ELATEC

RFID Systems

Transponder Reader TWN3 Technical Manual

Doc.-Rev. 1.12

Content

Introduction

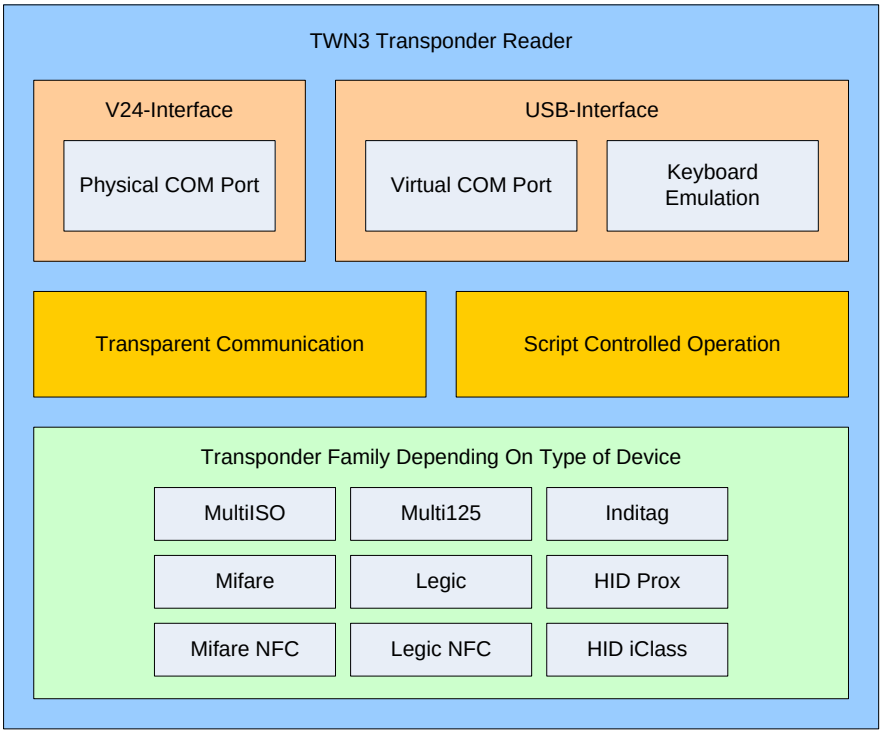
This document is the reference guide for the transponder reader family TWN3.

Note:

In order to use the functionality, which is described in this document, your TWN3 reader needs a firmware version V4.00 or above. The latest version of the firmware is part of the developer pack. Please revere to section “Updating the Firmware”, if you would like to update the firmware.

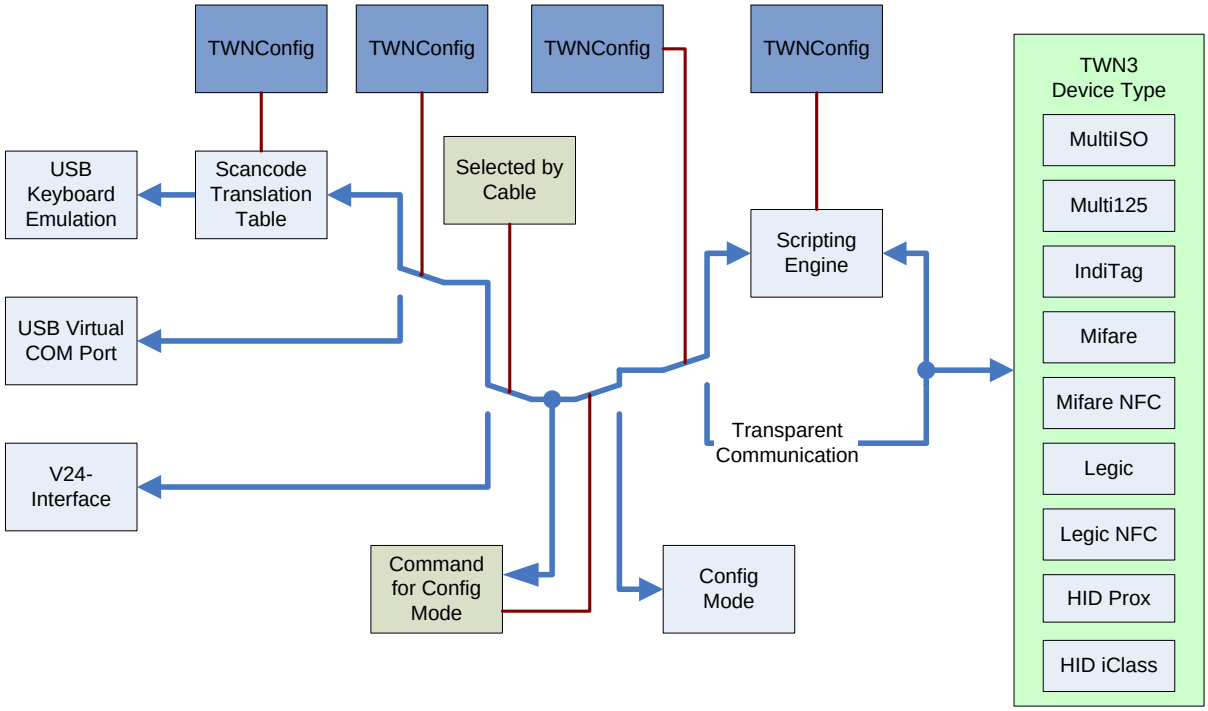
1. Functional Overview

Here is a block diagram of the basic functional components of a TWN3 transponder reader:



Let's take a more detailed view:

The diagram below is showing the functional units and how they can be configured:



2. Modes of Operation

The transponder reader TWN3 can be ordered in several hardware configurations:

- Support for the specific transponder family (Multi125, Mifare, Mifare NFC, HID Prox, HID iClass, Legic, Legic NFC, IndiTag, MultiISO)
- Physical type of connection (type of cable) to the host computer: USB or RS232, DSUB25, DSUB9 or PS/2

Many other configurations can be done by the system integrator:

- Type of USB mode (USB devices only)
- Behavior of keyboard emulation
- Scripting mode

2.1 USB-Device

A TWN3 USB reader is capable of supporting several modes of operation:

2.1.1 Keyboard Emulation (USB HID Device)

This is the default mode for USB devices. No drivers are required for running the device in a typical environment like Windows XP or Linux. Any output from the TWN3 transponder reader to the host is sent like keyboard input from a user. Therefore, any characters are displayed at the current position of the cursor on the screen of the computer.

Please be aware, that the communication between TWN3 device and host computer is unidirectional. This means, there is no possibility to send data from the host to the TWN3 device. In situations where this is required, we recommend the emulation of a serial port.

2.1.2 Emulating a Virtual Serial Port

Optionally, a USB device can be configured to emulate a virtual serial port. This mode of operation is to be preferred, if a direct communication between application and TWN3 transponder reader is required. This mode also enables a bidirectional communication between .

The communication protocol is identical to the version of TWN3 reader with a physical RS232 interface.

2.2 RS232-Device

2.2.1 Serial Communication Parameters

These are the default communication parameters for RS232 devices. Baudrate and parity can be configured as follows:

Parameter	Default Value	Optional Values
Baudrate	9600 Baud	1200 Baud, 2400 Baud, 4800 Baud, 9600 Baud, 19200 Baud, 38400 Baud, 57600 Baud
Databits	8	-
Parity	None (Even parity for TWN3 Multi125 in transparent mode)	None, Even, Odd
Stopbits	1	-
Handshake	None	-

2.2.2 Pin Assignment

Following pin assignment for the DSUB25 plug:

Pin	Signal
2	RxD from host
3	TxD to host
7	Signal ground
24	5V power supply from the host

Following pin assignment for the DSUB9 plug:

Pin	Signal
3	RxD from host
2	TxD to host
5	Signal ground
9	5V power supply from the host

Following pin assignment for the PS/2 plug:

Pin	Signal
6	RxD from host
2	TxD to host
3	Signal ground
4	5V power supply from the host

3. Installation

3.1 RS232-Device

Installing a TWN3 reader with a serial port requires an additional power supply, which is not standard for usual PCs. On the other hand, many devices do supply the 5V on a rarely used pin of the serial connector. Please contact your supplier for a specific solution.

The installation of the reader is as simple as connecting a USB device to a host.

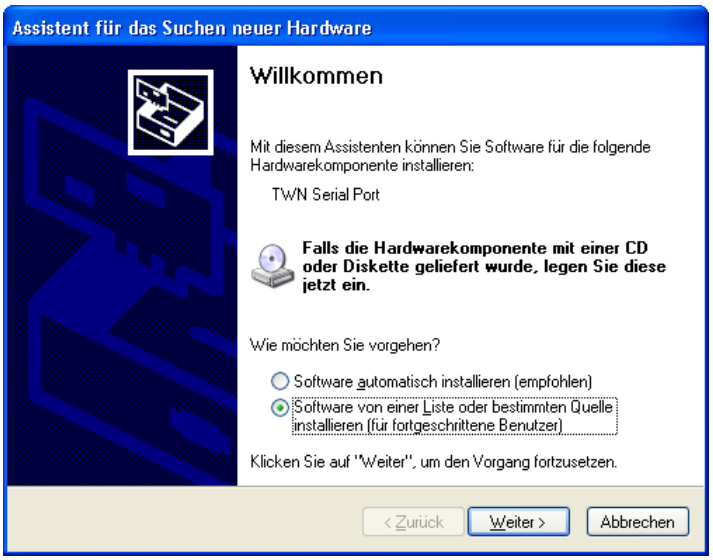
3.2 USB-Device (Keyboard Emulation)

Installing a TWN3 reader emulating a keyboard is rather simple due to the fact, that drivers do come with the operating system. Therefore, the device simply can be connected to the host computer and can be immediately used.

3.3 USB-Device (Virtual Serial Port)

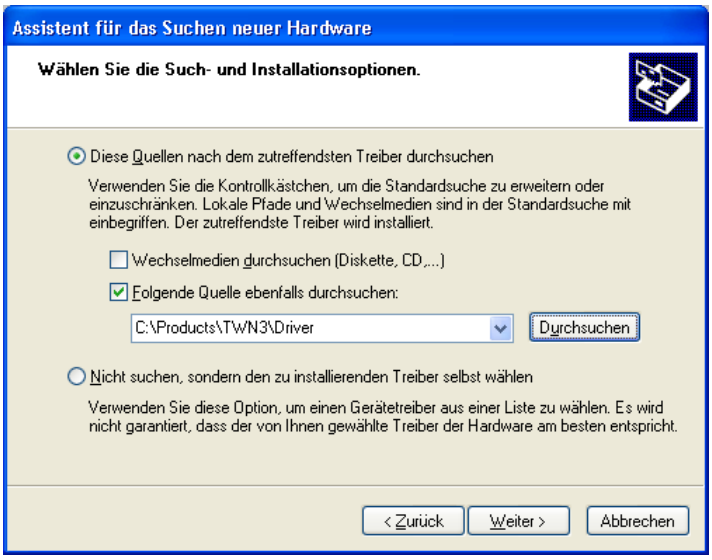
In order to install a TWN3 reader, which emulates a virtual serial port under Windows XP, keep the drivers nearby and follow these steps:

- Plug in the TWN3 reader into your host computer. The following screen should appear (in your native language)



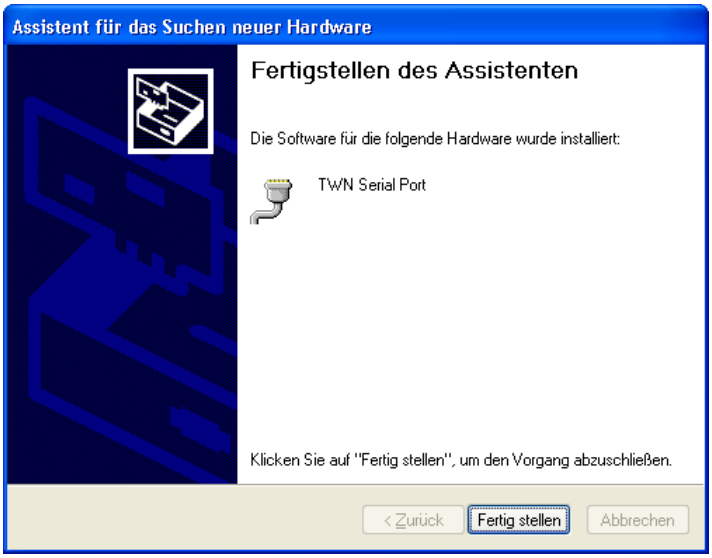
Select to install the software from a specific source.

- The following screen should appear:

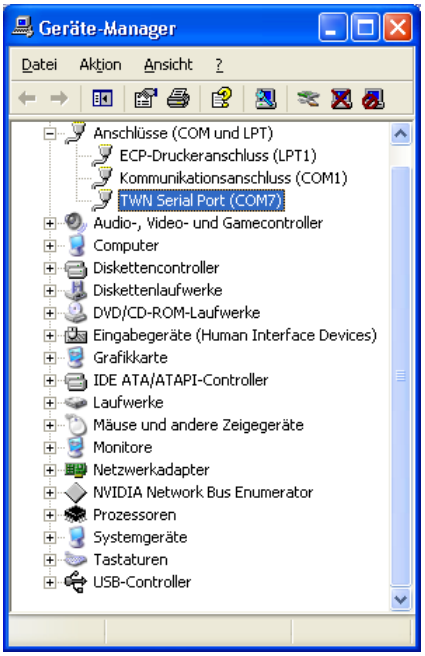


Select the directory, where the drivers reside and click continue. The drivers will be installed now.

- After installation, the following screen should appear:



The installation is now completed. In order to find the serial communication port, which is emulated by the TWN3 transponder reader, you may take a look into the device manager:



In this example, we find the TWN3 reader at COM7.

Depending on the further configuration of the device, you may now test the TWN3 transponder reader with a normal terminal program.

4. Configuration

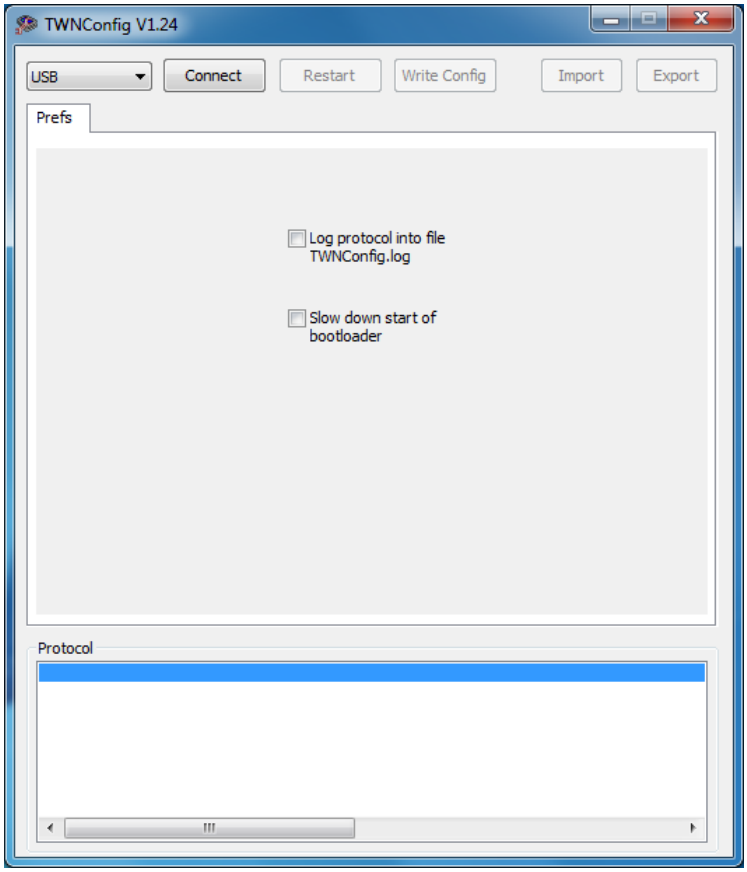
In order to configure a TWN3 transponder reader, the program TWNConfig.exe is required. Configuration is supported under Windows XP or Windows Vista. During configuration, a TWN3 transponder reader is switched into configuration mode. In this mode the entire setup of the device can be done. Configuration is possible both for RS232 and USB devices.

Note:

Please do not connect more than one TWN3 device at a time to your computer during the usage of TWNConfig. This ensures the knowledge about the TWN3 device which is actually to be configured.

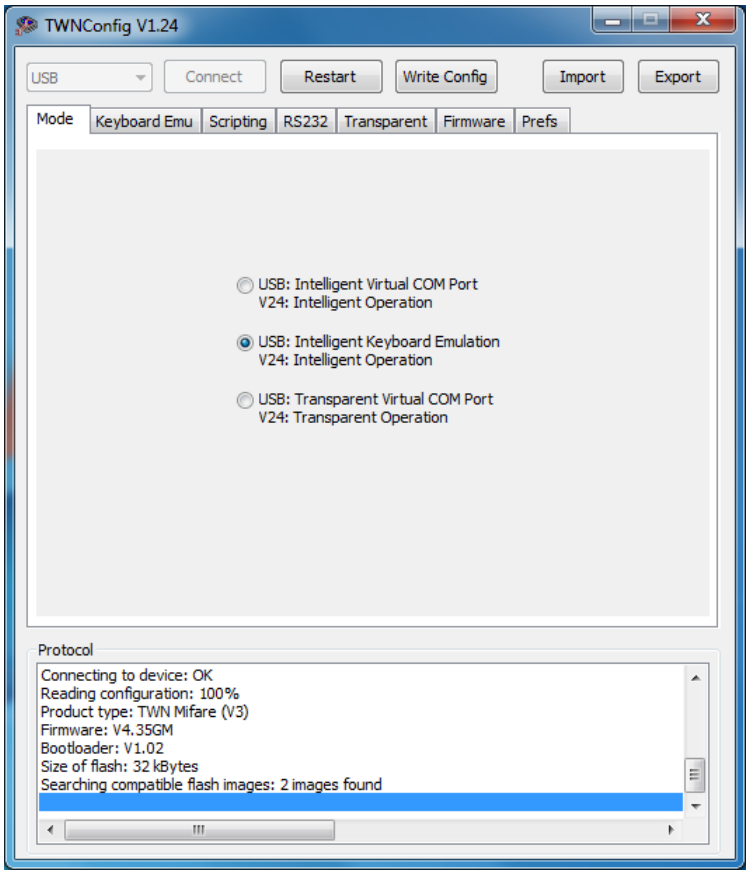
4.1 Entering the Configuration Mode

Assuming, that the TWN3 transponder reader is already connected to the host computer, start the program TWNConfig.exe. The following screen will appear:



Depending on the physical interface of the TWN3 transponder reader, choose the appropriate port in the top left combo box. Click the “Connect”-button:

TWNConfig is searching and connecting to a TWN3 device. You are now ready to do the required configurations on the device.

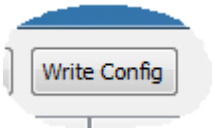


Note:

If you are configuring a USB device the first time, you have to install the appropriate configuration drivers. Please refer to “Installing USB-Drivers for Configuration”.

4.2 Writing a Configuration to a TWN3 Device

Once a configuration has been set up completely (either via importing a configuration or manually via the tab folders), the configuration can be written back to the TWN3 device. This will save the configuration permanently in the TWN3 device. In order to do that, click the button “Write Config”.



4.3 Resuming Normal Operation

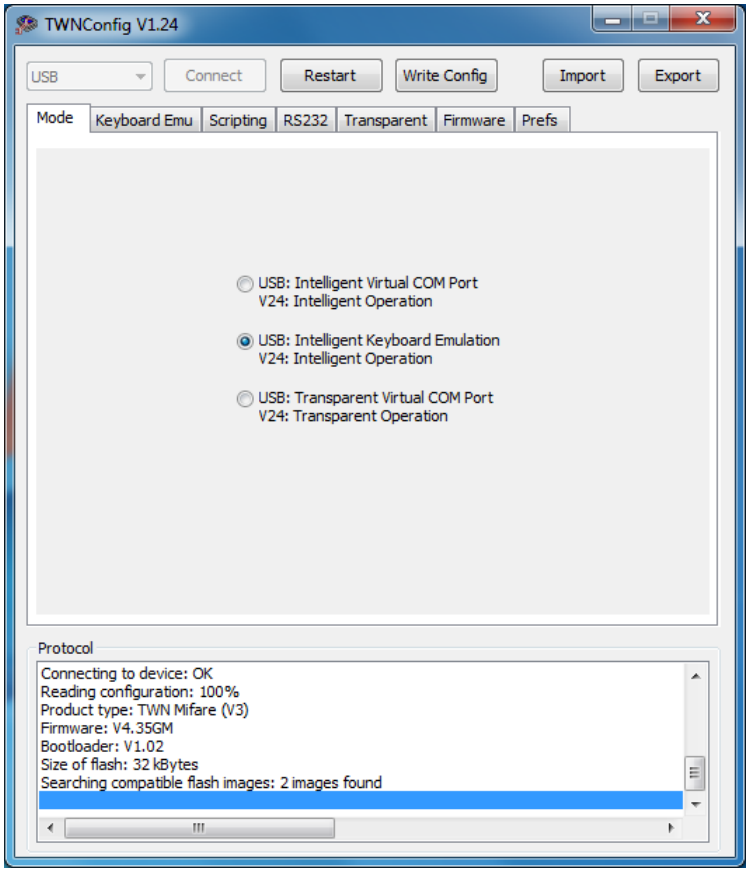
In order to leave the configuration mode of the TWN3 device and resume to normal operation click the “Restart” button.

Note:

Disconnecting the device from the host or a power cycle will keep the device in configuration mode!

4.4 Selecting Mode of Operation

In the tab folder “Mode of Operation” you select the basic mode in which the TWN3 device operates. This setup is used both for USB and RS232 devices:

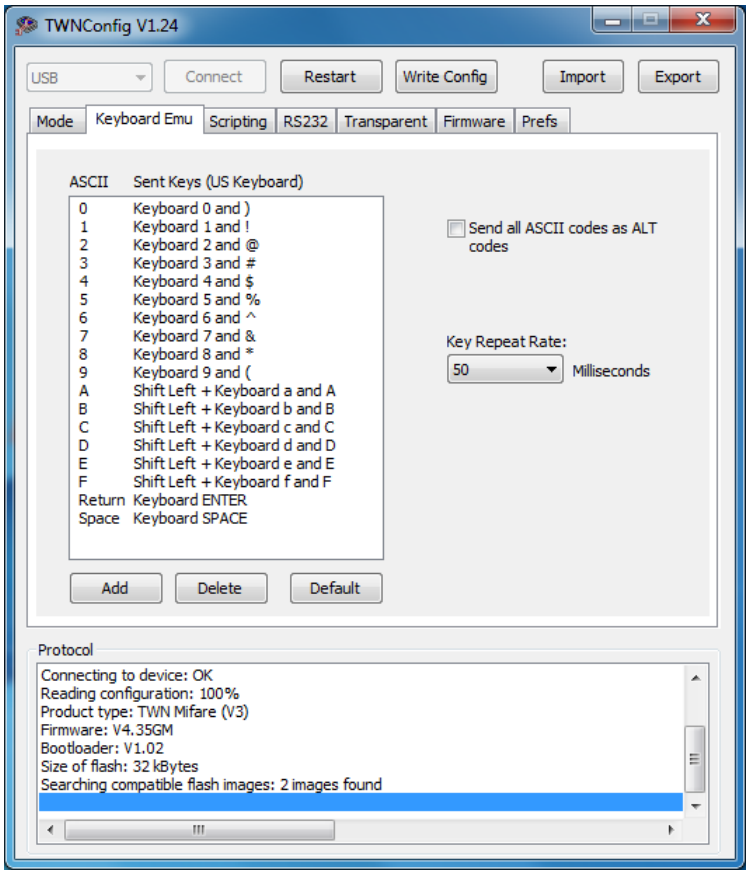


TWN3 USB	TWN3 RS232
Intelligent Virtual COM Port: Run a script on the TWN3 device (“intelligent”) and emulate a COM port	**Intelligent Operation:** Run a script on the TWN3 device (“intelligent”)
Intelligent Keyboard Emulation: Run a script on the TWN3 device (“intelligent”) and emulate a keyboard	**Intelligent Operation:** Run a script on the TWN3 device (“intelligent”)
Transparent Virtual COM Port: Establish a direct link between the virtual COM port and the internal transponder reading module.	**Transparent Operation** Establish a direct link between the serial port and the internal transponder reading module.

4.5 Setting Up the Keyboard Emulation

4.5.1 Table of Scan Codes

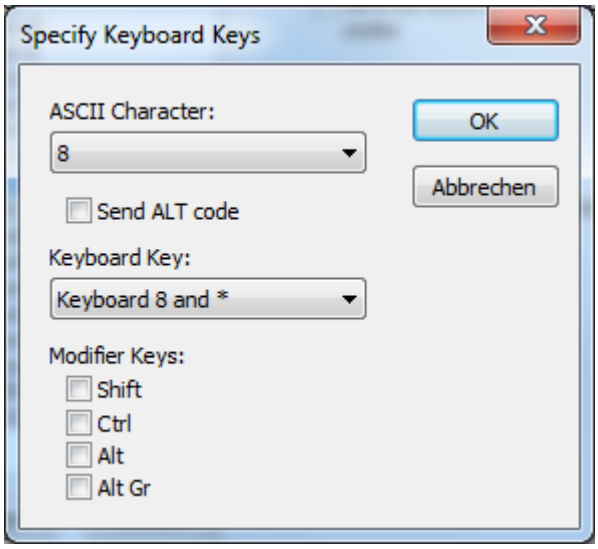
This tab folder enables you to change the scan codes of the keyboard emulation, which are sent to the host for a specific character. The default setup of the device already contains the often used characters ‘0’ – ‘9’, ‘A’ – ‘F’, carriage return and the space character.



There are some reasons, why you may want to change the existing setup:

- You need a setup for a specific country, where the layout of a keyboard is different from the default one.
- You need some additional keys in order to achieve your specific format to be sent to the host. This might be an additional space or a tab instead of return.

In order to do this, you may double-click on an existing entry in the table or specify a new entry by pressing the “Add”-button. In the following dialog you now are able to select the appropriate keys.



Please keep in mind, that the keyboard keys are to be specified in relation to a standard U.S. QUERTY keyboard, which is shown below:

Source: www.wikipedia.org

Notes:

- **A maximum of 48 entries in the scan code table is possible.**
- **Instead of specifying a key on the keyboard, sending the appropriate ASCII as ALT code can be configured.**

4.5.2 Sending ALT Codes

You may send ALT codes instead of key strokes on a keyboard.

Example:

The character ‘A’ (ASCII code 65) should be sent to the host. Following sequence is executed:

- Press ALT key
- Press key ‘6’ on the numeric keypad
- Release key ‘6’ on the numeric keypad
- Press key ‘5’ on the numeric keypad
- Release key ‘5’ on the numeric keypad
- Release ALT key.

There are advantages and disadvantages in doing so:

Advantages:

- There is no table of keystrokes necessary, which have to be set up. All characters with ASCII codes in the range from 1 to 255 can be sent.
- No adaptations to different keyboard layouts are necessary.

Disadvantage:

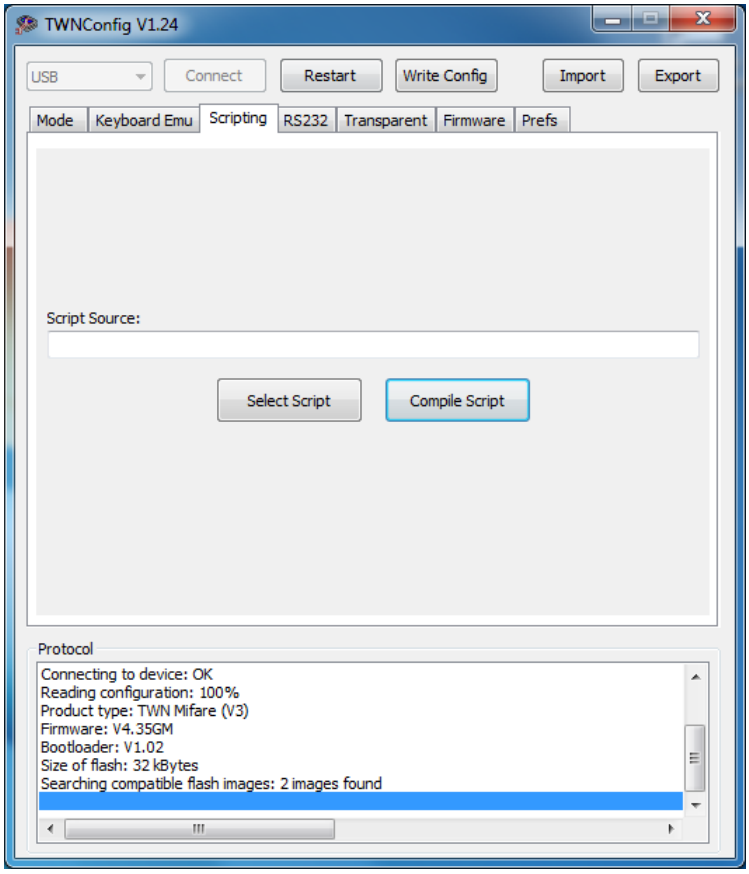
- Some programs do not accept sending ALT codes and react in a complete different way.
- The amount of key strokes is higher. Therefore, the maximum transfer speed is slower.

4.5.3 Key Repeat Rate

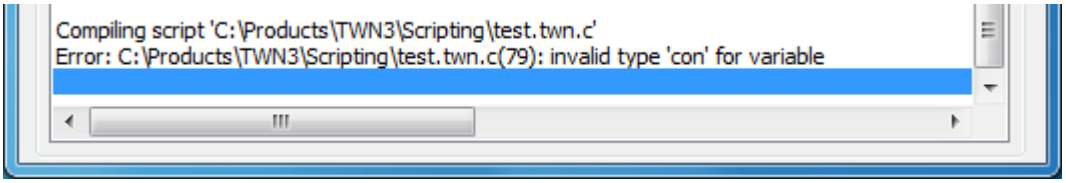
The repeat rate, with which key strokes are sent to the host can be adjusted. The time between key strokes is specified in multiples of milliseconds.

4.6 Installing Scripts

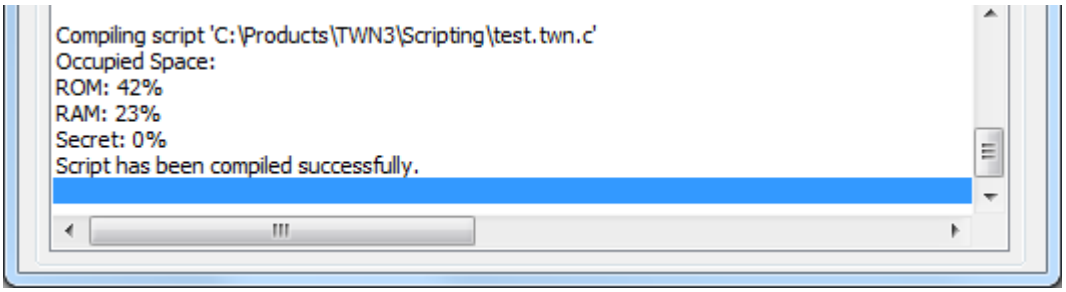
In order to install a script on a TWN3 device, perform following actions:



- Select the tab folder “Scripting”.
- Select a script file (extension “.twn.c”) by clicking the button “Select Script”.
- Click the “Compile Script”. This will start the script compiler.
- If there is an error detected in the script, the line number and type of error will be displayed.



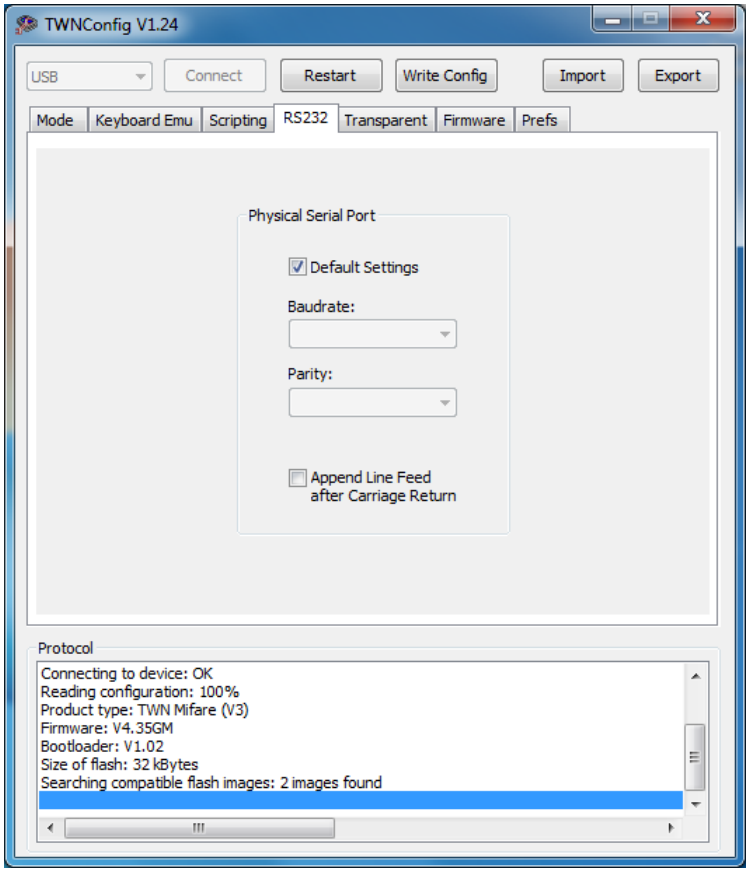
- If the compilation is successful, following screen will appear:



The compiled script is now part of the configuration within TWNConfig. Some additional information is displayed on how much storage space is occupied by this script. Up to now, the script has not been saved to the TWN3 device.

4.7 RS232 Settings

Within the tab folder “RS232”, you can setup the parameters for the RS232 communication parameters to the host computer.



As long as the checkbox “Default Settings” is activated the device will communicate with 9600 Baud and no parity (except version Multi125 which is using even parity in transparent mode).

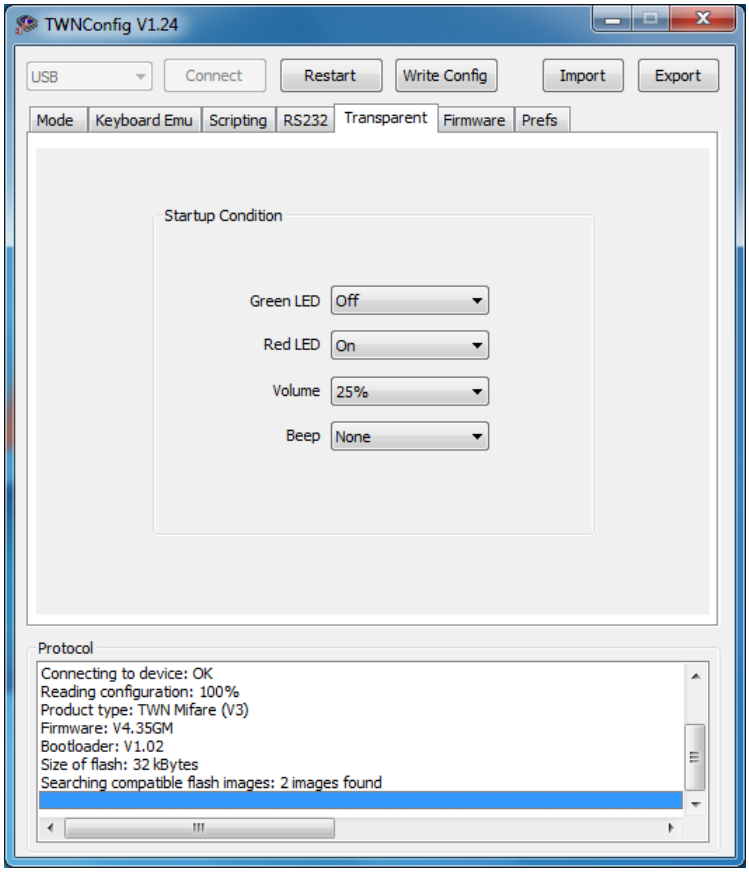
Unchecking the checkbox “Default Settings” will force the device to communicate with the desired baud rate and parity both in scripted and transparent mode.

The checkbox “Append Line Feed after Carriage Return” is related to a serial communication where the host computer expects an additional line feed after every carriage return sent to the host.

- A line feed will only be appended if:
  - This options is selected
  - The device is in intelligent mode (“running a script”)
  - The device is connected via RS232 interface or via USB and emulating a virtual serial port.
- This setting has no influence, if the device is running in keyboard emulation.
- This setting has no influence in transparent communication.

4.8 Startup Condition in Transparent Mode

Within the tab folder “Transparent”, you can setup the state of LEDs an beeper during startup of the device.

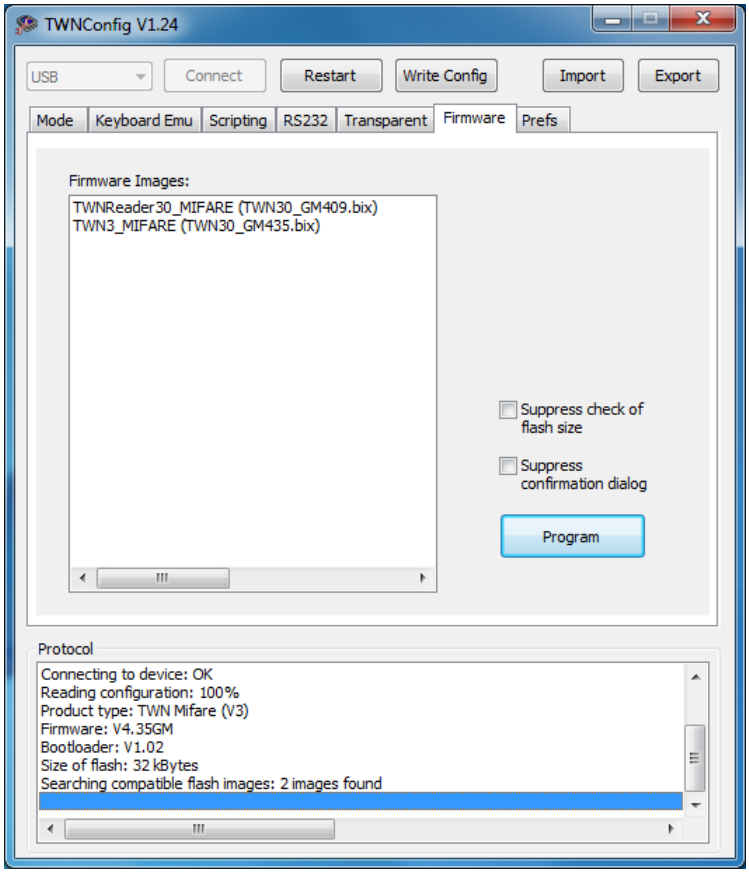


The default setup is:

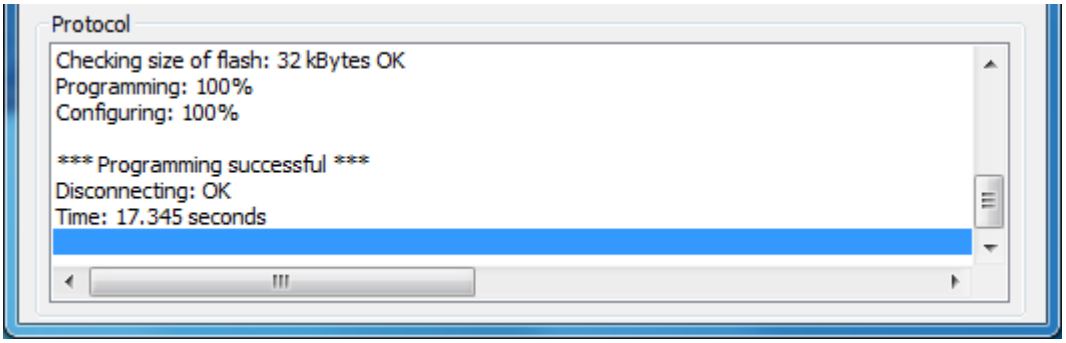
- Green LED off
- Red LED on
- Volume 25%
- No beep at startup

4.9 Updating the Firmware

In order to update the firmware of a TWN3 device select tab folder “Firmware”.



After any successful connection to a TWN3 device, the current directory will be searched for firmware images, which are compatible to the connected device. In order to re-program the firmware of a TWN3 device, click the “Program”-button. After successful programming, the following screen should be displayed:



Notes:

- **If programming fails for any reason (blackout or whatever), it is possible to restart the programming process. The TWN3 device can only be brought back to normal operation after successful programming of the firmware.**
- **Older versions of TWN3 readers may contain a microcontroller, which can not be programmed with the latest firmware due to limited storage capacity. In order to retrieve**

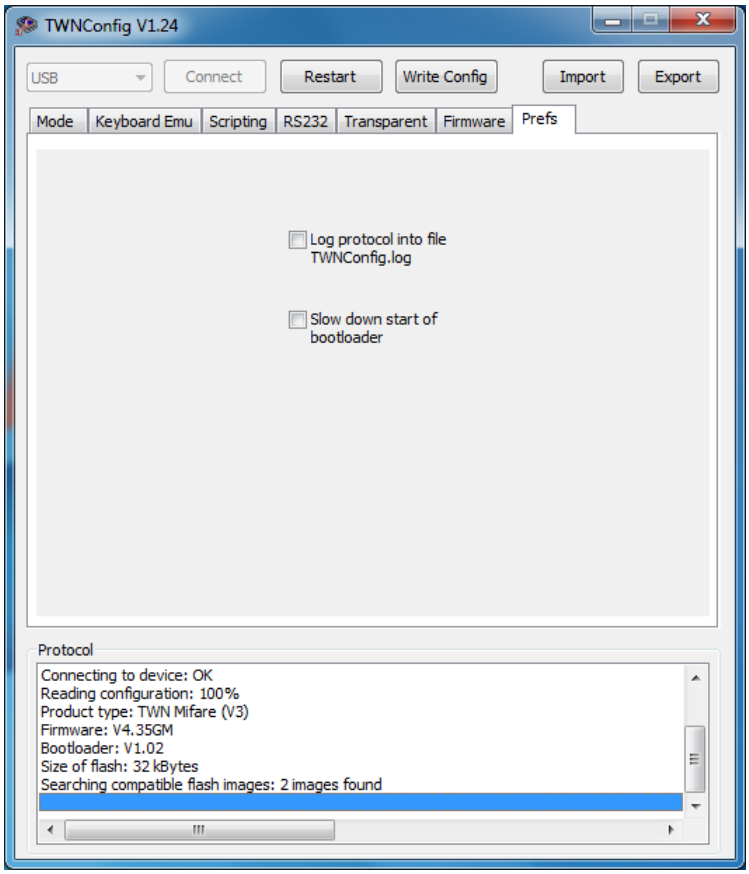
storage capacity, the firmware version 4.09 should be programmed into the device first. This firmware fits into any TWN3 device. TWNConfig is then able to determine the storage capacity of the device.

Note:

Do not use an earlier version of TWNConfig than V1.15 for programming a firmware version later than V4.09!

4.10 Preferences

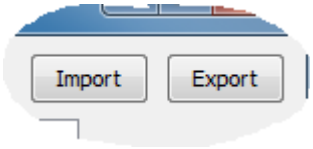
Within the tab folder “Prefs”, there are two settings:



- Activating the check box “Log protocol into file TWNConfig.log” will save all output, which appears in the list box “Protocol”, into the file “TWNConfig.log”. The file is located in the folder where TWNConfig resides.
- Activating the checkbox “Slow down start of bootloader” will do a somewhat slower activation of the boot loader of a TWN3 device. This may prevent from problems during activation of the boot loader, which have been seen on specific PCs.

4.11 Export and Import of Configurations

Once a device has been configured completely, this configuration can be exported to a file. This makes it much easier to setup many TWN3 devices with identical configuration.



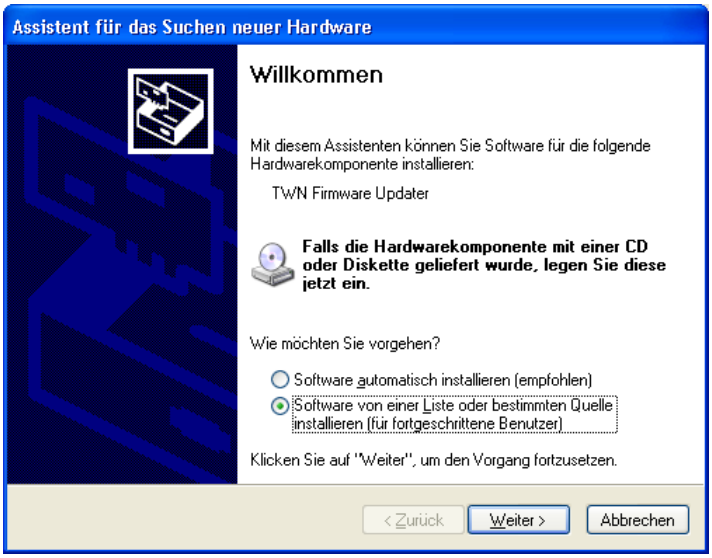
Note:

- **It is not possible to read the secret area from a TWN3 device. To save a configuration including their secrets, you have to compile the appropriate script, which defines these secrets. After successful compilation of this script you are able to export the configuration including script and secrets.**
- **Be aware, that the configuration file also contains the secrets now so this file should be handled as carefully as the source code of the script.**

4.12 Installing USB-Drivers for Configuration

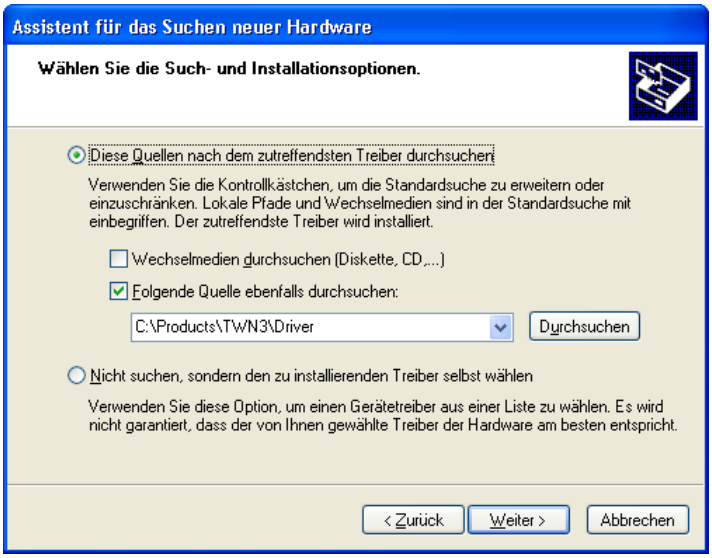
If the USB TWN3 reader is configured the first time, USB drivers for the configuration mode have to be installed. Here are the steps to do so:

- Once you have clicked the “Connect”-button within TWNConfig.exe the first time, the following screen will appear:



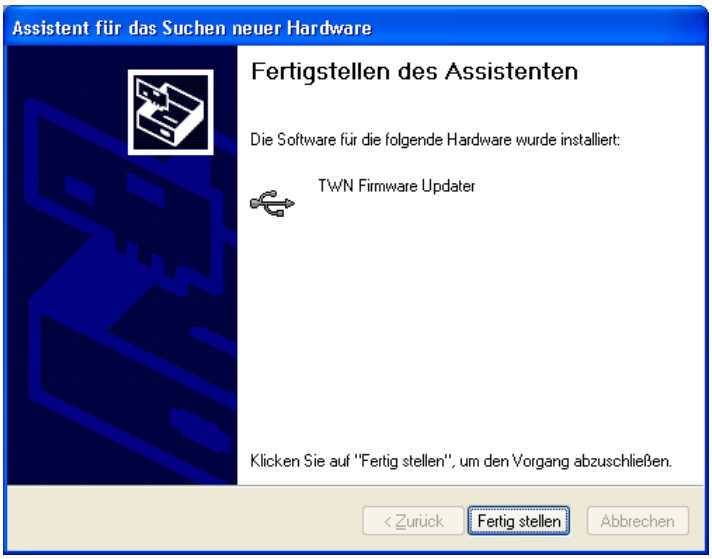
Select to install the software from a specific source.

- The following screen should appear:



Select the directory, where the drivers reside and click continue. The drivers will be installed now.

- After installation, the following screen should appear:



You are now ready to configure the TWN3 reader.

Note:

If the TWN3 reader is plugged into a different USB port of the host computer, this installation procedure has to be repeated.

5. Transparent Mode

Once a TWN3 device has been turned into transparent mode, a direct link will be established between the serial interface (RS232 or virtual USB), and the reading module. The direct communication with a transponder reader module is not compatible to each other and requires the knowledge of the specific communication protocol. Please see the following documents for related information:

TWN3 Type	Document
Multi125	T4T5Handbook x.xx.pdf
Mifare	TH_Mifare_x.xx.pdf
Mifare NFC	TH_Mifare_NFC_x.xx.pdf
MultiISO	TH_MultiISO_x.xx.pdf
IndiTag	This Document
HID Prox	This Document
HID iClass	Please contact your supplier for detailed information.
Legic	Please contact your supplier for detailed information.
Legic NFC	Please contact your supplier for detailed information.

5.1 HID Prox Transparent Protocol

Due to the fact, the TWN3 HID Prox performs read access only, there are no commands available, which can be sent to the reading module. The data received from the module is formatted as follows:

- If a transponder is read, a ASCII string is sent which is terminated by carriage return.
- The first character represents the number of valid bits, the remaining bytes do contain these bits.
- Two hexadecimal digits represent one byte.
- The first byte specifies the number of valid bits in the following ID.
- The remaining bytes do contain the ID itself.

Example:

Data sent by the reader:

```
1A808001C0<CR>
```

The first byte is 0x1A, 26 decimal. There are four bytes necessary to transport 26 bits. These bytes do contain:

Byte	1	2	3	4
Byte Value	0x80	0x80	0x01	0xC0
Bit Values	1000 0000	1000 0000	0000 0001	11(00 0000)

Please note, that the unused bits are the lowest significant bits of the last bytes.

5.2 IndiTag Transparent Protocol

Due to the fact, the TWN3 IndiTag performs read access only, there are no commands available, which can be sent to the reading module. The data received from the module is formatted as follows:

- If a transponder is read, a ASCII string is sent which is terminated by carriage return and line feed.
- A line always starts with a colon.
- The following characters represent the ID and a trailing checksum.
- Two hexadecimal digits represent one byte.
- The checksum is the 2nd complement of the addition of the ID bytes.

Example:

Data sent by the reader:

```
:112233445501<CR><LF>
```

The ID is 1122334455 (hexadecimal) and the checksum is 01 (hexadecimal)

5.3 Controlling LEDs and Beeper

Even in transparent mode there are commands available, which allow control of the built-in LEDs and the beeper. The commands depend on the communication protocol of the built-in reader module.

Please Note:

- The parameters and return values are identical to the corresponding system calls `LEDSet`, `LEDGet`, `SetVolume` and `Beep`.
- Please see the related documents for a detailed description of the communication in transparent mode.
- In order to use these commands, the firmware version V4.20 or later is required.

5.3.1 Set LEDs

Please see the system function call `LEDSet` for a detailed description of the parameters.

TWN3 Type	
Multi125	**Command**: <0x06><0xFF><0xE8><LEDs><Status><BCC>
	Response: <0x05><0x00><0xE8><0x00><BCC>
Mifare Mifare NFC MultiISO	**Command:** ":l<LEDs><Status>CR
	Response: 'S'CRLF (success) '?'CRLF (error)
Inditag HID Prox	**Command:** ":l<LEDs><Status>CR
	Response: 'S'CR (success) '?'CR (error)
HID iClass	**Command:** <0x80><0xE8><LEDs><Status><0x00>
	Response: <0x90><0x00>
Legic	**Command:** <0x04><0xE8><LEDs><Status><LRC>
	Response: <0x03><0xE8><0x00><LRC>
Legic NFC	**Command:** <0x04><0xE8><LEDs><Status><CRCHI><CRCLO>
	Response: <0x03><0xE8><0x00><CRCHI><CRCLO>

5.3.2 Get LEDs

Please see the system function call `LEDGet` for a detailed description of the parameter and the return value.

TWN3 Type	
Multi125	**Command**: <0x05><0xFF><0xE9><LED><BCC>
	Response: <0x06><0x00><0xE9><0x00><LED Status><BCC>
Mifare Mifare NFC MultiISO	**Command:** ":g<LED>CR
	Response: <LED Status>CRLF (success) '?'CRLF (error)
Inditag HID Prox	**Command:** ":g<LED>CR
	Response: <LED Status>CR (success) '?'CR (error)
HID iClass	**Command:** <0x80><0xE9><LED><0x00><0x01>
	Response: <LED Status><0x90><0x00>
Legic	**Command:** <0x03><0xE9><LED><LRC>
	Response: <0x04><0xE9><0x00><LED Status><LRC>
Legic NFC	**Command:** <0x03><0xE9><LED><CRCHI><CRCLO>
	Response: <0x04><0xE9><0x00><LED Status><CRCHI><CRCLO>

5.3.3 Set Volume

Please see the system function call `SetVolume` for a detailed description of the parameter.

TWN3 Type	
Multi125	**Command**: <0x05><0xFF><0xEA><Volume><BCC>
	Response: <0x05><0x00><0xEA><0x00><BCC>
Mifare Mifare NFC MultiISO	**Command:** ":v<Volume>CR
	Response: 'S'CRLF (success) '?'CRLF (error)
Inditag HID Prox	**Command:** ":v<Volume>CR
	Response: 'S'CR (success) '?'CR (error)
HID iClass	**Command:** <0x80><0xEA><Volume><0x00><0x00>
	<0x90><0x00>
Legic	**Command:** <0x03><0xEA><Volume><LRC>
	Response: <0x03><0xEA><0x00><LRC>
Legic NFC	**Command:** <0x03><0xEA><Volume><CRCHI><CRCLO>
	Response: <0x03><0xEA><0x00><CRCHI><CRCLO>

5.3.4 Beep

Please see the system function call `Beep` for a detailed description of the parameter.

TWN3 Type	
Multi125	**Command**: <0x05><0xFF><0xEB><Type><BCC>
	Response: <0x05><0x00><0xEB><0x00><BCC>
Mifare Mifare NFC MultiISO	**Command:** ":b<Type>CR
	Response: 'S'CRLF (success) '?'CRLF (error)
Inditag HID Prox	**Command:** ":b<Type>CR
	Response: 'S'CR (success) '?'CR (error)
HID iClass	**Command:** <0x80><0xEB><Type><0x00><0x00>
	<0x90><0x00>
Legic	**Command:** <0x03><0xEB><Type><LRC>
	Response: <0x03><0xEB><0x00><LRC>
Legic NFC	**Command:** <0x04><0xEB><Type><CRCHI><CRCLO>
	Response: <0x04><0xEB><0x00><CRCHI><CRCLO>

6. Scripting

6.1 Language Description

The scripting language for TWN3 readers is a simplified version of the language C. The main differences are:

- There is one data type available, which is a `byte`. A `byte` is an unsigned integer with a size of 8 bits.
- There are no pointers available. Instead, there is a reference operator, which is showing some similarity to the language C++.

6.1.1 Source Code

The source for a TWN3 script is given as a text file. Due to closeness to the language C, the extension should be ".c". Doing so will give the advantage of a working syntax highlighting in many programming editors. In order to distinguish normal C-code from TWN3 scripting code it is furthermore recommended to expand the **extension** to **".twn.c"**. This is also the default extension which is used by the configuration tool TWNConfig. The preferred extension for include files is **".twn.h"**.

A TWN3 script is one file of source. It is possible to include additional source files via a directive to the preprocessor.

6.1.2 Comments

In order to place a comment within the source code, two slashes are used. The remaining content of the line will be ignored by the compiler.

6.1.3 Case Sensitivity

The TWN3 script language is sensitive to upper and lower case. Examples:

```
byte a;     // Valid
Byte a;     // Invalid
byte Byte;  // Valid(!)
```

6.1.4 Preprocessor Directives

The preprocessor is removing comments from the source code and processing the preprocessor directives. Currently, there is one directive available.

6.1.4.1 #include Directive

Include another source file and treat it as a part of the compiled source. There are two possibilities:

```
#include <sys.twn.h>
```

Include the given file, which is located relative to the directory, where TWNConfig.exe resides.

```
#include "mydefs.twn.h"
```

Include the given file, which is located relative to the current directory

6.1.5 Functions

Functions may be defined ("prototype") in order to resolve forward references, or declared directly.

The prototype of a function has the following form:

```
(byte | void) identifier([list of arguments]);
```

The declaration of a function has the following form:

```
(byte | void) identifier([list of arguments])
  function body
```

The function body is a block of statements.

6.1.5.1 Return Values

A function either has a return value (byte) or not (void). Following form is required to return a value:

```
return expression;
```

6.1.5.2 Arguments

If a function has no arguments, the list of arguments has to be left empty (do not write void).

In order to declare arguments, write the list of arguments separated by commas. Arguments are passed by value or by reference. In order to pass an argument by reference instead of value, insert the '&' before the identifier of argument. Here are some examples of valid function prototypes:

```
void Func1();                    // No arguments

void Func2(byte i);              // A single argument,
                                 // which is passed by value

void Func3(byte in, byte &out); // Two arguments, where in is passed by
                                 // value and out is passed by reference
```

6.1.5.3 System Functions

A system function can only be declared as prototype. Following form:

```
(byte | void) identifier([list of arguments]) system number;
```

The list of available system functions is contained in the file sys.twn.h. For the script programmer there is normally no need to declare system functions on his own.

6.1.5.4 Function main

A TWN3 script always needs the function *main* to be implemented. The prototype for the function *main* is:

```
void main();
```

After internal initialization, the TWN3 reader will start execution of the script by calling this function *main*.

6.1.6 Statements

A single statement has the form

```
[expression];
```

This means, a statement is a (optional) expression followed by a semicolon. If only a semicolon without an expression is specified, it is called an empty statement. Statements can be enclosed by braces to build a block of statements. A block statement can be used wherever a single statement can be used.

6.1.6.1 if Statement

An if statement has the form:

```
if (expression) statement
```

Statement is executed only if the result of *expression* is not equal to zero.

6.1.6.2 if else Statement

An if else statement has the form:

```
if (expression) statement1 else statement2
```

Statement1 is executed only, if the result of *expression* is not equal to zero. Otherwise, *statement2* is executed.

6.1.6.3 while Statement

A while statement has the form:

```
while (expression) statement
```

Statement is executed, as long as the result of *expression* is not equal to zero.

6.1.6.4 do while Statement

A do while statement has the form:

```
do statement while (expression);
```

Statement is executed, until the result of *expression* is equal to zero.

6.1.6.5 for Statement

A for statement has the form:

```
for ([expression1]; [expression2]; [expression3] statement
```

As first step, *expression1* is evaluated. As long as *expression2* is not equal to zero, *statement* is executed. After execution of *statement*, *expression3* is evaluated. Therefore, a for statement can be rewritten as while statement with exactly the same behavior:

```
expression1;
while (expression2)
{
   statement
   expression3;
}
```

6.1.6.6 switch Statement

A switch statement has the form:

```
switch (expression)
{
[case constant expression: [case statement]]
[default: [default statement]]
}
```

The script is evaluating expression. Depending on the result of the expression the appropriate case is executed. If there is no appropriate case, the default case is executed. If there is no default label, execution is continued after the switch statement.

6.1.6.7 break Statement

Form:

```
break;
```

The break statement can be used in while, do/while, for and switch statements (loop or switch statements).

In a loop statement, control is passed directly to the next statement outside of the loop. In a switch statement, control is passed directly to the next statement outside of the switch body.

6.1.6.8 continue Statement

Form:

```
continue;
```

The continue statement can be used in while, do/while and for statements (loop statements). It directly passes execution to the loop continuation portion of the loop statement.

6.1.6.9 return Statement

Two forms are possible:

Functions, which do not return a value:

```
return;
```

The execution of the current function is stopped. Execution is continued in the calling function.

Functions which return a value:

```
return expression;
```

Expression is evaluated, execution is stopped, the result of the expression is passed to the calling function, execution is continued in the calling function.

6.1.6.10 goto Statement

Form:

```
goto label;
```

The goto statement directly passes execution to the position within a function, where the label statement has been defined.

6.1.6.11 Labels

A label has the form:

```
identifier: statement
```

They may appear on any position within a function body. A label is used as destination for a goto statement.

6.1.6.12 Empty Statement

A statement, which is doing nothing is the semicolon. Example:

```
for (i=0; i<10; i+=1)    // Waste some time and do ten times nothing
   ;
```

6.1.7 Storage Types

In the TWN3 scripting language, there is only one type of storage defined, which is the byte. A byte is an unsigned integer with a size of 8 bits.

6.1.8 Storage Classes

There are following storage classes available: Standard, const and secret. Without using any modifier, the standard storage is used. A variable, which is declared in the standard storage class, is allocated in the normal data segment.

Examples:

```
byte i;      // A single integer
byte a[15];  // An array of 15 bytes
```

6.1.8.1 const

An identifier, which is declared as const can be used for calculations at compile time. There is no physical memory occupied during runtime. Typically, you would use a const for defining constants, which are used throughout a script for easier understanding and adaptation for different purposes.

Example:

```
const byte c = 15;
```

6.1.8.2 secret

The secret data space is a read-only segment. The content of this segment is written once during programming the script into the TWN3 transponder reader. Furthermore, this segment can not be read directly by the script itself. Therefore, there is no way to simply read the content of this memory and send it to the host. There are only a few system functions, which take the content of this segment as input. Typically, the secret data space is used for keys, which are necessary for authentication to a transponder. Examples:

```
// Some well-known factory default keys for transponders
secret byte MifareKeyFF[6] = { 0xFF,0xFF,0xFF,0xFF,0xFF,0xFF };
secret byte MifareKeyAA[6] = { 0xA0,0xA1,0xA2,0xA3,0xA4,0xA5 };
secret byte MifareKeyBB[6] = { 0xB0,0xB1,0xB2,0xB3,0xB4,0xB5 };
secret byte Hitag2Key[4]   = { 'M','I','K','R' };
secret byte EM4050Key[4]   = { 0x00,0x00,0x00,0x00 };
```

6.1.9 Operators

Following operators are available:

Operator	Meaning	Example
()	Parenthesis	A = B * (C + D)
[]	Brackets	A = B[C]
!	Logical Not	A = !B
~	Bitwise Complement	A = ~B
-	Unary Minus	A = -B
+	Unary Plus	A = +B
*	Multiplication	A = B * C
/	Division	A = B / C
%	Modulus	A = B % C
+	Add	A = B + C
-	Subtract	A = B - C
<<	Shift Left	A = B << C
>>	Shift Right	A = B >> C
<	Lower	A = B < C
<=	Lower or Equal	A = B <= C
>	Greater	A = B > C
>=	Greater or Equal	A = B >= C
==	Equal	A = B == C
!=	Not Equal	A = B!= C
&	Binary And	A = B & C
^	Binary Exclusive Or	A = B ^ C
|	Binary Or	A = B | C
&&	Logical And	A = B && C
||	Logical Or	A = B || C
=	Assignment	A = B
+=	Addition/ Assignment	A += B
-=	Subtraction/ Assignment	A -= B
*=	Multiplication/ Assignment	A *= B
/=	Division/ Assignment	A /= B
%=	Modulus/ Assignment	A %= B
|=	Bitwise Or/ Assignment	A |= B
&=	Bitwise And/ Assignment	A &= B
^=	Bitwise Exclusive Or	A ^= B
<<=	Shift Left/ Assignment	A <<= B
>>=	Shift Right/ Assignment	A >>= B

6.2 Runtime Environment

6.2.1 Include File

The file `sys.twn.h` declares all constants and system function prototypes, which are necessary for accessing the TWN3 transponder reader functionality. It is strongly recommended to include this file in any TWN3 script:

```
#include <sys.twn.h>
```

6.2.2 Basic Definitions

In order to handle boolean operations in a more natural way, there are two constants defined:

```
const byte FALSE = 0;
const byte TRUE = 1;
```

System functions, which only return 0 or 1 in order to signal successful operation, are described to return `FALSE` or `TRUE` for better readability.

6.2.3 Bit Fields

Many system functions operate on an array of bytes, where a count of bits is and/or a start bit is specified. The table shows, how the bits are enumerated within the array of bytes:

Byte Index	**0**								**1**								**2**							
Bit Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Functions, which only specify a *bitcount*, operate on bits 0 to *bitcount*-1.

Functions, which specify a *startbit* and *bitcount*, operate on bits *startbit* to *startbit*+*bitcount*-1.

Please note, that both the most significant bits and the most significant bytes are still oriented to the left side of the bit field.

6.2.4 Startup Condition

Following conditions are met, before a TWN3 script is started:

- The entire variable data space is preset to 0.
- All timers are stopped.
- The LEDs are turned off.
- The volume of the beeper is set to minimum level but not turned off (volume 1).
- The communication with the transponder reading module is restarted.

6.2.5 System Function Calls

6.2.5.1 Transponder Operations

Following constants are defined for the various types of transponders which can be read by the family of TWN3 transponder readers:

TWN3 Type	Transponder Definition	Corresponding Value
Multi125	TAGTYPE_EM4102 TAGTYPE_HITAG1S TAGTYPE_HITAG2 TAGTYPE_EM4150 TAGTYPE_ISOFDX	4 5 6 7 9
Mifare	TAGTYPE_MIFARE	1
Mifare NFC	TAGTYPE_MIFARE TAGTYPE_ISO14443B TAGTYPE_HIDICLASS TAGTYPE_SRX TAGTYPE_FELICA	1 23 20 25 24
HID Prox	TAGTYPE_HIDPROX	2
HID iClass	TAGTYPE_HIDICLASS	20
Legic	TAGTYPE_LEGIC TAGTYPE_MIFARE TAGTYPE_ISO15693	3 1 21
Legic NFC	TAGTYPE_LEGIC TAGTYPE_MIFARE TAGTYPE_ISO14443B TAGTYPE_HIDICLASS TAGTYPE_ISO15693 TAGTYPE_FELICA	3 1 23 20 21 24
IndiTag	TAGTYPE_INDITAG	22
MultiISO	TAGTYPE_MIFARE TAGTYPE_ISO14443B TAGTYPE_HIDICLASS TAGTYPE_SRX TAGTYPE_ISO15693	1 23 20 25 21

6.2.5.1.1 Generally Available Transponder Operations

byte TagSearch(byte &IDData, byte &IDBitCnt, byte &TagType)

Search a transponder. This function behaves similar on different types of transponder readers, but not identical.

Parameter:

`byte &IDData`	Reference to a bit field (in fact an array of bytes), which receives the ID data.
`byte &IDBitCnt`	Number of valid bits(!), the ID consists of.
`byte &TagType`	Type of tag, which has been found.
Return:	If a transponder has been found, the return value is `TRUE`, otherwise it is `FALSE`.

The following table shows, how data is stored in the given array of bytes:

	Maximum length of ID (bits)	Maximum length of ID (bytes)	*IDBitCnt* is always a multiple of 8 bits
Multi125	64	8	Yes
Mifare	56	7	Yes
Mifare NFC	64	8	Yes
HID Prox	128	16	No
HID iClass	128	16	Yes
Legic	128	16	Yes
Legic NFC	128	16	Yes
IndiTag	64	8	Yes
MultiISO	64	8	Yes

If *IDBitCnt* is a multiple of 8 bits, then the number of involved bytes simply can be calculated by following formula:

```
IDByteCnt = IDBitCnt/8;
```

If *IDBitCnt* is not a multiple of 8 bits, then the number of involved bytes can be calculated by a somewhat more complicated formula:

```
IDByteCnt = (IDBitCnt+7)/8;
```

The second formula can be used in general but occupies somewhat more program space.

byte TagRead(byte Address, byte ByteCnt, byte &Data)

Read data from a selected transponder.

Parameters:

`byte Address`	The address within the address space of the transponder.
`byte ByteCnt`	Number of bytes to read.
`byte &Data`	Reference to an array of bytes, where the read data will be stored.
Return:	If the operation was successful, the return value is `TRUE`, otherwise it is `FALSE`.

byte TagWrite(byte Address, byte ByteCnt, byte &Data)

Write data to a selected transponder.

Parameters:

byte Address	The address within the address space of the transponder.
byte ByteCnt	Number of bytes to write.
byte &Data	Reference to an array of bytes to be written.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

6.2.5.1.2 Multi125-Specific Transponder Operations

byte Multi125SearchLogin(byte &IDData, byte &IDBitCnt, byte &TagType, byte &Secret)

Perform a search for transponders and login to Hitag2 or EM4150 transponders if applicable. This function behaves similar to the function TagSearch except the fact, that it also tries to perform a login with the given key information.

Parameters:

byte &IDData	Reference to a bit field (in fact an array of bytes), which receives the ID data.
byte &IDBitCnt	Number of valid bits(!), the ID consists of.
byte &TagType	Type of tag, which has been found.
byte &Secret	Reference to an array of bytes, which must contain four bytes. These bytes represent the key for the login process.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

byte Multi125Generic(byte &TXData, byte TXCount, byte &RXData, byte &RXCount, byte MaxRXCount, byte Timeout)

Send a specific command to the built in module of a Multi125 reader.

Parameters:

byte &TXData	Reference to an array of bytes which contains the command to be sent to the module.
byte TXCount	Count of bytes in the specified array of bytes to be sent.
byte &RXData	Reference to an array of bytes (receive buffer) which receives the answer from the module.
byte &RXCount	Count of bytes, which have been received.
byte MaxRXCount	The size of the receive buffer.
byte Timeout	Timeout time in multiples of 100 milliseconds.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

Please note, that both TXData and RXData do contain a telegram without length, address and BCC.

6.2.5.1.3 Mifare-, Mifare NFC- and MultiISO-Specific Transponder Operations

For TWN3 Mifare and TWN3 MultiISO, there are identical functions available, which directly communicate with the built-in module:

byte MifareLogin(byte &Secret, byte KeyType, byte Sector)

In order to do any operations on a sector of a Mifare transponder, a login has to be performed.

Parameters:

`byte &Secret`	Reference to a array of bytes, which has to contain six bytes. These bytes represent the key for the login process.
`byte KeyType`	Specifies, with which key the operation has to be performed. This is one of the defined constants `KEYA` or `KEYB`.
`byte Sector`	Specifies the sector for the login.
Return:	If the operation was successful, the return value is `TRUE`, otherwise it is `FALSE`.

void ModuleSendChar(byte Char)

Send a single ASCII character to the module.

Parameters:

`byte Char`	ASCII character to be sent.
Return:	None.

void ModuleSendHexByte(byte Byte)

Send a byte as a two-digit hexadecimal value to the module.

Parameters:

`byte Byte`	Byte value to be sent.
Return:	None.

byte ModuleReceiveLine(byte &RXData, byte &RXCount,
byte MaxRXCount, byte Timeout)

Receive a line of text from the module. A line of text is the typical response of the module to a command.

Parameters:

byte &RXData	Reference to an array of bytes, which contains the received ASCII characters (without carriage return and line feed).
byte &RXCount	The number of received ASCII characters.
byte MaxRXCount	Specifies the maximum number of characters the array RXData can hold.
byte Timeout	Specifies the time, the function waits for a response. The value is specified in multiples of 100 milliseconds.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

6.2.5.1.4 Legic- and Legic NFC Specific Operations

byte LegicGeneric(byte &TXData, byte TXCount, byte &RXData,
byte &RXCount, byte MaxRXCount, byte Timeout)

Send a specific command to the built in module of a Legic reader.

Parameters:

byte &TXData	Reference to an array of bytes which contains the command to be sent to the module.
byte TXCount	Count of bytes in the specified array of bytes to be sent.
byte &RXData	Reference to an array of bytes (receive buffer) which receives the answer from the module.
byte &RXCount	Count of bytes, which have been received.
byte MaxRXCount	The size of the receive buffer.
byte Timeout	Timeout time in multiples of 100 milliseconds.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

Please note, that TXData and RXData do contain a telegram without length byte and LRC or CRC. This information is calculated by the firmware of the TWN3 reader.

6.2.5.1.5 HID iClass Specific Operations

byte IClassGeneric(byte &TXData, byte TXCount,
byte &RXData, byte RXCount, byte Timeout)

Send a specific command to the built in module of a TWN3 HID iClass.

Parameters:

byte &TXData	Reference to an array of bytes which contains the command to be sent to the module.
byte TXCount	Count of bytes in the specified array of bytes to be sent.
byte &RXData	Reference to an array of bytes (receive buffer) which receives the answer from the module.
byte RXCount	Count of bytes, to be received.
byte Timeout	Timeout time in multiples of 100 milliseconds.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

byte IClassTagSearchApp(byte &AppData, byte &AppBitCnt)

Receive application data from the module. In order to use this function, no other transponder functions are allowed to be used.

Parameters:

byte &AppData	Reference to an array of bytes which receives the application data. The size of the array of bytes must be at least 18 bytes.
byte &AppBitCnt	Number of bits, which have been received.
Return:	If the operation was successful, the return value is TRUE, otherwise it is FALSE.

6.2.5.2 Functions for Host Communication

void HostSendVersion()

Send version information of the firmware to the host. This information is sent without a carriage return. Therefore, it is possible to append some more information, i.e. the version of the script, which is currently executed.

Parameter: None.
Return: None.

Example:

```
HostSendVersion();       // Send the firmware version
HostSendChar('.');       // Send another separator
HostSendChar('0');       // Send version of this small example
HostSendChar('2');
HostSendChar('\r');
```

This will send following string to the host:

```
ELA GM4.07.02
```

The string of course varies with the actual firmware installed on the transponder reader.

void HostSendChar(byte Char)

Send a single character to the host.

Parameter:
`byte` *`Char`* Char represents the ASCII value of the character to be sent to the host.
Return: None.

void HostSendHex(byte &Data, byte BitCnt, byte Width)

Convert a number, which is given as a bit field into hexadecimal ASCII format, and send it to the host. Letters are sent in upper case.

Parameters:

byte *&Data*	A reference to an array of bytes, which contains the bit field
byte *BitCnt*	The number of bits, which are valid within the array of bytes. A maximum of 128 bits can be converted.
byte *Width*	Specifies the number of digits, the output should contain. If width is 0, then at least 1 digit is sent. If *Width* is greater than the actual width of the number to be converted, then the number is preceded by zeros.
Return:	None.

Example:

```
byte ID[2];
ID[0] = 0x12;
ID[1] = 0x34;
HostSendHex(ID,16,0);       // Result is 1234
HostSendHex(ID,8,5);        // Result is 00012
HostSendHex(ID,13,5);       // Result is 00246
```

void HostSendDec(byte &Data, byte BitCnt, byte Width)

Convert a number, which is given as a bit field into decimal ASCII format, and send it to the host.

Parameters:

byte *&Data*	A reference to an array of bytes, which contains the bit field
byte *BitCnt*	The number of bits, which are valid within the array of bytes. A maximum of 128 bits can be converted.
byte *Width*	Specifies the number of digits, the output should contain. If width is 0, then at least 1 digit is sent. If *Width* is greater than the actual width of the number to be converted, then the number is preceded by zeros.
Return:	None.

Example:

```
byte ID[2];
ID[0] = 0x12;
ID[1] = 0x34;
HostSendDec(ID,16,0);       // Result is 4660
HostSendDec(ID,8,5);        // Result is 00018
HostSendDec(ID,13,5);       // Result is 00582
```

void HostSendNumber(byte &Data,byte FirstBit,byte BitCnt,
byte Radix,byte MinWidth,byte MaxWidth)

Convert a number, which is given as a bit field into ASCII format, and send it to the host. The conversion is made in the following sequence:

1. Convert the binary data to a number of digits, which is determined by the parameter *MaxWidth*. If *MaxWidth* is 0, then the number of digits is determined by the binary data itself.
2. If the result of the conversion is less than the number of digits specified by *MinWidth*, precede the converted number with zeros according to *MinWidth*.

Parameters:

byte &*Data*	A reference to an array of bytes, which contains the bit field
byte *FirstBit*	Index of the first bit to be converted
byte *BitCnt*	The number of bits, which are valid within the array of bytes. A maximum of 128 bits can be converted.
byte *Radix*	Base for conversion, use: 2 for binary conversion 8 for octal conversion 10 for decimal conversion 16 for hexadecimal conversion Valid values are from 2 to 36.
byte *MinWidth*	Specifies the minimum number of digits, the output should contain. If *MinWidth* is 0, then at least 1 digit is sent. If *MinWidth* is greater than the actual width of the number to be converted, then the number is preceded by zeros.
byte *MaxWidth*	Specifies the maximum number of digits, the output should contain. This allows inhibit of leading digits of an output. If *MaxWidth* is 0, then the number of digits is determined by the given binary data itself.
Return:	None.

Example:

```
byte ID[2];
ID[0] = 0x12;
ID[1] = 0x34;
HostSendNumber(ID,0,16,16,0,4);     // Result: "1234"
HostSendNumber(ID,0,16,16,0,3);     // Result: "234"
HostSendNumber(ID,0,16,16,8,3);     // Result: "00000234"
```

byte HostTestCmd(byte &Cmd, byte &CmdLen, byte MaxCmdLen)

This command implements a generic method for receiving an array of bytes from the host. This enables the programmer to implement a simple interface, which executes commands sent from the host to the reader. A host command is any sequence of ASCII characters which is terminated by '\r'. The character '\n' can be sent optionally but is ignored by the reader. The maximum number of bytes, (without '\r'), which can be transferred, is 35 bytes.

Parameters:

`byte &Cmd`	A reference to an array of bytes, which contains the received ASCII data from the host (without the '\r').
`byte &CmdLen`	The number of bytes, which have been received from the host. Even a command of the length 0 can be received.
`byte MaxCmdLen`	This value specifies the maximum number of bytes the array of bytes *Cmd* can hold.
Return:	If a command has been received from the host, the return value is `TRUE`, otherwise it is `FALSE`.

6.2.5.3 Accessing LEDs

void LEDSet(byte LEDs, byte Status)

Set the state of the red and/or the green LED.

Parameters:

`byte LEDs`	Binary or of the LEDs to be switched. The green LED is represented by the constant `GREEN`, the red LED is represented by the constant `RED`.
`byte Status`	The new status for the LEDs specified by *LEDs*. It may be either one of the following constants: `OFF`: Turn off `ON`: Turn on `BLINK`: Blink with a period time of 1000ms `TOGGLE`: Toggle on/off state. This has no influence on a blinking LED `BLINKFAST` Blink with a period time of 500ms
Return:	None.

Examples:

```
LEDSet(GREEN | RED,ON);    // Turn on both green and red LED
LEDSet(GREEN,BLINK);      // Let the green LED blink
```

byte LEDGet(byte LED)

Get the current status of a LED. Only the status of one LED can be retrieved at a time.

Parameter:

byte *LED*	Specifies either the value for the green (constant GREEN) or the red (constant RED) LED.
Return:	The current status of the LED specified by *LED.* OFF: The LED is off ON: The LED is on BLINK: The LED is blinking

6.2.5.4 Accessing the Beeper

void SetVolume(byte Volume)

Set the volume of the beeper.

Parameter:

byte *Volume*	A value between 0 (beeper turned off) and 4 (maximum volume).
Return:	None.

void Beep(byte Type)

Sound some type of beep.

Parameter:

byte *Type*	Seven types of beeps are defined by constants:
	BEEPLOW: A beep at lower frequency with a duration of 50ms
	BEEPHIGH: A beep at higher frequency with a duration of 50ms
	BEEPSUCCESS: A low-high sequence, which is intended to signal a successful operation.
	BEEPFAILED: A high-low sequence, which is intended to signal an operation which has not been successful.
	BEEPNONE: Perform a silent beep. This can be useful for applications, where it is possible to disable the beep.
	BEEPLOWLONG: A beep at lower frequency with a duration of 500ms
	BEEPHIGHLONG: A beep at higher frequency with a duration of 500ms
Return:	None.

6.2.5.5 Accessing the General Purpose Outputs

General purpose outputs are available at TWN3 Mifare NFC and TWN3 Legic NFC. These outputs are available at a separate connector on the PCB. Currently, there are two outputs defined: `OUTPUT0` and `OUTPUT1`.

void OutputSet(byte Outputs,byte Status)

Set the state of the general purpose output.

Parameters:

`byte Outputs`	Binary or of the outputs to be switched.
`byte Status`	The new status of the specified outputs. It may be either one of the following constants: `OFF`: Turn off (logic low) `ON`: Turn on (logic high)
Return:	None.

Examples:

```
OutputSet(OUTPUT0 | OUTPUT1,ON); // Turn on both output 0 and 1
OutputSet(OUTPUT1,OFF);          // Let the green LED blink
```

byte OutputGet(byte Output)

Get the current status of an output. Only the status of one output can be retrieved at a time.

Parameter:

`byte Output`	Specifies either the value for output 0 (`OUTPUT0`) or output 1 (`OUTPUT1`).
Return:	The current status of the specified output. `OFF`: The output is off (logic low) `ON`: The output is on (logic high)

6.2.5.6 Bit Operations

byte CompBits(byte &Data1, byte &Data2,byte BitCount)

Compare two bit sets.

Parameters:

`byte &Data1`	Reference to an array of bytes which represent a bit field
`byte &Data2`	Reference to an array of bytes which represent a bit field
`byte BitCount`	Number of bits (beginning from bit index 0) to be compared.
Return:	`TRUE`: The two bit fields are identical. `FALSE`: The two bit fields are not identical

void CopyBits(byte &DestBits, byte StartDestBit, byte &SourceBits, byte StartSourceBit, byte BitCount)

Copy bits from a source to a destination. Source and destination may be identical and the source section may overlap the destination. Depending on that, the correct method for copying will be chosen.

Parameters:

`byte &DestBits`	Reference to an array of bytes which represent a bit field which is the destination of the copy operation.
`byte StartDestBit`	First bit within the destination bit field where the bits are copied to.
`byte &`*`SourceBits`*	Reference to an array of bytes which represents a bit field which is the source of the copy operation
`byte StartSourceBits`	First bit within the source bit field where the bits are copied from.
`byte` *`BitCount`*	Number of bits to be copied.
Return:	None.

void FillBits(byte &Dest, byte StartBit, byte Value, byte BitCount)

Fill bits within a given bit field with either 0 or 1.

Parameters:

`byte &Dest`	Reference to an array of bytes which represent a bit field which is the destination for the operation.
`byte StartBit`	First bit within the bit field where the bits are filled.
`byte Value`	The bit value which is either 0 or 1.
`byte` *`BitCount`*	Number of bits to be filled.
Return:	None.

void SwapBits(byte &Data, byte StartBit, byte BitCount)

Swap the order of bits within a bit field.

Parameters:

`byte &Data`	Reference to an array of bytes which represent a bit field which is the destination for the operation.
`byte StartBit`	First bit within the bit field where bits are swapped.
`byte` *`BitCount`*	Number of bits to be swapped.
Return:	None.

6.2.5.7 Byte Operations

byte CompBytes(byte &Data1,byte &Data2,byte ByteCount)

Compare two byte arrays.

Parameters:

byte &*Data1*	Reference to an array of bytes.
byte &*Data2*	Reference to an array of bytes.
byte Byte*Count*	Number of bytes (beginning from index 0) to be compared.
Return:	TRUE: The two arrays are identical. FALSE: The two arrays are not identical

void CopyBytes(byte &DestBytes, byte &SourceBytes, byte ByteCount)

Copy bytes from a source to a destination. Source and destination may be identical and the source section may overlap the destination. Depending on that, the correct method for copying will be chosen.

Parameters:

byte &DestBytes	Reference to an array of bytes which is the destination of the copy operation.
byte &*SourceBytes*	Reference to an array of bytes which is the source of the copy operation
byte *ByteCount*	Number of bytes to be copied.
Return:	None.

void FillBytes(byte &Dest, byte Value, byte ByteCount)

Fill bytes within a given array with a value.

Parameters:

byte &Dest	Reference to an array of bytes which is the destination for the operation.
byte Value	The byte value with which the array will be filled.
byte *ByteCount*	Number of bytes to be filled.
Return:	None.

void SwapBytes(byte &Data, byte ByteCount)

Swap the order of bytes within an array.

Parameters:

byte &Data	Reference to an array of bytes which is the destination for the operation.
byte Byte*Count*	Number of bytes to be swapped.
Return:	None.

```
void ConvertDigitsToBinary(byte &Dest,byte ByteCnt,byte &Source,
                           byte DigitCnt,byte BitsPerDigit,
                           byte Radix);
```

Convert a packed array of digits stored in an array of bytes into a binary number.

Parameters:

`byte &`*Dest*	A reference to an array of bytes, which receives the result of the conversion
`byte ByteCnt`	The size in bytes of *Dest*.
`byte &Source`	A reference to an array of bytes, where the packed array of digits is stored.
`byte DigitCnt`	The number of digits, which are stored in *Source*.
`byte BitsPerDigit`	The number of bits, which form one digits.
`byte Radix`	The base in which the number is stored.
Return:	None.

Example 1:

```
byte In,Out;
In = 0x10;
ConvertDigitsToBinary(Out,1,In,1,4,10);

// Result:
// Out = 0x0A;
```

Example 2:

```
byte In[2],Out[3];
In[0] = 0x12;
In[1] = 0x34;
ConvertDigitsToBinary(Out,3,In,4,4,10);

// Result:
// Out = { 0x00,0x04,0xD2 };
```

byte ConvertBinaryToASCII(byte &Dest,byte &Source,byte FirstBit, byte BitCnt,byte Radix,byte MinDigits, byte MaxDigits)

Convert a number, which is given as a bit field into ASCII format, and store it in an array of bytes. The conversion is made in the following sequence:

1. Convert the binary data to a number of digits, which is determined by the parameter *MaxDigits*. If *MaxDigits* is 0, then the number of digits is determined by the binary data itself.
2. If the result of the conversion is less than the number of digits specified by *MinDigits*, precede the converted number with zeros according to *MinDigits*.

Parameters:

byte &*Dest*	A reference to an array of bytes, which receives the result of the conversion
byte &Source	A reference to an array of bytes, which contains the bit field
byte *FirstBit*	Index of the first bit to be converted
byte *BitCnt*	The number of bits, which are valid within the array of bytes. A maximum of 128 bits can be converted.
byte *Radix*	Base for conversion, use: 2 for binary conversion 8 for octal conversion 10 for decimal conversion 16 for hexadecimal conversion Valid values are from 2 to 36.
byte *MinDigits*	Specifies the minimum number of digits, the output should contain. If *MinDigits* is 0, then at least 1 digit is sent. If *MinDigits* is greater than the actual width of the number to be converted, then the number is preceded by zeros.
byte *MaxDigits*	Specifies the maximum number of digits, the output should contain. This allows inhibit of leading digits of an output. If *MaxWidth* is 0, then the number of digits is determined by the given binary data itself.
Return:	The actual number of ASCII bytes, which have been stored in the byte array *Dest*.

Example:

```
byte ID[2],Out[6];
ID[0] = 0x12;
ID[1] = 0x34;
ConvertBinaryToASCII(Out,ID,0,16,16,0,4);  // Result: "1234"
ConvertBinaryToASCII(Out,ID,0,16,16,0,3);  // Result: "234"
ConvertBinaryToASCII(Out,ID,0,16,16,8,3);  // Result: "00000234"
```

byte ScanHex(byte &Data, byte ByteCnt)

Convert an array of bytes containing ASCII characters which represent hexadecimal numbers into their binary representation. The conversion is done in place. This means that after successful conversion, number of valid is half of the given count of ASCII characters (two hex digits represent one binary byte).

Parameters:

byte &Data	Reference to an array of bytes which is the destination for the operation.
byte Byte*Count*	Number of (ASCII-) bytes to be converted.
Return:	Number of successful converted bytes.

6.2.5.8 Timer Operations

void StartTimer(byte ID, byte Time)

Start a timer. After the specified time, the timer goes into the timed-out state, which can be tested by the function *TestTimer*. A timer is running in real time in the background. This means, that even if other tasks are performed by the script, the time till time-out is still kept correctly. The timed-out state is reached only one time.

Parameters:

`byte ID`	The ID of a timer which maybe one of the four available timer 0 to 3.
`byte Time`	The timeout values specified in multiples of 100 milliseconds.
Return:	None.

void StopTimer(byte ID)

Stop a timer. This will prevent a started timer going into timed-out state. It is possible to stop a timer, which never has been started or stop an already stopped timer.

Parameter:

`byte ID`	The ID of the timer to be stopped in the range of 0 to 3.
Return:	None.

byte TestTimer(byte ID)

Test, if a timer has reached the timed-out state. The timed-out state can only be detected once. After that, the timer is stopped.

Parameter:

`byte ID`	The ID of the timer to be tested.
Return:	`TRUE`: Timed-out state has been reached. `FALSE`: Timer is still running or stopped.

6.2.5.9 Crypto Functions

These functions implement an API for crypto purposes. Please see the sample source file `xteatest_01.twn.c` for some reference vectors.

void XTEAInit(byte NRounds,byte &Secret)

Initialize the crypto routines by specifying the number of rounds and the key for en- and decryption.

Parameter:

`byte NRounds`	Number of rounds, the crypto algorithm should perform. A good compromise between speed and
`byte &Secret`	Reference to an array of 16 bytes (=128 bits) which stores the key .
Return:	None.

void XTEAEncrypt(byte &Data)

Encrypt an array of 16 bytes.

Parameter:

byte &Data	Reference to an array of 8 bytes to be encrypted.
Return:	None.

void XTEADecrypt(byte &Data)

Decrypt an array of 16 bytes.

Parameter:

byte &Data	Reference to an array of 8 bytes to be decrypted.
Return:	None.

void GetRandomBytes(byte &Data,byte ByteCount)

Calculate a number of random values in the range from 0 to 255.

Parameter:

byte &Data	Reference to an array, which receives the random bytes.
byte ByteCount	Specifies the number of values/bytes to be calculated.
Return:	None.

6.2.5.10 Retrieving System Information

byte GetConnection()

Retrieve the physical type of connection (RS232 or USB).

Parameter:	None.
Return:	Either one of the defined constants: RS232: The TWN3 reader is connected via a RS232 cable to the host. USB: The TWN3 reader is connected via a USB cable to the host

byte GetUSBMode()

Retrieve the information if the TWN3 reader is emulating a keyboard or if it is emulating a virtual COM port.

Parameter: None.

Return: Either one of the defined constants:

USBVCOM:	The TWN3 reader is emulating a virtual COM port.
USBHID:	The TWN3 reader is emulating a keyboard.

byte GetDeviceType()

Retrieve the information, which family of transponders this device supports.

Parameter: None.

Return: Either one of the defined constants:

DEVTYPE_MULTI125:	Multi125
DEVTYPE_MIFARE:	Mifare
DEVTYPE_MIFARENFC:	Mifare NFC
DEVTYPE_HIDPROX:	HID Prox
DEVTYPE_LEGICPRIME:	Legic Prime (obsolete)
DEVTYPE_HIDICLASS:	HID iClass
DEVTYPE_LEGICADVANT:	Legic
DEVTYPE_LEGICNFC:	Legic NFC
DEVTYPE_INDITAG:	Inditag
DEVTYPE_MULTIISO:	MultiISO

6.2.5.11 Miscellaneous

void Reset()

Restart the execution of the script.

Parameter: None.

Return: None.

7. Firmware History

Version	Changes
V4.02	• Initial release
V4.07	• Send ALT codes • Support for TWN3 IndiTag • Support for TWN3 MultiISO • New functions regarding Mifare (identical to MultiISO): *ModuleSendChar*, *ModuleSendHexByte* and *ModuleReceiveLine* • New functions regarding HID iClass: *IClassGeneric* and *IClassTagSearchApp* • Increased maximum key repeat rate
V4.08	• Support for ISO14443B (Version MultiISO)
V4.09	• Support for testing the size of flash (16kByte or 32kByte of a TWN3 device
V4.20	• New crypto functions *XTEAInit*, *XTEAEncrypt* and *XTEADecrypt* • Support configurable communication parameters for serial host connection • Command set for accessing LEDs and beeper in transparent mode • Specify startup condition of LEDs and beeper in transparent mode
V4.24	• New functions *HostSendNumber* and *GetRandomBytes*
V4.35	• New functions *ConvertDigitsToBinary*, *ConvertBinaryToASCII, OutputSet, OutputGet* • New parameters for function beep: `BEEPNONE`, `BEEPLOWLONG`, `BEEPHIGHLONG` • New LED state `BLINKFAST` • Support for TWN3 Mifare NFC and TWN3 Legic NFC

8. Technical Data

	HID Prox	Multi125	Inditag	Mifare	Mifare NFC	MultiISO	HID iClass	Legic	Legic NFC
Housing	Material ABS, colour black or white								
Frequency	125 kHz			13.56 MHz					
Dimensions	88mm x 56mm x 18mm								
Power Supply	5V ± 10% via communication cable								
Supply Current	50mA typ. 140mA peak	130mA typ. 220mA peak	160mA typ. 220mA peak	55mA typ. 120mA peak	65mA typ. 120mA peak	110mA typ. 180mA peak	220mA typ. 250mA peak	75mA typ. 280mA peak	140mA typ. 200mA peak
Temperature Range	0°C up to +50°C								
Antenna	Aircoil			PCB Aircoil					
Read-/Write Distance	Up to 10cm (depending on transponder)								
Supported Transponders	HID PROX	EM410x HITAG 1 HITAG 2 HITAG S EM4150 T5567, Q5	Indala	Mifare Ultralight, Mifare Mini Mifare 1k, 4k Mifare DESfire	Mifare Ultralight, Mifare Mini Mifare 1k, 4k Mifare DESfire	Mifare Family ISO14443A ISO14443B ISO15693	HID iCLASS	Legic Prime, Legic Advant	Legic Prime, Legic Advant

9. Regulatory Information

9.1 CE Declaration of Conformity

This product conforms to the following standards:

- ETSI EN 300330-1 V1.3.1 / ETSI EN 300330-2: V1.3.1
- ETSI EN 301489-1: V1.6.1 / ETSI EN 301489-3: V1.4.1
- DIN EN 55022: 2007-04 class B / DIN EN 55024: 2003-10
- DIN EN 50371:2001-11

9.2 FCC Statement

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Section 15.21 Information to user

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

Section 15.105 (b)

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

9.3 IC (Industry Canada) Statement

“This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.“

“Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.”

10. Trademarks

All referenced brands, product names, service names and trademarks mentioned in this document are the property of their respective owners.