This documentation uses the following icons next to the safety instruction and the associated text. Please read the (safety) instructions carefully and comply with them at all times.

Icons in explanatory text

1. Indicates an action.

⇨ Indicates an action statement.

⚠ DANGER

Acute danger to life!

If you fail to comply with the safety instruction next to this icon, there is immediate danger to human life and health.

⚠ CAUTION

Personal injury and damage to machines!

If you fail to comply with the safety instruction next to this icon, it may result in personal injury or damage to machines.

NOTICE

Restriction or error

This icon describes restrictions or warns of errors.

ℹ **Tips and other notes**

This icon indicates information to assist in general understanding or to provide additional information.

General example

Example that clarifies the text.

NC programming example

Programming example (complete NC program or program sequence) of the described function or NC command.

ℹ **Specific version information**

Optional or restricted function. The availability of this function depends on the configuration and the scope of the version.

Table of contents

List of figures

1 Overview

Task

The export functionality generates a channel-specific data structure containing all variables from an existing “List of External Variables” (referred to as V.E List or Variable) of a machine configuration.

Characteristics

This generated data structure can be imported to a PLC environment, thus permitting the PLC to access the V.E variables. It also permits the rapid and reliable creation of an interface between the NC controller and the PLC for data transfer.

Parametrisation

The parameter P-EXTV-00022 defines the specified number of characters is used for string variables.

Programming

The data structure is exported to a small NC program by the #EXPORT VE[...] [▶ 9] command Since the configuration of V.E variables no longer changes after start-up, this operation is usually executed only once when the machine is started.

Mandatory note on references to other documents

For the sake of clarity, links to other documents and parameters are abbreviated, e.g. [PROG] for the Programming Manual or P-AXIS-00001 for an axis parameter.

For technical reasons, these links only function in the Online Help (HTML5, CHM) but not in pdf files since pdfs do not support cross-linking.

2 Description

Data transfer between PLC and CNC via V.E variables

V.E variables permit the transfer of data in any direction between an NC program and the PLC.

The PLC can access V.E variables by simulating them as a data structure in the PLC.

Initial situation

A variable list of the configuration is created.

2.1 Generating the output file (#EXPORT VE)

The NC command **#EXPORT VE [..]** generates the required data structure for the V.E. variables for the channel in which the command is used.

With multi-channel systems, the NC command must be used in each channel in order to generate the data structure for the particular channel.

> The identifier <i> in the filename of the output file is a placeholder for the CNC channel number.

```
Syntax:
```

#EXPORT VE [3S | TWINCAT | KW]

3S / TWINCAT

For TwinCAT 2 and the original 3S CODESYS 2.3 PLC environment:

Output file: plc_3s_ve_types_ch_**<i>**.exp

For TwinCAT 3 and the original 3S CODESYS 3.5 PLC environment:

Output file: plc_3s_ve_types_ch_**<i>**.xml

Output directory:

- For TwinCAT, the output path defined in the SystemManager is used to search for NC programs. See: CNC configuration - CNC task GEO - HLI tab HLI - entry box: NC file path
- For 3S: Directory specified by P-STUP-00020 or as of V3.1.3052.05 by P-CHAN-00403

KW

For MULTIPROG PLC environment:

Output file: plc_kw_ve_types_ch_**<i>**.exp

Output directory: application-specific (P-STUP-00020 or using P-CHAN-00403) as of V3.1.3052.05 and higher

If no output directory is specified in a TwinCAT configuration, the output file is placed in the following directory depending on the TwinCAT version:

- TwinCAT 2 32-bit: Main directory C:\
- TwinCAT 3 64-bit: C:\Windows\SysWOW64

This is dependent on the corresponding write authorisations in each directory.

> The call of the CNC command #EXPORT VE absolutely requires the specification of the PLC destination system as parameter. The result is named accordingly.
>
> An error message 20509 is output if the parameter is missing.

Generate the output file

```
#EXPORT VE [TWINCAT] ;Generate V.E. PLC structure for TwinCAT
```

```
#EXPORT VE [3S] ;Generate V.E. PLC structure for 3S CODESYS
#EXPORT VE [KW] ; Generate V.E. PLC structure for MULTIPROG from KW
```

The command can be placed in an NC program or can be executed as a manual block. The command generates a file which is declared in a data structure compliant with IEC 61131-3 for all V.E variables created in the NC channel.

The generated file corresponds to the import/export format for the CODESYS or MULTIPROG development environments and can be imported there directly.

Additional structure declarations are required in the output file.

2.2 Errors on exporting

The declaration of the V.E variables is checked before the function generates the PLC data structure.

Any error messages occurring are logged in the (EXPORT) output file.

3 Example 1- Use short text strings

3.1 V.E. variable list

Assignment in V.E. variable list:

```
#
use_extended_string_var      0    # P-EXTV-00022
#
anzahl_belegt                4
#
var[0].name                  FARBE
var[0].type                  UNS16
var[0].scope                 CHANNEL
var[0].synchronisation       FALSE
var[0].access_rights         READ_WRITE
var[0].array_elements        3
#
var[1].name                  TEXT
var[1].type                  STRING
var[1].scope                 CHANNEL
var[1].synchronisation       FALSE
var[1].access_rights         READ_WRITE
var[1].array_elements        2
#
var[2].name                  INFO_IN
var[2].type                  OFFSET
var[2].scope                 GLOBAL
var[2].synchronisation       FALSE
var[2].access_rights         READ_WRITE
var[2].array_elements        2
#
var[3].name                  INFO_OUT
var[3].type                  OFFSET
var[3].scope                 GLOBAL
var[3].synchronisation       FALSE
var[3].access_rights         READ_WRITE
var[3].array_elements        2
var[3].create_hmi_interface  0
#
struct[0].name               OFFSET
struct[0].element[0].name    X
struct[0].element[0].type    UNS16
struct[0].element[1].name    Y
struct[0].element[1].type    UNS16
#
```

3.2 Example of output file for CODESYS

Representation in the exported file:

```
TYPE STRING_20:
STRUCT
    token:STRING(20);
    f1_st: ARRAY[0..2] OF BYTE;
END_STRUCT
END_TYPE

TYPE STRING_20_2:
STRUCT
    token:STRING(20);
    f1_st: ARRAY[0..106] OF BYTE;
END_STRUCT
END_TYPE

TYPE OFFSET:
STRUCT
    X: UINT;
    Y: UINT;
END_STRUCT
END_TYPE

TYPE VE_CHANNEL_DATA_CH_1:
STRUCT
    FARBE: ARRAY[0..2] OF UINT;
    f1: ARRAY[0..17] OF BYTE;
    TEXT: ARRAY[0..1] OF STRING_20;
END_STRUCT
END_TYPE

TYPE VE_GLOBAL_DATA_FROM_CH_1:
STRUCT
    INFO_IN: ARRAY[0..1] OF OFFSET;
    INFO_OUT: ARRAY[0..1] OF OFFSET;
END_STRUCT
END_TYPE
```

3.3 PLC example

Integrating the structure in a 3S PLC program:

```
VAR
  (* Use generated structure descriptions *)
  p_ve_chan_1 : POINTER TO VE_CHANNEL_DATA_CH_1;
  p_ve_glob   : POINTER TO VE_GLOBAL_DATA_FROM_CH_1;
  text        : STRING(20);
  init_ve_ptr : BOOL := TRUE;

END_VAR

(* Ensure that the internal management data is initialised *)

Hli(Start := TRUE);


IF Hli.Initialised = TRUE AND Hli.Error = FALSE THEN

  IF init_ve_ptr = TRUE THEN
```

```
    (* Provide pointer to structure(s) *)
    p_ve_chan_1 := ADR( gpVECH[0]^.ext_var32[0]);
    p_ve_glob   := ADR(gpVEGlobal^.ext_var32[0]);
```

```

  END_IF;

  (* Work with the variables (read, write) *)
  text := p_ve_chan_1^.TEXT[0].token;
  p_ve_chan_1^.FARBE[1] := 2;
END_IF
```

3.4 Example of output file for MULTIPROG

The following export for MULTIPROG is based on the identical V.E variable list [▶ 11] as the export for CODESYS [▶ 12].

```
TYPE
  TYPE_STRING_20 : ARRAY[0..20] OF BYTE;
END_TYPE

TYPE
  ALIGN_STRING_20_1 : ARRAY[0..2] OF BYTE;
END_TYPE

TYPE
  ALIGN_STRING_20_2 : ARRAY[0..106] OF BYTE;
END_TYPE

TYPE STRING_20_1:
STRUCT
  Token     : TYPE_STRING_20;
  alignment : ALIGN_STRING_20_1;
END_STRUCT;
END_TYPE

TYPE STRING_20_2:
STRUCT
  Token     : TYPE_STRING_20;
  alignment : ALIGN_STRING_20_2;
END_STRUCT;
END_TYPE

TYPE OFFSET:
STRUCT
  X: UINT;
  Y: UINT;
END_STRUCT;
END_TYPE

TYPE
T2_FARBE: ARRAY[0..2] OF UINT;
END_TYPE

TYPE
  F1_2:ARRAY[0..17] OF BYTE;
END_TYPE

TYPE
  T2_TEXT : ARRAY[0..1] OF STRING_20_1;
END_TYPE

TYPE VE_CHANNEL_DATA_CH_1:
STRUCT
FARBE: T2_FARBE;  (* index = 0 *)
    f1 : F1_2;
    TEXT: T2_TEXT;   (* index = 1 *)
END_STRUCT;
END_TYPE

TYPE
  T3_OFFSET : ARRAY[0..1] OF OFFSET;
END_TYPE

TYPE
  T3_OFFSET : ARRAY[0..1] OF OFFSET;
END_TYPE

TYPE VE_GLOBAL_DATA_FROM_CH_1:
STRUCT
    INFO_IN: T3_OFFSET;
    INFO_OUT: T3_OFFSET;
END_STRUCT;
END_TYPE
```

4 Restrictions in the case of a multi-channel controller structure

When the CNC starts up, the "GLOBALLY" declared variables for each NC channel are added incrementally to any existing variables. The memory layout in its entirety is only defined after start-up has finished. The start address to the common memory is then made available to the PLC.

- The #EXPORT function can only be started in one channel.
- Therefore, it only uses the "GLOBAL" variables declared in that channel. Variables from other channels that are assigned different index values, for example, are invisible. Therefore, they are not entered in the structure VE_GLOBAL_DATA_FROM_CH_<i>.
- A separate VE_GLOBAL_DATA_FROM_CH_<i> structure is created for each channel-specific V.E list where

Recommendation

Identical Global Variables in several channels are created in each of the channels.

5 Short instructions using the export functionality for V.E. variables

Procedure based on TwinCAT

1. Exporting V.E variables from the CNC using the export command #EXPORT VE[TWINCAT]
2. Open the export file with an editor and check for any warnings or errors. These are displayed by a text in the file.
3. Importing the export file to the existing PLC project
4. Create pointers to structures
   (* Use the generated structure descriptions *)
   p_ve_chan_1 : POINTER TO VE_CHANNEL_DATA_CH_1;
   p_ve_glob   : POINTER TO VE_GLOBAL_DATA_FROM_CH_1;
5. Assign the addresses of the V.E-specific HLI ranges only once as shown in the example of the defined pointer variables [▸ 13]
6. Integrate read and write access to structures
   p_ve_glob^.VARIABLE_1 := 22;   (*Write access*)
   gl_ar_var_3 := p_ve_glob^.VARIABLE_1; (*Read access*)

6 Parameter

P-EXTV-00022	Number of characters of a string variable
Description	This parameter can increase the permissible number of characters of string variables from 21 to 128 characters (each including the termination mark). If the addresses of the V.E. variable is specified in 24-byte blocks (see Memory layout), make sure that 128-byte variables of the STRING type are assigned several 24-byte blocks in the memory layout and that the index is incremented accordingly (cf. variable arrays).
Parameter	use_extended_string_var
Data type	BOOLEAN
Data range	TRUE, FALSE
Dimension	----
Default value	FALSE
Remarks	

7 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Download finder

Our download finder contains all the files that we offer you for downloading. You will find application reports, technical documentation, technical drawings, configuration files and much more.

The downloads are available in various formats.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on our internet page: www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline:	+49 5246 963-157
e-mail:	support@beckhoff.com

Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

Hotline:	+49 5246 963-460
e-mail:	service@beckhoff.com

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone:	+49 5246 963-0
e-mail:	info@beckhoff.com
web:	www.beckhoff.com

Index

More Information:
www.beckhoff.com/TF5200

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com