



# DOCUMENTATION ISG-kernel

## **Functional description** **Decrypting and encrypting a NC program**

Short Description:  
FCT-C12

# Preface

## Legal information

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This documentation was produced with utmost care. The products and scope of functions described are under continuous development. We reserve the right to revise and amend the documentation at any time and without prior notice.

No claims may be made for products which have already been delivered if such claims are based on the specifications, figures and descriptions contained in this documentation.

## Personnel qualifications

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This description is solely intended for skilled technicians who were trained in control, automation and drive systems and who are familiar with the applicable standards, the relevant documentation and the machining application.

It is absolutely vital to refer to this documentation, the instructions below and the explanations to carry out installation and commissioning work. Skilled technicians are under the obligation to use the documentation duly published for every installation and commissioning operation.

Skilled technicians must ensure that the application or use of the products described fulfil all safety requirements including all applicable laws, regulations, provisions and standards.

## Further information

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Links below (DE)

<https://www.isg-stuttgart.de/produkte/softwareprodukte/isg-kernel/dokumente-und-downloads>

or (EN)

<https://www.isg-stuttgart.de/en/products/softwareproducts/isg-kernel/documents-and-downloads>

contains further information on messages generated in the NC kernel, online help, PLC libraries, tools, etc. in addition to the current documentation.

## Disclaimer

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It is forbidden to make any changes to the software configuration which are not contained in the options described in this documentation.

## Trade marks and patents

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# 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

- 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.



### **Attention**

#### **Restriction or error**

This icon describes restrictions or warns of errors.



### **Notice**

#### **Tips and other notes**

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



### **Example**

#### **General example**

Example that clarifies the text.



### **Programing Example**

#### **NC programming example**

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



### **Release Note**

#### **Specific version information**

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

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# 1 Overview

## Task

Controller/machine manufacturers supply encrypted NC programs that end-users are not allowed to modify and cannot view.

The NC kernel processes encrypted NC programs.

## Properties

An encrypted NC program is recognised by its file extension. A key used for encryption and decryption must be defined for every file extension. Every file extension and the associated key define an encryption group.

A file is recognised as encrypted if its extension matches one of the encryption group file extensions. The CNC uses the associated key to decrypt the file automatically during NC program decoding.

The **program ISGCRYPTER** ) must be used. The examples shown here are taken from the program.

## Display

An NC program encrypted by the user can be decrypted by the program **ISG CRYPTER** if the required key is known.

Alternatively, the user can create a user-defined interface (HMI) that includes the "ISGEncrypt.dll" or "ISGEncrypt\_x64.dll" library (for a 64-bit application) and integrate the "decode\_cnc\_file()" method there.

## Parameterisation

The user can define 3 different encryption groups. The keys are transmitted by CNC objects [► 19] to the NC kernel at controller start-up or before program start.

The file extensions assigned to the keys are configured by P-CHAN-00283 [► 18].

## **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

### Initialisation

The following steps are required to use an encrypted NC program:

1. An NC program is encrypted with an individual key and saved to a folder.
2. The file extension is entered in the channel parameter list as an encrypted file type for the corresponding channel.
3. In parallel to the file extension, the associated key used to encrypt the file is entered in the NC kernel. Make the entry by using a write operation to a CNC object. This can be executed by the PLC.

### Sequence

When an NC program is invoked, the NC kernel detects from the extension whether it is encrypted. If the NC program is detected as encrypted, the kernel decrypts it using the specified key. If the file extension is defined as not encrypted, the program is processed as a normal NC program.



#### Attention

If the key is incorrect, the file is still decrypted. The NC kernel attempts to process the file and this then results in a syntax error.

### CNC diagnosis

Entries of NC program parts in the CNC diagnostic data "diag\_data.txt" are encrypted by a key from the controller manufacturer, i.e. they are not visible to users.

### Flow chart

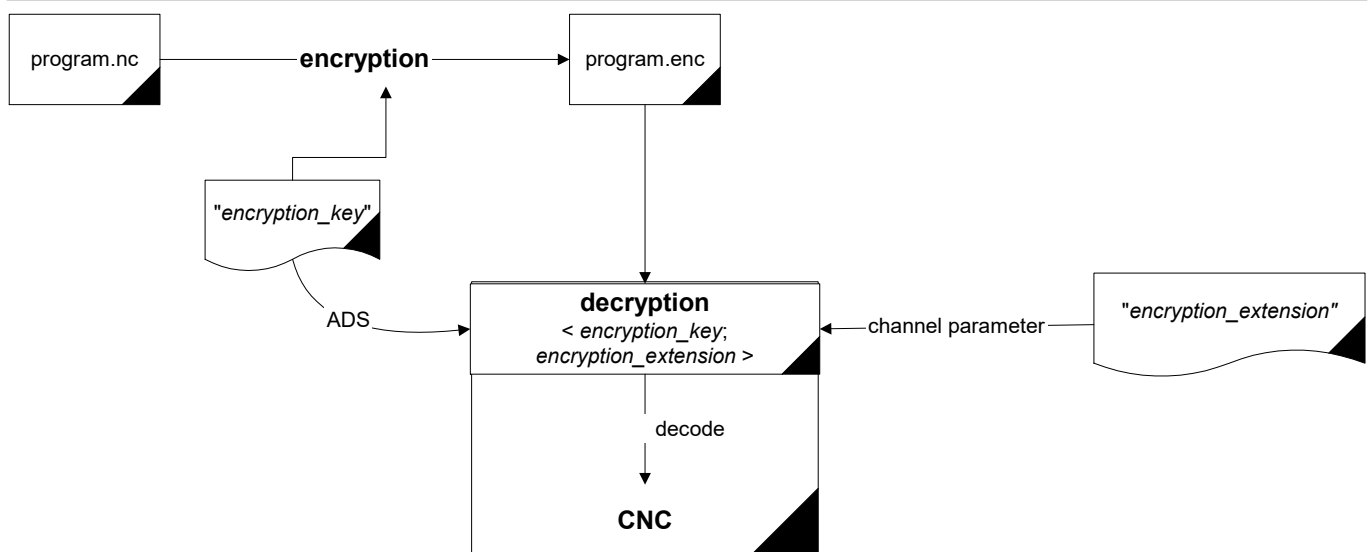


Fig. 1: Encryption/decryption flow chart of an NC program

## HMI process

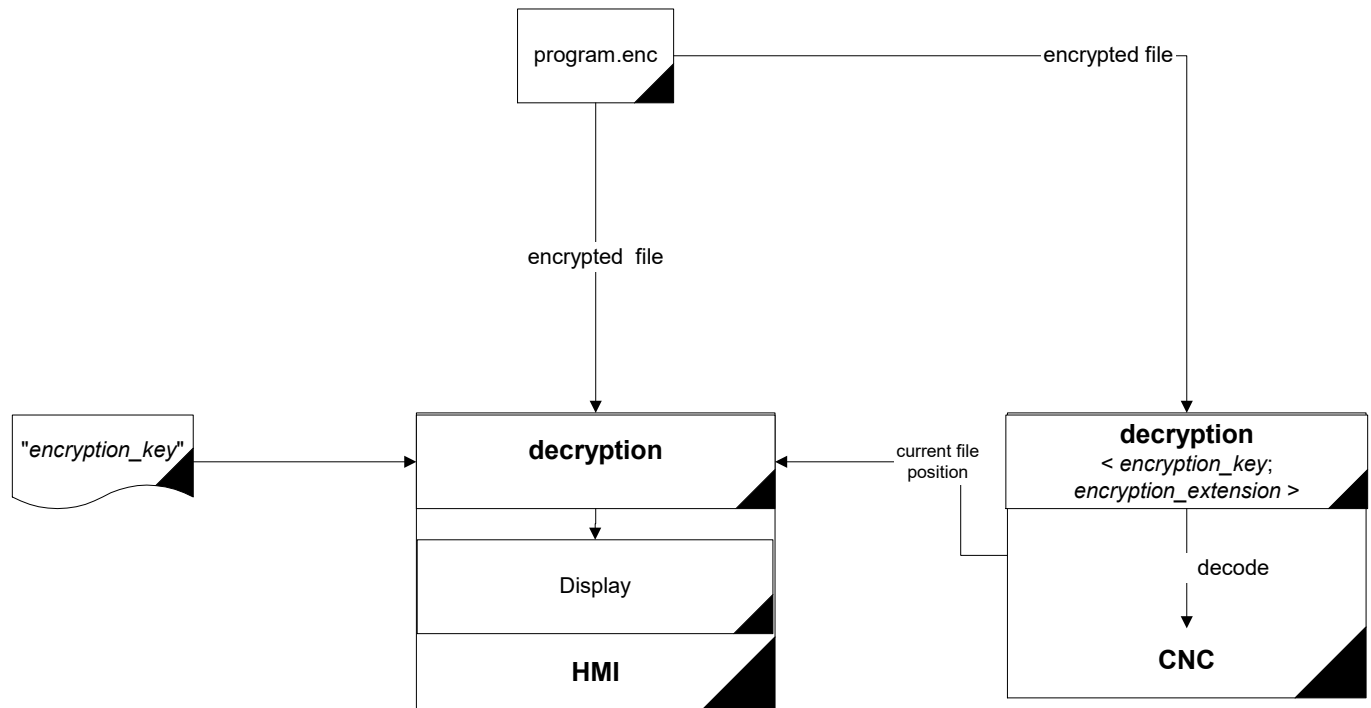


Fig. 2: Displaying an encrypted NC program



## 3 Encryption groups and configuration

### Groups

The user can define 3 different encryption groups for the NC kernel. Each of these groups consists of a pair comprising a key and a file extension. A key can contain a maximum of 56 characters plus '\0'.

A file extension must consist of 1 to 3 characters. When the NC kernel loads an NC program, it checks whether the extension of the NC program is entered in one of these 3 groups. If this is the case, the NC kernel decrypts the NC program with the key belonging to the associated group.

### Default configuration

Users can use the groups as they wish. The pair assignment of key and file extension is depicted in the table below:

Group	Key	Channel parameters
1	mc_encryption_key_0	encryption_extension[0] P-CHAN-00283
2	mc_encryption_key_1	encryption_extension[1] P-CHAN-00283
3	mc_encryption_key_2	encryption_extension[2] P-CHAN-00283

### 3.1 Channel parameter list



#### Example

Parameterisation options for file extensions in the channel parameter list

The table below shows an example of a setting for the extensions in the channel parameter list. The file extensions for groups 1 to 3 (index 0, 1, 2) can be set.

Channel parameters	Value
encryption_extension[0]	enc
encryption_extension[1]	od
encryption_extension[2]	e

A further group also exists. This group is permanently specified by the controller or machine manufacturer and is used for the encryption of user-created NC programs (e.g. CNC cycles). These NC programs have the extension "ecy".



#### Notice

**You are advised not to re-assign the file extension "ecy" for user-created definitions.**

If you define the file extension "ecy", it is not possible to use CNC cycles since NC programs encrypted by controller/machine manufacturers cannot be decrypted.

## 3.2 Setting keys via CNC objects

The keys for encryption groups must be set via CNC objects. Refer to the example below on how to address objects via the index group and index offset.

You can also set them online using the ISG Object Browser of the CNC.

As a security measure, all keys are only displayed hidden.

### Access to encryption

All groups are accessible as shown in the example below. The arrays can be written via CNC objects.



#### Example

##### Channel 1:

Task: COM

```
IDXGRP      :=16#00120101  ( Channel 1 )
IDXOFFS     :=16#00000094  ( mc_encryption_key_0)
IDXGRP      :=16#00120101  ( Channel 1 )
IDXOFFS     :=16#00000095  ( mc_encryption_key_1)
IDXGRP      :=16#00120101  ( Channel 1 )
IDXOFFS     :=16#00000096  ( mc_encryption_key_2)
```

#### ADS function block

Transfer takes place using the function block ADSWRITE(). The following applies to the example above:

```
fb_AdsWrite( NETID      :='',
              PORT       :=553,
              IDXGRP     :=16#00120101,
              IDXOFFS    :=16#00000094,
              SRCADDR    := ADR(mc_encryption_key_0),
              LEN        := SIZEOF(mc_encryption_key_0),
              WRITE      := TRUE
            );
```



#### Attention

When you write CNC objects, note that you may have to insert a "\0" at the string end.

## 4 Library methods

### ISGEncryption.dll

This auxiliary DLL includes the methods for encrypting and decrypting NC programs.

- encode\_cnc\_file()
- decoder\_cnc\_file()
- get\_version()



#### Notice

The library was designed for the European/Western character set. If different character sets are used, it may result in unforeseen side effects.

### 4.1 Encryption

The specified input file is fully encrypted with the specified key and is saved as the output file.

long **encode\_cnc\_file** (char \*pIn, char \*pOut,  
char\* encryption\_key, char\* err\_buffer )

#### Parameter

Name	Type	Meaning
pIn	char*	Name for input file
pOut	char*	Name for output
encryption_key	char*	Key
err_buffer	char*	Buffer for error messages: "Key is longer than 56 characters" "No key defined" "Could not open input file" "Could not open output file" If a blank string is entered, no error occurred. A maximum of 256 characters can be transmitted.

#### Return values

Value	Meaning
-2	Maximum key length exceeded.
-1	Key missing.
0<x	Encryption of x characters successful.

### 4.2 Decryption

The specified file is decrypted with the specified key and written to the buffer "pDest".

long **decode\_cnc\_file** (unsigned char \*pDest, char \*pName, long offset,  
long length, char \*decryption\_key,  
char \*err\_buffer)

## Parameter

Name	Type	Meaning
pDest	unsigned char*	Buffer for output
pName	char*	Name for input file
offset	long	Offset for reading in the input file
length	long	Read length
decryption_key	char*	Key
err_buffer	char*	Buffer for the following error messages: "Key is longer than 56 characters" "No key defined" "File offset was negative" "File length was negative" If a blank string is entered, no error occurred. A maximum of 256 characters can be transmitted.

## Return values

Value	Meaning
-4	Maximum key length exceeded.
-3	Offset parameter is negative.
-2	Length parameter is negative.
-1	Key missing.
0<x	Decryption of x characters successful.

## 4.3 Version number

The file version of the dll can be determined with the library method `get_version()`. This is the same version that is obtainable by right-clicking File => Properties => Details (see the figure below).

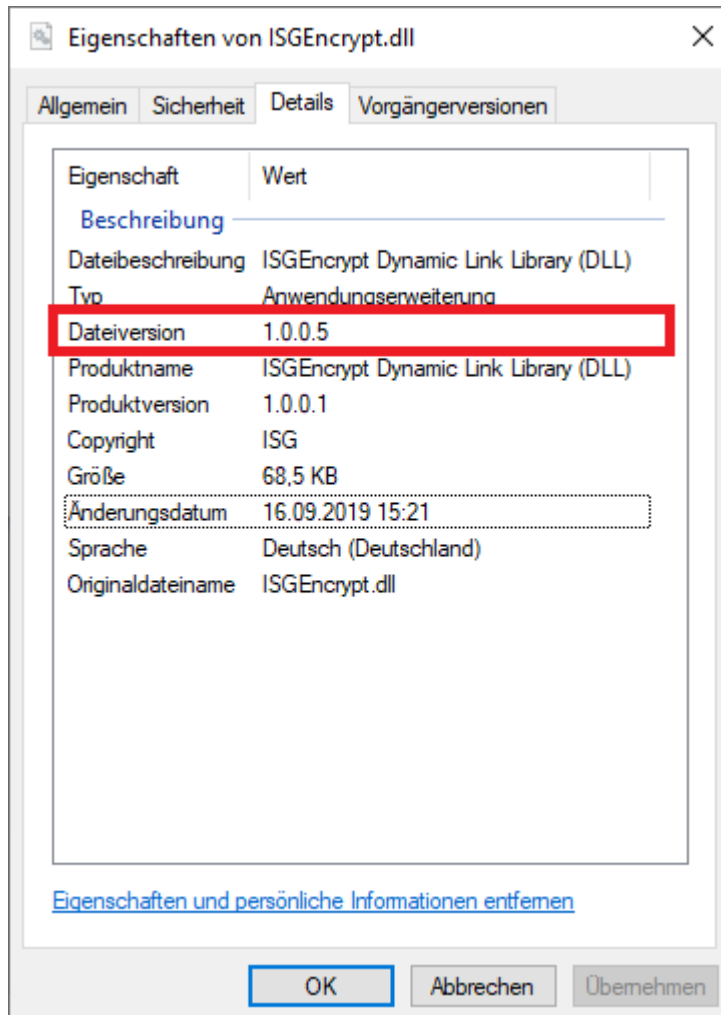


Fig. 3: Determining the dll file version

### Parameter

Name	Type	Meaning
pDest	unsigned char*	Buffer for version string

### Return values

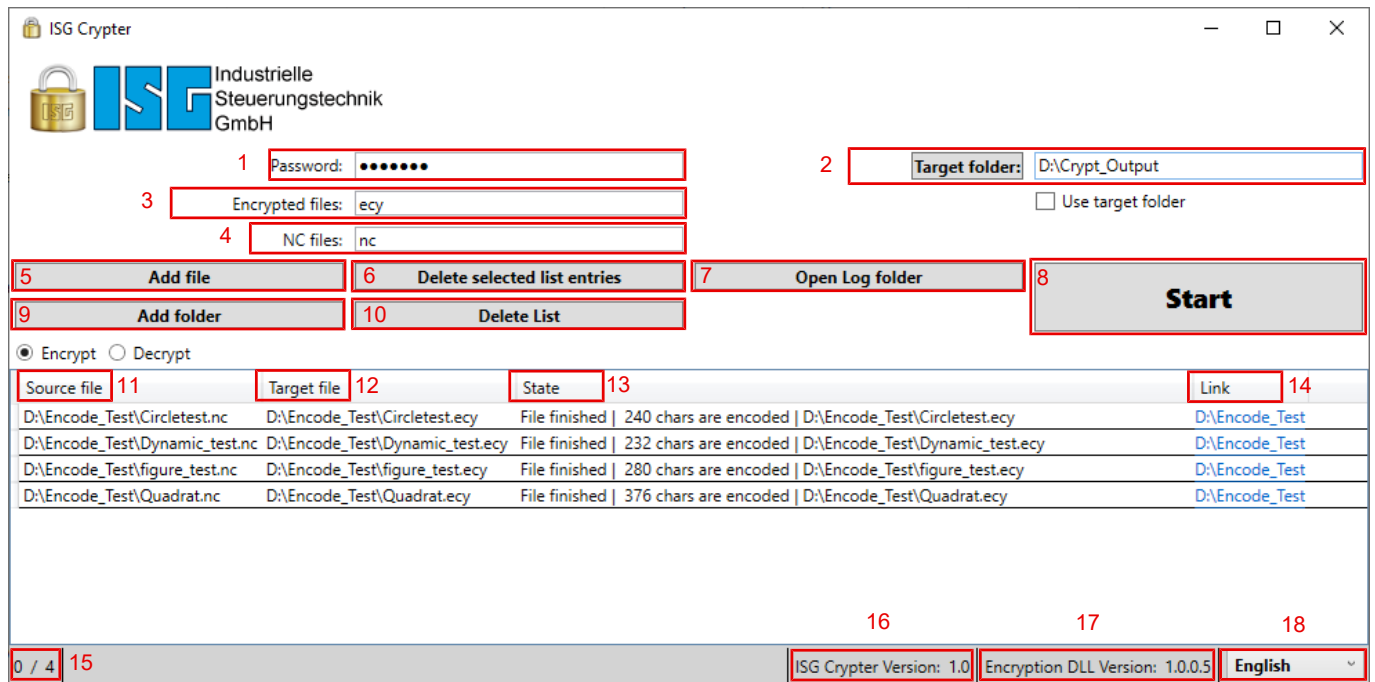
Value	Meaning
TRUE	Version string successfully copied to the buffer.
FALSE	Version string could not be written to the buffer.

## 5 Use of the dll in a test GUI



### Example

An example of C#/.NET is provided below. This shows the use of ISGEncryption.dll by an example application in the figure below.



The screenshot shows the ISG Crypter application window. The title bar reads 'ISG Crypter'. The logo on the left consists of a padlock icon and the text 'ISG Industrielle Steuerungstechnik GmbH'. The main interface includes several input fields and buttons:

- 1**: Password field (masked with dots).
- 2**: Target folder field (containing 'D:\Crypt\_Output').
- 3**: Encrypted files field (containing 'ecy').
- 4**: NC files field (containing 'nc').
- 5**: Add file button.
- 6**: Delete selected list entries button.
- 7**: Open Log folder button.
- 8**: Start button.
- 9**: Add folder button.
- 10**: Delete List button.

Below the buttons, there are radio buttons for 'Encrypt' (selected) and 'Decrypt'. A table displays the encryption process:

Source file <b>11</b>	Target file <b>12</b>	State <b>13</b>	Link <b>14</b>
D:\Encode_Test\Circletest.nc	D:\Encode_Test\Circletest.ecy	File finished   240 chars are encoded	D:\Encode_Test\Circletest.ecy
D:\Encode_Test\Dynamic_test.nc	D:\Encode_Test\Dynamic_test.ecy	File finished   232 chars are encoded	D:\Encode_Test\Dynamic_test.ecy
D:\Encode_Test\figure_test.nc	D:\Encode_Test\figure_test.ecy	File finished   280 chars are encoded	D:\Encode_Test\figure_test.ecy
D:\Encode_Test\Quadrat.nc	D:\Encode_Test\Quadrat.ecy	File finished   376 chars are encoded	D:\Encode_Test\Quadrat.ecy

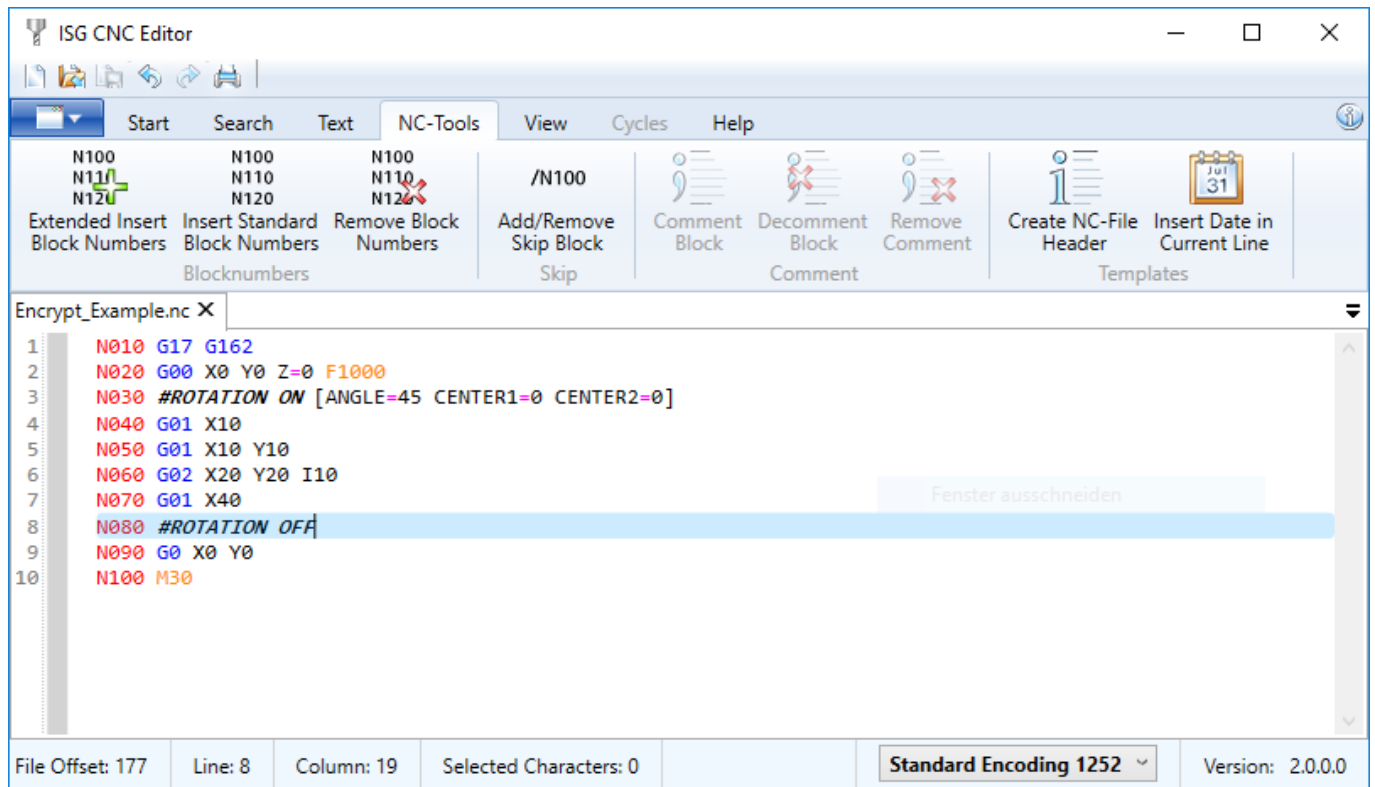
At the bottom, there is a status bar with:

- 15**: Progress indicator (0 / 4).
- 16**: ISG Crypter Version: 1.0
- 17**: Encryption DLL Version: 1.0.0.5
- 18**: Language dropdown menu (currently set to English).

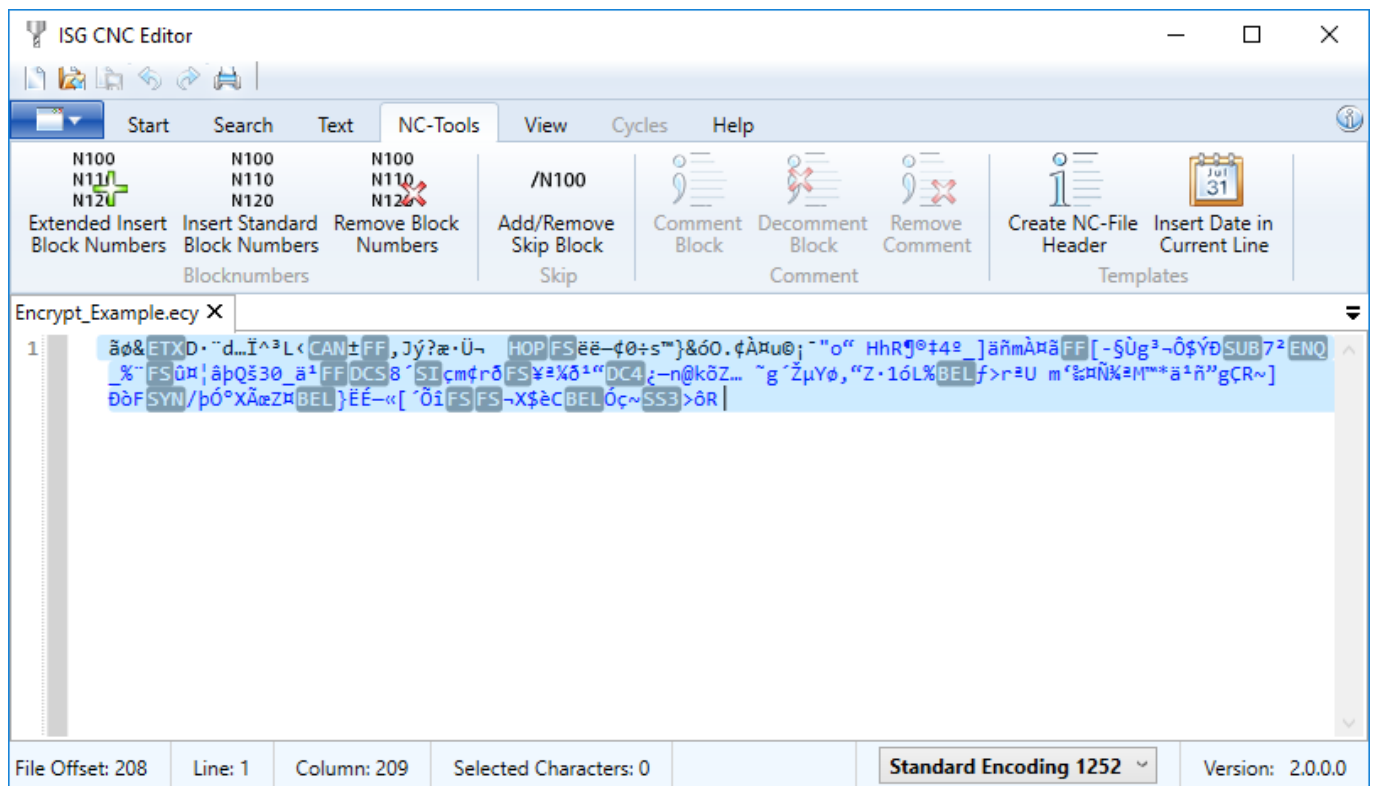
Fig. 4: Description of the GUI (= Graphical User Interface)

In-index	Meaning	Description
1	Password	<p>This is the password to encrypt/decrypt the NC program. The password may consist of 1 to 56 characters. However, we recommend min. 8 characters.</p> <p>The password is not stored in the encrypted program. Its validity is not verified later. In other words, an invalid password during decryption does not lead to an abort but the program cannot be correctly encrypted nor is it readable.</p>
2	Output directory	Besides the default directory (= directory of source file), you can select a different folder. If you use a different directory than that of the source file, tick the box below. If selected, all decrypted/encrypted files are saved here.
3	Encrypted files	File extension for encrypted files; *.ecy is the default. The file extension is also the file filter for decryption. Files with this extension are automatically detected as encrypted and decrypted at start.
4	NC files	Files with this extension are automatically detected as NC files and encrypted at start.
5	Add file	Add one or several files to the list to be processed (see window below).
6	Delete marked list entries	Marked list entries are removed from the program.
7	Open log directory	Open the directory containing the log files. The log files are generated in the selected language when they are encrypted or decrypted.
8	Start	Start of encryption or decryption. All entries in the list are processed, regardless of whether elements are marked in the list or not. First remove files from the list if they are not to be processed.
9	Add folder	Add the contents of an entire folder with the file filter (4) of the list to be processed (see window below).
10	Delete list	Removes all current entries from the encryption/decryption list.
11	Source file	Indicates what source files are encrypted/decrypted.
12	Destination file	Indicates the destination files created for encryption/decryption.
13	Status	The current status for encrypting/decrypting the file.
14	Link	Link to the output file folder.
15	Marked files	Number of marked elements / total number of elements.
16	ISG Crypter Version	Program version.
17	DLL version	Version of the dll for decryption.
18	Language	Set the required language. The possible languages are 'German', 'English', 'Russian', 'Italian', 'Spanish', 'French', 'Japanese' and 'Chinese'. The English terms are kept even when the language is changed.

## 5.1 Encryption example



**Fig. 5: Vie of the source file with readable code**



**Fig. 6: Encrypted file with encrypted code**





## Example

### Procedure to encrypt a file

The file in the figure "View of the source file with readable code" is encrypted. ISGEncryption.dll must be in the same folder as the example application.

1. In this case, choose "asdf" as the password.
2. Select "Encrypt\_Example.enc" (in the same folder as the input file) as the output file.
3. The result should be similar to the figure "Encrypted files".
4. Select the output file with "Decrypt File".
5. Enter 0 for "Start" and 16 for "Length".
6. Click "Show" should return the same output as in the figure "Source data".

## 6 Parameter

### 6.1 Channel parameters

P-CHAN-00283	Define file extensions to encrypt NC programs
Description	<p>The NC channel can process encrypted NC programs. Encryption is recognised by the file extension. A maximum of 3 self-defined file extensions are available in the channel parameter 'encryption_extension[...]' to configure file extensions.</p> <p>A file extension can consist of one to maximum 3 characters. No distinction is made between uppercase and lowercase letters in the file extension. A check is made whether the extension is entered in one of the 3 groups before opening an NC program. If the check is positive, the NC kernel decrypts the NC program with the key belonging to the related group. Both main programs and global subroutines can be encrypted.</p> <p>For more information about encryption see [FCT-C12 ► 6]].</p>
Parameter	encryption_extension[i] where i = 0 2
Data type	STRING
Data range	Maximum of 3 characters
Dimension	----
Default value	<p><i>encryption_extension[0] ----</i></p> <p><i>encryption_extension[1] ----</i></p> <p><i>encryption_extension[2] ----</i></p> <p><i>encryption_extension[3] ecy *</i></p>
Remarks	<p>* File extensions can be set for the groups 1 to 3 (Index 0, 1, 2). A further group also exists. This group especially is pre-defined by the controller or machine manufacturer and is used for the encryption of self-created NC programs (e.g. cycles). The extension is 'ecy'. It is recommended not to re-use this extension for new user-defined definitions</p> <p>Parameterisation example:</p> <p><i>encryption_extension[0] enc (1st group)</i></p> <p><i>encryption_extension[1] od (2nd group)</i></p> <p><i>encryption_extension[2] d (3rd group)</i></p>

## 6.2 CNC objects

### Notes on addressing

<C<sub>ID</sub>> Channel or channel ID starting with 1

For further information on addressing CNC objects, see [FCT-C13//Description].

<b>Name</b>	<b>mc_encryption_key_0</b>		
<b>Description</b>	<p>This object specifies the key for the first encryption group.</p> <p>The encryption group is defined by the parameter P-CHAN-00283 [► 18] and refers to the specified file extension.</p> <p>This key acts on encryption_extension[0]</p>		
<b>Task</b>	COM (Port 553)		
<b>Indexgruppe</b>	0x12010<C <sub>ID</sub> >	<b>Index offset</b>	0x94
<b>Data type</b>	STRING	<b>Length/byte</b>	57
<b>Attributes</b>	write	<b>Unit</b>	-
<b>Remarks</b>			

<b>Name</b>	<b>mc_encryption_key_1</b>		
<b>Description</b>	<p>This object specifies the key for the second encryption group.</p> <p>The encryption group is defined by the parameter P-CHAN-00283 and refers to the specified file extension.</p> <p>This key acts on encryption_extension[1]</p>		
<b>Task</b>	COM (Port 553)		
<b>Indexgruppe</b>	0x12010<C <sub>ID</sub> >	<b>Indexoffset</b>	0x95
<b>Data type</b>	STRING	<b>Length/byte</b>	57
<b>Attributes</b>	write	<b>Unit</b>	-
<b>Remarks</b>			

<b>Name</b>	<b>mc_encryption_key_2</b>		
<b>Description</b>	<p>This object specifies the key for the third encryption group.</p> <p>The encryption group is defined by the parameter P-CHAN-00283 [► 18] and refers to the specified file extension.</p> <p>This key acts on encryption_extension[2]</p>		
<b>Task</b>	COM (Port 553)		
<b>Indexgruppe</b>	0x12010<C <sub>ID</sub> >	<b>Indexoffset</b>	0x96
<b>Data type</b>	STRING	<b>Length/byte</b>	57
<b>Attributes</b>	write	<b>Unit</b>	-
<b>Remarks</b>			

## 7 Appendix

### 7.1 Suggestions, corrections and the latest documentation

Did you find any errors? Do you have any suggestions or constructive criticism? Then please contact us at [documentation@isg-stuttgart.de](mailto:documentation@isg-stuttgart.de). The latest documentation is posted in our Online Help (DE/EN):



QR code link: <https://www.isg-stuttgart.de/documentation-kernel/>

The link above forwards you to:

<https://www.isg-stuttgart.de/fileadmin/kernel/kernel-html/index.html>



#### Notice

##### Change options for favourite links in your browser;

Technical changes to the website layout concerning folder paths or a change in the HTML framework and therefore the link structure cannot be excluded.

We recommend you to save the above "QR code link" as your primary favourite link.

##### PDFs for download:

DE:

<https://www.isg-stuttgart.de/produkte/softwareprodukte/isg-kernel/dokumente-und-downloads>

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# Index

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