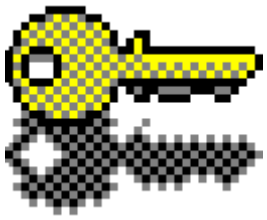
Enigma for Windows



Version 3.0

User´s Manual

Stefan **W**olf **S**oftware
GartenStr. 22
D-61449 Steinbach/Ts.
GERMANY
FON/FAX: +49 (0) 6171 980483
Compu$erve: 100111,140

Shareware Version

Thank You for trying out ***Enigma for Windows*** version 3.0 - a Shareware program. What does **SHAREWARE** really mean? Many users think that it's public domain software or programs free of charge, this is certainly not true. Shareware is a marketing method for commercial Software - that is all. It is typically used when the author does not have a big advertising budget. The huge advantage for you the user is that: You have a chance to thoroughly try out and get to know the program before you make the decision to purchase or register the program. With regular commercial software you purchase the software and then hope it works as advertised. In addition, buying direct from the software producer saves additional costs. Shareware has the ultimate money back guarantee if you don't use the program, you don't pay for it.

License Agreement

You are hereby licensed to use this Shareware Version for a **60** day evaluation period; make as many copies of this version as you want. You can give exact copies of this version to anyone. You can distribute this version in its unmodified form via electronic means. There is no charge for any of the above. If you use this software after the **60** day evaluation period a registration fee of **$ 59** is required.

Pricing, specifications, and conditions are subject to change without notice.

Send all registrations and inquiries for site (multiple CPU or network) licensing to SWS at the address on the previous page.

Registered Users: (those who paid and received a registration number)

SWS hereby grants a "book" license to the original individual (even if purchased by a company) user of this copy of ***Enigma for Windows*** . You may use the program on your computer and make one backup for storage as long as there is no possibility of use or residence on more than one machine at any time. Just like two people cannot read the same book in different locations at the same time. Every registered copy of ***Enigma for Windows*** has a unique, embedded serial number for traceabililty. Registered users may transfer its rights under this license, provided that the party to whom such rights are transferred agrees to the terms and conditions of this license, and written notice is provided to **SWS**. Upon such transfer, you must transfer or destroy all copies of the registered program. If you do not agree to these terms, return the software and documentation to **SWS**..

Limited Warranty

We guarantee that all goods are in perfect condition and that we will replace any flawed material if you inform us about justified complaints within 10 days after delivery .

This software and the accompanying files are sold "as is" and without warranties as to performance of merchantability or any other warranties whether expressed or implied. Because of the various hardware and software environments into which ***Enigma for Windows*** may be put, no warranty of fitness for a particular purpose is offered. **The user must assume the entire risk of using the program**. Any liability of the seller will be limited exclusively to product replacement or refund of purchase price.

All brands and their products are trademarks of their respective holders and should be noted as such.

Table of Contents

1. What is Enigma for Windows ?

Enigma for Windows is a powerful program for encrypting[1] and decrypting files and directories of any type. Besides being able to conceal the contents of files it can be used as an electronic paper shredder. This program is named after the legendary encoding machine **Enigma 4** that was used by the Germans in the Second World War.

Everyone has files that should not be seen by others. Be it a patent or something as important as a love letter. Everyday many employees handle data that is not meant for the eyes of others, for example company statistics, personnel records, payrolls and others. This type of data is only "safe" after it has been locked away with a lock and key.

In this day and age of massive computer use by banks, doctors, officials and a multitude of other offices it has become necessary to find alternatives to the traditional methods of securing data. Computer networks and the free exchange of data across these networks have added a whole new dimension to this problem.

Even though it is a good idea to lock away diskettes which contain sensitive data, encoding the data on those diskettes and using your own personal password as the key gives you a higher level of security. You should always encrypt sensitive or secret documents that you have received so they can under no circumstances be read without your permission.

Encrypted files cannot be read or decrypted by any other users. The only way to make the file readable and usable again is to decrypt it with the same password that was used to encrypt it.

The ability to keep your data safe from unauthorised access depends on the encryption method that you use. Two methods have gained widespread acceptance; the RSA[2] - Public Key Encryption method and the Data Encryption Standard (DES). The DES is used by many US. Government agencies and is a de facto standard. This method was also implemented in ***Enigma for Windows*** because of its safety and proven workability in everyday use. One can be sure that data encrypted with (Triple) DES cannot be decrypted in a reasonable amount of time with the help of today´s technology.

Many offices and government agencies use paper shredders to destroy their sensitive documents. The function **Wipe** is the electronic equivalent of this. Many computer users do not know that files deleted with the DOS command ***del*** can often be recovered from their harddisks without much trouble even after a longer period of time. After using the **Wipe** function on a file you can be sure that no trace of it can be found on your harddisk any more.

1.1. History of Enigma for Windows

Version 1.0 - 09.01.1992

* Initial release.

Version 1.1 - 05.01.1993

* Error in file handling was fixed.
* Option to compress files before encrypting.

Version 2.0 - 05.01.1994

* A comfortable installation program.
* Context sensitive help by pressing the **F1** key.
* Encrypting, decrypting and deleting of several files or whole directories in one step.
* Dialog controlled choice of the target directory.
* Stopping the encryption process.
* 15 % performance gain for DES based operations.
* Command line interface added.
* English version is now available.
* Enhanced setup.
* The option of compressing a file before it is encrypted was removed.
* Files created with Version 1.x are incompatible with version 2.0. This was necessary in order to permit the simultaneous handling of several files. The product of this work is a modern archive structure on which future versions will be oriented.

Version 3.0 - 12.01.1994

* New double and triple DES algorithms added.
* Single DES encryption in shareware version enabled.
* All implemented decryption methods (up to triple DES) are enabled in shareware version.
* DES routines has been isolated in a separate DLL to support their implementation in third party DES applications.
* Triple DES developer kit added.
* Screen distortion error by use of custom screen fonts fixed.
* Support of a default user specific password for each algorithm.
* Screen locking feature added.

1.2. Specifications

The DES-Algorithm used in this program conforms to the following standards (as far as this is possible for a software implementation).

FIPS[3] PUB 46-1 - Data Encryption Standard (1988)
Contains the specification for the Data Encryption Standard (DES) algorithm, which can be implemented hardware to protect sensitive unclassified information.

FIPS PUB 74 - Guidelines for Implementing and Using the NBS DES (1981)
Companion to FIPS PUB 46-1. Contains guidance for the use of cryptographic techniques.

FIPS PUB 81 - DES Modes of Operation (1980)
Companion to FIPS-PUB 46-1. Contains descriptions of the four modes of operation for the DES: Electronic Code book (ECB), Cipher Block Chaining (CBC), Cipher Feedback (CFB), and Output Feedback (OFB).

ANSI[4] X3.92 - Data Encryption Algorithm (DEA)
ANSI X3.106 - DEA Modes of Operation

In 1986 the ISO[5] published the "DEA-1" specification, where it is recommended that DES be used for encoding data. The Wipe algorithm conforms to specification CSC-STD-005-85 of the National Computer Security Centre, it is described in the department of Defence Magnetic Remanence Security Guideline, 15 Nov. 85, Section 5.3.1 .

1.3. Technical Support

All questions regarding registration, technical support, discount and wholesale prices should be addressed to:

Stefan Wolf Software
GartenStr. 22
D-61449 Steinbach/Ts.
GERMANY
FON/FAX: +49 (0) 6171 980483
Compu$erve: 100111,140

2. Installation

2.1. System Requirements

The minimum requirements for running ***Enigma for Windows*** Version 3.0 are:

Software:

* Microsoft Windows version 3.1 or Windows NT or better.
* IBM OS/2 Version 2.1 or better.

Note: If you use on-line compressors such as ***Stacker*** or ***DoubleSpace*** we **cannot** guarantee that data which has been deleted with **Wipe** cannot be recovered again.

Hardware:

* ***Enigma for Windows*** does not require any special hardware to other than the computers ability to run one of the above mentioned operating systems.

Note: Even though ***Enigma for Windows*** uses very fast algorithms their complexity (mainly the DES modes) make encrypting and decrypting data a time-consuming operation. It is therefor recommended that you use an AT-486.

2.2. Installation Procedure

2.2.1. The Setup Program

The setup program performs the following tasks:

***** Expand and copies the ***Enigma for Windows*** program to your hard disk to the directory you specify (default is ***C:\ENIGMA30***). Once installed ***Enigma for Windows*** Version 3.0 will occupy approximately 1900 KB of hard disk space.

***** It modifies the MS-Windows initialization file ***WIN.INI*** by adding the following line ***EN3=C:\ENIGMA30\ENIGMA30.EXE ^.EN3***.

***** Creates the MS-Windows Program Manager group ***Enigma for Windows.***

***** Creates the ***ENIGMA30.INI*** file in the Windows directory.

2.2.2. Installing Enigma for Windows

1. Start MS-Windows !

2. Start the Program Manager !

3. Chosse the **Run** command in the **File** menu in the Program Manager !

4. Type ***A:\INSTALL*** or ***B:\INSTALL*** depending on which drive you are installing from !

5. A dialog box will appear and the recommended directory for the installation of ***Enigma for Windows*** will be shown.

Choose the directory in which you want to install the program. If the chosen directory doesn't exist it will be created. Click the button **OK** to start the installation.

6. The installation program will now begin to copy the ***Enigma for Windows*** files to the target directory.

Note: If you want to install ***Enigma for Windows*** in a network environment make sure that you have read/write privileges in the directory specified.

2.3. Updating Enigma for Windows

The versions 1.1 and 3.0 are **not** compatible. It is therefor necessary to decrypt the data with the version that it was encrypted with. Files encrypted with version 2.x can be decrypted by the current version. Older or existing versions are not removed by the installation program. You will have to remove your old installation manually.

2.4. Starting Enigma for Windows

There are several ways to start ***Enigma for Windows*** :

Starting from the MS-Windows Program Manager:

1. Open or activate the Program Manager window !
2. Open the group window which contains ***Enigma for Windows*** !
3. Double-click the ***Enigma for Windows*** symbol or use the cursor and press **Enter** !

Starting from the Program Managers **File** menu:

1. Open the **File** menu in the Program Managers menu bar !
2. Choose **Run** !
   > If the program is in your path enter ***ENIGMA30*** !
   > If the program is not in your path enter the complete path to where it is located, for example ***C:\ENIGMA30\ENIGMA30.EXE*** !
3. Click **OK**

Starting from the MS-DOS-prompt:

1. At the DOS-Prompt type the command ***WIN ENIGMA30 !***
2. Press **Enter** !

Note: If you receive a message that the file could not be found this means that the directory containing ***Enigma for Windows*** is not in the path. Change to the directory which contains ***ENIGMA30.EXE*** and try to start it again.

Starting from a MS-Windows command line interface:

1. Once ***WinCLI***, ***WinCLI Pro***, ***4Win*** ... is running change the directory to where the program is located enter ***ENIGMA30***.

When you start ***Enigma for Windows*** for the first time you will see a dialog box which will ask you to register the program. Enter your registration number here. You will find it written on the label of your program diskette. The double and triple DES algorithms are not available until you have entered your registration number. In order to save your own passwords it is also necessary to enter the registration number.

2.5. Accessing Help

Enigma for Windows has a Context Sensitive Help System to guide you through commands and procedures.

To view the Help Contents:

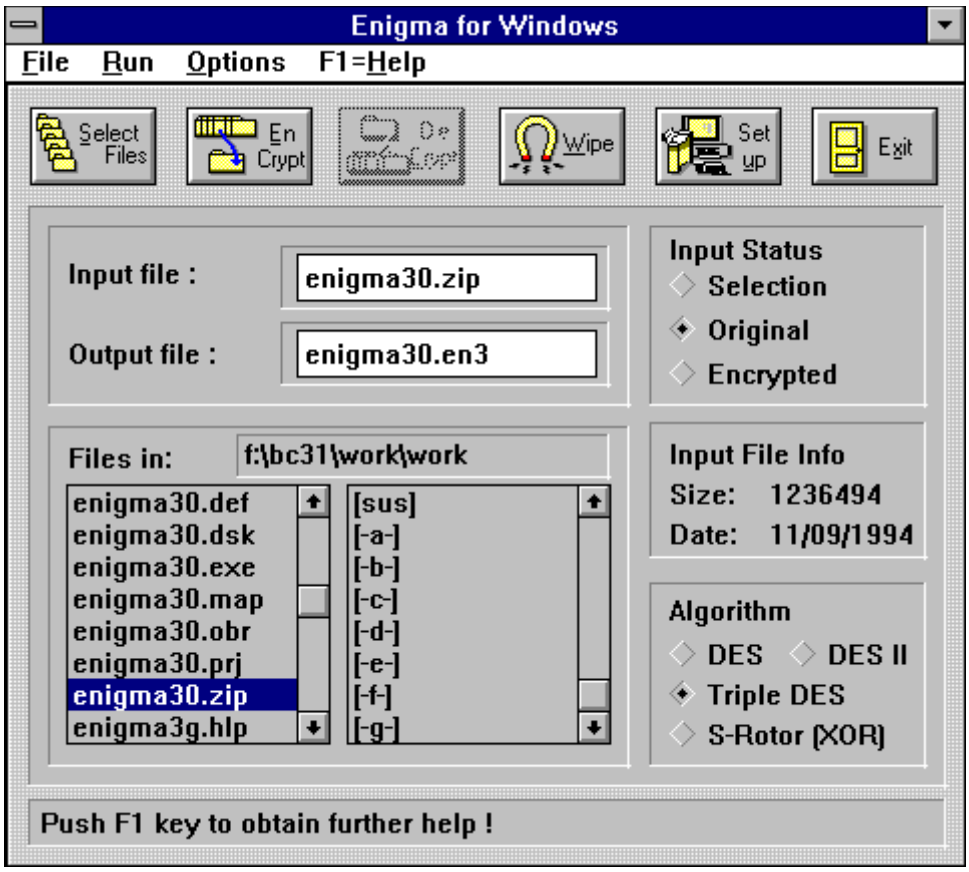
* From the **Help** menu, choose **Contents**.

To get Context Sensitive Help where you are on the screen:

* Press **F1** or within a dialog box, press the **Help** button if available.

3. The User Interface

In the main window you will find two listboxes and several text fields, 6 dialog buttons, a few status elements and the menu bar.



Dialog Buttons: Each of these 6 buttons (from left to right) has an equivalent in the menu bar. It is also possible to activate each button by a key stroke.

Select Files: Opens a dialog in which a single file or whole directories can be selected. **[(ALT-S),(ALT-F,S)]**
EnCrypt: Encrypts the selected files. **[(ALT-E),(ALT-R,E)]**
DeCrypt: Decrypts the selected file. **[(ALT-C),(ALT-R,C)]**
Wipe: Wipes out the selected files. **[(ALT-W),(ALT-R,W)]**
Setup: Opens the window in which various program parameters can be changed. **[(ALT-U),(ALT-O,S)]**
Exit: Exits ***Enigma for Windows***. **[(ALT-X),(ALT-F,X),(ALT-F4)]**

List Boxes:

Left: Shows the files which are in the current directory.
Right: Shows all directories and drives.

Text Fields:

Input file: This text field shows the name of the input file. It is automatically filled by clicking a file in the left listbox.
Output file: Text field for the name of the output file. You must **manually** enter the name of the output file here before encrypting.
Files in: Shows the current directory.
Size: Shows the size of the selected input file(s).
Date: Gives the date on which the selected file was created or will be created.
Bottom border: A text field in which help texts are displayed dependent on the mouse cursor position.

Status Elements:

Selection: This status element is marked if a valid input file list has been selected.
Original: This status element is on if the file shown in the input file field has not yet been encrypted with ***Enigma for Windows*** . If you want to encrypt a file that has already been encrypted you must click by hand this element.
Encrypted: This status element is marked when the file in the text field **Input file** has been encrypted with this program.
DES: Status element shows that the DES algorithm is being used. It is automatically marked when a DES encrypted input file has been chosen for decoding.
DES II: Status element shows that the double DES algorithm is being used. It is automatically marked when a double DES encrypted input file has been chosen for decoding.
Triple DES: Status element shows that the triple DES algorithm is being used. It is automatically marked when a triple DES encrypted input file has been chosen for decoding.
S-Rotor: Shows that the S-Rotor algorithm is being used for encryption and decryption. It is set automatically when the input file has been encrypted with S-Rotor.

3.1. The Enigma for Windows Setup

This dialog box is opened by clicking the **Setup** Button in the Main Dialog Box or by pressing the key combination **(Alt-U)**. This chapter discusses the configuration of ***Enigma for Windows***.

Remove files with a simple delete instead of using Wipe
The files are simply deleted and can possibly be restored.
(default: not marked) [(ALT-R)]

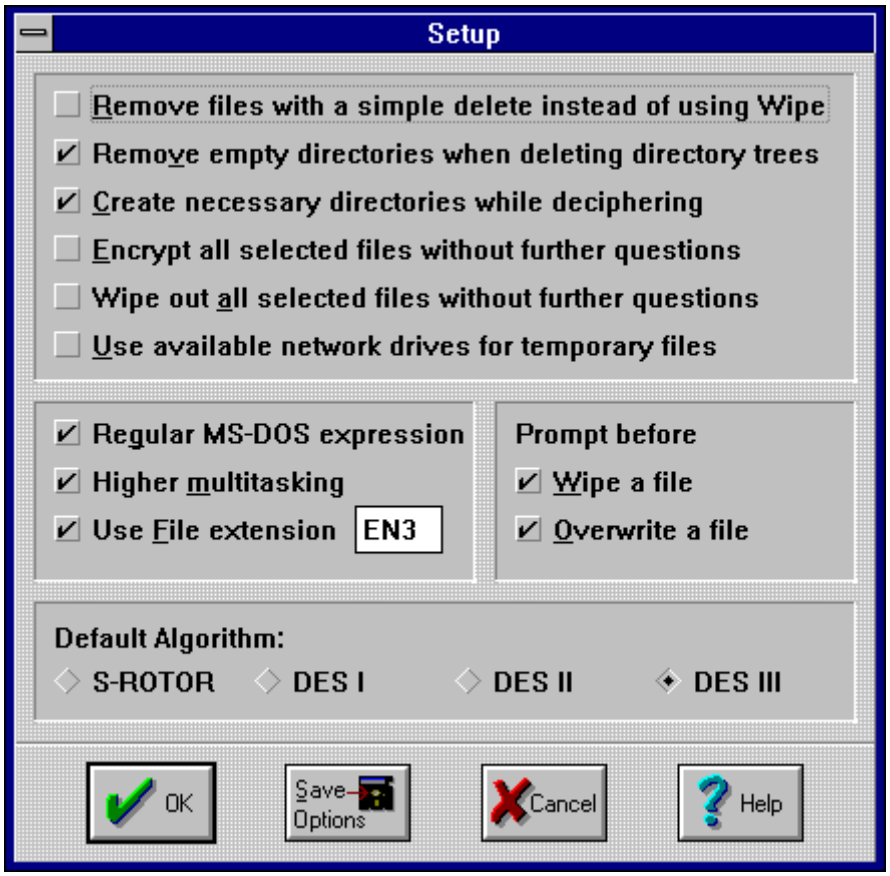
Remove empty directories when deleting directory trees
Removes empty directories when deleting files and whole directory trees with Wipe.
(default: marked) [(ALT-V)]

Create necessary directories while decrypting
Creates the necessary directory structure while decryption. If this button is not marked the filenames containing a path name will be written into the current directory. For example, ***tmp\dir1\file.txt*** will be decrypted and written into the current directory with the name ***file.txt***. **(default: marked) [(ALT-C)]**

Encrypt all selected files without further questions
If this status element is marked the selected files will be encrypted without further questions, otherwise you would be able to modify your selection in an dialog box. **(default: not marked) [(ALT-E)]**

Wipe out all selected files without further questions
If this status element is marked the selected files will be wiped without further question, otherwise you would be able to modify your selection in an dialog box. **(default: not marked) [(ALT-A)]**

Use available network drives for temporary files
If there is not enough space on local drives temporary files are created on available network drives. **(default: not marked) [(ALT-U)]**



Regular MS-DOS expression
When this status element is marked the use of ***.*** also leads to include files that do not end with an extension. For example, the file ***Makefile*** would be selected by using ***.***. Otherwise, when this status element is not marked you would have to use the

expression * to include such files. **(default: marked) [(ALT-G)]**

Higher multitasking
If this status element is marked, MS-Windows has more time to process the internal message queue and it uses more CPU time for other applications which are running. **(default: marked) [(ALT-M)]**

Use File extension [EN3]
If you do not add an extension to the name of the output file, the program will automatically add the extension of the textbox. The use of a systematic extension can be helpful in locating encrypted files. **(default: marked) [(ALT-F)]**

Prompt before Wipe out a file
Asks for confirmation before deleting an file with **Wipe**. **(default: marked) [(ALT-W)]**

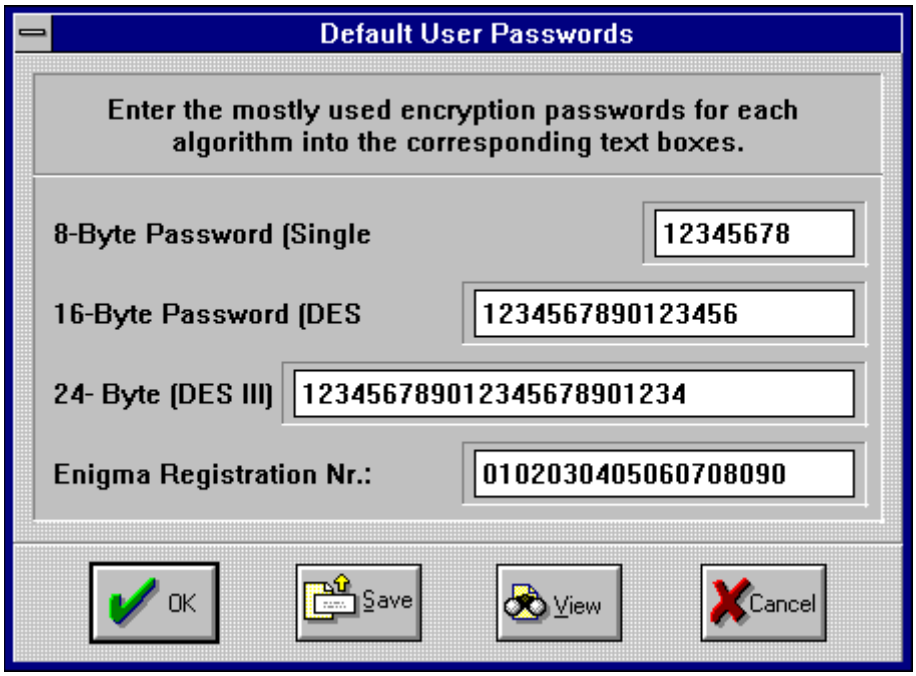
Prompt before Overwriting a file
Asks for confirmation before overwriting a existing file. This option should always stay marked and you should always make sure that the file was decrypted with the right password otherwise rubbish might be written over the input file.
(default: marked) [(ALT-O)]

Default Algorithm
Mark here the algorithm with which you want to do most of your encryption.
(default: DES I (Shareware) or DES III if registered)

Changes in this menu are only active for the current session. If you want to change the option's permanently you must click the button **Save Options**. **[(ALT-S)]**

3.2. Default User Passwords

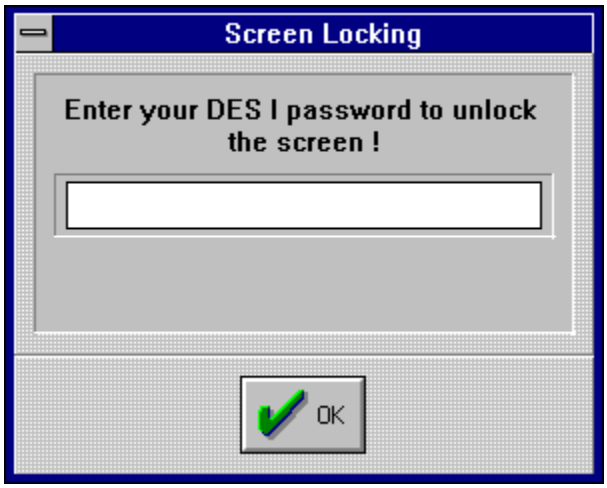
With the help of this dialog you can set a fixed private passwords for each algorithm which can be used for encryption. Enter your favourite passwords and your registration number into the corresponding text boxes. For the DES and S-Rotor algorithm you should choose an eight character word - 16 byte and 24 byte length keys are essential for double DES and triple DES to work properly. You must click the **Save** button if you want use these keys in later sessions. To show your current passwords enter your registration number and click the **View** button !



Default user passwords are only available in the registered version because the registration number must be entered in order to store these passwords. You should keep your installation diskette in a safe place so that no one can find out this number.

3.3. Screen Locking

By selecting this menu item you are been able to lock your current MS-Windows session. You computer will ignore any input by mouse or keyboard outside of this window. It is not possible to start a another program or to switch the session.



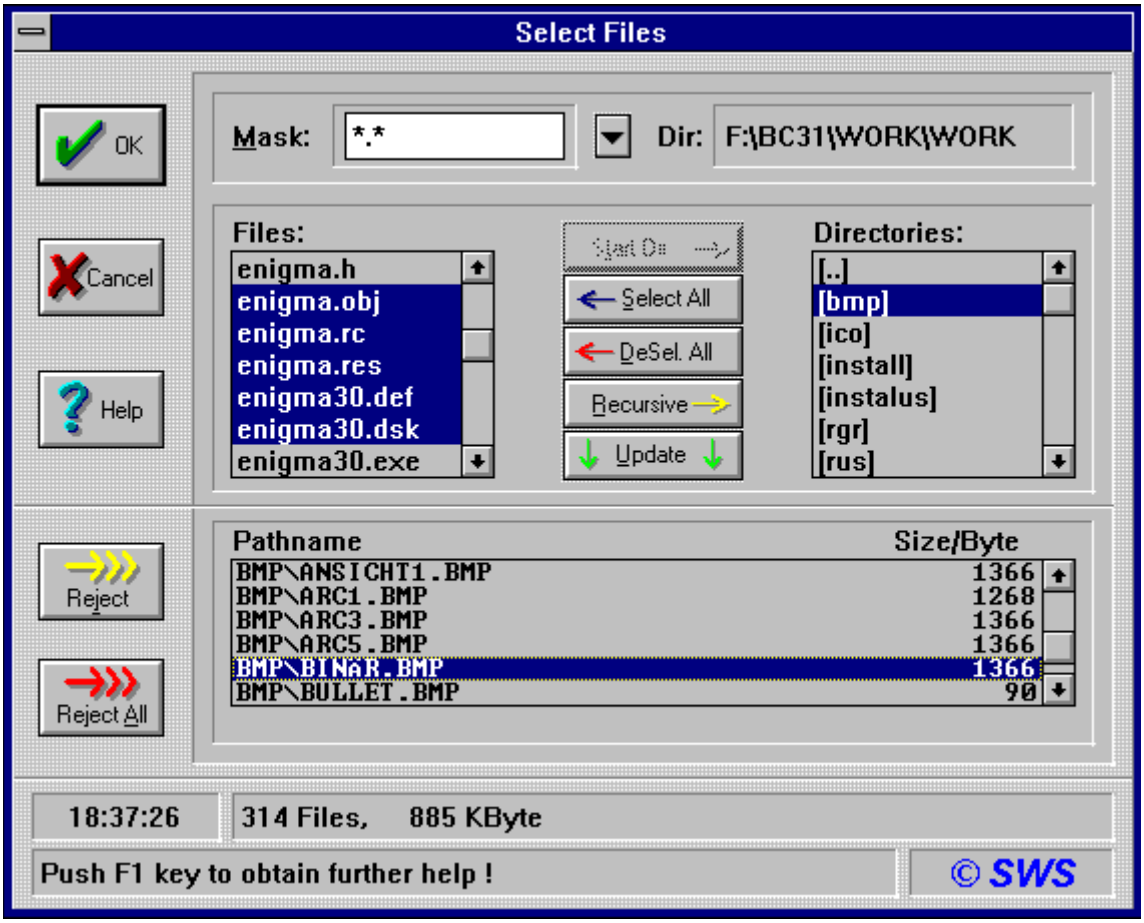
You can unlock your screen by typing in your default DES I password in the text box. This feature protects your computer from attacks by unauthorized persons **and** little green men and women **and** vogons and klingons while you are absent from your desk.

4. Getting Started

Before you can encrypt or delete several files in one step you must collect them in a file list. This section will lead you through the selection process.

4.1. Selecting Files

This dialog box contains three listboxes which are used to select and collect the files that are to be encrypted or deleted. With the help of various buttons you can select individual files or whole directory trees. The selected files are listed in the bottom listbox. Marked files in the other two listboxes can be moved to the bottom window by clicking the **Update** button. After you are done selecting files confirm your selection by clicking the **OK** button.



Mask: When you click the button right beside the textbox the left listbox is updated according to the regular expression in this textbox. **[(ALT-M)]**

Start Dir: This button selects the starting directory for the encryption. When you are working with several files in different directories a defined starting point must be set in order to restore the directory structure when the files are decrypted. At first this button is grayed and the current directory is set as the starting directory. This button becomes available when you change to a directory which higher up in the directory hierarchy ([..]) than the current starting directory or when you change to another drive. **[(ALT-T)]**

Select All: Tags all files in the left listbox. This listbox allows a so called multiple choice selection, this means that you can select files by simply holding down the left mouse button and pulling the mouse cursor downward. If you press the **CTRL** key at the same time you can also select files which do not immediately follow each other. **[(ALT-S)]**

DeSel. All: Untags all files in the left listbox. **[(ALT-D)]**

Recursive: Clicking this button causes the highlighted directory in the right listbox to be tagged. Clicking the **Update** button will copy all files in that directory or those of its sub directories into the bottom listbox in accordance with the file mask. **[(ALT-R)]**

Update: This button causes all tagged files to be copied into the bottom listbox. It must activated again to copy each subsequently tagged file into the bottom listbox. [(ALT-U)]

Reject: Removes marked files from the bottom listbox. **[(ALT-J)]**

Reject All: Removes all files from the bottom listbox. **[(ALT-A)]**

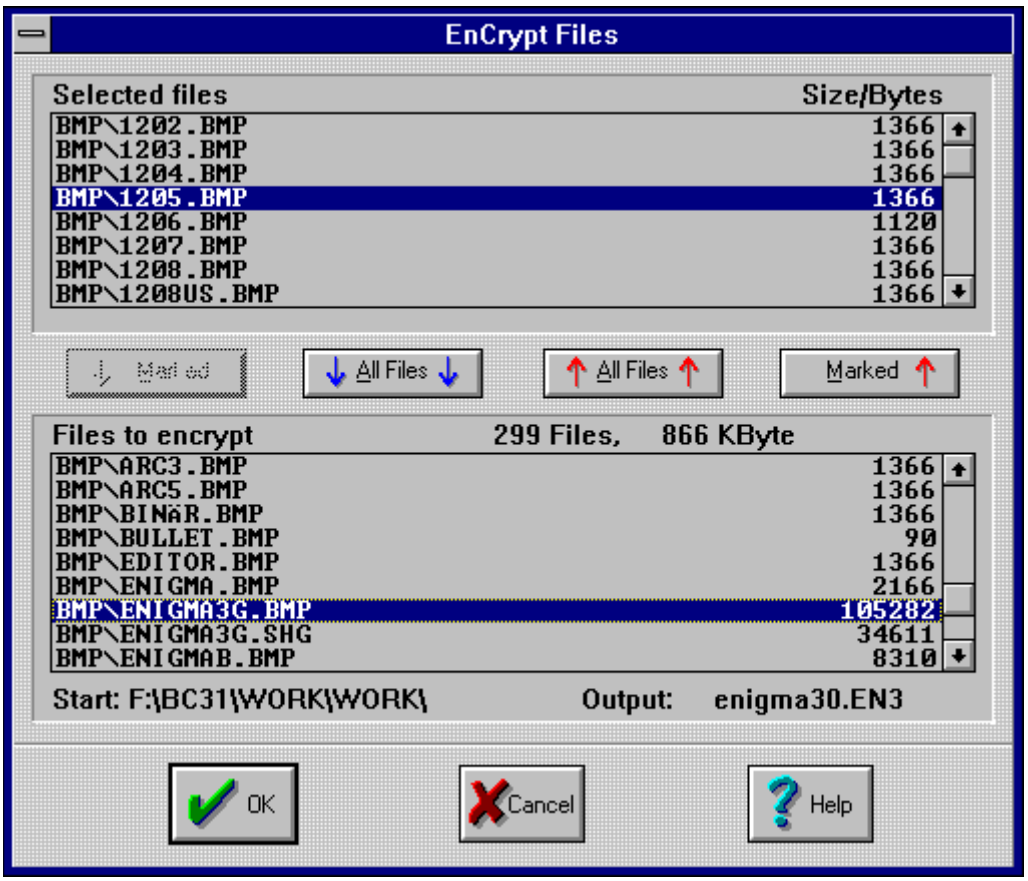
Further information about a file can be obtained by double clicking it in the bottom listbox.

4.2. Encrypting Files

It is possible to either encrypt a single file or several files at once. If several files are to be encrypted they must be marked in the dialog **Select Files**. A permissible selection of files can be recognised by the status of the status element **Selection**. In this case the words **>> Selection List <<** will appear in the text field **Input File**, if only one file is selected this text field will contain the file name. Now you must type the name of the output file without the path in the text field **Output File**.

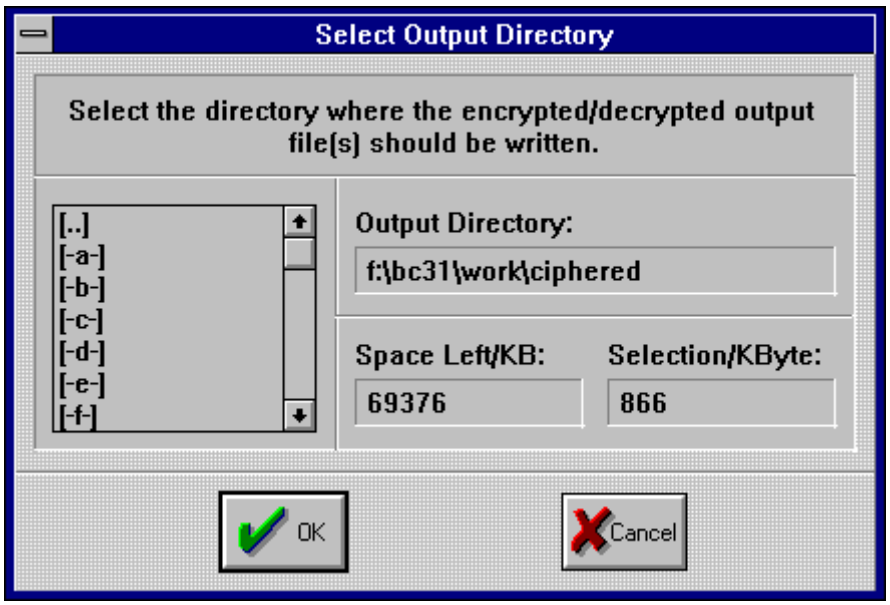
After selecting the input file(s), output file the encryption algorithm must be chosen. In order to do this click either the status element **S-Rotor**, **DES**, **DES II** or **Triple DES**, then confirm the choice by clicking the button **EnCrypt** or by choosing the command **EnCrypt File(s)...** in the **Run** menu. If you have selected several files a new dialog will appear which prompts you to confirm your selection.

Note: The status element **Original** must be marked by hand if an encrypted files is to be encrypted again.

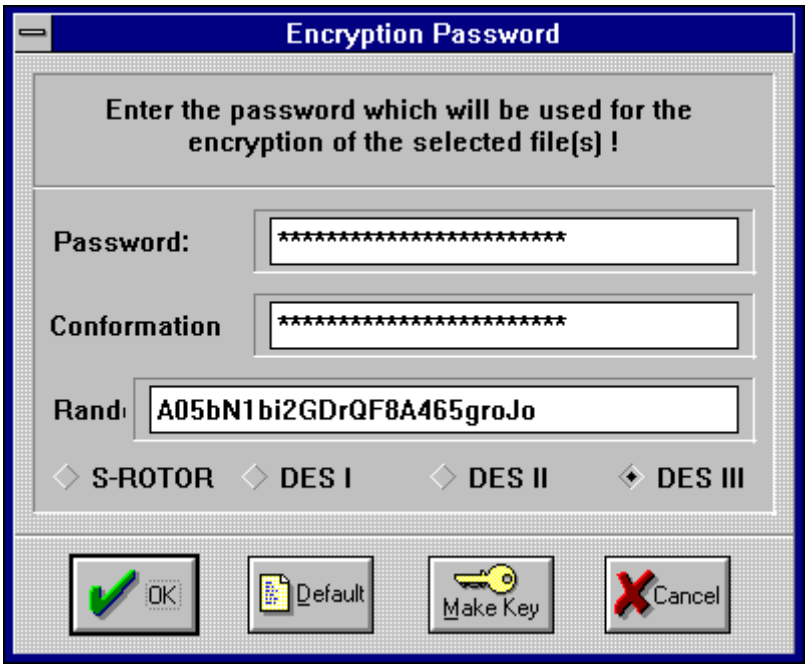


Use the 4 buttons in the middle of the dialog box to move the files around between the listboxes . All files shown in the bottom listbox will be encrypted. When you are ready to encrypt click the **OK** button.

A dialog will appear in which you can chose in what directory the output file will be copied into. Compare the file size with the directory size in order to ensure that there is enough space to hold the output file.

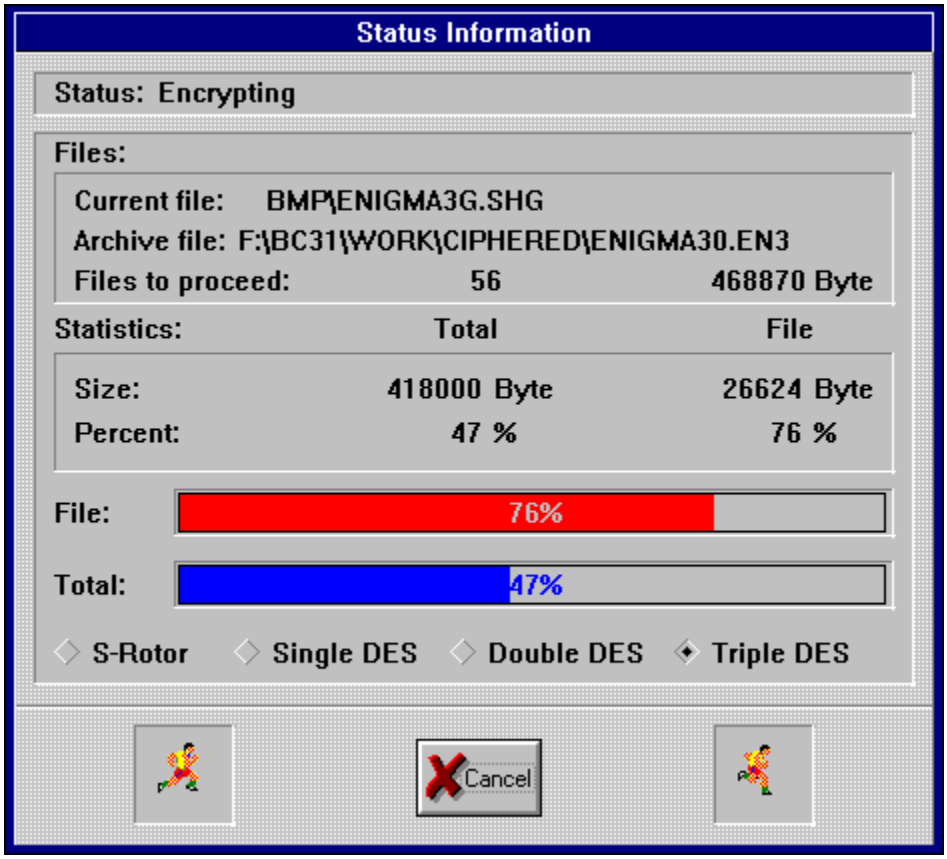


Before the selected files are encrypted you must enter your personal password. No one can decrypt these encrypted file without knowledge of this password. The password should be as long as possible and it can contain any character which you can enter with the keyboard. Your input will be interpreted case sensitive, that means there is a difference between an **a** and an **A**. The password is not shown on the screen when you enter it for protection against unwanted observers. For safety reasons it has to be entered twice (Fields **Password:** and **Confirmation:**).



Clicking the **Make Key** switch causes an algorithm specific password to generated by a random character generator, it can be seen in the field **Automatic:**. You should write this password down before clicking **OK**. If you click the **Default** button your default user password is used for encryption.

Now the encryption process can be started; a new window will appear which informs you about the encryption process and from here you can interrupt the encryption process at any time.



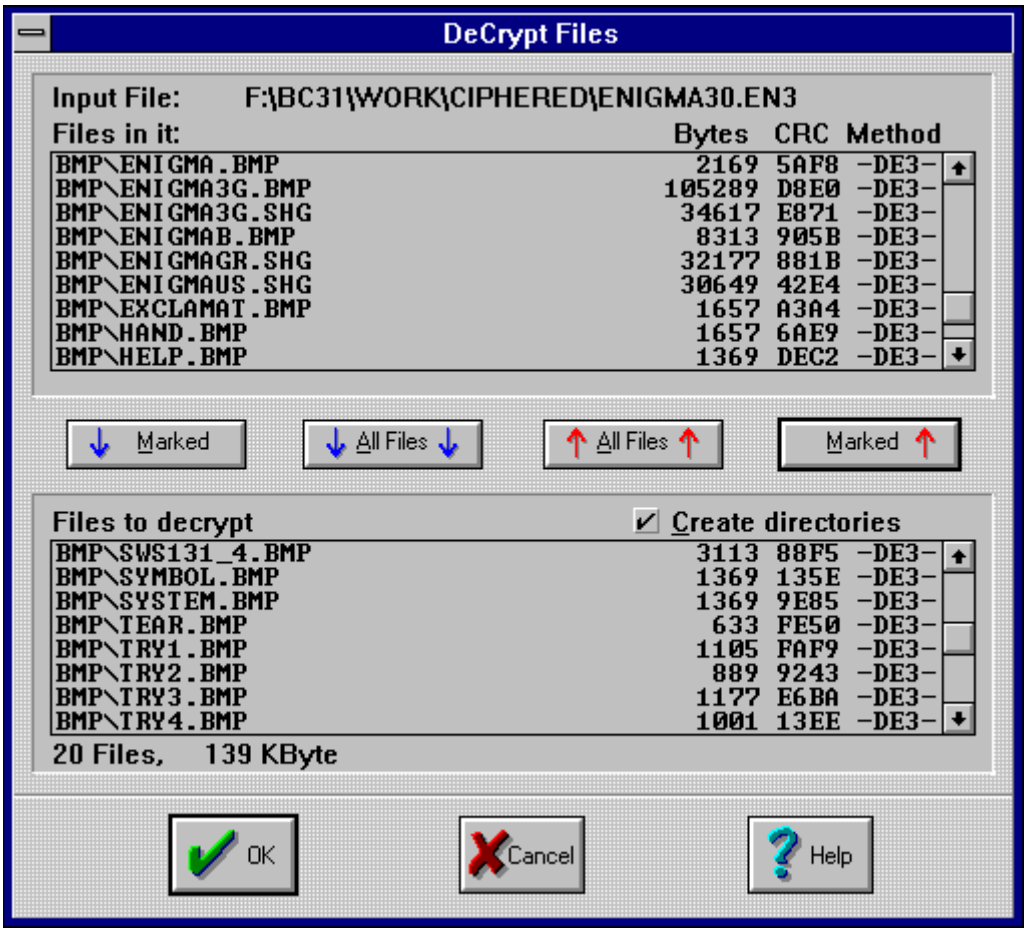
After successful encryption of the tagged files, you can immediately wipe out these tagged files from your hard disk with **Wipe**.

If you have selected an encrypted file as the output file all files will be appended to it which are not already contained in it. If files have been selected with the same name(s) as those already in the encrypted file the latter will be replaced. If you use a different password from that in the existing encrypted file you must ensure that you use the appropriate password for decrypting each encrypted file. We do NOT recommend this procedure ! Please be careful when wiping out the selected files. Make sure that your output file is not in this list, or else your data would be lost forever.

4.3. Decrypting File

Tag the file that is to be decrypted in the left listbox in the main dialog. If the file is encrypted the status element **Encrypted** will automatically be marked. You can only decrypt files that were encrypted with ***Enigma for Windows*** Version 2.0 or better. The file name will appear in the text field **Input File**. After the file has been selected click the switch **DeCrypt** or activate the **DeCrypt File** command in the **Run** menu.

After this a dialog will appear which shows what files are present in the input file. Here it is possible to select the files which should be decrypted. Confirm the selection by clicking **OK**.



Now a new dialog will appear in which you can select in which directory the decrypted files should be copied into. Afterwards a new dialog will prompt you for the password that was used to encrypt the file(s).

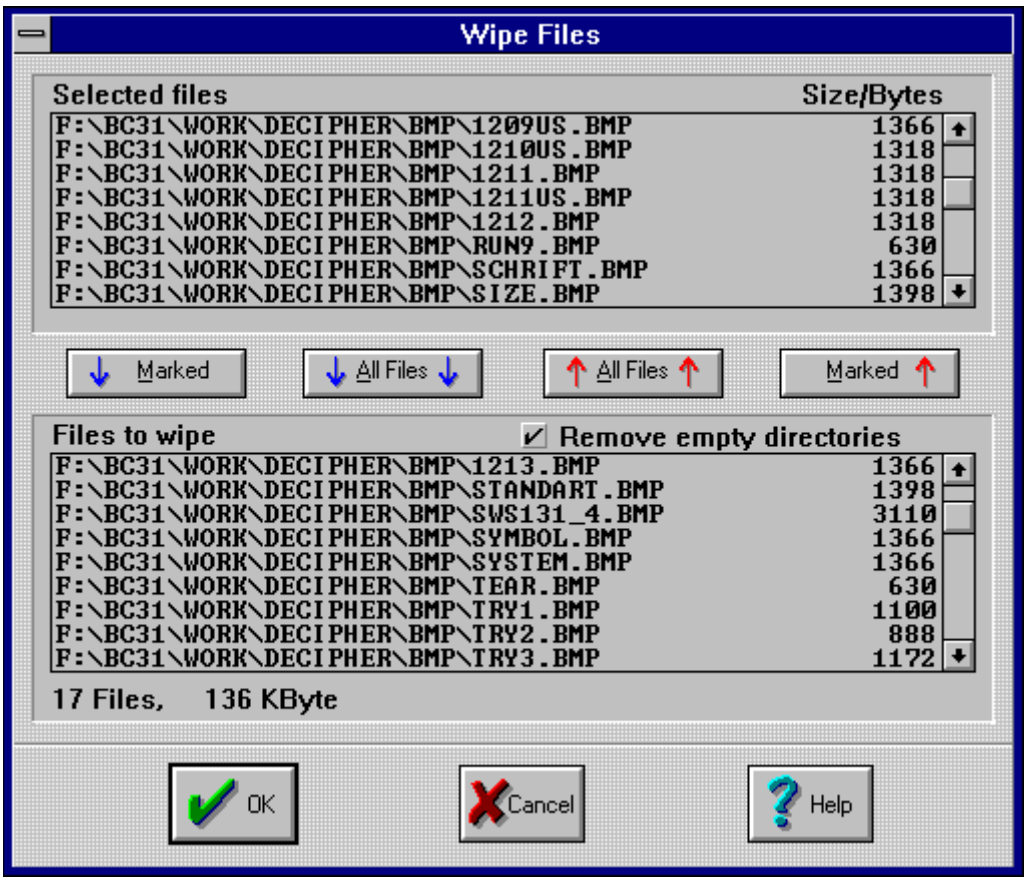
The decryption process can now be started. Once started a new window will appear which informs you about the decryption process. Here the decryption process can be interrupted at any time.

After all the files in your input file have been decrypted make sure that your data has been decrypted correctly before you delete the input file. The program has no way of testing whether the correct password was used to encrypt the file(s) and there is no sure way of testing whether the result is meaningful. If you use the wrong password to decrypt the input file the output file will contain rubbish and you must decrypt the input file again with the correct password.

4.4 Wiping Files

It is possible to delete a single file or several files at once. If several files are to be deleted they must selected in the dialog **Select Files**. A permissible selection of files can be recognised by the status of the status element **Selection**. In this case the words **>> Selection List <<** will appear in the text field **Input File**, if only one file is selected this text field will contain the file name.

After this is done you can click the **Wipe** button or activate the **Wipe File(s)...** command in the **Run** menu. If you have selected several files a new dialog will appear which prompts you to confirm your selection.



When you are ready to delete click the **OK** button and a new window will appear which informs you about the progress of the deleting operation and here it is possible to interrupt the operation at any time.

After this operation the data is lost for ever, so please be careful when selecting the files which you want to delete.

5. Algorithms

5.1. Data Encryption Standard (DES)

In 1972 the National Bureau of Standards (hereafter: NBS) made a public invitation to tender for the development of a program which would allow files (unclassified computer data) of any type to be encrypted. The low response prompted the NBS to ask the National Security Agency (NSA) for help. Here they had some experience in the development of simple encoding and encryption algorithms. After long discussions the NBS decided to use the Data Encryption Standard (DES) as a standard. The DES had been developed at IBM.

The DES has its roots in an encoding method which was developed in Germany during WW I by the electrical engineer Arthur Scherbius. In the second World War the Germans developed an electromechanical encoding device called **Enigma 4** which was based on the work of Arthur Scherbius. Like the **Enigma 4** the DES uses a series of permutations which for themselves are individually rather simple but when used repeatedly they are extremely complicated. In the **Enigma 4** encoding machine the permutations are generated by mechanical wheels while in the DES they are produced by program code or by hard wired chips.

DES in ECB mode handles data blocks of 64 bits at one time. DES is basically a bit permutation, substitution, and recombination function performed on blocks of 64 bits of data and 56 bits of key (eight 7-bit characters).

First, the 64 bit input block is subjected to a fixed initial permutation **IP** and split into two 32 bit blocks $\mathbf{L}_0$ and $\mathbf{R}_0$. Then each block is scrambled up in 16 iterations. The resulting 32 bit blocks $\mathbf{L}_{16}$ and $\mathbf{R}_{16}$ are then permuted back to a 64 bit block by a permutation table **IP'** which is the inverse of **IP**. The resulting 64 bit encrypted block is then written to the output block. In each iteration $\mathbf{I}_i$ the block $\mathbf{L}_{i-1}$ is coupled with the 32 bit output of the function $\mathbf{f(R}_{i-1}\mathbf{,k}_i\mathbf{)}$ by an XOR operation. The iteration $\mathbf{I}_{16}$ is an exception, here the blocks are swapped. The function **f()** receives the block $\mathbf{R}_{i-1}$ and the 48 bit output of the function **K(*i*)** as its arguments. **f()** permutes the 32 bits of $\mathbf{R}_{i-1}$ into 48 bits by using the permutation table **E**. The result is exclusive ORed with the 48 bit output from the function **K(*i*)**. The 48 bit result is then split into eight 6 bit values. Then the function **S** realizes a 4 bit value for each 6 bit value by an non-lineare substitution. The eight 4 bit values are then combined to a 32 bit value, which is then coupled with the permutation table **P**. The resulting 32 bit is the output of the f(). The function S composed of eight substitution modules $\mathbf{s}_1,\mathbf{s}_2,\ldots,\mathbf{s}_8$ (the mysterious S-boxes) which are used on the eight 6 bit values from above. In this 16x4 matrix each of the 64 elements has a value between 0 and 15, a 4 bit value which substitutes a 6 bit value. The matrix co-ordinates of a 6 bit value are obtained in the following manner: bits 1 and 6 as binary give column 0..3, with bits 2 through 5 the row 0..15 is calculated. The function **S** returns the 4 bit value of the so addressed matrix element. The function **K(*i*)** returns the 48 bit value $\mathbf{k}_i$ based on the key. There are two further permutation tables for the key. In the first iteration the key is permuted with the first table and then split into two halves. Each of these halves is shifted to the left once (***i*** = 1,2,9,16) or twice depending on the iteration number ***i***. Each subsequent iteration $\mathbf{I}_i$ after the first uses the shifted value of the preceding iteration as input, shifts the value again and finally permutes it with the

second permutation table. The decryption process uses the same algorithm, except that the decryption reverses the half exchanges during the iterations and uses the permuted key values returned by **K(*i*)** in the reverse order. In double and triple DES mode the key (16 byte or 24 byte) is split into 8 byte subkeys. Then the described algorithm is executed 2 or 3 times consecutively, each time with an another subkey.

5.1.1. The Safety of DES

>> The best that can be expected is that the degree of security be great enough to delay solution by the enemy for such a length of time that when the solution is finally reached, the information thus obtained has lost all its value. << William F. Friedman

It can be shown that after a few iteration steps each bit in the output block is dependent upon every bit of the input block and the key. A minimal change in the input block or in the key causes more than half of the bits in the output block to change, this is the so-called avalanche effect. To crack the output block a frequency analysis is of no use and a potential hacker can only use brute-force methods for the key search. This means that theoretically 72 quadrillion (2^{56}) keys have to be tried.

On a Sun SparcStation-2 , a key can be tested in 0.00005 seconds, an average of 20000 keys per second - results in a time of maximal 114168 years to find a key for a given encrypted text. With the help of a custom chip which is able to test a million keys a second it would take about 2284 years to try all possible combinations. 10000 of these chips in a parallel array would get the same result in about 80 days. A test for the plausibility of the decrypted text which has to be done after each test is not included in these calculations.

In August 1993 the Canadian Michael J. Wiener described how to build an exhaustive DES key search machine for $ 1 million that can find a key in 3.5 hours in average. Each of the used key search frames has the equivalent power of 14 million Sun workstations.

To greatly improve the security of DES the double- and triple DES algorithms have been implemented. With triple DES encryption, each input block is processed three times using independent keys to produce the encrypted block. Almost all attacks concentrate on exhaustive or brute force methods as well as Wiener's approach. Object of these methods is to try all theoretically possible keys. In the age of colossally increased computer power and parallel systems these methods have become alarmingly practical - certainly with an unreasonable expenditure for private persons. A fairly painless way to improve security dramatically is to switch to triple-DES - which for the next decades is a sure-fire method to protect against these attacks.

The weakest link in DES are the users themselves whom exchange their passwords or keep their passwords insufficiently secure.

5.2. S-ROTOR

The S-Rotor uses an XOR substitution algorithm, this means that every character of the text is coupled with a character in the password by a XOR operation to produce a character in the output file. This means that in contrast to trivial encoding algorithms where the characters of the password are coupled with the text characters one after another the S-Rotor uses a procedure that randomly selects a character of the password to couple with a character of the text.

The randomising procedure is dependent upon the length of the password. By filling the output buffer with random numbers the degree of disorder is further increased. Because the password itself is not written into the output file it would be very difficult to decrypt a text without knowledge of the password even if you had the source code of S-Rotor.

You should thoroughly memorise your password. If a file is accidentally encrypted more than once it can be decrypted by entering the passwords in the opposite order. A text that has been encrypted twice with the same password does NOT yield the original text.

5.3. Regular expression

In the **Select Files** dialog a (limited) regular expression can be entered to create a file mask. The following characters have been implemented:

- ***** Matches any sequence of characters including a sequence of length zero.
- **?** Matches every single character.
- **[...]** Character set, it matches any one of a group of characters that are enclosed in the square brackets.
- **[^...]** Complemented character set, this matches any character which is not inside the brackets.
- **-** Can be used inside brackets to define a range of numbers. For example, **sws[1-36]** matches **sws1**, **sws2**, **sws3** and **sws6**.
- **** This is used to suppress the special meaning of a character when matching. For example **\]** matches the character **]** also **\[** and **\-** can be used anywhere inside a bracket and **\^** directly after the opening bracket. The expression **\xyz** is equivalent to the ASCII character whose octal value is equal to **xyz**.

All other character match themselves

Appendix

A.1. Footnotes

1 (Encrypting): The function of classical cryptography is to make documents and intelligence unreadable for unauthorised persons. The transformation of real text into secret code is called Encryption.

2 (RSA): An encoding algorithm developed in 1978 at the MIT by Ronald **R**ivest, Adi **S**hamir and Leonard **A**delman. It uses two keys (passwords) one public and one private. The former can be found in published listings which are accessible to all users. The text is encrypted with the public and private password of the receiver. The receiver decodes the text by entering his private password. The algorithm encodes text by factoring large numbers into their primes with the (unproved) hope that the factorisation cannot be reversed with toady's technology.

3 (FIPS): Federal **I**nformation **P**rocessing **S**tandards

4 (ANSI X3): American **N**ational **S**tandards **I**nstitute (Information Processing)

5 (ISO): International **S**tandards **O**rganization

A.2. Program Files

ENIGMA30.EXE	Enigma for Windows executable
ENIGMA3U.HLP	Enigma for Windows help file (english)
ENIGMA30.WRI	Enigma for Windows user´s manual
DES3.DLL	Triple DES DLL for MS-Windows 3.1
INSTALL.EXE	Installation utility
ENIGMA30.INF	Configuration file for the installation
README.1ST	You should read this first
REGISTER.WRI	Registration form
SUGGEST.WRI	Suggestion form
BWCC.DLL	Borland's Custom Controls DLL

BWCC.DLL is copyrighted (c) by Borland International.

Developer Kit:

DES3/BENCH.TXT	Benchmark results of the DES DLL
DES3/DES.EXE	Triple DES program for MS-DOS
DES3/DES.C	ANSI-C source code for it
DES3/DES3.DLL	Triple DES DLL for MS-Windows 3.1
DES3/DES3.H	Prototype definitions of callable DES functions
DES3/DES3.TXT	Quick description of the kit
DES3/DES3C.LIB	MS-DOS library compact memory model
DES3/DES3H.LIB	MS-DOS library huge memory model
DES3/DES3L.LIB	MS-DOS library large memory model
DES3/DES3M.LIB	MS-DOS library medium memory model
DES3/DES3D.LIB	MS-DOS library small memory model
DES3/DES3W.LIB	Import library for MS-Windows
DES3/DOSVALID.EXE	MS-DOS programm for ANSI X9.9 DES validation
DES3/MAKEFILE	Makefile for Borland C++
DES3/VALIDATE.C	Source code of the validation program
DES3/VALIDATE.DEF	MS-Windows definition file
DES3/VALIDATE.OUT	Validation output
DES3/WINVALID.EXE	Validation program for MS-Windows