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Manual

roloFlash 2



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I Preface

- roloFlash allows for mobile and PC-independent flashing of your products which can be based on various microcontrollers. Under certain conditions, multiple microcontrollers can be flashed in your product. A list of currently supported microcontrollers is available in chapter "Specifications".
- Since roloFlash is free of operator controls, and thusly avoids operating errors, your products can be flashed by untrained personnel or customers.
- Neither PC nor microcontroller-specific tool-chains are necessary.
- Use roloFlash in field, at your customers' sites and in large- and small-batch production.
- Gain more freedom by employing a uniform process for all supported microcontroller families*.

Term "Atmel"

Although microcontroller manufacturer Atmel has been acquired by Microchip, the name "Atmel" continues to be used in our documentation and software, to avoid confusion with other controllers by Microchip (e.g. the PIC-family).

Term "Target board"

The term "target board" is used to mean your products to be flashed. The products contain the microcontroller(s) to be flashed. From now on, this term is used regularly throughout this document.

Term "Target"

The term "target" is used to mean the microcontrollers to be flashed (multiple microcontrollers can be flashed in a JTAG chain). From now on, this term is used regularly throughout this document.

Term "Microcontroller to be flashed"

In addition to "flashing" you can read out your microcontrollers' flash memory (and e. g. save it as HEX file), verify it (e. g. against a HEX file), erase or modify it. For the sake of intelligibility, only the process of "flashing" gets mentioned from now on, without elaborating on the other possibilities every time.

Characters "<" and ">"

In descriptions of the functions and procedures, parameters are often enclosed by "<" and ">". This is to indicate to replace the parameter with a meaningful value (without the angle brackets):

Example:

```
delay <duration>
```

You could write, e. g.

```
delay 1000
```

to have a delay of 1 second.

II Scope of Delivery

Carefully check the package contents:

- roloFlash 2
- microSD card
 - prepared for use in your roloFlash, containing documentation, examples, firmware and roloBasic compiler
 - for insertion into roloFlash's card slot

Note: The microSD card is either inserted into roloFlash or into the adapter or is enclosed separately.

III Description

1 Universal Connector (Programming Connector)

The female 10-pin universal connector gets plugged either onto:

- a matching male connector on the target board to be programmed, or
- a matching target board adapter (sold separately), which in turn gets plugged onto the target board to be programmed.

On the front of roloFlash, you will find a pin-1-marking directly above the programming connector.

The connector's contact spacing is 2.54 mm (0.1 inches).

1.1 Pin Assignments (Overview)

Depending on the configured bus, roloFlash's signal semantics can differ.

The default pinout is for the JTAG configuration. If individual pins are to be used as GPIOs, then the JTAG pin naming scheme is the base for naming the GPIOs.

When using JTAG or SWD, the pinout is identical to that of a female ARM CoreSight 10 connector, just with a 2.54 mm (0.1 inches) pitch instead of the original 1.27 mm (0.05 inch) pitch.

GPIO	UART 1	UART 0	TPI	ISP	PDI	UPDI aWire	JTAG	SWD		SWD	JTAG	UPDI aWire	PDI	ISP	TPI	UART 0	UART 1	GPIO	
Signal									Pins		Signal								
Vtgt									1 ●	2	SWDIO	TMS	DATA	DATA	MISO	DATA	TX		TMS
GND									3 ●	4	SWDCLK	TCK		CLK	SCK	CLK			TCK
GND									5 ●	6		TDO					RX		TDO
RTCK	RX								7 ●	8		TDI			MOSI				TDI
GND De- tect	TX								9 ●	10				RST	RST				RST

Table 1: Overview of target board pinouts in top view

Note:

There are numerous adapters available to adapt roloFlash's pinout to various common programming connector pinouts; these adapters are listed in the subchapters of the appropriate busses.

In addition, a universal adapter is available:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) and 2.54 (thru-hole)

1.2 Pinout JTAG Interface

When using the JTAG interface, the following pinout is used:

Signal	Pin	Pin	Signal
V_{tgt}	1 ●	● 2	TMS
GND	3 ●	● 4	TCK
GND	5 ●	● 6	TDO
	7 ●	● 8	TDI
	9 ●	● 10	

Table 2: Top view of male JTAG connector of a target board

Note:

The pinout is identical (1:1) to the female 10-pin JTAG high-density-connector (ARM Cortex debug connector), except it has a contact spacing of 2.54 mm instead of the HD-connector's 1.27 mm.

Note:

The remaining signals are not vital for JTAG and thusly available for use by other busses. For example, you can operate the reset pin (pin 10) as GPIO and use it to reset the target.

Another possibility for resetting the target is provided by the AIRCR register in ARM-based microcontrollers (e.g. STM32 MCUs):

```
aircr_array = dim(long, 1)
aircr_array[0] = $05fa0004
print "Resetting target ...\\r\\n"
target_write tHandle, aircr_array, RAM, WRITEONLY, $e000ed0c
```

Note:

The following adapters are available to adapt the pinout to common programming connector pinouts:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Target-Adapter ARM JTAG 20p	20	2	2.54
roloFlash-2-Target-Adapter ARM Cortex Debug 10p HD	10	2	1.27
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) + 2.54 (THT)

1.3 Pinout SWD Interface

When using the SWD interface, the following pinout is used:

Signal	Pin	Pin	Signal
V _{tgt}	1 ●	● 2	SWDIO
GND	3 ●	● 4	SWDCLK
GND	5 ●	● 6	
	7 ●	● 8	
	9 ●	● 10	

Table 3: Top view of male SWD connector of a target board

Note:

The pinout is identical (1:1) to the female 10-pin JTAG high-density-connector (ARM Cortex debug connector), except it has a contact spacing of 2.54 mm instead of the HD-connector's 1.27 mm.

Note:

The remaining signals are not vital for SWD and thusly available for use by other busses. For example, you can operate the reset pin (pin 10) as GPIO and use it to reset the target.

Another possibility for resetting the target is provided by the AIRCR register in ARM-based microcontrollers (e.g. STM32 MCUs):

```
aircr_array = dim(long, 1)
aircr_array[0] = $05fa0004
print "Resetting target ...\\r\\n"
target_write tHandle, aircr_array, RAM, WRITEONLY, $e000ed0c
```

Note:

The following adapters are available to adapt the pinout to common programming connector pinouts:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Target-Adapter ARM JTAG 20p	20	2	2.54
roloFlash-2-Target-Adapter ARM Cortex Debug 10p HD	10	2	1.27
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) + 2.54 (THT)

1.4 Pinout Atmel ISP Interface

When using the ISP interface, the following pinout is used:

Signal	Pin	Pin	Signal
V _{tgt}	1 ●	● 2	MISO
GND	3 ●	● 4	SCK
GND	5 ●	● 6	
	7 ●	● 8	MOSI
	9 ●	● 10	RST

Table 4: Top view of male ISP connector of a target board

Warning!

This pinout is **not compatible** to the 10-pin Atmel ISP pinout, even if it fits mechanically!

Note:

The remaining signals are unused by ISP and thusly available for use by other busses. For example, you can operate them as GPIO.

Note:

The following adapters are available to adapt the pinout to common programming connector pinouts:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Target-Adapter Atmel ISP/TPI 6p	6	2	2.54
roloFlash-2-Target-Adapter Atmel ISP/TPI 10p	10	2	2.54
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) and 2.54 (thru-hole)

1.5 Pinout Atmel TPI Interface

When using the TPI interface, the following pinout is used:

Signal	Pin	Pin	Signal
V_{tgt}	1 ●	● 2	DATA
GND	3 ●	● 4	CLK
GND	5 ●	● 6	
	7 ●	● 8	
	9 ●	● 10	RST

Table 5: Top view of male TPI connector of a target board

Warning!

This pinout is **not compatible** to the 10-pin Atmel ISP pinout, even if it fits mechanically!

Note:

The remaining signals are unused by TPI and thusly available for use by other busses. For example, you can operate them as GPIO.

Note:

The following adapters are available to adapt the pinout to common programming connector pinouts:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Target-Adapter Atmel ISP/TPI 6p	6	2	2.54
roloFlash-2-Target-Adapter Atmel ISP/TPI 10p	10	2	2.54
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) and 2.54 (thru-hole)

1.6 Pinout Atmel PDI Interface

When using the PDI interface, the following pinout is used:

Signal	Pin	Pin	Signal
V_{tgt}	1 ●	● 2	DATA
GND	3 ●	● 4	CLK
GND	5 ●	● 6	
	7 ●	● 8	
	9 ●	● 10	

Table 6: Top view of male PDI connector of a target board

Warning!

This pinout is **not compatible** to the 10-pin Atmel ISP pinout, even if it fits mechanically!

Note:

The remaining signals are unused by PDI and thusly available for use by other busses. For example, you can operate them as GPIO.

Note:

The following adapters are available to adapt the pinout to common programming connector pinouts:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Target-Adapter Atmel PDI 6p (Note: This adapter is suitable for ATmel UPDI, too)	6	2	2.54
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) + 2.54 (THT)

1.7 Pinout Atmel UPDI / aWire Interface

When using the UPDI interface or aWire interface, the following pinout is used:

Signal	Pin	Pin	Signal
V_{tgt}	1 ●	● 2	DATA
GND	3 ●	● 4	
GND	5 ●	● 6	
	7 ●	● 8	
	9 ●	● 10	

Table 7: Top view of male UPDI / aWire connector of a target board

Warning!

This pinout is **not compatible** to the 10-pin Atmel ISP pinout, even if it fits mechanically!

Note:

The remaining signals are unused by UPDI and aWire and thusly available for use by other busses. For example, you can operate them as GPIO.

Note:

The following adapters are available to adapt the pinout to common programming connector pinouts:

Description	Pins	Rows	Spacing [mm]
roloFlash-2-Target-Adapter Atmel PDI 6p (Note: This adapter is suitable for Atmel UPDI and Atmel aWire, too)	6	2	2.54
roloFlash-2-Universal-Adapter	1-20	1-2	1.27 (SMD) and 2.54 (thru-hole)

1.8 Pinout UART 0 Interface

When using the UART 0 interface, the following pinout is used:

Signal	Pin	Pin	Signal
V_{tgt}	1 ●	● 2	TX
GND	3 ●	● 4	
GND	5 ●	● 6	RX
	7 ●	● 8	
	9 ●	● 10	

Table 8: Top view of matching male connector of a target board

Note:

If there are no conflicts with other pins, other busses can be opened at the same time. With this UART, this is not the case for JTAG, SWD, Atmel ISP, Atmel PDI, Atmel TPI, and Atmel UPDI. Instead, you can use UART 1 interface for this purpose.

Note:

The remaining signals are unused by UART 0 and thusly available for use by other busses. For example, you can operate them as GPIO.

1.9 Pinout UART 1 Interface

When using the UART 1 interface, the following pinout is used:

Signal	Pin	Pin	Signal
V _{tgt}	1 ●	● 2	
GND	3 ●	● 4	
GND	5 ●	● 6	
RX	7 ●	● 8	
TX	9 ●	● 10	

Table 9: Top view of matching male connector of a target board

Note:

If there are no conflicts with other pins, other busses can be opened at the same time. With this UART, this is the case for JTAG, SWD, Atmel ISP, Atmel PDI, Atmel TPI, and Atmel UPDI.

Note:

The remaining signals are unused by UART 1 and thusly available for use by other busses. For example, you can operate them as GPIO.

1.10 Pinout GPIO Interface

For every pin that can be used as GPIO, there is a separate interface. The following pins are available:

Signal	Pin	Pin	Signal
	1 ●	● 2	TMS
	3 ●	● 4	TCK
	5 ●	● 6	TDO
RTCK	7 ●	● 8	TDI
GND Detect	9 ●	●10	Reset

Table 10: Top view of matching male connector of a target board

Note:

Pins TDO and RTCK cannot be used as output.

Note:

If there are no conflicts with other pins, other busses can be opened at the same time.

Example:

roloFlash's reset line is not part of the JTAG and SWD bus, since it is not required for the actual JTAG or SWD protocol. You can open the reset pin as a GPIO pin in parallel to the opened JTAG or SWD bus, and control the reset of the target with it.

2 Pull-Up- / Pull-Down Resistors

For a well-defined voltage level on all pins, roloFlash employs internal pull-up and pull-down resistors:

Resistor	Signal	Pin	Pin	Signal	Resistor
-	V_{tgt}	1 ●	● 2	TMS	Pull-up 1 M Ω
-	GND	3 ●	● 4	TCK	Pull-down 1 M Ω
-	GND	5 ●	● 6	TDO	Pull-up 1 M Ω
Pull-up 1 M Ω	RTCK	7 ●	● 8	TDI	Pull-up 1 M Ω
Pull-up 1 M Ω	GND Detect	9 ●	● 10	Reset	Pull-up 1 M Ω

Table 11: Top view of matching male connector of a target board

3 Voltage Range

roloFlash gets powered by the target board via pin 1 (V_{tgt}), thereby all data lines are adapted by roloFlash to this very voltage.

Voltage range: 2.0 - 5.5 volts

4 Electrical Protection Measures

roloFlash offers the following protection measures:

- Voltage reversal of the supply voltage: The supply voltage line gets reversibly disconnected by a transistor.
- Overvoltage of the supply voltage: With voltages over 5.7 V, a protection circuit reversibly disconnects the supply voltage line.
- All data lines are reversibly protected by polyswitches against over-current.
- In order to protect the target board, the second GND contact on pin 5 is connected to GND on Pin 3 via a polyswitch which reversibly protects against a shortcircuit between pin 3 and pin 5.
- All lines are equipped with ESD protection components, which fulfill IEC 61000-4-2 level 4 (15 kV (air discharge) , 8 kV (contact discharge)).

These measures offer an extensive protection against operating errors like voltage reversal etc. Nonetheless it cannot be excluded that operating errors lead to damages to target board and/or roloFlash.

5 LEDs

roloFlash contains five programmable bi-color (red and green) LEDs on the front. Using the LEDs, you can e. g.

- show a running light visualizing the flash process
- output errors in red

6 microSD Card Slot

The card slot is designed for a microSD or microSDHC card comprising the compiled script to be run (RUN_V06.BIN) as well as the images to be flashed.

7 Typical Usage

The typical course of action consists of two parts:

- Preparation of the microSD card on a PC (e. g. in development department)
- Flashing of the target boards (e. g. by untrained personnel in production department, customers or technicians in the field)

7.1 Preparation of the microSD card on a PC

E. g. in the development department

The authoritative source for program flow is the file "RUN_V07.BIN", which gets processed by roloFlash to execute the program sequence encoded in it. The supplement "V07" correlates to the major-part of roloFlash's software version.

- If you want to format a microSD card, do so using Windows 7 or higher (Windows XP is not suitable).
- Model the desired process in roloBasic. For this, you can use or adapt one of the many supplied sample scripts. In chapter "Specifications" you will find a list of exact names of microcontrollers known to roloFlash and you can use in your roloBasic script. The file you create should have the file extension ".BAS".
- Your roloBasic file can start with a magic cookie line, **it is recommended to use:**

#roloFlash 2, v07+

If a magic cookie line exists, it has to start with "**#roloFlash 2**". An optional version number can be specified as shown above, the suffix "+" will make roloFlashes with an even higher version number accept the file. Optional you can restrict the usage of the script to versions beginning with v07 with "**#roloFlash 2,v07.***". An erroneous magic cookie line will lead to the compiler refusing compilation. The version number corresponds to the major number of the roloFlash's firmware version.

- Models roloFlash 2 and roloFlash 2 AVR: The Basic files are executable on all models; there is no model-specific compiler. The magic cookie lines are identical for all models.
- Your script can point to:
 - standard ".HEX" files (Intel HEX format: "I8HEX", "I16HEX", and "I32HEX")
 - Motorola S-Record / SREC / S19 / S28 / S37 files
 - ".ELF" files
 - ".RAW" files

which are to be flashed to the target.

- On the PC, run the compiler "rbc_v07.exe". This creates a compiled file (an "image") of the same name with the file extension ".BIN".
- Rename the file to "RUN_V07.BIN" or instead of running "rbc_v07.exe" run the batch file "compil_e_v07.bat", which creates "RUN_V07.BIN" from "RUN_V07.BAS". After that, copy the file "RUN_V07.BIN" and the files needed by the script (e. g. a ".HEX" file and possibly a required loader file) to the microSD card, whereby RUN_V07.BIN must reside in the root directory.

You can store the script files (".BAS"), the compiled files (".BIN") and the compiler at your own discretion on the PC and/or on the microSD card. roloFlash only evaluates the file "RUN_V07.BIN" (as well as the files being referenced by the code).

Note: With firmware versions older than V05.AA, the roloFlash 2 family always processes the file "RUN.BIN". As of version V05.AA, the major version gets included in the file name, which therefore reads "RUN_V05.BAS" or "RUN_V06.BAS", respectively.

This makes it possible to place multiple "RUN_Vxx.BIN" on the microSD card, and then use it with different roloFlashes which have different firmware versions (at least V05.AA). Each roloFlash picks the "RUN_Vxx.BIN" file matching his firmware.

7.2 Flashing of the Target Boards

E. g. untrained personnel in the production department

Here, the course of action is very simple:

- Supply the target board with energy.
- Plug roloFlash onto the matching connector of the target board (or connect it via an adapter).
- roloFlash gets powered by the target board and automatically starts processing of the file "RUN_V07.BIN", by which usually the actual flashing is carried out. Meanwhile, e. g., a green running light visualizes the flashing process.
- After successfully processing "RUN_V07.BIN", which is usually indicated by a green lit LED 5, remove roloFlash – done.

IV Updating roloFlash

1 Updating the Bootloader

Starting with firmware versions v07.xx, roloFlash needs a new bootloader version to run these app firmware versions.

If roloFlash is to be updated from a version before v07.AA to version v07.AA or later, you must update the bootloader beforehand. In all other cases, this chapter is irrelevant.

After updating to the new bootloader, you can still upgrade and downgrade your firmware versions as you please.

For updating the bootloader, a special bootloader update firmware is provided:

- RF2_06ZZ.HMP for roloFlash 2
- RF2A06ZZ.HMP for roloFlash 2 AVR

From the perspective of the old bootloader, this is just an ordinary firmware which can be installed as usual.

The update consists of two steps that both have to be executed, in the following order:

1. Installation of the bootloader update firmware
2. Update of the bootloader

1. Installation of the bootloader update firmware

- The root folder of the microSD card has to contain exactly one firmware file (RF2_V06ZZ.HMP or RF2AV06ZZ.HMP). If multiple firmware files are present, the update process will not be started.
- The update process starts when roloFlash **without** microSD card get plugged onto any target board and the microSD card gets inserted **afterwards**.
- The target board serves as power supply only.

- The progress of the update process is indicated using the LEDs, see chapter „[roloFlash Update](#)“.
- As long as no microSD card is inserted, LED 1 is red.
- During the update, LED 2 and LED 3 will flash green alternatively. **roloFlash should not be unplugged during the update.**
If, however, roloFlash did get unplugged during the update, the firmware might be defective. In this state, roloFlash should automatically insist on another update.
I.e. after a power cycle, roloFlash will wait for the microSD card to be inserted, and the firmware on it will be flashed anew.
In case an update got interrupted, please start the update again, even if you think that the interrupted update might have been successful nevertheless.
- When successful, LED 1 and LED 2 will light up green.
- roloFlash stays in this state until unplugged. Unplug roloFlash now.
- Afterwards, remove the file for the bootloader update firmware from the microSD card.

2. Update of the bootloader

- Insert a microSD card (which can be empty) into roloFlash and plug it onto a target.
- Now the actual Update of the bootloader starts. LED 2 lights up red.
- During the update, LED 3 and LED 4 will flash green alternatively.
roloFlash must not get unplugged now.
If, however, roloFlash did get unplugged during this process, the bootloader might be defective. This can only be fixed by sending roloFlash in to the manufacturer.
- When successful, LED 2 will light up red and LED 5 will light up green.
- roloFlash stays in this state until unplugged. Unplug roloFlash now.
- After the next time roloFlash gets plugged onto a target, it will run with the updated bootloader. You should now directly continue with updating the firmware (see next chapter).

2 Updating roloFlash Firmware

roloFlash has its own firmware which can get updated.

Version numbers

The version number is composed of `major` and `minor`:

- `major`:
Major gets updated when:
 - the roloBasic interface (API) changes.
- `minor`:
Minor gets updated for changes that don't affect the roloBasic interface, e. g.:
 - Bug fixes
 - Target database entries have been added
 - Speed optimizations

Consequently, as long as `major` has not been updated, no update of the roloBasic compiler is needed, and `RUN_V07.BIN` files already compiled are still valid.

Filenames for the firmware update

The filename for the firmware update adheres to the usual 8.3 naming convention of the FAT filesystem and is structured as follows:

`RF2_aabb.HMP` where:

- `aa` = major (as number, e. g. "01")
- `bb` = minor (as letter, e. g. "AA")

Starting the update

- If roloFlash is currently powered, unplug it from the power source.
- Copy the desired firmware file to the microSD card and insert it into roloFlash.
- For updating, exactly one firmware file must be present in the root directory of the microSD card. If multiple firmware files are present, the update process will not start.

- Connect roloFlash to a target board for power supply. The update process will start and will show an appropriate LED flashing pattern (see next chapter, "The update process").
- There is no check if the firmware on the microSD card is newer or older than roloFlash's currently used firmware. Thus, you can return to an older version, if you ever need to.
- After successful update, remove the firmware file from the microSD card to prevent another update.

Note: The prepared microSD card that comes with roloFlash contains the current firmware version in a subdirectory (usually named "firmware"). This file will only be considered for an update, if it gets copied (or moved) to the root directory of the microSD card.

The update process

- During the process, the target board merely serves as a power supply for roloFlash.
- The process gets visualized using roloFlash's LEDs, see chapter "[roloFlash Update](#)". In particular, LED 1 is lit red during and after the update.
- During the update, LED 1 is lit red, and LED 2 and LED 3 blink alternatively for multiple seconds. **roloFlash should not be removed during the update process.**

If, however, roloFlash has been removed during the process, the firmware stored inside roloFlash might be defective. In this state, roloFlash should automatically insist on a new update, i.e. upon the next connection to a power source (usually a target board), roloFlash keeps waiting, until a microSD card with a valid firmware file is inserted. This file is then used for the update, which starts immediately after detection of the firmware file.

If an update process got interrupted, do repeat the update process, even if you're under the impression that the interrupted process was successful in the end.

- Upon success, LED 1 stays lit red, and LED 2 is lit green.
- roloFlash remains in this state until removed from the target board. Please remove roloFlash now.
- Remove the firmware file from the microSD card.

- As of the next time you plug on roloFlash on a target board, it runs with the updated firmware.

If the update process has not been successful, please use a microSD card which:

- has been freshly formatted with FAT32 under Windows 7 or higher, and
- solely contains the file for the firmware update.

Note:

It is recommended that no firmware files are left on the microSD card, if it is to be used in the production department or handed over to a customer.

V List of Supplied roloBasic Scripts

1 Hello world

Location:

- scripts\hello-world\RUN_V07.BAS
- Additionally, this script as well as the compiled RUN_V07.BIN are in the microSD card's root directory on delivery.

Preparation:

- To use it, copy the script as RUN_V07.BAS to the microSD card's root directory.
- Start the compiler using „compile_v07.bat“ in order to create the required RUN_V07.BIN from RUN_V07.BAS.

Function:

- Removes a possibly existent previous LOG.TXT file.
- Writes some text to the LOG.TXT file, including „Hello world“.
- Shows a green running light from LED 1 to LED 4 for 3 seconds.
- Shows a red running light from LED 1 to LED 4 for 3 seconds.
- Shows a green running light from LED 4 to LED 1 for 3 seconds.
- Shows a red running light from LED 4 to LED 1 for 3 seconds.
- Finally, LED 5 lights up green.

2 Versions

Location:

- scripts\versions\RUN_V07.BAS

Preparation:

- To use it, copy the script as RUN_V07.BAS to the microSD card's root directory.
- Start the compiler using „compile_v07.bat“ in order to create the required RUN_V07.BIN from RUN_V07.BAS.

Function:

- Removes a possibly existent previous LOG.TXT file.
- Writes roloFlash's version numbers etc. to the LOG.TXT file:
 - Company Name
 - Device name
 - Software Version
 - Hardware Version
 - Bootloader Version
 - Image Version
- Finally, LED 5 lights up green.

3 Erase-and-Flash

Location:

- In directory scripts\STM32:
 - STM32_F1_F3\JTAG\erase-and-flash\RUN_V07.BAS
 - STM32_F1_F3\SWD\erase-and-flash\RUN_V07.BAS
 - STM32_F2_F4_F7\JTAG\erase-and-flash\RUN_V07.BAS

- STM32_F2_F4_F7\SWD\erase-and-flash\RUN_V07.BAS
- STM32_H7\JTAG\erase-and-flash\RUN_V07.BAS
- STM32_H7\SWD\erase-and-flash\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\ISP\erase-and-flash\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\TPI\erase-and-flash\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\PDI\erase-and-flash\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\UPDI\erase-and-flash\RUN_V07.BAS

Preparation:

- This script is available in a version for STM32, Atmel ISP, Atmel TPI, Atmel PDI and Atmel UPDI microcontrollers, respectively.
- To use it, copy the version of the script matching your microcontroller as RUN_V07.BAS to the microSD card's root directory.
- Subsequently adapt the name of your target and the filename of the HEX file for the flash memory in the script (for Atmel: Optionally, you can specify another HEX file for the EEPROM).
- Optionally, you can adapt the bus speed as well as roloFlash's CPU frequency.
- Start the compiler using „compile_v07.bat“ in order to create the required RUN_V07.BIN from RUN_V07.BAS.

Function:

- Starts a running light from LED 1 to LED 4 to visualize the flash process.
- Removes a possibly existent previous LOG.TXT file.
- Opens the appropriate bus for the target.
- From the internal target database, roloFlash reads information specific to the microcontroller you specified, including the ID in form of a signature or device ID (for Atmel ISP / TPI / PDI / UPDI), or in form of one or more IDCODEs (for an STM32 controller 2 IDCODEs for core and boundaryScan controller), as well as other parameters required for flashing.

- Reads the ID(s) of the connected target and compares it to the values from the database.
- Should the ID(s) mismatch (e. g. different microcontroller), the process aborts with output of an error message.
- Erases the target's flash memory (mass erase).
- If specified by you: Your HEX file gets written to the target's flash memory, while simultaneously getting verified.
- Atmel only: Your HEX file gets written to the target's EEPROM, while simultaneously getting verified.
- Meanwhile, a green running light is shown, and if successful, LED 5 lights up green at the end.
- Writes results to log file (LOG.TXT).

4 Read

Location:

- In directory scripts\STM32:
 - STM32_F1_F3\JTAG\read\RUN_V07.BAS
 - STM32_F1_F3\SWD\read\RUN_V07.BAS
 - STM32_F2_F4_F7\JTAG\read\RUN_V07.BAS
 - STM32_F2_F4_F7\SWD\read\RUN_V07.BAS
 - STM32_H7\JTAG\read\RUN_V07.BAS
 - STM32_H7\SWD\read\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\ISP\read\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\TPI\read\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\PDI\read\RUN_V07.BAS
- scripts\Microchip_Atme\AVR\UPDI\read\RUN_V07.BAS

Preparation:

- This script is available in a version for STM32, Atmel ISP, Atmel TPI, Atmel PDI and Atmel UPDI microcontrollers, respectively.

- To use it, copy the version of the script matching your microcontroller as RUN_**V07**.BAS to the microSD card's root directory.
- Subsequently adapt the name of your target and the filename of the HEX file for the flash memory in the script (for Atmel: Optionally, you can specify another HEX file for the EEPROM).
- Optionally, you can adapt the bus speed as well as roloFlash's CPU frequency.
- Start the compiler using „compile_**V07**.bat“ in order to create the required RUN_**V07**.BIN from RUN_**V07**.BAS

Function:

- Starts a running light from LED 4 to LED 1 to visualize the reading process.
- Removes a possibly existent previous LOG.TXT file.
- Opens the appropriate bus for the target.
- From the internal target database, roloFlash reads information specific to the microcontroller you specified, including the ID in form of a signature or device ID (for Atmel ISP / TPI / PDI / UPDI), or in form of one or more IDCODEs (for an STM32 controller 2 IDCODEs for core and boundaryScan controller), as well as other parameters required for flashing.
- Reads the ID(s) of the connected target and compares it to the values from the database.
- Should the ID(s) mismatch (e. g. different microcontroller), the process aborts with output of an error message.
- If specified by you: The target's flash memory gets completely read out and written to the HEX file specified.
- Atmel only: If specified by you: The target's EEPROM gets completely read out and written to the HEX file specified.
- Meanwhile, a green running light is shown, and if successful, LED 5 lights up green at the end.
- Writes results to log file (LOG.TXT).

VI roloFlash API (List of Procedures and Functions)

API (Application Programming Interface) means the interface roloBasic needs to access all roloFlash specific procedures and functions.

Procedures:

Procedures do not have a return value. Specified parameters must be given without parentheses.

Example:

```
delay 1000
```

Functions:

Functions have a return value. Specified parameters must be given in parentheses.

Example:

```
handle = fs_open(0, "TEST.TXT")
```

If the function does not have any parameters, the parentheses can be dispensed with.

Example:

```
value = getTargetBoardVoltage
```

or

```
value = getTargetBoardVoltage()
```

Letter Case:

roloBasic is case-insensitive, but for the sake of better readability, the following conventions are used:

- Compounds of multiple words in names of functions, procedures and variables: the first letter of a name (and of the first word after an underscore ("_")) is a lower-case character, all other words start with an upper-case character. Example:
`loaderUsed = target_getLoaderUsage(targetHandle)`
- Constants are completely upper-case. Example:
`target_writeFromFile targetHandle, 0, fileName, HEX, FLASH, WRITEVERIFY`

1 Internal Database

roloFlash has an integrated database containing information for many targets. This information serves the following purposes:

- To check in roloBasic if it is really the desired target that is connected (e. g. JTAG IDCODE, Atmel signature or device ID).
- To provide data required for flashing.

Using the name of the desired controller, you can obtain a handle from the database and utilize it to request further information. This handle does not have to be closed afterwards.

1.1 db_getHandle

Get database handle for specified target.

```
dbHandle = db_getHandle(<name>)
```

Prerequisites:

- none

Parameters:

name

Name of target. The name stored in the database might be abbreviated, e. g. if there are multiple targets differing only e. g. in their circuit

packaging type (DIL, PLCC, QFP, BGA, ...) while having otherwise identical parameters. Please look up the correct name for your controller in the list of supported microcontrollers in chapter "Specifications", and mind the letter case.

Return value:

- a database handle. Can be used to get information about target using `db_get`.

Exceptions:

`unknownTarget`
`apiTypeFault`

Target is unknown in target database
Invalid data type for "name"

1.2 `db_get`

Inquire information about specific properties of a target.

`Value = db_get(<dbHandle>, <property>)`

Prerequisites:

- valid database handle

Parameters:

dbHandle

Handle for accessing the database, see `db_getHandle`

property

Type of information to determine. Not all properties are available for all database handles. In case a property cannot be determined, an exception is generated. Possible values for "property" are:

DB_NAME: Name of target. (Can be shorter than the name used for getting the database handle)

DB_FAMILY: A value denoting membership of a certain family of mi-

crocontrollers. This value is required to obtain a target handle (see `target_open`).

DB_COREIDCODE: In case of a JTAG device: IDCODE of target

DB_BOUNDARYSCANIDCODE : In case of a JTAG device, the target can contain an additional Boundary Scan JTAG device, the IDCODE of which is stored in this property.

DB_FLASHSIZE: Size of flash memory in bytes.

DB_FLASHPAGESIZE: Page size in bytes for writing of memory with certain page sizes (e. g. Atmel AVR and Atmel Xmega).

DB_EEPROMSIZE: Size of EEPROM in bytes.

DB_EEPROMPAGESIZE: Page size in bytes for writing of EEPROM with certain page sizes (e. g. Atmel Xmega).

DB_DEVICEID: Device ID or Signature (e. g. Atmel) (array with 3 bytes)

Return value:

- Value of inquired property

Exceptions:

`propertyNotFound`

The desired value is unknown or does not exist (e. g. `DB_COREIDCODE` for non-JTAG targets)

`apiTypeFault`

Invalid data type for `dbHandle` or property

2 Busses

Principally, roloFlash considers every interface, that can be used to flash a target, to be a bus.

This holds true even if the interface inherently allows only one microcontroller to be connected (e. g. the ISP interface for Atmel AVR is construed as bus).

- Generally, a bus must be opened first.
- While trying to open a bus, it is checked if the bus is available. If it is already opened, an exception is generated (`resourceUnavailable`). The same exception is generated if another bus is already open its

signals or internal resources would overlap with the bus to be opened.

- A microcontroller (target) attached to a bus can be addressed only after obtaining a target handle from this bus.
- The connection to a target handle can be closed again.
- A bus can be closed, too. In this case, the signal lines affected become high-impedance again.

2.1 bus_open

```
busHandle = bus_open(<busType>, <indexOfBus>,  
<speed>...)
```

Opens the appropriate bus of type <busType> and provides a bus handle. Depending on the bus, one or more signal lines could be initialized in the process.

Depending on the bus used, there can be further parameters. Usually, a bus speed is specified; if not, you can look up the appropriate function in the respective subchapter of the bus used.

Prerequisites:

- none

Parameters:

busType

Determines the type of bus to be opened. Available busses are:

- JTAG
- SWD
- ISP
- PDI
- UPDI
- TPI
- UART

indexOfBus

Specifies the number of the bus to be opened. The first bus has index 0.

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (`sys_setCpuClock`) of roloFlash. Supported bus speeds are listed in the appropriate subchapter for the bus used.

If the specified frequency is unsupported, it gets rounded down internally to the next possible value.

Return value:

- a bus handle. This can be used to call other functions, e. g. `target_open`.

Exceptions:

<code>apiValueRange</code>	Invalid value for index or speed
<code>apiTypeFault</code>	Invalid type for index or speed
<code>resourceUnavailable</code>	The bus cannot be opened. Possible causes: - bus is already open - another bus has been opened, and opening this bus simultaneously is impossible

2.2 bus_close

`bus_close <busHandle>`

Closes the given bus. The affected signal lines become deactivated in the process.

If the bus happens to have open targets present, these targets become detached and their target handles become invalid.

Prerequisites:

- valid bus handle

Parameters:

busHandle

The bus handle for the open bus.

Return value:

- none (procedure)

Exceptions:

invalidHandle
apiTypeFault

Handle has been closed already
Invalid type for busHandle

2.3 bus_setSpeed

bus_setSpeed <busHandle>, <speed>

Changes the speed of an already open bus. The maximal speed gets capped to „speed“. If a target is connected to this bus, the programming speed of the target results from the specified speed.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from bus_open.

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (`sys_setCpuClock`) of roloFlash. Supported bus speeds are listed in the appropriate subchapter for the bus used.

If the specified frequency is unsupported, it gets rounded down internally to the next possible value.

Note for JTAG and SWD bus, respectively:

It is possible that `bus_scan` scans the JTAG or SWD chain slower than the specified value. The value given is, however, relevant to all other transfers.

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.
- Or, after using `sys_setCpuClock`, set the bus speed again using `bus_setSpeed`.

Return value:

- none (procedure)

Exceptions:

`apiValueRange`
`apiTypeFault`

Invalid value for speed
Invalid type for `busHandle` or speed

2.4 `bus_getSpeed`

```
speed = bus_getSpeed(<busHandle>)
```

Queries the current bus speed for an open bus. It can be the same or less than the bus speed specified with `bus_open` or `bus_setSpeed`, respectively.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from bus_open.

Return value:

- Bus speed in Hz

Exceptions:

apiTypeFault

Invalid type for busHandle

2.5 JTAG and SWD Bus

General information about busses are in the superior chapter. Based on it, this chapter elaborates on behavior specific to the JTAG and SWD busses.

2.5.1 JTAG Chain

JTAG chain with up to 10 devices are supported.

The function bus_scan scans the JTAG chain and returns an array with the founded IDCODES.

To open a JTAG devices with the function open_target, the index of the device to be selected, has to be given.

2.5.2 bus_open(JTAG/SWD, ...) and available speeds

```
busHandle = bus_open(JTAG, <indexOfBus>, <speed>)
```

or

```
busHandle = bus_open(SWD, <indexOfBus>, <speed>)
```

Opens the JTAG or SWD bus, respectively, and initializes the signal lines. The maximal bus speed gets capped to „speed“. Sets the programming speed for the target.

Prerequisites:

- none

Parameters:

busType

- JTAG for JTAG bus.
- SWD for SWD bus.

index

Must be 0 (there is only one bus in each case).

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (sys_setCpuClock) of roloFlash.

At a maximal CPU clock rate of 120 Mhz, the following bus speeds are supported:

15000000	7500000	5000000	3750000	3000000
2500000	2142857	1875000	1666666	1500000
1363636	1250000	1153846	1071428	1000000
937500	882352	833333	789473	750000
714285	681818	652173	625000	600000
576923	555555	535714	517241	500000
483870	468750	454545	441176	428571
416666	405405	394736	384615	375000
365853	357142	348837	340909	333333
326086	319148	312500	306122	300000
294117	288461	283018	277777	272727
267857	263157	258620	254237	250000
245901	241935	238095	234375	230769
227272	223880	220588	217391	214285
211267	208333	205479	202702	200000
197368	194805	192307	189873	187500

185185	182926	180722	178571	176470
174418	172413	170454	168539	166666
164835	163043	161290	159574	157894
156250	154639	153061	151515	150000
148514	147058	145631	144230	142857
141509	140186	138888	137614	136363
135135	133928	132743	131578	130434
129310	128205	127118	126050	125000
123966	122950	120967	119047	117187
115384	113636	111940	110294	108695
107142	105633	104166	102739	101351
100000	98684	97402	96153	94936
93750	92592	91463	90361	89285
88235	87209	86206	84745	83333
81967	80645	79365	78125	76923
75757	74626	73529	72463	71428
70422	69124	67873	66666	65502
64377	63291	62240	61224	60000
58823	57692	56603	55555	54545
53380	52264	51194	50167	49019
47923	46875	45871	44776	43731
42613	41551	40540	39473	38461
37406	36319	35294	34246	33185
32119	31055	30000	28957	27932
26929	25906	24875	23847	22831
21802	20775	19762	18750	17730
16722	15706	14705	13698	12690
11682	10676	9671	8670	7668
6666	5664	4662	3661	2660
1659				

At a minimal CPU clock rate of 24 Mhz, the following bus speeds are supported:

1500000	750000	500000	375000	300000
250000	214285	187500	166666	150000
136363	125000	115384	107142	100000
93750	88235	83333	78947	75000
71428	68181	65217	62500	60000
57692	55555	53571	51724	50000
48387	46875	45454	44117	42857
41666	40540	39473	38461	36585
34883	33333	31914	30612	29411

28301	27272	25862	24590	23437
22388	21126	20000	18987	17857
16853	15789	14705	13636	12605
11538	10489	9433	8426	7425
6410	5395	4385	3378	2377
1376				

If the specified frequency is unsupported, it gets rounded down internally to the next possible value.

Note:

After calling `bus_open(JTAG, <indexOfBus>, <speed>)`, it might be necessary to call `bus_enforceJTAG <busHandle>` afterwards, in case the target is in SWD mode.

Note:

It is possible that `bus_scan` scans the JTAG or SWD chain slower than the specified value. The value given is, however, relevant to all other transfers.

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.
- Or, after using `sys_setCpuClock`, set the bus speed again using `bus_setSpeed`.

Return value:

- a `busHandle`. This can be used to call other functions, e. g. `target_open`

Exceptions:

<code>apiValueRange</code>	Invalid value for index or speed
<code>apiTypeFault</code>	Invalid type for index or speed
<code>resourceUnavailable</code>	The bus cannot be opened. Possible causes: - bus is already open - another bus has been opened, and opening this bus simultaneously is impossible

2.5.3 bus_enforceJTAG

`bus_enforceJTAG <busHandle>`

Ensures that targets capable of the SWD protocol are in JTAG mode. If the target is in SWD mode, it gets switched to JTAG mode.

Prerequisites:

- valid bus handle

Parameters:

busHandle

The bus handle for the JTAG or SWD bus, obtained via `bus_open`.

Note:

If the target is already in JTAG mode, nothing changes. The impact of this command on targets not capable of SWD, especially not having an ARM core, are unknown. Therefore, the following is not recommended:

- Use this command when you expect targets capable of SWD and want to make sure that these are in SWD mode.
- In this case, use this command **after** opening the bus and **before** scanning of the bus:

```
busHandle = bus_open(JTAG, <indexOfBus>, <speed>)  
bus_enforceJTAG busHandle
```


the bus definitely gets switched to SWD), as this sequence is part of the SWD specification.

Therefore, the following is recommended:

- This command is only necessary for special situations (e. g. working in JTAG mode, then setting the target to SWD mode just before removing roloFlash).

Return value:

- none (procedure)

Exceptions:

apiTypeFault

Invalid type for busHandle

2.5.5 bus_scan

```
idCodes = bus_scan(<busHandle>)
```

Executes a scan on the JTAG or SWD bus and returns an array with the IDCODES of the JTAG / SWD devices found.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from bus_open.

Return value:

- an array with IDCODES. JTAG devices not supported are represented as a "0". For SWD, currently only one device is supported.

Exceptions:

apiValueRange
apiTypeFault

Invalid value for index or speed
Invalid bus handle for the JTAG or SWD bus

2.5.6 bus_configure

(JTAG bus only)

bus_configure <busHandle>, <index>, <drWidth>

Configures the JTAG bus for subsequent calls of bus_transceive.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from bus_open.

index

The index of the JTAG device in the JTAG chain, that is to be addressed.

drWidth

Width of the DR register.

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for index or drWidth.
Invalid bus handle for the JTAG or SWD bus

2.5.7 bus_transceive

(Not for SWD, see bus_write and bus_read)

```
answerArray = bus_transceive(<busHandle>, <scanType>,  
<dataArray>
```

Transmits and receives a JTAG transfer.

Prerequisites:

- valid bus handle
- previous call to bus_scan
- previous call to bus_configure

Parameters:

busHandle

Bus handle obtained from bus_open.

scanType

IR scan or DR scan:

DRSCAN: DR scan with the width specified via bus_configure

IRSCAN: IR scan with the width determined by bus_scan

dataArray

An array of type char, int or long with enough elements to provide the required number of bits. The least significant bits are used. You cannot use a Vari array.

Example: if the DR register is 35 bits wide and a long array is used, then this array needs at least 2 elements. The datum at position 0 is used completely, and the lowest 3 bits of the datum at position 1 are used.

Notes:

- With this command, you can directly communicate with JTAG devices, even if they are not supported by roloFlash.
- If you communicate with a target that is also to be worked on using roloFlash functions with support for this target, interdependencies cannot be ruled out.

Return value:

- An array with the same type as specified per dataArray, and with a suitable number of elements to store the answer.

Exceptions:

apiValueRange
apiTypeFault

Invalid value for index or ScanType.
Invalid bus handle for the JTAG bus
Invalid dataArray

2.5.8 bus_write

(Not for JTAG, see bus_transceive)

```
bus_write <busHandle>, <apacc_dpacc>, <armRegister,>  
<data>
```

Transmit an SWD transfer.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from bus_open.

apacc_dpacc

write as APACC or DPACC:

APACC: write as APACC

DPACC: write as DPACC

armRegister

Index of ARM-Registers to be addressed. Value range is 0..3. There are no constants for these values; the following values can be used:

0 : CSW

1 : TAR

3 : DRW

Note: This corresponds to the address offset of the respective 32 bits sized AHB-AP registers, divided by 4.

data

32 bits of data.

Notes:

- With this command, you can directly communicate with SWD devices, even if they are not supported by roloFlash.
- If you communicate with a target that is also to be worked on using roloFlash functions with support for this target, interdependencies cannot be ruled out.

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for apacc_dpacc or armRegister.
Invalid bus handle for the SWD bus.

2.5.9 bus_read

(Not for JTAG, see bus_transceive)

```
data = bus_read(<busHandle>, <apacc_dpacc>, <armRegister>, <data>
```

Receives an SWD transfer.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from bus_open.

apacc_dpacc

write as APACC or DPACC:

APACC: write as APACC

DPACC: write as DPACC

armRegister

Index of ARM-Registers to be addressed. Value range is 0..3. There are no constants for these values; the following values can be used:

0 : CSW

1 : TAR

3 : DRW

Note: This corresponds to the address offset of the respective 32 bits sized AHB-AP registers, divided by 4.

Notes:

- With this command, you can directly communicate with SWD devices, even if they are not supported by roloFlash.
- If you communicate with a target that is also to be worked on using roloFlash functions with support for this target, interdependencies cannot be ruled out.

Return value:

- 32 bits of data.

Exceptions:

apiValueRange
apiTypeFault

Invalid value for apacc_dpacc or armRegister.
Invalid bus handle for the SWD bus.

2.6 Atmel ISP Bus

General information about busses can be found in the superior chapter. Based on this, this chapter elaborates on behavior specific to the ISP bus.

2.6.1 bus_open(ISP, ...) and Available Speeds

```
busHandle = bus_open(ISP, <indexOfBus>, <speed>)
```

Opens the ISP bus and initializes the signal lines. The maximal bus speed gets capped to „speed“. Sets the programming speed for the target.

Prerequisites:

- none

Parameters:

busType

ISP for ISP bus.

indexOfBus

Must be 0 (there is only one bus in each case).

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (`sys_setCpuClock`) of roloFlash.

At a maximal CPU clock rate of 120 Mhz, the following bus speeds are supported:

15000000	7500000	5000000	3750000	3000000
2500000	2142857	1875000	1666666	1500000
1363636	1250000	1153846	1071428	1000000
937500	882352	833333	789473	750000
714285	681818	652173	625000	600000
576923	555555	535714	517241	500000
483870	468750	454545	441176	428571
416666	405405	394736	384615	375000
365853	357142	348837	340909	333333
326086	319148	312500	306122	300000
294117	288461	283018	277777	272727
267857	263157	258620	254237	250000
245901	241935	238095	234375	230769
227272	223880	220588	217391	214285
211267	208333	205479	202702	200000
197368	194805	192307	189873	187500
185185	182926	180722	178571	176470
174418	172413	170454	168539	166666
164835	163043	161290	159574	157894
156250	154639	153061	151515	150000
148514	147058	145631	144230	142857
141509	140186	138888	137614	136363
135135	133928	132743	131578	130434
129310	128205	127118	126050	125000
123966	122950	120967	119047	117187
115384	113636	111940	110294	108695
107142	105633	104166	102739	101351
100000	98684	97402	96153	94936
93750	92592	91463	90361	89285

88235	87209	86206	84745	83333
81967	80645	79365	78125	76923
75757	74626	73529	72463	71428
70422	69124	67873	66666	65502
64377	63291	62240	61224	60000
58823	57692	56603	55555	54545
53380	52264	51194	50167	49019
47923	46875	45871	44776	43731
42613	41551	40540	39473	38461
37406	36319	35294	34246	33185
32119	31055	30000	28957	27932
26929	25906	24875	23847	22831
21802	20775	19762	18750	17730
16722	15706	14705	13698	12690
11682	10676	9671	8670	7668
6666	5664	4662	3661	2660
1659				

At a minimal CPU clock rate of 24 Mhz, the following bus speeds are supported:

1500000	750000	500000	375000	300000
250000	214285	187500	166666	150000
136363	125000	115384	107142	100000
93750	88235	83333	78947	75000
71428	68181	65217	62500	60000
57692	55555	53571	51724	50000
48387	46875	45454	44117	42857
41666	40540	39473	38461	36585
34883	33333	31914	30612	29411
28301	27272	25862	24590	23437
22388	21126	20000	18987	17857
16853	15789	14705	13636	12605
11538	10489	9433	8426	7425
6410	5395	4385	3378	2377
1376				

If the specified frequency is unsupported, it gets rounded down internally to the next possible value.

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.
- Or, after using `sys_setCpuClock`, set the bus speed again using `bus_setSpeed`.

Return value:

- a `busHandle`. This can be used to call other functions, e. g. `getTargetPresent`

Exceptions:

<code>apiValueRange</code>	Invalid value for index
<code>apiTypeFault</code>	Invalid type for index
<code>resourceUnavailable</code>	The bus cannot be opened. Possible causes: - bus is already open - another bus has been opened, and opening this bus simultaneously is impossible

2.6.2 Configure Reset Mode

```
bus_resetMode <busHandle> <resetMode>
```

Sets the reset mode for the ISP bus.

After opening the ISP bus, the reset mode is set to `pushpull`, i. e.:

- If no reset is applied, the RST line is active high.
- If a reset is applied, the RST line is active low.

2.7 Atmel TPI Bus

General information about busses can be found in the superior chapter. Based on this, this chapter elaborates on behavior specific to the TPI bus.

2.7.1 bus_open(TPI, ...) and Available Speeds

```
busHandle = bus_open(TPI, <indexOfBus>, <speed>)
```

Opens the TPI bus and initializes the signal lines. The maximal bus speed gets capped to „speed“. Sets the programming speed for the target.

Prerequisites:

- none

Parameters:

busType

TPI for TPI bus.

indexOfBus

Must be 0 (there is only bus in each case)

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (sys_setCpuClock) of roloFlash.

At a maximal CPU clock rate of 120 Mhz, the following bus speeds are supported:

15000000	7500000	5000000	3750000	3000000
2500000	2142857	1875000	1666666	1500000
1363636	1250000	1153846	1071428	1000000
937500	882352	833333	789473	750000
714285	681818	652173	625000	600000
576923	555555	535714	517241	500000
483870	468750	454545	441176	428571
416666	405405	394736	384615	375000

365853	357142	348837	340909	333333
326086	319148	312500	306122	300000
294117	288461	283018	277777	272727
267857	263157	258620	254237	250000
245901	241935	238095	234375	230769
227272	223880	220588	217391	214285
211267	208333	205479	202702	200000
197368	194805	192307	189873	187500
185185	182926	180722	178571	176470
174418	172413	170454	168539	166666
164835	163043	161290	159574	157894
156250	154639	153061	151515	150000
148514	147058	145631	144230	142857
141509	140186	138888	137614	136363
135135	133928	132743	131578	130434
129310	128205	127118	126050	125000
123966	122950	120967	119047	117187
115384	113636	111940	110294	108695
107142	105633	104166	102739	101351
100000	98684	97402	96153	94936
93750	92592	91463	90361	89285
88235	87209	86206	84745	83333
81967	80645	79365	78125	76923
75757	74626	73529	72463	71428
70422	69124	67873	66666	65502
64377	63291	62240	61224	60000
58823	57692	56603	55555	54545
53380	52264	51194	50167	49019
47923	46875	45871	44776	43731
42613	41551	40540	39473	38461
37406	36319	35294	34246	33185
32119	31055	30000	28957	27932
26929	25906	24875	23847	22831
21802	20775	19762	18750	17730
16722	15706	14705	13698	12690
11682	10676	9671	8670	7668
6666	5664	4662	3661	2660
1659				

At a minimal CPU clock rate of 24 Mhz, the following bus speeds are supported:

1500000	750000	500000	375000	300000
---------	--------	--------	--------	--------

250000	214285	187500	166666	150000
136363	125000	115384	107142	100000
93750	88235	83333	78947	75000
71428	68181	65217	62500	60000
57692	55555	53571	51724	50000
48387	46875	45454	44117	42857
41666	40540	39473	38461	36585
34883	33333	31914	30612	29411
28301	27272	25862	24590	23437
22388	21126	20000	18987	17857
16853	15789	14705	13636	12605
11538	10489	9433	8426	7425
6410	5395	4385	3378	2377
1376				

If the specified frequency is unsupported, it gets rounded down internally to the next possible value.

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.
- Or, after using `sys_setCpuClock`, set the bus speed again using `bus_setSpeed`.

Return value:

- a `busHandle`. This can be used to call other functions, e. g. `getTargetPresent`

Exceptions:

apiValueRange	Invalid value for index
apiTypeFault	Invalid type for index
resourceUnavailable	The bus cannot be opened. Possible causes: - bus is already open - another bus has been opened, and opening this bus simultaneously is impossible

2.7.2 Configure Reset Mode

```
bus_resetMode <busHandle> <resetMode>
```

Sets the reset mode for the TPI bus.

After opening the TPI bus, the reset mode is set to `pushpull`, i. e.:

- If no reset is applied, the RST line is active high.
- If a reset is applied, the RST line is active low.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle obtained from `bus_open`

rstMode

- **PIN_ACTIVELOW:**
 - If no reset is applied, the RST line is high-impedance.
 - If a reset is applied, the RST line is active low.
- **PIN_ACTIVEHIGH:**
 - If no reset is applied, the RST line is high-impedance.

- If a reset is applied, the RST line is active high.
- **PIN_PUSHPULL:**
 - If no reset is applied, the rST line is active high.
 - If a reset is applied, the RST line is active low.
- **PIN_INVERTED:**
 - If no reset is applied, the rST line is active low.
 - If a reset is applied, the RST line is active high.

Note:

- The rstModes `PIN_ACTIVEHIGH` and `PIN_INVERTED` are inverted, compared to the usual reset functions and pull the line to high for a reset. This is only useful for controllers the reset of which is active high. In this case, `PIN_INVERTED` is recommended.

Return value:

- none

Exceptions:

`apiTypeFault`

Unzulässiger Typ für `busHandle`

2.8 Atmel PDI-Bus

General information about busses can be found in the superior chapter. Based on this, this chapter elaborates on behavior specific to the PDI bus.

2.8.1 `bus_open(PDI, ...)` and Available Speeds

```
busHandle = bus_open(PDI, <indexOfBus>, <speed>)
```

Opens the PDI bus and initializes the signal lines. The maximal bus speed gets capped to „speed“. Sets the programming speed for the target.

Prerequisites:

- none

Parameters:

busType

PDI for PDI bus.

indexOfBus

Must be 0 (there is only one bus in each case).

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (sys_setCpuClock) of roloFlash.

At a maximal CPU clock rate of 120 Mhz, the following bus speeds are supported:

15000000	7500000	5000000	3750000	3000000
2500000	2142857	1875000	1666666	1500000
1363636	1250000	1153846	1071428	1000000
937500	882352	833333	789473	750000
714285	681818	652173	625000	600000
576923	555555	535714	517241	500000
483870	468750	454545	441176	428571
416666	405405	394736	384615	375000
365853	357142	348837	340909	333333
326086	319148	312500	306122	300000
294117	288461	283018	277777	272727
267857	263157	258620	254237	250000
245901	241935	238095	234375	230769
227272	223880	220588	217391	214285
211267	208333	205479	202702	200000
197368	194805	192307	189873	187500
185185	182926	180722	178571	176470
174418	172413	170454	168539	166666
164835	163043	161290	159574	157894
156250	154639	153061	151515	150000
148514	147058	145631	144230	142857
141509	140186	138888	137614	136363

135135	133928	132743	131578	130434
129310	128205	127118	126050	125000
123966	122950	120967	119047	117187
115384	113636	111940	110294	108695
107142	105633	104166	102739	101351
100000				

At a minimal CPU clock rate of 24 Mhz, the following bus speeds are supported:

1500000	750000	500000	375000	300000
250000	214285	187500	166666	150000
136363	125000	115384	107142	100000

If the specified frequency is unsupported, it gets rounded down internally to the next possible value. Atmel specifies the minimal bus speed as 100 kHz. Values smaller than that get rounded to 100 kHz.

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.
- Or, after using `sys_setCpuClock`, set the bus speed again using `bus_setSpeed`.

Return value:

- a `busHandle`. This can be used to call other functions, e. g. `getTargetPresent`

Exceptions:

<code>apiValueRange</code>	Invalid value for index
<code>apiTypeFault</code>	Invalid type for index
<code>resourceUnavailable</code>	The bus cannot be opened. Possible causes: - bus is already open - another bus has been opened, and opening this bus simultaneously is impossible

2.9 Atmel UPDI / aWire Bus

General information about busses can be found in the superior chapter. Based on this, this chapter elaborates on behavior specific to the UPDI bus and aWire bus, respectively.

2.9.1 bus_open(UPDI / AWIRE, ...) and Available Speeds

```
busHandle = bus_open(UPDI, <indexOfBus>, <speed>)
```

```
busHandle = bus_open(AWIRE, <indexOfBus>, <speed>)
```

Opens the UPDI bus or aWire bus, respectively, and initializes the signal lines. The maximal bus speed gets capped to „speed“. Sets the programming speed for the target.

Prerequisites:

- none

Parameters:

busType

UPDI for UPDI bus or AWIRE for aWire bus.

indexOfBus

Must be 0 (there is only one bus in each case).

speed

The speed of the bus in Hz. The supported bus speeds depend on the CPU clock (`sys_setCpuClock`) of roloFlash.

At a maximal CPU clock rate of 120 Mhz, the following bus speeds are supported:

500000	483870	468750	454545	441176
428571	416666	405405	394736	384615
375000	365853	357142	348837	340909
333333	326086	319148	312500	306122

300000	294117	288461	283018	277777
272727	267857	263157	258620	254237
250000	245901	241935	238095	234375
230769	227272	223880	220588	217391
214285	211267	208333	205479	202702
200000	197368	194805	192307	189873
187500	185185	182926	180722	178571
176470	174418	172413	170454	168539
166666	164835	163043	161290	159574
157894	156250	154639	153061	151515
150000	148514	147058	145631	144230
142857	141509	140186	138888	137614
136363	135135	133928	132743	131578
130434	129310	128205	127118	126050
125000	123966	122950	120967	119047
117187	115384	113636	111940	110294
108695	107142	105633	104166	102739
101351	100000	98684	97402	96153
94936	93750	92592	91463	90361
89285	88235	87209	86206	84745
83333	81967	80645	79365	78125
76923	75757	75000		

At a minimal CPU clock rate of 24 Mhz, the following bus speeds are supported:

375000	300000	250000	214285	187500
166666	150000	136363	125000	115384
107142	100000	93750	88235	83333
78947	75000			

If the specified frequency is unsupported, it gets rounded down internally to the next possible value. Atmel specifies the minimal bus speed as 100 kHz. Values smaller than that get rounded to 100 kHz.

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.

- Or, after using `sys_setCpuCLOCK`, set the bus speed again using `bus_setSpeed`.

Return value:

- a `busHandle`. This can be used to call other functions, e. g. `getTargetPresent`

Exceptions:

<code>apiValueRange</code>	Invalid value for index
<code>apiTypeFault</code>	Invalid type for index
<code>resourceUnavailable</code>	The bus cannot be opened. Possible causes: <ul style="list-style-type: none">- bus is already open- another bus has been opened, and opening this bus simultaneously is impossible

2.10 UART

2.10.1 `bus_open(UART, ...)` and Available Speeds

```
busHandle = bus_open(UART, <indexOfBus>, <baudrate>, <dataBits>, <parity>, <stopbits>)
```

Opens one of the two UART interfaces and initializes the signal lines. The parameters get configured as specified.

Prerequisites:

- none

Parameters:

busType

UART for UART interface

indexOfBus

- 0 for UART0 interface
- 1 for UART1 interface

baudrate

Baud rate in Hz. The achievable baud rates depend on the UART used and on the CPU clock rate.

Baud rates other than the usual baud rates listed here are also possible. They must fit the range of specified minimal and maximal values.

Table 1: UART0 Interface at CPU clock = 120 Mhz

Nominal [Hz]	Actual [Hz]	Deviation in %
Maximally 3750000	3750000	0
3000000	3000000	0
2000000	2000000	0
1000000	1000000	0
500000	500000	0
250000	250000	0
230400	230769	0,16
115200	115163	-0,03
76800	76824	0,03
57600	57581	-0,03
38400	38412	0,03
28800	28804	0,01
19200	19200	0
14400	14398	-0,01
9600	9600	0
4800	4800	0
2400	2400	0
Minimally 1200	1200	0

Table 2: UART0 Interface at CPU Clock = 24 Mhz

Nominal [Hz]	Actual [Hz]	Deviation in %
Maximally 375000	375000	0
250000	250000	0
230400	230769	0,16
115200	115384	0,16
76800	76923	0,16
57600	57692	0,16
38400	38461	0,16
28800	28846	0,16
19200	19230	0,16
14400	14388	-0,08
9600	9600	0
4800	4800	0
2400	2400	0
Minimally 1200	1200	0

Tabelle 3: UART1 Interface at CPU Clock = 120 Mhz

Nominal [Hz]	Actual [Hz]	Deviation in %
Maximally 1875000	1875000	0
1000000	1000000	0
500000	500000	0
250000	250000	0
230400	230769	0,16
115200	115384	0,16
76800	76726	-0,1
57600	57581	-0,03
38400	38412	0,03
28800	28790	-0,03
19200	19206	0,03
14400	14402	0,01
9600	9600	0
4800	4800	0
2400	2400	0
Minimally 1200	1200	0

Table 4: UART1 Interface at CPU Clock = 24 Mhz

Nominal [Hz]	Actual [Hz]	Deviation in %
Maximally 375000	375000	0
250000	250000	0
230400	230769	0,16
115200	115384	0,16
76800	76923	0,16
57600	57692	0,16
38400	38461	0,16
28800	28846	0,16
19200	19230	0,16
14400	14388	-0,08
9600	9600	0
4800	4800	0
2400	2400	0
Minimally 1200	1200	0

If the specified frequency is unsupported, it gets rounded up or down internally to the next possible value.

databits

- 8 for 8 data bits

parity

- PARITY_NONE: no parity
- PARITY_EVEN: even parity
- PARITY_ODD: odd parity

stopbits

- 1 for 1 stop bit
- 2 for 2 stop bits

Note:

If the interface is already open when you change roloFlash's clock rate using `sys_setCpuClock`, the bus speed changes with it. The following course of action is therefore recommended:

- Use `sys_setCpuClock` first and open the bus afterwards.
- Or, after using `sys_setCpuClock`, set the bus speed again using `bus_setSpeed`.

Return value:

- a `busHandle`. This can be used to call other functions, e. g. `bus_write`

Exceptions:

<code>apiValueRange</code>	Invalid value for one of the parameters
<code>apiTypeFault</code>	Invalid type for one of the parameters
<code>resourceUnavailable</code>	The interface cannot be opened. Possible causes: <ul style="list-style-type: none">- Interface has already been opened- another bus has been opened, and opening this interface simultaneously is impossible

2.10.2 `bus_write`

```
bus_write <busHandle>, <text>
```

Outputs the given text to the UART interface. Program execution continues after the output has been completed.

Prerequisites:

- valid bus handle

Parameters:

`busHandle`

bus handle obtained from `bus_open`

3 Target in General

To obtain access to a target, a target handle has to be requested from a previously opened bus. All functionality regarding the target is then carried out specifying this very target handle. With roloFlash, every interface that can be used to flash a target, is considered a bus. This holds true even if the interface inherently allows only one microcontroller to be connected (e. g. the ISP interface for Atmel AVR is construed as bus).

- Generally, the appropriate bus the target belongs to has to be opened beforehand.
- A microcontroller (target) attached to the bus can be addressed only after a target handle was obtained from the bus first.
- The connection to a target can be closed again.
- If a bus gets closed, the target gets closed, too.

3.1 target_open

```
targetHandle = target_open(<busHandle>, <index>, <family>)
```

Enables access to a target and returns a target handle.

Note:

Only 1 target can be accessed at the same time, i.e. there may only be 1 open device handle.

Note:

This function does not check if a target is actually connected. If this is to be checked, target_getPresent can be used.

Prerequisites:

- valid bus handle

Parameters:

busHandle

Bus handle for the opened bus.

index

Determines which target on the bus gets opened. The manner of counting depends on the bus. In most cases, the targets are numbered consecutively, the first target has index 0.

For busses that only support one target, an index of 0 has to be specified.

Note:

With JTAG (e. g. STM32), it is possible that multiple targets correspond to one microcontroller. A microcontroller can, for instance, announce two JTAG devices on the JTAG bus, one for the actual controller, the other one for a boundary scan controller.

Note:

Please specify 0 for busses only supporting one target (e. g. ISP bus).

family

This parameter determines the controller family the target controller belongs to. Its value can be given either directly (see below) or identified by querying the internal database beforehand. Possible families:

- ATMELISP
- ATMELPDI
- ATMELUPDI
- ATMELTPI
- STM32F1
- STM32F2
- STM32F3
- STM32F4
- STM32F7
- STM32H7

Return value:

- a target handle. It can be used to call other functions, e. g. `target_getPresent`.

Exceptions:

`apiValueRange`
`apiTypeFault`
`invalidHandle`

Invalid value for index
Invalid type for `busHandle` or index
Invalid `busHandle` (e. g. already closed)

3.2 `target_close`

`target_close` <`targetHandle`>

Closes the given target.

Prerequisites:

- valid target handle

Parameters:

`targetHandle`

Target handle for the target to be closed.

Return value:

- none (procedure)

Exceptions:

invalidHandle

The target handle or the corresponding bus has already been closed

apiTypeFault

Invalid type for targetHandle

3.3 target_getPresent

```
value = target_getPresent(<targetHandle>)
```

Detects if a target is connected. The operating mode remains unchanged. The detection process always involves an actual communication with the target, so that current information can be obtained.

Note for Atmel ISP bus:

If the target is in RunMode, it temporarily gets reset and put into Program-Mode. At the end of the detection process, the reset signal gets suspended and the target reaches RunMode again. A program that might be running on the target gets thusly restarted.

If the target is already in ProgramMode, the same query process applies, but the target stays in ProgramMode all the time.

Note for Atmel PDI bus and Atmel UPDI bus:

A query over PDI/UPDI is carried out independently of the target being in RunMode or ProgramMode. The target remains in the respective mode. A reset does not take place.

Annotation:

With roloFlash, there should always be a target connected, as roloFlash would not be powered otherwise. This function is intended mainly for rolo-Flash variants that have their own power supply

It is also conceivable that roloFlash gets plugged onto something other than a target. Therefore, this function establishes an actual communication with the target.

Prerequisites:

- valid target handle

Parameters:

targetHandle

The target handle for the target to be addressed.

Return value:

0 = no target found

1 = target found

Exceptions:

invalidHandle

The target handle or the corresponding bus has already been closed

apiTypeFault

Invalid type for targetHandle

The target can be in the following operating modes:

RunMode

Target runs normally, as if roloFlash was not connected.

ProgramMode

Target can be programmed (flashed).

The procedure `target_setMode` changes the operating mode.

Other procedures or functions depend on a certain operating mode. Where this is the case, it is detailed in the appropriate procedure or function description.

3.4 target_setMode

target_setMode <targetHandle>, <targetMode>

Puts both target and roloFlash into the given operating mode.

The target can be in the following operating modes:

RunMode

Target runs normally, as if roloFlash was not connected.

ProgramMode

Target can be programmed (flashed).

Other procedures or functions depend on a certain operating mode. Where this is the case, it is detailed in the appropriate procedure or function description.

Prerequisites:

- valid target handle

Parameters:

targetHandle

The target handle for the target to be addressed.

targetMode

Specification of desired mode:

PROGRAMMODE: This mode is a requirement for the majority of functions involving a target, especially for writing of flash memory. In the course of this, the target can get stopped, depending on the target family.

RUNMODE: The target is running. If the target contains software, it gets executed.

Return value:

- none (procedure)

Note for JTAG bus and SWD bus:

- ProgramMode: Does not affect whether the target is currently running or not. In this mode, only initializations for accessing target memory are carried out.
- RunMode: Starts the target only if no previous write accesses to the target's flash memory have taken place.

Note for Atmel ISP-Bus:

- programMode: If the target is in RunMode, the target gets put into the "Programming Enable Mode" and gets held in reset state. A program potentially present on the target will be stopped in the process.
- runMode: The „Programming Enable Mode“ is suspended, as well as the reset state. The targets starts running immediately afterwards.

Note for Atmel PDI bus:

- ProgramMode: Does not affect whether the target is currently running or not. In this mode, only initializations for accessing target memory via PDI are carried out.
- runMode: The PDI clock is stopped, and subsequently, the "Programming Mode" is terminated. The target issues a reset and starts running.

Note for Atmel UPDI bus:

- programMode: If the target is in RunMode, the target gets put into the "Programming Enable Mode" and gets held in reset state. A program potentially present on the target will be stopped in the process.
- runMode: The „Programming Enable Mode“ is suspended, as well as the reset state. The target starts running immediately afterwards.
- If the target is in "Programming Enable Mode" while roloFlash gets removed, the target remains in this mode. A program potentially preset

on the target does not start unless the target's power supply gets interrupted for a short time. Starting the target can be forced by calling `target_setMode` with the parameter `runMode`, before removing roloFlash. Alternatively, you can close the `targetHandle` using `target_close`.

Exceptions:

<code>targetCommunication</code>	Communication with the target does not work.
<code>invalidHandle</code>	The target handle or the corresponding bus has already been closed
<code>apiTypeFault</code>	Invalid type for <code>targetHandle</code>

3.5 target_restart

`target_restart <targetHandle>`

Restarts the target, which returns to the same operating mode:

RunMode

A reset is applied briefly, then deactivated. Therefore, the target starts running from the beginning. `RunMode` is maintained.

ProgramMode

A reset cycle is applied, too, after which the `ProgramMode` gets restored. Meanwhile, if there is a firmware present on the target, it could have run for a short period of time.

It is recommended to employ this command only if it either cannot critically do any harm, or if there is no firmware on the target.

Note for JTAG bus and SWD bus:

Since roloFlash conceptually does not consider the JTAG bus or SWD bus to have a reset line, this command is not available. You can, however, open the reset line as GPIO and trigger a reset yourself. As this is invisible for roloFlash's JTAG and SWD communication module, roloFlash sees the

target as remaining in its former operating mode, which might not match the actual operating mode of the target. In case you want to trigger a reset for the target, and want to continue working on it using roloFlash, please close the target handle for this target and request a new target handle afterwards:

```
! Activate reset:
handle = GPIO_open(GPIO_RST, PIN_PUSH_PULL, 0)
! Stay in reset for 100 ms:
delay 100
! Suspend reset by closing GPIO:
closeBus handle
! Closing and re-opening of the target to reset
! roloFlash's JTAG/SWD communication module:
target_close targetHandle
targetHandle = target_open(<bushandle>, <index>, <family>)
```

Note for Atmel ISP bus:

The "Programming Enable Mode" as well as the reset get suspended. The target starts running immediately afterwards.

RunMode

Reset gets activated briefly (100 ms), then deactivated again. Therefore, the target starts running from the beginning. RunMode is maintained.

ProgramMode

Reset gets suspended briefly (3 ms), and ProgramMode gets restored afterwards. Meanwhile, if there is a firmware on the target, it could have run for a short period of time.

Application Example for Targets with Atmel ISP Interface:

The procedure is necessary, e. g. when changing fuses on the target, and the changes should be in effect immediately. This applies in particular for activating a quartz for the target, which subsequently enables a higher programming speed:

```
! Activate quartz to enable higher
! programming speeds:
target_writeBits(targetHandle, FUSES_LOW, value)
! Activate the changes by using target_restart
target_restart targetHandle
bus_setSpeed(bushandle, 1000000) ! e.g. 1 MHz
target_writeFromFile ...
```

Note for Atmel PDI-Bus:

Although the reset line is part of the PDI bus, it does not get used as such for PDI. Consequently, the bus can be used without holding the target in reset state.

RunMode

Reset gets activated briefly (100 ms), then deactivated again. Therefore, the target starts running from the beginning. RunMode is maintained.

ProgramMode

The PDI bus is deactivated, a reset gets triggered (100 ms), then the PDI bus gets activated again and ProgramMode gets restored. The target starts running from the beginning.

Note for UPDI bus:

Since roloFlash conceptually does not consider the UPDI bus to have a reset line, this command is not available. However, if the reset line is available on your target board's programming connector, you can open the reset line as GPIO and trigger a reset yourself. As this is invisible for roloFlash's UPDI communication module, roloFlash sees the target as remaining in its former operating mode, which might not match the actual operating mode

of the target. In case you want to trigger a reset for the target, and want to continue working on it using roloFlash, please close the target handle for this target and request a new target handle afterwards.

Prerequisites:

- valid target handle

Parameters:

targetHandle

The target handle for the target to be addressed.

Return value:

- none (procedure)

Exceptions:

targetCommunication	Communication with the target does not work.
invalidHandle	The target handle or the corresponding bus has already been closed
apiTypeFault	Invalid type for targetHandle

3.6 Read/Write Target Memory Map

For different memory types within the targets, roloFlash supports a so-called memory map. Depending on target and memory type, it can provide information about different properties of the memory; these properties can be configured by the user, some of them have to be configured before flashing. Oftentimes, the required values can be found in the database.

The example scripts are a good starting point here.

3.6.1 target_setMemoryMap

```
target_setMemoryMap <targetHandle>, <memType>, <memProperty> <value>
```


Sets the specified property for the specified memory type to the value given.

Prerequisites:

- valid targetHandle

Parameters:

targetHandle

Target handle for the target to be addressed

memType

Type of memory:

FLASH: Flash memory

RAM: RAM

EEPROM: EEPROM

memProperty

Memory property to be set:

MEM_STARTADDR: Start address of memory

MEM_SIZE: Size of memory in bytes

MEM_PAGESIZE: For some targets: Size of a memory page

value

The value to be set

Return value:

- none (procedure)

Exceptions:

targetCommunication
invalidHandle

Communication with the target does not work.
The target handle or the corresponding bus has
already been closed

FunctionNotSupported
apiTypeFault
ValueNotAllowed

Invalid combination of MemType and Property
Invalid type for targetHandle
Invalid value

3.6.2 target_getMemoryMap

```
value = target_getMemoryMap(<targetHandle>, <memType>,  
<memProperty>)
```

Determines the specified property's value for the given memory type.

Prerequisites:

- valid targetHandle

Parameters:

targetHandle

The target handle for the target to be accessed.

memType

Memory type:

FLASH: Flash memory

RAM: RAM

EEPROM: EEPROM

memProperty

Memory property:

MEM_STARTADDR: Start address of memory

MEM_SIZE: Size of memory in bytes

MEM_PAGESIZE: For some targets: Size of a memory page

Return value:

- Determined value

Exceptions:

targetCommunication	Communication with the target does not work.
invalidHandle	The target handle or the corresponding bus has already been closed
FunctionNotSupported	Invalid combination of MemType and Property
apiTypeFault	Invalid type for targetHandle
valueUnknown	Value cannot be determined

3.6.3 target_clearMemoryLayout

target_clearMemoryLayout <targetHandle>

Clears an existing memory layout (memory map).

Prerequisites:

- valid targetHandle
- target must be in ProgramMode

Parameters:

targetHandle

Target handle for target to be addressed

Return value:

- none (procedure)

Exceptions:

targetWrongMode

Target is not in "ProgramMode".

invalidHandle

The target handle or the corresponding bus has already been closed

apiTypeFault

Invalid type for targetHandle

3.7 Loader

Some controller families are handled using a so-called loader.

In these cases, prior to using certain functions, a loader program has to be loaded into the target's RAM and executed there. Depending on the target, the loader is present within the roloFlash firmware or has to be present on the microSD card:

Controller family	Loader	Functions using a loader
STM32L0, STM32L1 and STM32WB	<no loader>	
STM32	<internal>	target_writeFromFile mit memType = Flash target_read mit memType = Flash
Atmel ISP	<no loader>	
Atmel TPI	<no loader>	
Atmel PDI	<no loader>	
Atmel UPDI	<no loader>	

Selection and activation of a suitable loader happens automatically, as soon as a function is called that requires a loader (see above table). In that case, roloFlash transfers the loader to the target and starts it right before execution of the called function.

The procedure target_setLoaderPreference allows specifying whether a loader should be used (where possible).

The function target_getLoaderUsage determines if a loader will actually be used.

Consequentially:

- You do not need to explicitly take care of the loader, it just needs to be present on the microSD card (in case of an external loader).
- An application that might be present on the target will be stopped.
- After calling a function that needs a loader, the loader can stay active and is available for other functions requiring a loader.
- Some parts of the target's RAM get modified.

Attribute	With Loader	Without Loader
Flash speed	much faster	slower does not apply to Atmel ISP, TPI, PDI and UPDI
RAM of the target	is used and changed	is unused and not changed

3.8 Erase, Write, Read and Verify Target

3.8.1 target_eraseFlash

```
target_eraseFlash <targetHandle>
```

Erases the target's entire Flash memory. With some targets, the EEPROM gets automatically erased in the process, too (see Atmel fuse „EESAVE“). Details can be found in the appropriate data sheet of a target.

Prerequisites:

- valid targetHandle
- target must be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

- none (procedure)

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
invalidHandle	Target handle or the appropriate bus has already been closed.
apiTypeFault	Invalid type for the target handle.

3.8.2 target_writeFromFile

```
target_writeFromFile <targetHandle>, <fileSystem>,  
<fileName>, <fileFormat>, <memType>, <verify>, <star-  
tAddr>, <cryptSpec>
```

Writes a file to the target's memory.

Prerequisites:

- valid target handle
- target has to be in ProgramMode

Parameters:

targetHandle

Target handle for the target to be addressed

fileSystem

Specifies on which file system the file resides. Possible values are:
SDCARD, FLASHVARS, FLASHDISK.

fileName

The requirements for file names apply, see chapter „Flash-Data“.

fileFormat

Format of given file. Possible values:

HEX: Intel-HEX format (ASCII file). (HEX32 can be used synonymously)

SREC: Motorola SREC format (S19, S28, S37, ASCII file). (S19, S28 and S37 can be used synonymously)

ELF: ELF format, which many compilers create as an intermediate step. It often contains a lot of extra information not necessary for flashing and which is therefore ignored.

RAW: Raw format (binary file with raw data and no address)

memType

Which memory type to write to. This value is specific to the particular target family and is described in the respective chapters.

verify

Specifies if verification should be carried out. Possible values:

WRITEONLY: Write without verification

VERIFYONLY: Data is verified only (nothing gets written to target memory)

WRITEVERIFY: Write and verify

startAddr

(optional). This parameter is for raw format files only. As raw files do not contain any address specification, this parameter is used to pass that information to roloFlash.

cryptSpec

Optional parameter for writing of an encrypted file.

The parameter "padding" within the contained dataSpec can have the following values:

- **0-15:** Number of bytes that should be ignored after decryption.
- **SEC_NOPADDING:** Do not truncate data after decryption. This mode can only be applied with SEC_CTR and is recommended for it.

- **SEC_PKCS7:** After decryption, data gets truncated according to PKCS7 padding. If the data does not comply with PKCS7, an exception "paddingError" will be generated.

Return value:

- none (procedure)

Note for Verify = WRITEVERIFY

The data that has just been written to the target get read back from the target and compared to the data read from file. For this, said data do not get read and decoded a second time from the microSD card, but the data copy already buffered in roloFlash's RAM is used instead. This way, any read faults regarding the microSD cards cannot be detected. However, with HEX files, the contained CRC values are read out and verified, so that reading errors are consequently unlikely.

If you want to further increase data integrity, use this function twice: First with "verify = WRITEONLY" and then with "verify = VERIFYONLY". This procedure may take longer than a single call with "verify = WRITEVERIFY".

Note for HEX and SREC Files

Lines starting with ';' will be interpreted as comment and thusly ignored.

Exceptions:

targetMemoryLayout, hexFileSize, hexFileCRC, hexFileSyntax, srecRecordTypeTooSmall	See chapter „Exceptions of roloFlash“.
targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
targetError	There is an error on the target's side.
apiTypeFault	Invalid type for one of the parameters.
invalidHandle	Target handle or the appropriate bus has already been closed.
targetVerify	During verification, mismatching data has been read. Possible causes: - Communication problems - Data rate too high - Target has not been erased previously (affects predominantly flash memory)
<various file system exceptions>	See chapter „Exceptions of the File System“.
cryptError	General error in calculation.
secParamError	The specified CryptSpec ist erroneous.
secPaddingError	PKCS7 is specified, but decrypted data does not conform to PKCS7 encoding.

3.8.3 target_readToFile

target_readToFile <targetHandle>, <fileSystem>, <file-Name>, <fileFormat>, <memType>, <startAddr>, <length>

Reads from target memory, creates a new file, and writes the read data into that file in the format specified.

Prerequisites:

- valid target handle
- target has to be in ProgramMode

Parameters:

targetHandle

Target handle for the target to be addressed.

fileSystem

Specifies on which file system the file resides. Possible values are:
SDCARD, FLASHVARS, FLASHDISK.

fileName

The requirements for file names apply, see chapter „[Flash-Data](#)“. If the file exists, it will be overwritten.

fileFormat

File format to use for writing. Possible values:

HEX: Intel HEX format (ASCII file). If the address range is below 1 MB, the Extended Segment Address Record (type 02) will be used (format I16HEX), otherwise, the Extended Linear Address Record (type 04) will be used (format I32HEX).

HEX32: Intel HEX format (ASCII file). Independent of the address range, the Extended Linear Address Record (type 04) will always be used (Format I32HEX).

SREC: Motorola SREC format (ASCII file). Depending on the address range, the smallest possible encoding is used (S19, S28 or S37)

S19: Motorola SREC format in S19 format (ASCII file). If the address range (64 kB) is insufficiently small, an exception `addressTooBigForFileFormat` will be generated.

S28: Motorola SREC format in S28 format (ASCII file). If the address range (16 MB) is insufficiently small, an exception `addressTooBigForFileFormat` will be generated.

S37: Motorola SREC format in S37 format (ASCII file).

RAW: Raw format (binary file containing raw data without address specification).

With Intel Hex Format and with Motorola SREC Format, you can optionally specify the number of data bytes per line by combining it with the the format specifier via the OR operator. If left unspecified, the default value for the appropriate format is used (Intel Hex format: 16 bytes, Motorola SREC format: 32 bytes). Highest valid value is 255, greater values lead to undefined behavior. While the Intel Hex formats allow for 255 bytes, the maximum allowed value is a little less.

The specified value will be automatically corrected to lie within the allowed range. Therefore, specifying 255 automatically gives you the maximum number of bytes per line.

With Intel Hex format and with Motorola SREC format, line endings are encoded as <cr><lf>. If files should be encoded solely using <cr> or <lf>, you can suffix the format using the OR operation with the constant **CR** or **LF**.

Example: **HEX32 or 64 or LF** will generate I32HEX files with 64 bytes data per line and only <lf> as line endings.

memType

Which memory type to write to. This value is specific to the particular target family and is described in the respective chapters.

startAddr

First address to read from.

length

Number of bytes to read.

Return value:

- none (procedure)

Note for verification while reading

To achieve a verification similar to the one used when writing to the target, you can verify the read file by subsequently calling `target_writeFromFile` with "verify = verifyOnly".

Exceptions:

targetMemoryLayout, hexFileSize, hexFileCRC, hexFileSyntax and srecRecordTypeTooSmall	See chapter „Exceptions of roloFlash“.
targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
targetError	There is an error on the target's side.
apiTypeFault	Invalid type for one of the parameters.
invalidHandle	Target handle or the appropriate bus has already been closed.
<various file system exceptions>	See chapter „Exceptions of the File System“.

3.8.4 target_write

target_write <targetHandle>, <dataArray>, <memType>, <verify>, <startAddr>

Writes a roloBasic data array to the target's memory.

Prerequisites:

- valid targetHandle
- target has to be in ProgramMode

Parameters:

targetHandle

Target handle for the target to be addressed

dataArray

A char array containing the data to be written.

memType

Which memory type to write to. This value is specific to the particular target family and is described in the respective chapters.

verify

Specifies if verification should be carried out. Possible values:
WRITEONLY: Write without verification
VERIFYONLY: Data is verified only (nothing gets written to target memory)
WRITEVERIFY: Write and verify

startAddr

Target memory address to write the data to.

Return value:

- none (procedure)

Exceptions:

targetMemoryLayout	See chapter „Exceptions of roloFlash“.
targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
targetError	There is an error on the target's side.
apiTypeFault	Invalid type for one of the parameters.
invalidHandle	Target handle or the appropriate bus has already been closed.
targetVerify	During verification, different data has been read. Possible causes: - Kommunikation problems - Data rate too high - Target has not been erased previously (affects predominantly Flash memory)
<various file system exceptions>	See chapter „Exceptions of the File System“.

3.8.5 target_read

```
DataArray = target_read(<targetHandle>, <memType>, <startAddr>, <length>)
```

Reads from target memory, creates a roloBasic char array, and fills this array with the data read from target.

Prerequisites:

- valid target handle

- target has to be in ProgramMode

Parameters:

targetHandle

Target handle for the target to be addressed.

memType

Which memory type to read from. This value is specific to the particular target family and is described in the respective chapters.

startAddr

First target memory address to read from.

length

Number of bytes to read.

Return value:

- char array with data read

Note for verification while reading

To achieve a verification similar to the one used when writing to the target, you can verify the read file by subsequently calling `target_write` with "verify = verifyOnly".

Exceptions:

OutOfMemory

Insufficient memory available for creating roloBasic array.

targetMemoryLayout	See chapter „Exceptions of roloFlash“.
targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
targetError	There is an error on the target's side.
apiTypeFault	Invalid type for one of the parameters.
invalidHandle	Target handle or the appropriate bus has already been closed.
<various file system exceptions>	See chapter „Exceptions of the File System“.

3.9 Target STM32

Currently, the following subfamilies are supported:

- STM32F0
- STM32F1
- STM32F2
- STM32F3
- STM32F4
- STM32F7
- STM32H7
- STM32L0 (without loader)
- STM32L1 (without loader)
- STM32L4
- STM32L4+
- STM32G0
- STM32WB (without loader)

All functions of chapters „Target in General“ to „Erase, Write, Read and Verify Target“, including all subchapters, are supported.

MemTypes:

Supported memTypes for writing:

- FLASH
- RAM (also for access to registers)

Supported memTypes for reading:

- FLASH
- RAM (also for access to registers)
- READMEMORY (for accesses to RAM, Flash and registers)

Parallelism:

For targets belonging to the families STM32F2, STM32F4, and STM32F7, the flash parallelism for writing and erasing of the flash memory must be chosen correctly, dependent on the power supply voltage (see respective reference or programming manual by ST Microelectronics, keyword „Parallelism“).

For targets of the STM32H7 family, the parallelism for writing to flash memory can be freely chosen.

Loader:

It is possible to use a loader (stored inside roloFlash) when using the following functions:

- `target_writeFromFile` mit `memType = FLASH`
- `target_write` mit `memType = FLASH`

The advantage of a loader is the higher speed, at the cost of modifying the target's RAM content. Choosing whether a loader is used or not is done via the procedure `target_setLoaderPreference`.

No loader can be used in the following cases:

- STM32F2, STM32F4 and STM32F7 with parallelism of 8 or 32 bits
- STM32H7 with parallelism of 8 or 16 bits
- STM32L0, STM32L1 and STM32WB

In these cases, the loader will be automatically ignored.

3.9.1 `target_setVoltageForParallelism`

(Only STM32F2, STM32F4 and STM32F7)

`target_setVoltageForParallelism <targetHandle>, <voltage>`

Sets the flash parallelism to a value suitable for the specified target power supply voltage.

Prerequisites:

- valid target handle

Parameters:

targetHandle

Target handle for the target to be addressed

voltage

Target power supply voltage in mV.

Return value:

- none (procedure)

Note:

Using this procedure saves you from manually determining the parallelism suitable for the current power supply voltage.

If the parallelism is unsupported by the loader, the loader is not used.

Exceptions:

<code>FunctionNotSupported</code>	This function supports only families STM32F2, STM32F4 and STM32F7.
<code>apiValueRange</code>	Invalid value for voltage.
<code>invalidHandle</code>	The target handle or bus have already been closed.
<code>apiTypeFault</code>	Invalid type for one of the parameters.

3.9.2 target_setParallelism

(Only STM32F2, STM32F4, STM32F7 and STM32H7)

target_setParallelism <targetHandle>, <parallelism>

Sets the flash-parallelism to be used. Parallelismus benutzt werden soll.

- For STM32F2, STM32F4 and STM32F7:
The parallelism specified must suit the power supply voltage. When left unspecified, the default of 8 bits will be used, as this value is valid for all supported voltages.
- For STM32H7:
The parallelism does not depend on the power supply voltage. When left unspecified, the default of 32 bits will be used. This value might change in future roloFlash firmwares.

Prerequisites:

- valid target handle

Parameters:

targetHandle

Target handle for the target to be addressed

parallelism

Flash-parallelism in bits. Valid values are 8, 16, and 32. 64-bit parallelism, which needs an external power supply for programming, is **not** supported.

Return value:

- none (procedure)

Note:

This procedure can be used as an alternative to `target_setVoltageForParallelism`, but you have to manually determine if the parallelism chosen is suitable for the current power supply voltage.

If the parallelism is unsupported by the loader, the loader is not used.

Exceptions:

<code>FunctionNotSupported</code>	This function only supports families STM32F2, STM32F4, STM32F7 and STM32H7.
<code>apiValueRange</code>	Invalid value for parallelism.
<code>invalidHandle</code>	Target handle or bus has already been closed.
<code>apiTypeFault</code>	Invalid type for one of the parameters.

3.9.3 target_getParallelism

(Only STM32F2, STM32F4, STM32F7 and STM32H7)

`parallelism = target_getParallelism <targetHandle>`

Returns the currently set value for flash-parallelism. It must match the current power supply voltage.

Prerequisites:

- valid target handle

Return value:

- Parallelism in bits (8, 16 or 32)

Exceptions:

<code>FunctionNotSupported</code>	This function only supports families STM32F2, STM32F4, STM32F7 and STM32H7.
<code>invalidHandle</code>	Target handle or bus have already been closed.

3.9.4 target_setLoaderPreference

target_setLoaderPreference <targetHandle>, <loaderPreference>

Specifies, if a loader shall be used (if possible).

Prerequisites:

- valid target handle

Parameters:

targetHandle

Target handle for the target to be addressed

loaderPreference

- 0: No loader will be used. In this mode, no RAM locations will be changed during flashing.
- else: If possible, as loader will be used. Using a loader, you might achieve higher speeds while flashing. If a loader is actually used, can be determined using target_getLoaderUsage.

Return value:

- none (procedure)

Note:

If you do not call this function, a loader will be used, whenever possible. If a parallelism has been configured for STM32F2, STM32F4, STM32F7 or STM32H7 that is not supported by the loader, then the loader does not get used. With STM32L0, STM32L1 and STM32H7, no loader will be used.

Exceptions:

FunctionNotSupported

apiValueRange

invalidHandle

apiTypeFault

The function is not supported.

Invalid value for loaderPreference.

The target handle has already been closed, or the bus is already closed.

Invalid type for one of the parameters.

3.9.5 target_getLoaderUsage

loaderUsed = target_setLoaderUsage(<targetHandle>)

Determines if a loader will be used.

Prerequisites:

- valid target handle

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

- 0: No loader will be used.

- 1: A loader will be used.

Exceptions:

invalidHandle

apiTypeFault

Target handle or bus have already been closed.

Invalid type for one of the parameters.

3.10 Target Atmel AVR (ISP Interface)

All functions of chapters „Target in General“ to „Erase, Write, Read and Verify Target“, including all subchapters, are supported.

No loader will get used.

MemTypes:

Supported memTypes for writing:

- FLASH
- EEPROM

Supported memTypes for reading:

- FLASH
- EEPROM

3.10.1 target_getDeviceId

```
s = target_getDeviceId(<targetHandle>)
```

Reads the target's signature / device ID. This can be used to distinguish between different controllers.

Note:

Use of the terms "device ID" and "signature" varies throughout the manufacturer's documents, depending on the controller. Independent of this, roloFlash documentation uses the term "device ID" exclusively.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

Read out device ID or signature. The device ID gets returned in a byte-array with 3 bytes. This device ID can be compared with a device ID from the target database.

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for target handle.

3.10.2 target_readBits

value = target_readBits(<targetHandle>, <index>)

Read out specified fuses or lock-bits as byte.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

index

Specifies which fuses or lock-bits to read. For this purpose, the following constants are defined: FUSES_LOW, FUSES_HIGH, FUSES_EXT and LOCK_BITS.

For controllers without extended fuses, the value returned for FUSES_EXT undefined (no exception is generated).

Return value:

Read out fuses or lock-bits as byte.

Exceptions:

<code>targetWrongMode</code>	Target is not in "ProgramMode".
<code>targetCommunication</code>	Communication with the target does not work.
<code>apiValueRange</code>	Invalid value for index.
<code>invalidHandle</code>	Target handle or bus have already been closed.
<code>apiTypeFault</code>	Invalid type for one of the parameters.

Example:

Return value of \$1E for FUSE_LOW on an ATmega8:

\$1E is 00011110 in binary, so the following fuse bits are set:

- Bit 1 (CKSEL1)
- Bit 2 (CKSEL2)
- Bit 3 (CKSEL3)
- Bit 4 (SUT0)
- All other fuse bits in the lower fuses are reset (i.e. 0).

3.10.3 target_writeBits

`target_writeBits <targetHandle>, <index>, <value>`

Writes to the specified fuses or lock-bits.

Attention!

- Some bit combinations can render your chip useless. Please pay attention to the values and check them in your controller's documentation.
- Set the lock bits only after having executed all other accesses to the chip.
- If you want to work on a chip locked by lock-bits, first execute `target_eraseFlash`. This procedure also resets the lock-bits.

Prerequisites:

- valid target handle

- target has to be in ProgramMode.

Note:

Some changes to fuses take effect or are visible by `target_readBits` only after a reset. For more information, consult the respective target's manual. For resetting, you can use the procedure `target_restart`.

Parameters:

targetHandle

Target handle for the target to be addressed

index

Specifies which fuses or lock-bits to write to. For this purpose, the following constants are defined: `FUSES_LOW`, `FUSES_HIGH`, `FUSES_EXT` and `LOCK_BITS`.

For controllers without extended fuses, nothing gets written when specifying `FUSES_EXT` (no exception is generated).

value

Fuse bits combination to be written as byte.

Return value:

- none (procedure)

Exceptions:

<code>targetWrongMode</code>	Target is not in "ProgramMode".
<code>targetCommunication</code>	Communication with the target does not work.
<code>apiValueRange</code>	Invalid value for index or value
<code>invalidHandle</code>	Target handle or bus have already been closed.
<code>apiTypeFault</code>	Invalid type for one of the parameters.

Beispiel:

Setting the following fuse bits for `FUSE_LOW` on an ATmega8:

- Bit 1 (CKSEL1)
- Bit 2 (CKSEL2)
- Bit 3 (CKSEL3)
- Bit 4 (SUT0)

and resetting all other fuse bits in the low fuses corresponds to a binary value of 00011110, i.e. hexadecimal \$1E, so \$1E has to be specified as <value>.

3.10.4 target_setExtendedAddressMode

target_setExtendedAddressMode <targetHandle>, <value>

For controllers with 256 kB or more flash memory, the regular command set is insufficient for programming over the ISP interface, instead, an extended address mode is required.

When configuring the flash memory size (via target_setMemoryMap with memType = flash and memProperty = mm_size), this value gets set automatically.

Using this function, this value can be overridden.

Prerequisites:

- valid targetHandle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

value

- 0: Do not use extended address mode
- else: Use extended address mode

Return value:

- none (procedure)

Exceptions:

targetWrongMode
invalidHandle
apiTypeFault

Target is not in "ProgramMode".
Target handle or bus have already been closed.
Invalid type for one of the parameters.

3.11 Atmel TPI (TPI Interface)

All functions of chapters „Target in General“ to „Erase, Write, Read and Verify Target“, including all subchapters, are supported.

No loader is used.

MemTypes:

Supported memTypes for writing:

- FLASH

Supported memTypes for reading:

- FLASH

3.11.1 target_getDeviceId

```
s = target_getDeviceId(<targetHandle>)
```

Reads the target's signature / device ID. This can be used to distinguish between different controllers.

Note:

Use of the terms "device ID" and "signature" varies throughout the manufacturer's documents, depending on the controller. Independent of this, roloFlash documentation uses the term "device ID" exclusively.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

Read out device ID or signature. The device ID gets returned in a byte-array with 3 bytes. This device ID can be compared with a device ID from the target database.

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for target handle.

3.11.2 target_readBits

value = target_readBits(<targetHandle>, <index>)

Read out specified fuses or lock-bits as byte.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

index

0: Fuse byte 0 or configuration byte, respectively
Lock-Bits: for lock-bits

Return value:

Read out fuses or lock-bits as byte.

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
apiValueRange	Invalid value for index.
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for one of the parameters.

3.11.3 target_writeBits

target_writeBits <targetHandle>, <index>, <value>

Writes the specified fuses or lock-bits.

Attention!

- Some bit combinations can render your chip useless. Please pay attention to the values and check them in your controller's documentation.
- Set the lock bits only after having executed all other accesses to the chip.
- If you want to work on a chip locked by lock-bits, first execute target_eraseFlash . This procedure also resets the lock-bits.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Note:

Some changes to fuses take effect or are visible by target_readBits only after a reset. For more information, consult the respective target's manual. For resetting, you can use the procedure target_restart.

Parameters:

targetHandle

Target handle for the target to be addressed

index

0: Fuse Byte 0 or configuration byte, respectively

Lock-Bits: for lock-bits

value

Fuse or lock bits combination to be written as byte.

Return value:

- none (procedure)

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
apiValueRange	Invalid value for index or value
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for one of the parameters.

3.12 Target Atmel PDI (PDI Interface)

All functions of chapters „Target in General“ to „Erase, Write, Read and Verify Target“, including all subchapters, are supported.

No loader is used.

MemTypes:

Supported memTypes for writing:

- FLASH
- EEPROM

Supported memTypes for reading:

- FLASH
- EEPROM

3.12.1 target_getDeviceId

```
id = target_getDeviceId(<targetHandle>)
```

Reads the target's signature / device ID. This can be used to distinguish between different controllers.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

Read out device ID or signature. The device ID gets returned in a byte-array with 3 bytes. This device ID can be compared with a device ID from the target database.

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for TargetHandle.

3.12.2 target_readBits

```
value = target_readBits(<targetHandle>, <index>)
```

Read out the specified fuses or lock-bits as byte.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

index

- 0: Fuse byte 0
- 1: Fuse byte 1
- 2: Fuse byte 2
- 3: <invalid>
- 4: Fuse byte 4
- 5: Fuse byte 5
- 6: <invalid>
- 7: Lock-bits

Note: for lock-bits, the constant LOCK_BITS can be used.

Return value:

Read out fuse or lock-bits as byte.

Exceptions:

<code>targetWrongMode</code>	Target is not in "ProgramMode".
<code>targetCommunication</code>	Communication with the target does not work.
<code>apiValueRange</code>	Invalid value for index.
<code>invalidHandle</code>	Target handle or bus have already been closed.
<code>apiTypeFault</code>	Invalid type for one of the parameters.

3.12.3 `target_writeBits`

`target_writeBits` <targetHandle>, <index>, <value>

Writes to the specified fuses or lock-bits.

Attention!

- Some bit combinations can render your chip useless. Please pay attention to the values and check them in your controller's documentation.
- Set the lock bits only after having executed all other accesses to the chip.
- If you want to work on a chip locked by lock-bits, first execute `target_eraseFlash`. This procedure also resets the lock-bits.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Note:

Some changes to fuses take effect or are visible by `target_readBits` only after a reset. For more information, consult the respective target's manual. For resetting, you can use the procedure `target_restart`.

Parameters:

targetHandle

Target handle for the target to be addressed

index

0: Fuse byte 0

1: Fuse byte 1

2: Fuse byte 2

3: <invalid>

4: Fuse byte 4

5: Fuse byte 5

6: <invalid>

7: Lock-bits

Note: for lock-bits, the constant LOCK_BITS
can be used.

value

Fuse or lock bit combination to be written as byte.

Return value:

- none (procedure)

Exceptions:

targetWrongMode

Target is not in "ProgramMode".

targetCommunication

Communication with the target does not work.

apiValueRange

Invalid value for index or value

invalidHandle

Target handle or bus have already been closed.

apiTypeFault

Invalid type for one of the parameters.

3.13 Target Atmel UPDI (UPDI-Interface)

All functions of chapters „Target in General“ to „Erase, Write, Read and Verify Target“, including all subchapters, are supported.

No loader is used.

MemTypes:

Supported memTypes for writing:

- FLASH
- EEPROM
- USERSIGNATURE

Supported memTypes for reading:

- FLASH
- EEPROM
- USERSIGNATURE

3.13.1 target_getDeviceId

```
id = target_getDeviceId(<targetHandle>)
```

Reads the target's signature / device ID. This can be used to distinguish between different controllers.

Note:

Use of the terms "device ID" and "signature" varies throughout the manufacturer's documents, depending on the controller. Independent of this, roloFlash documentation uses the term "device ID" exclusively.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

Read out device ID or signature. The device ID gets returned in a byte-array with 3 bytes. This device ID can be compared with a device ID from the target database.

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for TargetHandle.

3.13.2 target_readBits

value = target_readBits(<targetHandle>, <index>)

Reads out specified fuses or lock-bits as byte.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

index (from manufacturer documentation for ATtiny417/817)

- 0: WDTCFG
- 1: BODCFG
- 2: OSCCFG
- 3: <invalid>
- 4: TCD0CFG
- 5: SYSCFG0
- 6: SYSCFG1
- 7: APPEND
- 8: BOOTEND
- 9: <invalid>
- 10: Lock-bits

Note: for lock-bits, the constant LOCK_BITS can be used.

Return value:

Read out fuses or lock-bits as byte.

Exceptions:

<code>targetWrongMode</code>	Target is not in "ProgramMode".
<code>targetCommunication</code>	Communication with the target does not work.
<code>apiValueRange</code>	Invalid value for index.
<code>invalidHandle</code>	Target handle or bus have already been closed.
<code>apiTypeFault</code>	Invalid type for one of the parameters.

3.13.3 `target_writeBits`

`target_writeBits` <targetHandle>, <index>, <value>

Writes to the specified fuses or lock-bits.

Attention!

- Some bit combinations can render your chip useless. Please pay attention to the values and check them in your controller's documentation.
- Set the lock bits only after having executed all other accesses to the chip.
- If you want to work on a chip locked by lock-bits, first execute `target_eraseFlash`. This procedure also resets the lock-bits.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Note:

Some changes to fuses take effect or are visible by `target_readBits` only after a reset. For more information, consult the respective target's manual. For resetting, you can use the procedure `target_restart`.

Parameters:

targetHandle

Target handle for the target to be addressed

index (from manufacturer documentation for ATtiny417/817)

0: WDTCFG

1: BODCFG

2: OSCCFG

3: <invalid>

4: TCD0CFG

5: SYSCFG0

6: SYSCFG1

7: APPEND

8: BOOTEND

9: <invalid>

10: Lock-bits

Note: for lock-bits, the constant `LOCK_BITS` can be used.

value

Fuse or lock bits combination to be written as byte.

Return value:

- none (procedure)

Exceptions:

`targetWrongMode`

`targetCommunication`

`apiValueRange`

`invalidHandle`

`apiTypeFault`

Target is not in "ProgramMode".

Communication with the target does not work.

Invalid value for index or value

Target handle or bus have already been closed.

Invalid type for one of the parameters.

3.14 Target Atmel AVR32 (aWire-Interface)

All functions of chapters „Target in General“ to „Erase, Write, Read and Verify Target“, including all subchapters, are supported.

No loader is used.

MemTypes:

Supported memTypes for writing:

- FLASH
- RAM

Supported memTypes for reading:

- FLASH
- RAM
- READMEMORY

3.14.1 target_getDeviceId

```
id = target_getDeviceId(<targetHandle>)
```

Reads the target's signature / device ID. This can be used to distinguish between different controllers.

Note:

Use of the terms "device ID" and "signature" varies throughout the manufacturer's documents, depending on the controller. Independent of this, roloFlash documentation uses the term "device ID" exclusively.

Prerequisites:

- valid target handle
- target has to be in ProgramMode.

Parameters:

targetHandle

Target handle for the target to be addressed

Return value:

Read out device ID or signature. The device ID gets returned in a byte-array with 4 bytes. This device ID can be compared with a device ID from the target database.

Exceptions:

targetWrongMode	Target is not in "ProgramMode".
targetCommunication	Communication with the target does not work.
invalidHandle	Target handle or bus have already been closed.
apiTypeFault	Invalid type for TargetHandle.

4 Flash-Data

The term "flash data" denotes an internal storage area in roloFlash that can be accessed by the user as follows:

- with file system functions (fs_...)
- with flash data specific functions (fd_...)

This storage area (flash data) is subdivided into two sections:

- flash disk (constant: FLASHDISK)
- flash vars (constant: FLASHVARS)
(Vars as abbreviation of "Variables")

which come in different size variants, depending on the roloFlash model:

Model	Flash Disk*	Flash Vars
roloFlash 2	640 kByte singleBuffer - or - 256 kByte doubleBuffer	16 kByte doubleBuffer
roloFlash 2 AVR	640 KByte singleBuffer - or - 256 kByte doubleBuffer	16 kByte doubleBuffer

*Flash disk: the specified size applies to this release. It is possible that there will be other firmwares for roloFlash, that will implement other features, at the expense of the size of the flash disk. Flash vars are not affected by this.

Technical differences between flash disk and flash vars

- size
- flash vars cannot be reconfigured to singleBuffer

Use as file system

In both storage areas you can create, read, write files as can be expected in a file system. The appropriate functions are described in the next chapter, "Files". Flash disk and flash vars will generally behave like an SD card.

If the RUN_V07.BIN file and the data to be flashed onto the target both reside in the flash disk, you can completely do without using an SD card. A RUN_V07.BIN file present on flash disk will take precedence over a potentially present RUN_V07.BIN on SD card.

Other functions

Additionally, you can save arbitrary values under arbitrary IDs in these internal storage areas.

Requirements for IDs:

- Numbers, or
- arrays of char (strings, without restrictions on the characters used), maximally 511 characters, case-sensitive, '/' is different from '\'

Possible values:

- Numbers, or
- arrays of char, arrays of int or arrays of long (except for vari-arrays)

CRC

Furthermore, values can be safeguarded with a CRC32, which will be automatically checked when reading a value..

Internal representation

The flash disk and flash vars storage areas are part of the internal flash storage of roloFlash. This internal flash storage is organized in sectors which can only be erased completely, a process that leads to ageing of the flash cells. The microcontroller manufacturer guarantees 10,000 erase cycles.

For this reason, quite some effort has been spent saving data in these storage areas as efficiently as possible, to prevent these erase cycles to occur too often.

Increment type

Oftentimes, values need to be stored that get incremented or decremented by one time and time again. For especially efficient storage of such values, the size of a bit field can be specified upon creation. This way, incrementing or decrementing by one can be done by erasing a single bit internally. With such a variable, you can implement a flash-cycle counter extremely efficiently.

DoubleBuffer versus SingleBuffer

In **doublebuffer mode** the storage area is subdivided into two equally large blocks, where one block is always free. Therefore, there is less storage space available. However, space occupied by deleted or overwritten data will be freed again. Areas to be erased are marked internally. When a write operation cannot be executed anymore, all data will be copied to the other block and thusly, space occupied by deleted or overwritten data will be re-

claimed. Afterwards, the write operation will be conducted. Before changing the storage block, roloFlash checks, if the write operation will be possible after the change. If that is not the case, the change will not be executed, as it does not lead to desired state.

In **singlebuffer mode** all of the storage area is contained in a single block. Therefore, space occupied by deleted or overwritten data cannot be reclaimed (except by `fd_format`). However, even in singlebuffer mode, the doublebuffer algorithm will be used as long as possible. Thusly, you *can* reclaim space occupied by deleted or overwritten data, but just while there is still enough space to operate in doublebuffer mode internally.

Simulation of flash data functions for SD card

For many functions and procedures described in this chapter, a similar behavior will be simulated while using an SD card.

This enables testing processes with an SD card first and deploying them in flash disk or flash vars.

<fileName> and <id>

Many file access functions (starting with "fs_", see next chapter) require a parameter <fileName> for the file name.

This parameter corresponds to the parameter <id> for many flash data functions (starting with "fd_" in this chapter).

If the chosen IDs conform to the file name requirements, both file access functions and flash data functions can be used to access the data.

Atomic operations

Many functions are atomic: If a function designated as "atomic" is interrupted by a failing power supply for roloFlash, the following is guaranteed:

- Data has been completely processed and stored.

or

- Data has not been stored at all (no changes).

This behavior is only valid for flash data, not for SD card.

Intended purpose of flash disk versus flash vars

- Flash disk: Should be used mainly for larger and infrequently over-written files like images for flashing or RUN_V07.BIN.
- Flash vars: Should be used mainly for smaller pieces of information, like counters etc.

4.1 fd_write

```
fd_write <fileSystem>, <id>, <data>, <countingBytes>,  
<crcMode>
```

Writes data with the specified ID. When `id` points to already existing data, the existing data will be replaced. `countingBytes` can be used to specify the size of a bit field. A CRC can be set.

Atomic:

- yes (behavior for SD card unspecified): In case of a power outage, data is either completely taken over or not at all.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed. Possible values are:

SDCARD: A file will be created on SD card, which is then used to store the specified information. The file format used is specific to rolo-Flash. The bitfield provided for the increment type in flash data will not be created, but only simulated in its function.

FLASHVARS FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-system, id must be a valid file name for SD card.

data

A number or an array of byte, array of int or array of long. For arrays of byte, data can also be accessed using file system functions (starting with "fs_").

countingBytes

(optional, values greater than 0 are only allowed, if <data> is a number, default = 0) For values greater than 0, an increment type is created, and (at least) the number of bytes for the bit field is reserved. For recurring calls of this function, this parameter does not have to be specified, otherwise, it should have the same value. In this case, roloFlash tries to represent the value internally by unsetting bits in the bit field. If this is not possible, the increment type will be created anew. Therefore, you do not need to pay attention whether the bit field is sufficient for storing a value or not.

With the increment type, values getting incremented or decremented often can be stored extremely efficiently, e.g. for use as a flash cycle counter.

crcMode

(optional, default = NOCRC)

Possible values are:

NOCRC

USECRC (not applicable with increment type): A CRC32 checksum is calculated and stored

Return value:

- none (procedure)

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.2 fd_createArray

fd_createArray <fileSystem>, <id>, <size>, <type>, <crcMode>

Creates an empty array of specified type and size. A CRC can be allowed for (but not set). The array gets initialized with zeros.

Atomic:

- yes (behavior for SD card unspecified): In case of a power outage, data is either completely taken over or not at all.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed. Possible values are:

SDCARD: A file will be created on SD card, which is then used to store the specified information. The file format used is specific to roloFlash.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, id must be a valid file name for SD card.

size

Size in elements.

type

CHAR: Creates an array of char.

INT: Creates an array of int.

LONG: Creates an array of long.

crcMode

(optional, default = NOCRC)

Possible values are:

NOCRC

PLANNEDCRC: Since the array has not yet been written to, the CRC cannot yet be calculated. This reserves the appropriate space for a CRC to be added later. The CRC can later be calculated and stored by means of `fd_setCrc`.

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.3 `fd_writeArrayElem`

`fd_writeArrayElem` <fileSystem>, <id>, <index>, <data>

Overwrites data in the already present array specified by `id` at position `index`.

You can only set bits in the process. Otherwise, an exception (`flashWriteError`) will be set. If the array has been created using `fd_createArray`, all values are set to zero initially. This guarantees that every position can be written to at least once.

Atomic:

- yes (behavior for SD card unspecified): In case of a power outage, data is either completely taken over or not at all.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are:

SDCARD: The specified change will be stored in the file already present on SD card. The file format used is specific to roloFlash.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, id must be a valid file name for SD card.

index

Position where data should be written to.

data

Number within the value range of the array type.

Note regarding CRC:

As this procedure changes the array, no CRC must be set. Therefore, the array must have been created by either `fd_write` without CRC or by `fd_createArray`. The procedure `fd_setCrc` must not yet have been called.

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.4 fd_writeSubArray

fd_writeSubArray <fileSystem>, <id>, <index>, <data>

Overwrites data in the already present array specified by `id` at position `index`.

You can only set bits in the process. Otherwise, an exception (`flashWriteError`) will be set, in this case data remains completely untouched. If the array has been created using `fd_createArray`, all values are set to zero initially. This guarantees that every position can be written to at least once.

Atomic:

- no (behavior for SD card unspecified): In case of a power outage, array data might only partly be taken over.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are:

SDCARD: The specified change will be stored in the file already present on SD card. The file format used is specific to roloFlash.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, id must be a valid file name for SD card.

index

Position for begin of data to be written.

data

An array of the same type.

Note regarding CRC:

As this procedure changes the array, no CRC must be set. Therefore, the array must have been created by either `fd_write` without CRC or by `fd_createArray`. The procedure `fd_setCrc` must not yet have been called.

Return value:

- none (procedure)

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.5 `fd_read`

```
data = fd_read(<fileSystem>, <id>, <crcMode>)
```

Reads the data stored under the specified ID.

Atomic:

- Pure read function

Prerequisites:

- Data must be present under the specified ID. On SD cards, the data must be in the roloFlash specific format, i.e. having been created by `fd_write` or `fd_createArray`.

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, `id` must be a valid file name for SD card.

crcMode

(optional, default = TRYCRC)

Possible values are:

NOCRC: CRC does not have to be present. Will be ignored, if present.

TRYCRC: CRC does not have to be present. Will be evaluated, if present.

USECRC: CRC must be present and will be evaluated.

Return value:

- the requested data

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.6 fd_readArrayElem

```
value = fd_readArrayElem(<fileSystem, <id>, <index>, <crcMode>)
```

Reads an element from the array specified by id.

Atomic:

- Pure read function

Prerequisites:

- Data must be present under the specified ID. On SD cards, the data must be in the roloFlash specific format, i.e. having been created by fd_write or fd_createArray.

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions fd_write or fd_createArray.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, id must be a valid file name for SD card.

index

Eine Position innerhalb des Arrays, von der der Wert gelesen werden soll. Der Index muss sich innerhalb des Arrays befinden.

crcMode

(optional, default = TRYCRC)

Possible values are:

NOCRC: CRC does not have to be present. Will be ignored, if present.

TRYCRC: CRC does not have to be present. Will be evaluated, if present.

USECRC: CRC must be present and will be evaluated.

Return value:

- The requested value

Note:

Under the specified ID, data with one of the array types must be present.

Exceptions:

dataTypeError
<various file system
exceptions>

Attempted access to data not of array type.
See chapter „File System Exceptions“.

4.7 fd_readSubArray

```
data = fd_readSubArray(<fileSystem, <id>, <index>,  
<size>, <crcMode>)
```

Returns a subarray of the array specified by id.

Atomic:

- Pure read function

Prerequisites:

- Data must be present under the specified ID. On SD cards, the data must be in the roloFlash specific format, i.e. having been created by `fd_write` or `fd_createArray`.

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, `id` must be a valid file name for SD card.

index

Position within array, from which the data should be read.

size

Size of requested area (number of elements). The area specified by `index` and `size` must be within the array.

crcMode

(optional, default = TRYCRC)

Possible values are:

NOCRC: CRC does not have to be present. Will be ignored, if present.

TRYCRC: CRC does not have to be present. Will be evaluated, if present.

USECRC: CRC must be present and will be evaluated.

Return value:

- Array with the requested data.

Note:

Under the specified ID, data of one of the array types must be present.

Exceptions:

dataTypeError	Attempted access to data not of array type.
<various file system exceptions>	See chapter „File System Exceptions“.

4.8 fd_remove

fd_remove <fileSystem>, <id>

Deletes data stored under the specified ID.

Atomic:

- yes (behavior for SD card unspecified): In case of a power outage, data is either completely taken over or not at all.

Note:

- the procedure corresponds to fs_remove, with the only difference being able to specify a number for id in this procedure.

Prerequisites:

- SD card: The file specified by id must be open.

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are:

SDCARD, FLASHVARS and FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, `id` must be a valid file name for SD card.

Return value:

- none (procedure)

Exceptions:

`fileNotFound`

The specified file does not exist.

`fileIsOpen`

The specified file is still open.

<various file system exceptions>

See chapter „File System Exceptions“.

4.9 `fd_getItemCount`

```
count = fd_getItemCount(<fileSystem>)
```

Determines number of stored elements.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are (SD card is not supported):

FLASHVARS and **FLASHDISK**

Return value:

- Number of stored elements.

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.10 fd_getId

id = fd_getId(<fileSystem>, <index>)

Determines the ID of the stored element with the specified index.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are (SD card is not supported):
FLASHVARS and **FLASHDISK**

Return value:

- ID of the stored element with the specified index.

Note:

- Together with the function fd_getItemCount, all stored elements can be accessed.

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.11 fd_idExists

```
found = fd_idExists(<fileSystem>, <id>)
```

Determines if something is stored under the specified ID.

Atomic:

- Pure read function

Note:

- the function corresponds to fs_fileExists, with the only difference being able to also specify a number for id in this function.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, id must be a valid file name for SD card.

Return value:

0 = file does not exist

1 = file exists

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.12 fd_isArray

isArray = fd_isArray(<fileSystem>, <id>)

Determines if an array is stored under the specified ID.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions fd_write or fd_createArray.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, id must be a valid file name for SD card.

Return value:

0 = no array (number or increment type)

1 = array of char, int or long

4.13 fd_getArraySize

```
size = fd_getArraySize(<fileSystem>, <id>
```

Determines number of elements for array specified by id.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions fd_write or fd_createArray.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, id must be a valid file name for SD card.

Return value:

- Number of elements

Note:

Under the specified ID, data of one of the array types must be present.

Exceptions:

dataTypeError	Attempted access to data not of array type.
<various file system exceptions>	See chapter „File System Exceptions“.

4.14 fd_getType

```
myType = fd_getType(<fileSystem>, <id>)
```

Determines the type of the number or array stored under *id*.

A number is stored under *id*:

char, int or long, depending on the current value of the number

An array is stored under *id*:

char, int or long, depending on the type of the array elements

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card

which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS
FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-system, `id` must be a valid file name for SD card.

Return value:

- Type of data or type of elements for an array.

4.15 `fd_getCountingBytes`

```
count = fd_getCountingBytes(<fileSystem>, <id>)
```

For an increment type, this returns how many bytes have been reserved for the bit field. The number might be slightly larger than originally requested. For all other types, this function returns 0.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, id must be a valid file name for SD card.

Return value:

- Number of bytes for the bitfield for increment type.

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.16 fd_setCrc

fd_setCrc <fileSystem>, <id>

Sets the CRC. The CRC must have been allowed for beforehand when using fd_createArray with the parameter PLANNEDCRC. If the CRC has been set already and is wrong, an exception is generated.

Atomic:

- yes (behavior for SD card unspecified): In case of a power outage, the CRC is either set or remains unset.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, `id` must be a valid file name for SD card.

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.17 `fd_getCrc`

```
crc = fd_getCrc(<fileSystem>, <id>)
```

Returns stored CRC, or 0, if the CRC has not been set yet.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS

FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, `id` must be a valid file name for SD card.

Return value:

- if CRC has been set: value of stored CRC

- otherwise: 0

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.18 `fd_calcCrc`

```
crc = fd_calcCrc(<fileSystem>, <id>)
```

Calculates CRC for data specified by id. This can also be executed if a CRC was not provided for.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS
FLASHDISK

id

A number or an array of byte. If SDCARD was specified as file-System, `id` must be a valid file name for SD card.

Return value:

- calculated CRC

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.19 fd_hasCrc

```
hasCrc = fd_hasCrc(<fileSystem>, <id>)
```

Determines if space for a CRC has been reserved for data specified by `id`.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD: Reads the desired information from a file on SD card which was previously created by roloFlash through functions `fd_write` or `fd_createArray`.

FLASHVARS
FLASHDISK

id

A number or an array of byte. If SDCARD was specified as fileSystem, `id` must be a valid file name for SD card.

Return value:

0 = no CRC provided for

1 = CRC provided for

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.20 fd_getFreeMem

size = fd_getFreeMem(<fileSystem>)

Determines remaining free memory.

Note:

The behavior differs, depending on buffering mode: With doublebuffer mode (and, as long as it is still possible in singlebuffer mode), memory of deleted or overwritten data is available immediately.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed. Possible values are (SD card is not supported):

FLASHVARS and **FLASHDISK**

Return value:

Size of free memory in bytes.

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.21 fd_getBytesWritten

```
count = fd_getBytesWritten(<fileSystem>)
```

Determines how many bytes in the specified storage area were written during the current power cycle. This enables an assessment of the effect on flash memory ageing. E.g. incrementing or decrementing an increment type has no influence on the result of this function, as long as the bitfield can still store changes.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are (SD card is not supported):
FLASHVARS and **FLASHDISK**

Return value:

Number of bytes written within this power cycle.

Exceptions:

<various file system exceptions> See chapter „File System Exceptions“.

4.22 fd_setSingleBufferMode

fd_setSingleBufferMode <fileSystem>, <value>

Reconfigures the memory area to doublebuffering or singlebuffering mode. This happens without data loss. If this is not possible without losing data, an exception is generated. In this case, data has to be deleted first, otherwise, the memory area has to be formatted.

Atomic:

- Yes, switching modes will either be done completely or not at all. It is also possible that switching will be completed upon next power up.

Prerequisites:

- Enough space to organize the data accordingly.

Parameters:

fileSystem

Specifies on which file system the procedure should be executed. Possible values are (flash vars and SD card are not supported):
FLASHDISK

value

Boolean:

- 0: Memory will be switched to double buffering.
- 1: Memory will be switched to single buffering.

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.23 fd_getSingleBufferMode

```
value = fd_getSingleBufferMode(<fileSystem>)
```

Determines if the specified storage area is set to singlebuffer or doublebuffer mode.

Atomic:

- Pure read function

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are (SD card is not supported):

FLASHVARS and **FLASHDISK**

Return value:

0 = doublebuffer mode

1 = singlebuffer mode

Exceptions:

<various file system
exceptions>

See chapter „File System Exceptions“.

4.24 fd_cleanup

fd_cleanup <fileSystem>

Physically overwrites deleted or overwritten values in memory (security feature).

Atomic:

- no: in case of a power outage, it is possible that only a part of the obsolete data has been overwritten.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are (SD card is not supported):
FLASHVARS and **FLASHDISK**

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

4.25 fd_format

fd_format <fileSystem>

Removes all data. As a security feature, data is physically overwritten in flash memory.

Atomic:

- no: in case of a power outage, it is possible that only a part of the obsolete data has been overwritten.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are (SD card is not supported):
FLASHVARS and **FLASHDISK**

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

5 Files

File Systems:

Depending on the roloFlash version, the following file systems can be accessed:

- SD card (constant: SDCARD)
- Flash vars (constant: FLASHVARS)
- Flash disk (constant: FLASHDISK)

Requirements for file names for the SD card:

- Filenames must follow the 8.3 rule: „XXXXXXXX.YYY“.
- Only characters „A“ - „Z“, „0“ - „9“, „_“ and „-“ are valid.
- Letters must be capital letters.

Requirements for directory names for the SD card:

- Directory names may contain eight characters at most: „XXXXXXXX“.
- Otherwise, the same conventions as for filenames apply.
- '/' (recommended) and '\' are treated equally.

Requirements for IDs (file names and directory names) for flash data:

- You can use arbitrary strings (array of char) or numbers.
- For strings, all characters are allowed (incl. 0-character, Carriage return and Linefeed), case-sensitive. Characteres "/" and "\" are differentiated.

Current directory is always the root directory:

- There is no „change directory“. The current path is always the root directory. Thusly, a filename must always contain the complete path.
- Both „/“ and „\“ are supported separators for separating directories and file names within a path.

ATTENTION:

We recommend using "/" as path separator instead of "\" (used under DOS and Windows).

If you want to use "\" as path separator, you have to double each occurrence of "\" (escape it), e.g "mysubdir\\myfile.txt".

All functions start with the prefix "fs_" ("fileSystem").

5.1 fs_mediaExists

```
bool fs_mediaExists(<fileSystem>)
```

Check if specified medium exists.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the function should be executed. Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

Note:

- **SDCARD:** Determines if an SD card is plugged in.
- **FLASHVARS:** Determines if the memory area FLASHVARS exists.
- **FLASHDISK:** Determines if the memory area FLASHDISK exists.

Return value:

0 = Medium does not exist

1 = Medium exists

Exceptions:

<various file system exceptions>

See chapter „File System Exceptions“.

5.2 fs_create

`fs_create <fileSystem>, <fileName>, <size>`

Creates the specified file. Afterwards, the file is still closed. If the file already exists, this procedure has no effect.

If you want to create a file and write something to it, you have to additionally open it:

```
fs_create SDCARD, "TEST.TXT"
```

```
handle = fs_open(SDCARD, "TEST.TXT")
```

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

fileName

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

For Flash data: The file name must be a valid ID for Flash data, see „Requirements for IDs“.

size

Size of file to be created; the file is filled with zeros.

For SDCARD: the parameter is optional.

For Flash data: the parameter is required.

Return value:

- none (procedure)

Exceptions:

apiTypeFault
<various file system
exceptions>

Invalid type for fileName.
See chapter „File System Exceptions“.

5.3 fs_rename

fs_rename <fileSystem>, <fileNameOld>, <fileNameNew>

Rename a file.

Prerequisites:

- <fileNameNew> must not exist previously.
- For SD card: If <fileNameOld> and <fileNameNew> contain paths, then they must be identical.
For Flash data: No limitations.

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

fileNameOld, fileNameNew

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

For Flash data: The file name must be a valid ID for Flash data, see „Requirements for IDs“.

Return value:

- none (procedure)

Exceptions:

FileNotFound

The specified file does not exist.

filesOpen

The specified file is still open.

<various file system

See chapter „File System Exceptions“.

exceptions>

5.4 fs_remove

`fs_remove <fileSystem>, <fileName>`

Remove the specified file or directory, if present.

Prerequisites:

- SD card: the file must not be open.

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

fileName

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

For Flash data: The file name must be a valid ID for Flash data, see „Requirements for IDs“.

Return value:

- none (procedure)

Exceptions:

fileNotFound

The specified file does not exist.

fileIsOpen

The specified file is still open.

<various file system exceptions>

See chapter „File System Exceptions“.

5.5 fs_mkDir

fs_mkDir <fileSystem>, <dirName>

Creates the specified directory. If it already exists, this procedure has no effect.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed. Possible values are:

SDCARD (FLASHVARS and FLASHDISK unsupported, no error message will be generated).

For compatibility, a value of "0" is synonymous to SDCARD.

Note regarding FLASHVARS and FLASHDISK:

Nevertheless you can use file names containing "/" anywhere for all flash data IDs and flash data file names, thereby emulating a file system hierarchy.

dirName

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

Return value:

- none (procedure)

Exceptions:

apiTypeFault
<various file system
exceptions>

Invalid type for dirName.
See chapter „File System Exceptions“.

5.6 fs_fileExists

```
bool fs_fileExists(<fileSystem>, <fileName>)
```

Checks if the specified file exists.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

fileName

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

For Flash data: The file name must be a valid ID for Flash data, see „Requirements for IDs“.

Return value:

0 = File does not exist

1 = File exists

Exceptions:

apiTypeFault
<various file system
exceptions>

Invalid type for fileName.
See chapter „File System Exceptions“.

5.7 fs_filesize

size = fs_filesize(<fileSystem>, <fileName>)

Determines the size of the specified file.

Prerequisites:

- File exists.

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and **FLASHDISK**

For compatibility, a value of "0" is synonymous to SDCARD.

fileName

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

For Flash data: The file name must be a valid ID for Flash data, see „Requirements for IDs“.

Return value:

Size of file in bytes.

Note:

When accessing FlashVars or FlashDisk, data of type "array of byte" must be present under the specified file name.

Exceptions:

apiTypeFault

Invalid type for fileName.

dataTypeError

Attempted access to data not of type "array of bytes" (on FlashVars or FlashDisk).

<various file system exceptions>

See chapter „File System Exceptions“.

5.8 fs_open

```
fileHandle = fs_open(<fileSystem>, <fileName>)
```

Opens the specified file.

Prerequisites:

The file must already exist. If a new file should be opened, fs_create must be used beforehand.

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

fileName

For SD cards: The requirements for file names for SD cards apply, see „Requirements for file names“.

For Flash data: The file name must be a valid ID for Flash data, see „Requirements for IDs“.

Return value:

File handle for accessing the file (e. g. for `fs_read` and `fs_write`).
The file handle is also necessary for closing the file (`fs_close`).

Note:

When accessing FlashVars or FlashDisk, data of type "array of byte" must be present under the specified file name.

Exceptions:

`apiTypeFault`
`dataTypeError`

Invalid type for fileName.

Attempted access to data not of type "array of bytes" (on FlashVars or FlashDisk).

<various file system exceptions>

See chapter „File System Exceptions“.

5.9 fs_read

```
a = fs_read(<fileHandle>, <position>, <count>)
```

Reads specified number of bytes from given file.

Prerequisites:

- Valid Filehandle (by means of `fs_open`).

Parameters:

fileHandle

The file handle returned by `fs_open`.

position

Byte position that should be read from.

count

Number of bytes to be read.

Return value:

Array of byte with the data read out. The array has size `count`. If not enough data could be read, the array is accordingly smaller. If you try to read at the or after the end of file, an empty array with size 0 will be returned.

Exceptions:

<code>apiValueRange</code>	Invalid value for <code>fileHandle</code> , <code>position</code> or <code>count</code> .
<code>apiTypeFault</code>	Invalid type for <code>fileHandle</code> , <code>position</code> or <code>count</code> .
<code><various file system exceptions></code>	See chapter „File System Exceptions“.

5.10 fs_write

`fs_write <fileHandle>, <position>, <array>`

Writes the specified data into the given file.

Should the position be out of the current file size, the file gets filled with random data up to that position.

Prerequisites:

- Valid Filehandle (returned by `fs_open`).

Parameters:

fileHandle

The FileHandle returned by `fs_open`.

position

Byte position that should be written to.

array

Array of byte with the data to be written.

Return value:

- none (procedure)

Exceptions:

<code>apiValueRange</code>	Invalid value for fileHandle, position or count.
<code>apiTypeFault</code>	Invalid type for fileHandle, position or count.
<code><various file system exceptions></code>	See chapter „File System Exceptions“.

5.11 `fs_truncate`

`fs_truncate <fileHandle>, <len>`

Truncates the file to the specified length. If the file is already smaller, this procedure has no effect.

Prerequisites:

- Valid Filehandle (returned by `fs_open`).

Parameters:

fileHandle

The file handle returned by `fs_open`.

len

Length that the file should be truncated to.

Return value:

- none (procedure)

Exceptions:

apiValueRange	Invalid value for fileHandle.
apiTypeFault	Invalid type for fileHandle or len.
<various file system exceptions>	See chapter „File System Exceptions“.

5.12 fs_close

fs_close <fileHandle>

Closes the file. This invalidates the given Filehandle, which thusly must not be used anymore.

Prerequisites:

- Valid file handle (returned by fs_open).

Parameters:

fileHandle

File handle returned by fs_open.

Return value:

- none (procedure)

Exceptions:

apiValueRange	Invalid value for fileHandle.
apiTypeFault	Invalid type for fileHandle.
<various file system exceptions>	See chapter „File System Exceptions“.

5.13 fs_sync

fs_sync <fileSystem>

Ensures that all data not yet written to the microSD card now does get written to it. It is recommended to call this procedure, if write accesses to the card occur.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.

Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility, a value of "0" is synonymous to SDCARD.

Return value:

- none (procedure)

Exceptions:

<various file system exceptions>	See chapter „File System Exceptions“.
----------------------------------	---------------------------------------

6 LEDs

Always only one LED simultaneously:

- Within roloBasic, only 1 LED can be lit at any one time, in order to reduce the current load of the target as much as possible.

Numbering and Colors:

- The LED numbering in roloBasic is the same as on the roloFlash case.
- The LEDs can be lit green or red. For this, the constants `COLOR_GREEN` and `COLOR_RED` are available.

Non-blocking:

- All procedures in this chapter are non-blocking. This means, e. g. that a running light activated by `led_runningLight` runs in parallel to the subsequent execution of roloBasic.

6.1 led_on

```
led_on <index>, <color>
```

Makes the given LED light up in the specified color.

Prerequisites:

- none

Parameters:

index

Number of LED

color

`COLOR_GREEN` or `COLOR_RED`

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for index or color.
Invalid type for index or color.

6.2 led_off

led_off

Turns off all LEDs.

Prerequisites:

- none

Parameters:

- none

Return value:

- none (procedure)

Exceptions:

- none

6.3 led_blink

led-blink <index>, <color>, <speed>

Makes given LED flash with the given speed.

Prerequisites:

- none

Parameters:

index

Number of LED

color

COLOR_GREEN or COLOR_RED

speed

Speed of flashing in ms

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for index, color or speed.
Invalid type for index, color or speed.

6.4 led_runningLight

led_runningLight <from>, <to>, <color>, <speed>

Starts a running light.

Prerequisites:

- none

Parameters:

from, to

The running light runs from LED 'from' to LED 'to'.
If 'from' is smaller than 'to', the light runs in the other direction.
If 'from' equals 'to', one LED is lit permanently.

color

COLOR_GREEN or COLOR_RED

speed

Speed of flashing in ms.

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for from, to, color or speed.
Invalid type for from, to, color or speed.

6.5 led_runningLightOutstanding

```
led_runningLightOutstanding <from>, <to>, <color>,  
<speed>, <outstandingLedNumber>
```

Starts a running light with the specified LED having the opposite color.

Prerequisites:

- none

Parameters:

from, to

The running light runs from LED 'from' to LED 'to'.
If 'from' is smaller than 'to', the light runs in the other direction.
If 'from' equals 'to', one LED is lit permanently.

color

COLOR_GREEN or COLOR_RED

speed

Speed of flashing in ms

outstandingLedNumber

Number of LED that lights up in opposite color.

Return value:

- none (procedure)

Exceptions:

apiValueRange	Invalid value for from, to, color, speed or outstandingLedNumber.
apiTypeFault	Invalid type for from, to, color, speed or outstandingLedNumber.

7 SecureApi

roloFlash can:

- calculate CRC32 checksums: **sec_crc**
- calculate hashes (MD5 and SHA1): **sec_hash**
- encrypt and decrypt data (AES 128, 192 and 256):
sec_encrypt and **sec_decrypt**
- flash encrypted files: **target_writeFromFile**
- execute encrypted roloBasic scripts: **chain**

Optional parameter „opstate“

For the first 3 of the aforementioned functions, there is an optional parameter „opstate“. It is used for marking start and end of data, for larger or non-contiguous data:

- **SEC_SINGLEBLOCK** (default): Data consists of only one block. This is the default value, and therefore is assumed if "opstate" is not specified. Furthermore, it is identical to the sum of SEC_FIRSTBLOCK and SEC_LASTBLOCK.
- **SEC_FIRSTBLOCK**: Must be set for the first block of data; a new calculation will start.
- **SEC_NEXTBLOCK**: The block is neither the first nor the last block in a calculation.
- **SEC_LASTBLOCK**: Must be set for the last block of data, in order to finish the calculation.

For encryption and decryption:

Cryptspec is used in the following functions:

- decrypt / encrypt
- target_writeFromFile
- chain

cryptSpec:

cryptSpec is a Vari-Array containing exactly two more Vari-Arrays: **algoSpec** and **dataSpec**.

algoSpec:

algoSpec is a Vari-Array with following parameters:

- **algo(-rithm)**: currently, only AES is supported. Must always be the constant SEC_AES.
- **width**: key length; valid values are 128, 192 and 256.
- **mode**: the AES mode.

- **SEC_ECB:** electronic code book mode. Every block gets encrypted individually.
https://de.wikipedia.org/wiki/Electronic_Code_Book_Mode
- **SEC_CBC:** cipher block chaining mode. Before encrypting the first block, an additional initialization vector gets XORed with the clear text. For all other blocks, the encryption result of the previous block gets XORed with the clear text.
https://de.wikipedia.org/wiki/Cipher_Block_Chaining_Mode
- **SEC_CTR:** counter mode. Instead of the clear text, a counter gets encrypted; 0 for the first block, then 1 etc. The result gets XORed with the clear text. With this mode, you are not bound to block sizes, as the data gets not processed by the algorithm. Instead, the algorithm creates a bit stream, that is used for XORing with the data. Padding is thusly neither necessary nor recommended.
https://de.wikipedia.org/wiki/Counter_Mode

dataSpec:

- dataSpec is a Vari-Array with following parameters:
- **key:** an array of char, array of int or array of long (except for vari-Array), which contains the key.
- **iv:** (only for algoSpec mode SEC_CBC and SEC_CTR). An array of char, array of int or array of long (except for vari-Array), which contains the initialization vector.
- **padding:** padding with optional PKCS7:
https://en.wikipedia.org/wiki/PKCS_7
Depending on the individual function and on whether it is a decryption or encryption, there are different possibilities.
 - **0-15:** number of bytes to ignore after decryption.
 - **SEC_NOPADDING:** do not apply padding. Recommended for SEC_CTR.
 - **SEC_PKCS7:** After decryption, data gets truncated according to PKCS7 padding. If the data does not conform to PKCS7, an exception "paddingError" is generated. For encryption, padding bytes will be appended beforehand, so the necessary block size is reached.

7.1 sec_crc

```
crcValue = sec_crc(<array>, <crcSpec>, <opstate>)
```

or

```
crcValue = sec_crc(<fileSystem>, <fileName>, <crcSpec>,  
<opstate>)
```

Calculate the **CRC-32** for an array or a file.

Prerequisites:

- none

Parameters:

array (for data)

An array of char, array of int or array of long (except for vari-Array), which contains the data.

fileSystem (or for file)

Specifies on which file system the file resides. Possible values:
SDCARD, FLASHVARS, FLASHDISK.

fileName (or for file)

The requirements for file names apply, see chapter „[Flash-Data](#)“.

crcSpec

Specify constant **SEC_CRC32**.

opstate

(optional)

Required to calculate the CRC of the entirety of multiple pieces of data.

Return value:

- CRC Wert (auch als Zwischenergebnis bei opstate SEC_FIRSTBLOCK oder SEC_NEXTBLOCK)

Note:

- Using **opstate**, the CRC value of the entirety of multiple arrays and files (even mixed) can be calculated.

Exceptions:

secError	- general error during calculation - opstate was specified as SEC_NEXTBLOCK or SEC_LASTBLOCK, without prior usage of SEC_FIRSTBLOCK.
apiValueRange	Invalid value for crcSpec or opstate.
apiTypeFault	Invalid type for a parameter.

7.2 sec_hash

hashArray = sec_hash(<array>, <hashSpec>, <opstate>)

or

crcValue = sec_crc(<fileSystem>, <fileName>, <hashSpec>, <opstate>)

Calculates the **MD5 hash** or **SHA1 hash** for an array or a file. Hash functions can be used in roloBasic in order to calculate HMAC hashes (hashes with keys).

Prerequisites:

- none

Parameters:

array (for data)

An array of char, array of int or array of long (except for vari-Array), which contains the data.

fileSystem (or for file)

Specifies on which file system the file resides. Possible values:
SDCARD, FLASHVARS, FLASHDISK.

fileName (or for file)

The requirements for file names apply, see chapter „Flash-Data“.

hashSpec

Specify constant **SEC_MD5** or **SEC_HASH**.

opstate

(optional)

Required to calculate hash value of the entirety of multiple pieces of data.

Return value:

- 0 for opstate SEC_FIRSTBLOCK or SEC_NEXTBLOCK
- hash value in all other cases

Note:

- Using **opstate**, the CRC value of the entirety of multiple arrays and files (even mixed) can be calculated. This enables calculation of HMAC.

Exceptions:

- | | |
|---------------|---|
| secError | - general error during calculation
- opstate was specified as SEC_NEXTBLOCK or SEC_LASTBLOCK, without prior usage of SEC_FIRSTBLOCK. |
| apiValueRange | Invalid value for hashSpec or opstate. |
| apiTypeFault | Invalid type for a parameter. |

7.3 sec_encrypt

sec_encrypt <array>, <cryptSpec>, <opstate>

Encrypt data in specified array using cryptSpec and the optional opstate.

Prerequisites:

- none

Parameters:

array

An array of char, array of int or array of long (except for vari-Array), which contains the data. The length of the data must be a multiple of the block size of the encryption (AES: 16 bytes).

Exceptions:

- dataSpec within cryptSpec contains SEC_PKCS7 as padding algorithm, and it is the last block of data to be encrypted (i.e. opstate not specified or specified as SEC_SINGLEBLOCK or SEC_LASTBLOCK).
- cryptSpec contains SEC_CTR as algoSpec, and dataSpec in cryptSpec contains SEC_NOPADDING as padding algorithm, and it is the last block of data to be encrypted (i.e. opstate not specified or specified as SEC_SINGLEBLOCK or SEC_LASTBLOCK).

cryptSpec

Contains information about the encryption, including the key. The definition can be found at the beginning of chapter "SecureAPI".

opstate

(optional)

Required for encrypting the entirety of multiple pieces of data.

Return value:

- none (procedure)

Note:

- When using PKCS7, it is recommended to create the array with a reserve of 16 bytes, as the array can grow due to the padding. This facilitates the internal memory management. Example for 1024 bytes:

```
array = reserve(char, 1024 + 16)  
resize array , 1024
```

- The encryption works on data in arrays. The roloBasic script collection contains a function for encrypting and decrypting files.

Exceptions:

cryptError	- general error during calculation - opstate was specified as SEC_NEXTBLOCK or SEC_LASTBLOCK, without prior usage of SEC_FIRSTBLOCK.
secParamError	The specified cryptSpec is faulty.
apiValueRange	Invalid value for hashSpec or opstate.
apiTypeFault	Invalid type for a parameter.

7.4 sec_decrypt

sec_decrypt <array>, <cryptSpec>, <opstate>

Decrypt data in specified array using cryptSpec and optional opstate.

Prerequisites:

- none

Parameters:

array

An array of char, array of int or array of long (except for vari-Array), which contains the data. Except for SEC_CTR, the length of the data must be a multiple of the block size of the encryption (AES: 16 bytes).

Exception:

- cryptSpec contains SEC_CTR as algoSpec, and dataSpec in cryptSpec contains SEC_NOPADDING as padding algorithm, and it is the last block of data to be encrypted (i.e. opstate not specified or specified as SEC_SINGLEBLOCK or SEC_LASTBLOCK).

cryptSpec

Contains information about the decryption, including the key. The definition can be found at the beginning of chapter "SecureAPI".

opstate

(optional)

Required for encrypting the entirety of multiple pieces of data.

Return value:

- none (procedure)

Note:

- The encryption works on data in arrays. The roloBasic script collection contains a function for encrypting and decrypting files.

Exceptions:

cryptError	- general error during calculation - opstate was specified as SEC_NEXTBLOCK or SEC_LASTBLOCK, without prior usage of SEC_FIRSTBLOCK.
secParamError	The specified cryptSpec is faulty.
secPaddingError	PKCS7 is specified, but decrypted data does not conform to the PKCS7 encoding.
apiValueRange	Invalid value for hashSpec or opstate.
apiTypeFault	Invalid type for a parameter.

8

9 GPIO Interface

9.1 GPIO_open

```
busHandle = GPIO_open(<index>, <mode>, <level>)
```

Opens one of the GPIO interfaces and initializes the lines. The mode is set as specified. The state of the pin could possibly change.

Note:

- Pins TDO and RTCK can only be used as input.

Prerequisites:

- none

Parameters:

index

- 2 or **GPIO_TMS** for the TMS pin (pin 2)
- 4 or **GPIO_TCK** for the TCK pin (pin 4)
- 6 or **GPIO_TDO** for the TDO pin (pin 6)
- 7 or **GPIO_RTCK** for the RTCK pin (pin 7)
- 8 or **GPIO_TDI** for the TDI pin (pin 8)
- 9 or **GPIO_GNDDDET** for the GND Detect pin (pin 9)
- 10 or **GPIO_RST** for the reset pin (pin 10)

mode

- **PIN_INPUT**: use this pin as input
- **PIN_ACTIVELOW**: use this pin as output, but drive it only active-low.
- **PIN_ACTIVEHIGH**: use this pin as output, but drive it only active-high.
- **PIN_PUSHPULL**: use this pin as output.

level

This value must not be specified for mode = PIN_INPUT. For all other modes, this value denotes the output level for this pin (0 or 1).

Return value:

- A bus handle. This can be used to call other functions like GPIO_set.

Exceptions:

apiValueRange	Invalid value for one of the parameters.
apiTypeFault	Invalid type for one of the parameters.
functionNotSupported	Pins TDO and RTCK can only be used as input.
BadArgumentCount	Number of arguments is wrong. Occurs if: - both mode „PIN_INPUT“ and a level have been specified, - a mode other than „PIN_INPUT“, but no value for „level“ has been specified.
resourceUnavailable	The interface cannot be opened. Possible causes: - the interface has already been opened - another bus has been opened, and cannot be opened simultaneously with this GPIO

9.2 GPIO_setMode

GPIO_setMode <busHandle>, <mode>, <level>

Changes the mode of a GPIO pin. The mode is set as specified. The state of the pin could possibly change.

Prerequisites:

- valid busHandle

Parameters:

busHandle

The busHandle returned by GPIO_open.

mode

- **PIN_INPUT**: use this pin as input
- **PIN_ACTIVELOW**: use this pin as output, but drive it only active-low.
- **PIN_ACTIVEHIGH**: use this pin as output, but drive it only active-high.
- **PIN_PUSHPULL**: use this pin as output.

level

This value must not be specified for mode = PIN_INPUT. For all other modes, this value denotes the output level for this pin (0 or 1).

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault
functionNotSupported
BadArgumentCount

Invalid value for one of the parameters.
Invalid type for one of the parameters.
Pins TDO and RTCK can only be used as input.
Number of arguments is wrong.
Occurs if:
- both mode „PIN_INPUT“ and a level have been specified,
- a mode other than „PIN_INPUT“, but no value for „level“ has been specified.

9.3 GPIO_set

GPIO_set <busHandle>, <level>

Sets the GPIO pin to the specified level.

Prerequisites:

- valid busHandle

Parameters:

busHandle

The bus handle returned by GPIO_open.

level

Output level for this pin (0 or 1)

Return value:

- none (procedure)

Exceptions:

apiValueRange	Invalid value for level
apiTypeFault	Invalid type for one of the parameters.
functionNotSupported	This pin is used as input, therefore, this function cannot be used.

9.4 GPIO_get

```
value = GPIO_get(<busHandle>)
```

Read out the specified GPIO pin.

Prerequisites:

- valid busHandle

Note:

This function is only available, if roloFlash does not drive the line itself:

- with mode = PIN_INPUT
- with mode = PIN_ACTIVELOW and level = 1
- with mode = PIN_ACTIVEHIGH and level = 0

Parameters:

busHandle

The bus handle returned by GPIO_open.

Return value:

- Read out pin:
0: Pin is low

1: Pin is high

Exceptions:

apiTypeFault	Invalid type for busHandle
functionNotSupported	The pin cannot be read out, since roloFlash actively drives it, see above note.

10 Querying roloFlash Properties

Using the following system functions and system constants, you can determine various pieces of information about your roloFlash.

10.1 Version Numbers etc.

Name	Value / Meaning
sys_companyName	„halec < https://halec.de >“
sys_deviceName	„roloFlash 2“ or „roloFlash 2 AVR“
sys_softwareVersion	Version number of firmware
sys_hardwareVersion	Version number of hardware
sys_bootloaderVersion	Version number of the bootloader
sys_imageVersion	roloFlash expects the image generated by the compiler in this version. Therefore, please use the compiler matching the roloFlash firmware.

10.2 sys_serialNumber

Name	Value / Meaning
sys_serialNumber	Exception „functionNotSupported“

In previous roloFlash firmware versions (before v07.AA), this function was implemented erroneously and did not reliably supply unambiguous results to be able to distinguish one roloFlash from another.

This functionality is now corrected and provided by the new function `sys_uniqueId` (see next chapter).

10.3 `sys_uniqueId`

Name	Value / Meaning
<code>sys_uniqueId</code>	A string comprising 24 characters, each character being in the range '0' - '9' or 'A' - 'F'.

The `uniqueId` is non-ambiguous for each roloFlash specimen. Thusly, you can create roloBasic scripts that run only on certain specimens of roloFlash.

Example:

1. Determine `uniqueId` once:

```
print "uniqueId: ", sys_uniqueId, "\r\n"
```

Extract from log file:

```
uniqueId: 1B9FE86E90B7660F08E387B
```

2. Your script is to run only on this very roloFlash, otherwise it should abort with an exception:

```
if sys_uniqueId <> "1B9FE86E90B7660F08E387B"  
    print "Wrong roloFlash, abort\r\n"  
    throw userException  
endif
```

Note:

For the `uniqueId`, a unique device ID predefined by the chip manufacturer is used internally.

11 Miscellaneous

11.1 sys_setLogMode

sys_setLogMode <logMode>

Set logging mode (see following chapter, „[print](#)“).

Printing will append to the file „LOG.TXT“. If this file does not exist, it will be created.

Prerequisites:

- none

Parameters:

logMode :

LOGMODE_OFF: print output is suppressed.

LOGMODE_NORMAL: The file is opened and stays opened. Print output gets buffered and occasionally written to the file. At the end of the script, the remaining buffered data gets written to the file, and the file gets closed.

LOGMODE_IMMEDIATE: For each print output, the log file gets opened, the output gets written to the file, and the file gets closed again. This ensures that at the time of execution of the next script line, the previous print output has been stored onto the microSD card.

Return value:

- none (procedure)

Note: The default value for logMode is LOGMODE_NORMAL.

Recommendations:

Use LOGMODE_IMMEDIATE only for troubleshooting. As each print output opens the file anew, writes to it and closes it again, the FAT (file allo-

cation table) on the microSD card gets written to each time. This can lead to higher wear and tear of the microSD card and ultimately make it fail.

If you do not require log output at all, you can change to LOGMODE_OFF at the beginning of the script. You can also change the logMode at any point in the script.

If you work with LOGMODE_NORMAL, the log output might be written to the microSD card only after processing the script has finished. If you light up the last LED in green in your scripts, preferably do it at the end of the script, so that the subsequent writing of buffered data to the microSD card can be concluded within the user's reaction time. Probably they will remove roloFlash afterwards.

If you inform another device (e. g. via UART or GPIO) that roloFlash has finished its task and this device subsequently turns off power to the target (and thusly to roloFlash), the script might not have completely finished, so that log outputs might be missing or the file system might be damaged. In this case you should set logMode to LOGMODE_IMMEDIATE directly before informing the device about the finished task.

Exceptions:

apiValueRange
apiTypeFault

Invalid value for logMode.
Invalid type for logMode.

11.2 print

```
print <a>, <b>, ...
```

The parameters *a*, *b* etc. get printed. This procedure takes any number of parameters.

Printing writes to the end of the file „LOG.TXT“. If the file does not exist, it will be created.

Prerequisites:

- none

Parameters:

a, b, ...

Here you can output numbers and arrays. Example:

```
value = 42
```

```
print "The value is: ", value
```

If a given parameter is neither a number nor a char-array, nothing is output.

Return value:

- none (procedure)

Note: The output depends on the chosen log mode (see previous chapter, „Miscellaneous“).

Exceptions:

<various file system
exceptions>

See chapter „File System Exceptions“.

11.3 sprint

```
s = sprint(<a>, <b>, ...)
```

Returns the specified parameters as strings. The number of parameters is unlimited. The output is the same as with `print`, but it is not written into the file „LOG.TXT“, but is instead the return value of this function.

Prerequisites:

- none

Parameters:

a, b, ...

Numbers and arrays of char. Example:

```
value = 42
```

```
s = sprintf("The value is: ", value)
```

If any of the specified parameters is neither number or char array, the call to sprintf will lead to absolutely nothing being returned.

Return value:

- Array of char containing the output

Exceptions:

<none>

11.4 delay

```
delay <duration>
```

Waits for the specified time in ms. Only afterwards will this procedure return.

Prerequisites:

- none

Parameters:

duration

Time to wait in ms.

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for duration.
Invalid type for duration.

11.5 sys_getSystemTime

```
t = sys_getSystemTime
```

Determines the time lapsed since system start in ms.

Prerequisites:

- none

Parameters:

- none

Return value:

System time in ms.

Exceptions:

- none

11.6 getTargetBoardVoltage

```
u = getTargetBoardVoltage
```

Determines voltage provided by target board (in mV).

Prerequisites:

- none

Parameters:

- none

Return value:

Determined voltage in mV.

Exceptions:

- none

11.7 sys_setCpuClock

sys_setCpuClock <frequency>

Changes the internal CPU clock of roloFlash.

- a higher clock needs more energy from the target board
- a lower clock might need longer to process a roloBasic script incl. flashing.

At start, roloFlash's clock is set to 24 MHz, for lower energy consumption.

Attention!

Busses already opened might change their own clock speed in the process. You can query the current clock speed.

Recommendation:

If required, change the clock speed at the beginning of your script.

Prerequisites:

- none

Parameters:

frequency

Clock frequency in Hz.
Supported values:

- CPU_CLOCKMAX: 120000000 (120 MHz)
- CPU_CLOCKMIN: 24000000 (24 MHz)

The clock frequency always gets adjusted to the next smaller clock speed, but always to at least 24 Mhz.

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for frequency.
Invalid type for frequency.

11.8 sys_getCpuClock

u = sys_getCpuClock

Determine the current clock speed of roloFlash in Hz.

Prerequisites:

- none

Parameters:

- none

Return value:

Read out clock speed in Hz.

Exceptions:

- none

11.9 sys_getEraseCounters

```
eraseCounters = sys_getEraseCounters
```

Determines how often certain flash sectors of roloFlash have been erased.

Prerequisites:

- none

Parameters:

- none

Return value:

- An array of long with 12 values corresponding to the internal flash sectors of roloFlash. Reasons for erasing flash sectors are:

- For flash data & doublebuffering: If a write request could not be handled directly anymore and consequently triggered switching buffers.
- For flash data: fd_format, fd_cleanup and fd_getSingleBufferMode
- Firmware updates

Mapping of sectors:

Sector	roloFlash 2 roloFlash 2 AVR
0	Internal
1	
2	FlashVars
3	
4	Firmware
5	
6	
7	FlashDisk
8	
9	
10	
11	

The manufacturer of the microcontroller used inside roloFlash guarantees 10,000 erase-cycles.

Exceptions:

- none

11.10 setBitBlock

setBitBlock <destArray, sourceArray, position, length>

Copy the number of bits specified by length from the start of sourceArray to the specified position in destArray.

- destArray and sourceArray must be of same array type (array of char, array of int or array of long) and will get interpreted as bit array.
- sourceArray is always read from position 0 onwards.
- Should sourceArray or destArray unable to hold the number of bits specified by length, correspondingly fewer bits will be copied.

Prerequisites:

- none

Parameters:

destArray

Array (array of char, array of int or array of long) that data gets copied into at the specified position.

sourceArray

Array (array of char, array of int oder array of long) that data gets copied from, from position 0 onwards.

position

Position in destArray where data will be copied to. The position must be within destArray.

length

Number of bits to be copied. If necessary, this number will be reduced so that sourceArray can provide the enough bits and destArray can absorb enough bits.

Return value:

- none (procedure)

Exceptions:

apiValueRange
apiTypeFault

Invalid value for position or length.
Invalid type.

11.11 getBitBlock

```
destArray = getBitBlock(<sourceArray, position,  
length>)
```

Return an array containing the number of bits from `sourceArray` specified by `length`, and starting at the specified position.

- The array returned is of the same type (array of char, array of int or array of long) as `sourceArray`.
- The size of the array returned is exactly sufficient to contain the number of bits specified by `length`. Unused bits are set to 0.
- Should `sourceArray` contain fewer bits than requested by `length`, correspondingly fewer bits will be copied. This does not change the size of the array returned.

Prerequisites:

- none

Parameters:

sourceArray

Array (array of char, array of int oder array of long) that data gets copied from, from position 0 onwards.

position

Position in `sourceArray` from where data gets copied from. The position must be within `sourceArray`.

length

Number of bits. If necessary, will be reduced so that `sourceArray` can provide enough bits.

Return value:

An array containing the data copied. Its size follows the specified `length`. The type is the same as that of `sourceArray` (array of char, array of int or array of long).

Exceptions:

OutOfMemory
apiValueRange
apiTypeFault

Not enough memory to create roloBasic array.
Invalid value for position or length.
Invalid type.

11.12 chain

chain <fileSystem>, <fileName>, <cryptSpec>

Stops the currently running roloBasic script and starts a different compiled roloBasic script with the file extension “.BIN“.

Prerequisites:

- none

Parameters:

fileSystem

Specifies on which file system the procedure should be executed.
Possible values are:

SDCARD, FLASHVARS and FLASHDISK

For compatibility reasons, 0 is synonymous for SDCARD.

fileName

The specified file must be a compiled roloBasic file.

For SD cards: the file name must be a valid file name for SD cards, see „Requirements for file names“.

For flash data: the file name must be a valid ID for flash data, see „Requirements for I“.

cryptSpec

Optional parameter for executing an encrypted file.

The parameter padding within the contained dataSpec may contain the following values:

- **0-15:** number of bytes to be ignored after decryption.

- **SEC_NOPADDING:** after decryption, data will not be truncated. This mode is only applicable and recommend for SEC_CTR.
- **SEC_PKCS7:** after decryption, data will be truncated according to PKCS7 padding. If the data does not conform to PKCS7, an exception "secPaddingError" will be generated.

Return value:

- none (procedure)

Note:

To be able to access all resources, like buses and UART etc., in the newly opened compiled roloBasic script, it is recommended to release all already occupied resources before executing the chain procedure.

Exceptions:

apiTypeFault	Invalid type
dataTypeError	Attempted access to data not of type "array of bytes" (FlashVars or FlashDisk)
<diverse Exceptions des Dateisystems>	See chapter „File System Exceptions“.
cryptError	General error in calculation.
secParamError	The specified cryptSpec is erroneous.
secPaddingError	PKCS7 is specified, but decrypted data does not conform to the PKCS7 encoding.

VII Exceptions

The roloBasic manual has a detailed description of how exceptions can be thrown and caught again. If an exception is not caught, it gets displayed using the LEDs.

If the exception to be displayed is not a number, an exception "exception-NotANumber" gets shown. Further details can be found in chapter „[Exception has Occurred](#)“. Only exceptions thrown by the user (instead of the system) can be non-numeric.

There are different kinds of exceptions that all get treated equally:

- roloBasic exceptions
- File system exceptions
- roloFlash exceptions
- Exceptions thrown by the user

1 roloBasic Exceptions

These exceptions occur for errors that are not particularly related to roloFlash, but to the processing of roloBasic. A typical example would be a valueRange exception.

These exceptions are also listed in the roloBasic manual.

If errors as described for exceptions valueRange, argumentFault and typeFault occur while calling an API function or procedure, the exceptions apiValueRange, apiArgumentFault or apiType Fault are created instead. The respective number of these exceptions is exactly 200 higher than the appropriate roloBasic exceptions.

Name	Number	Description
outOfMemory	1	Too little free memory present
rootstackOverflow	2	Internal system error
nullpointerAccess	3	Internal system error
valueRange	4	Value range overrun, e.g. while assigning values to arrays.
divisionByZero	5	Division by 0. Can occur with div or mod
argumentFault	6	Invalid number of arguments while calling a roloBasic function or procedure.
illegalFunction	7	A variable was called like a function or procedure, but does not contain a valid function or procedure.
indexRange	8	Index range overrun while accessing array.
typeFault	9	A parameter passed has the wrong type.

2 File System Exceptions

These exceptions occur in relation to the file system or the microSD card.

Name	Number	Description
deviceError	101	Reading from or writing to the microSD card failed.
badCluster	102	Problems within the file system. The file system should be checked on a PC for consistency.
notMounted	103	Access to the microSD card, although it was not mounted. This indicates a problem with the microSD card.
removeError	104	The microSD card has been removed.
createError	105	Creation of file or directory failed.
fileNotOpen	106	The file is not open.
fileNotFound	107	The specified file or directory could not be found.
diskFull	108	The microSD card is full.
truncateError	109	Truncating of a file using fs_truncate failed.
illegalCluster	110	Problems within file system. The file system should be checked on a PC for consistency.
fileLocked	111	Trying to open an already open file a second time. Maybe a call to fs_close has been forgotten.

outOfFileHandles	112	The number of simultaneously open files is limited to 3. Tried to open another file.
loaderNotFound	113	The required loader was not found on the microSD card.
fileIsOpen	114	Attempt to remove or rename a file that is still open (see fs_remove, fd_remove, fs_rename).
renameError	115	Renaming a file has failed. Maybe a file with the new name already exists (see fs_rename, fd_rename).
dataTypeError	116	Attempted access to data not having the expected data type (see fd_readArrayElem, fd_readSubArray, fd_getArraySize, fs_fileSize, fs_open).

3 roloFlash Exceptions

Name	Number	Description
exceptionIsNotANumber	200	An exception that is not a number has been thrown and not caught within roloBasic. In this case the original exception gets discarded and replaced by this exception. This can happen only for exceptions thrown by the user, since all other functions use the numerical exceptions described here exclusively. Beispiel: throw "Error"
imageTooLarge	201	The roloBasic script is too big. About 65,000 bytes can be loaded at most. Please check the size of the file generated by the roloBasic compiler.
imageWrongVersion	202	The roloBasic compiler utilized does not match the roloFlash firmware. It is recommended to always use the latest compiler and the latest firmware for roloFlash.
productWrongVersion	203	It has been tried to load an image of a different product onto roloFlash, e. g. to load an image for roloFlash 1 onto roloFlash 2.
apiValueRange	204	Value range overrun of a parameter while calling an API function or procedure. Example: ledOn 6, COLOR_GREEN ! There are only 5 LEDs (Note : the error number is

		exactly 200 higher than the appropriate roloBasic exception "valueRange")
imageNotFound	205	The file RUN_V07.BIN could not be found, neither on the internal flash disk nor on the microSD card (if inserted).
apiBadArgumentCount	206	Invalid number of arguments while calling an API function or procedure. (Note: the error number is exactly 200 higher than the appropriate roloBasic exception "badArgumentCount")
apiTypeFault	209	A parameter passed to an API function or procedure has the wrong type. (Note: the error number is exactly 200 higher than the appropriate roloBasic exception "typeFault")
targetWrongMode	210	The procedure or function called requires a particular mode of the target. For instance, the procedure setProgrammingSpeed requires the target to be in ProgramMode.
targetCommunication	211	An error during communication with the target.
targetMemoryLayout	212	The memory layout of the target controller has not been specified (target_setMemoryMap).
eraseError	213	Erasing of target failed.
targetVerify	214	Data read back differs from comparison data.
targetAlignment	215	Memory alignment of target was not abided to. For instance, on an STM32H7, data blocks to be written to flash memory must begin at a 32 byte border in flash memory.
hexFileSize	230	Implausible size of specified hex file. Maybe the hex file is defective or empty.
hexFileCRC	231	Checksum error while parsing the hex file. Maybe the hex file is defective.
hexFileSyntax	232	Syntax error while parsing the hex file. Maybe the hex file is defective.
srecRecordTypeTooSmall	233	A file format for writing SREC files has been selected that cannot encode the addresses used. Please use a file format for larger addresses (S28, S37) or defer the selection of a suitable file format to roloFlash (file format SREC).
badLoader	234	The specified loader cannot be used.
invalidHandle	250	The handle used is invalid. The handle has been closed already, or a wrong parameter has been

		used instead of a handle.
resourceUnavailable	251	The requested resource is unavailable. This can happen while opening a bus and another bus that shares some resources is already open. Most notably, this exception occurs if the same bus gets opened twice.
unknownTarget	252	The requested controller cannot be found in the database (see <code>db_getHandle</code>).
propertyNotFound	253	The required property is not available for the specified controller (see <code>db_get</code>).
familyNotSupported	254	The specified controller family is not supported (see <code>getTargetHandle</code>).
functionNotSupported	255	A function or procedure has been called that is not supported for the current target. E. g. the procedure <code>target_writeBits</code> is only supported for Atmel controllers.
valueUnknown	256	Failed trying to read a value that cannot be determined (see <code>target_getMemoryMap</code>).
valueNotAllowed	257	Failed using an invalid value (see <code>target_setMemoryMap</code>).
timeoutError	258	The called function or procedure takes too much time. There may be a problem with the target. If after such an error work with the current target is to be continued, it might be necessary to first close the target handle and re-request another one.
targetError	260	The target reported an error not specified in detail. For ARM targets, this could be a set sticky bit.
writeProtectError	261	The addressed memory area of the target is write protected.
readProtectError	262	The addressed memory area of the target is read protected.
writeError	263	There was an error while writing to the addressed memory area.
readError	264	There was an error while reading from the addressed memory area.
targetMissingProperty	265	A value required was not set.
targetResourceAccessConflict	266	An access resulted in a conflict. This can happen with STM32WB, if the PESD bit in the FLASH_SR register is set.
fdCRCmissingError	290	An access to an element in flash data requires a

		CRC, but that element has been created with <code>crcMode=NOCRC</code> and accessed with <code>crcMode=USECRC</code> .
<code>fdCRCnotSupported</code>	291	A CRC has been requested for an increment type in flash data. The increment type does not support CRC (see <code>fd_write</code>).
<code>fdCRCalreadySetError</code>	292	For flash data, array types can have a CRC. The CRC is not set at the beginning and can only be set once. Afterwards, the array cannot be written to. This exception occurs after using <code>fd_setCrc</code> and afterwards calling <code>fd_writeArrayElem</code> or <code>fd_writeSubArray</code> .
<code>fdCRCmismatch</code>	293	Reading from flash data lead to a read CRC mismatching the CRC calculated for the read data.
<code>fdWriteError</code>	294	A write access to flash data failed. Data under the current ID or even the whole file system might be corrupt.
<code>fdCorruptedFile</code>	295	The element in flash-data is corrupt. Maybe even the whole file system might be corrupt.
<code>fdCorruptedError</code>	296	The complete flash data file system is corrupt.
<code>secParamError</code>	340	<code>sec_encrypt/sec_decrypt/chain/target_writeFromFile</code> : specified <code>cryptSpec</code> is erroneous.
<code>secError</code>	341	Processing error while decrypting, encrypting, or calculation of a hash value or CRC. Also occurs when block sizes have not been observed (AES: 16 bytes).
<code>secPaddingError</code>	342	A padding was specified in <code>cryptSpec</code> for decryption or encryption, and processing the PKCS7 padding failed.m

4 User Exceptions

- The user can throw exceptions using `throw`. These can be numeric and use also use predefined values, e. g.:
`throw rangeError`

- To better differentiate between user-created exceptions and other exceptions, different exception numbers can be used. For this purpose, the constant `userException` with a value of 1000 is available. The advantage of this value is that is particularly visible in the blink code, if the exception is not caught. This constant can be used as offset for own exceptions, e. g:
`throw userException + 1`
- You can also throw non-numeric exceptions. If such an exception does not get caught, it gets converted to the exception `exceptionIsNotANumber` at the end of the script and visualized by a blink code: e. g.:
`throw "error"`

VIII Description of LED Codes

1 Normal Operation

1.1 No microSD card found

LEDs:

- 1: red
- 2:
- 3:
- 4:
- 5:

Description:

No microSD card found, or the card is not formatted as FAT32.

Note:

For normal operation, it is required that the microSD card has already been inserted before plugging roloFlash onto a target board. Inserting the microSD card after plugging on roloFlash is a case reserved for updating roloFlash's firmware. If you want to use roloFlash normally, and just forgot to insert the microSD card beforehand, just remove roloFlash from the target board, insert the microSD card, and plug on roloFlash again.

1.2 Exception has Occurred

If an exception occurred and it was not caught in the roloBasic script, the number of the exception gets visualized by an LED blink code.

LEDs:

- 1: red: comes on and off shortly at beginning of the blink code

- 2: red: flashing, number corresponds to 1000s of exception
- 3: red: flashing, number corresponds to 100s of exception
- 4: red: flashing, number corresponds to 10s of exception
- 5: red: flashing, number corresponds to 1s of exception

Description:

This code came about by two possible events:

- An appropriate „throw“ command has been executed in the script.

Example:

```
if getVoltage() > 4000
  throw 1234 !Create exception 1234
endif
```

- A function or procedure could not fulfil its task and created an exception.

2 roloFlash Update

Updating the roloFlash firmware is detailed in chapter „[Updating roloFlash](#)“.

2.1 Waiting for microSD Card for Update

LEDs:

- 1: red
- 2:
- 3:
- 4:
- 5:

Description:

If while starting roloFlash no microSD card is inserted, and roloFlash has not been flashed with a firmware yet, roloFlash waits for the insertion of a microSD card to start the roloFlash firmware update pro-

cess afterwards.

2.2 Update is Running

LEDs:

- 1: red
- 2: green \ flashing alternately
- 3: green /
- 4:
- 5:

Description:

The update process is running. It takes about 10-15 seconds. Please do not abort this process.

2.3 Update Finished Successfully

LEDs:

- 1: red
Note: For previous bootloader versions (before v2.0), LED1 was lit green.
- 2: green
- 3:
- 4:
- 5:

Description:

The update has been finished successfully. After removing roloFlash from the power source, the new firmware will be used for all future operations.

2.4 Update Failed: File Error

LEDs:

- 1: red
- 2: red
- 3:

4:
5:

Description:

The update failed with a file error. The old firmware might still be available.

Possible remedy:

- Retry update..
- Update using a different firmware.

2.5 Update Failed: File Not Found

LEDs:

1: red
2:
3: red
4:
5:

Description:

The update could not be started, as no file for the update could be found. The old firmware is still available.

Possible remedy:

Copy the file for the firmware update to the microSD card, then try again to update.

Note:

This error pattern is also shown, if the firmware file is corrupt (mismatching hash value).

2.6 Update Failed: Multiple Files Found

LEDs:

1: red
2:
3:

4: red
5:

Description:

The update could not be started, as multiple files eligible for an update were found and thusly, it is unclear which file to use. The old firmware is still available.

Possible remedy:

Only one update file may be present for an update. Please remove superfluous files and re-try the update.

2.7 Update Failed: Other Reasons

LEDs:

1: red
2:
3:
4:
5: red

Description:

The update failed. The old firmware might be still available.

Possible remedy:

- Retry update.
- Try update with a different firmware file.

IX Specifications

1 Supported Controllers from ST Microelectronics

The following controllers are known to the database. The names listed here can be used with `db_getHandle`.

1.1 STM32F0

Connection via SWD interface.

STM32F030C6, STM32F030C8, STM32F030CC, STM32F030F4,
STM32F030K6, STM32F030R8, STM32F030RC, STM32F031C4,
STM32F031C6, STM32F031E6, STM32F031F4, STM32F031F6,
STM32F031G4, STM32F031G6, STM32F031K4, STM32F031K6,
STM32F038C6, STM32F038E6, STM32F038F6, STM32F038G6,
STM32F038K6, STM32F042C4, STM32F042C6, STM32F042F4,
STM32F042F6, STM32F042G4, STM32F042G6, STM32F042K4,
STM32F042K6, STM32F042T6, STM32F048C6, STM32F048G6,
STM32F048T6, STM32F051C4, STM32F051C6, STM32F051C8,
STM32F051K4, STM32F051K6, STM32F051K8, STM32F051R4,
STM32F051R6, STM32F051R8, STM32F051T8, STM32F058C8,
STM32F058R8, STM32F058T8, STM32F070C6, STM32F070CB,
STM32F070F6, STM32F070RB, STM32F071C8, STM32F071CB,
STM32F071RB, STM32F071V8, STM32F071VB, STM32F072C8,
STM32F072CB, STM32F072R8, STM32F072RB, STM32F072V8,
STM32F072VB, STM32F078CB, STM32F078RB, STM32F078VB,
STM32F091CB, STM32F091CC, STM32F091RB, STM32F091RC,
STM32F091VB, STM32F091VC, STM32F098CC, STM32F098RC,

STM32F098VC

1.2 STM32F1

Connection via JTAG or SWD interface.

Supported controllers:

STM32F100C4, STM32F100C6, STM32F100C8, STM32F100CB,
STM32F100R4, STM32F100R6, STM32F100R8, STM32F100RB,
STM32F100RC, STM32F100RD, STM32F100RE, STM32F100V8,
STM32F100VB, STM32F100VC, STM32F100VD, STM32F100VE,
STM32F100ZC, STM32F100ZD, STM32F100ZE, STM32F101C4,
STM32F101C6, STM32F101C8, STM32F101CB, STM32F101R4,
STM32F101R6, STM32F101R8, STM32F101RB, STM32F101RC,
STM32F101RD, STM32F101RE, STM32F101RF, STM32F101RG,
STM32F101T4, STM32F101T6, STM32F101T8, STM32F101TB,
STM32F101V8, STM32F101VB, STM32F101VC, STM32F101VD,
STM32F101VE, STM32F101VF, STM32F101VG, STM32F101ZC,
STM32F101ZD, STM32F101ZE, STM32F101ZF, STM32F101ZG,
STM32F102C4, STM32F102C6, STM32F102C8, STM32F102CB,
STM32F102R4, STM32F102R6, STM32F102R8, STM32F102RB,
STM32F103C4, STM32F103C6, STM32F103C8, STM32F103CB,
STM32F103R4, STM32F103R6, STM32F103R8, STM32F103RB,
STM32F103RC, STM32F103RD, STM32F103RE, STM32F103RF,
STM32F103RG, STM32F103T4, STM32F103T6, STM32F103T8,
STM32F103TB, STM32F103V8, STM32F103VB, STM32F103VC,
STM32F103VD, STM32F103VE, STM32F103VF, STM32F103VG,
STM32F103ZC, STM32F103ZD, STM32F103ZE, STM32F103ZF,
STM32F103ZG, STM32F105R8, STM32F105RB, STM32F105RC,
STM32F105V8, STM32F105VB, STM32F105VC, STM32F107RB,
STM32F107RC, STM32F107VB, STM32F107VC

1.3 STM32F2

Connection via JTAG or SWD interface.

Supported controllers:

STM32F205RB, STM32F205RC, STM32F205RE, STM32F205RF,
STM32F205RG, STM32F205VB, STM32F205VC, STM32F205VE,
STM32F205VF, STM32F205VG, STM32F205ZC, STM32F205ZE,
STM32F205ZF, STM32F205ZG, STM32F207IC, STM32F207IE,
STM32F207IF, STM32F207IG, STM32F207VC, STM32F207VE,
STM32F207VF, STM32F207VG, STM32F207ZC, STM32F207ZE,
STM32F207ZF, STM32F207ZG, STM32F215RE, STM32F215RG,
STM32F215VE, STM32F215VG, STM32F215ZE, STM32F215ZG,
STM32F217IE, STM32F217IG, STM32F217VE, STM32F217VG,
STM32F217ZE, STM32F217ZG

1.4 STM32F3

Connection via JTAG or SWD interface.

Supported controllers:

STM32F301C6, STM32F301C8, STM32F301K6, STM32F301K8,
STM32F301R6, STM32F301R8, STM32F302C6, STM32F302C8,
STM32F302CB, STM32F302CC, STM32F302K6, STM32F302K8,
STM32F302R6, STM32F302R8, STM32F302RB, STM32F302RC,
STM32F302RD, STM32F302RE, STM32F302VB, STM32F302VC,
STM32F302VD, STM32F302VE, STM32F302ZD, STM32F302ZE,
STM32F303C6, STM32F303C8, STM32F303CB, STM32F303CC,
STM32F303K6, STM32F303K8, STM32F303R6, STM32F303R8,
STM32F303RB, STM32F303RC, STM32F303RD, STM32F303RE,
STM32F303VB, STM32F303VC, STM32F303VD, STM32F303VE,
STM32F303ZD, STM32F303ZE, STM32F318C8, STM32F318K8,
STM32F328C8, STM32F334C4, STM32F334C6, STM32F334C8,

STM32F334K4, STM32F334K6, STM32F334K8, STM32F334R6,
STM32F334R8, STM32F358CC, STM32F358RC, STM32F358VC,
STM32F373C8, STM32F373CB, STM32F373CC, STM32F373R8,
STM32F373RB, STM32F373RC, STM32F373V8, STM32F373VB,
STM32F373VC, STM32F378CC, STM32F378RC, STM32F378VC,
STM32F398VE

1.5 STM32F4

Connection via JTAG or SWD interface.

Supported controllers:

STM32F401CB, STM32F401CC, STM32F401CD, STM32F401CE,
STM32F401RB, STM32F401RC, STM32F401RD, STM32F401RE,
STM32F401VB, STM32F401VC, STM32F401VD, STM32F401VE,
STM32F4050E, STM32F4050G, STM32F405RG, STM32F405VG,
STM32F405ZG, STM32F407IE, STM32F407IG, STM32F407VE,
STM32F407VG, STM32F407ZE, STM32F407ZG, STM32F410C8,
STM32F410CB, STM32F410R8, STM32F410RB, STM32F410T8,
STM32F410TB, STM32F411CC, STM32F411CE, STM32F411RC,
STM32F411RE, STM32F411VC, STM32F411VE, STM32F412CE,
STM32F412CG, STM32F412RE, STM32F412RG, STM32F412VE,
STM32F412VG, STM32F412ZE, STM32F412ZG, STM32F413CG,
STM32F413CH, STM32F413MG, STM32F413MH, STM32F413RG,
STM32F413RH, STM32F413VG, STM32F413VH, STM32F413ZG,
STM32F413ZH, STM32F4150G, STM32F415RG, STM32F415VG,
STM32F415ZG, STM32F417IE, STM32F417IG, STM32F417VE,
STM32F417VG, STM32F417ZE, STM32F417ZG, STM32F423CH,
STM32F423MH, STM32F423RH, STM32F423VH, STM32F423ZH,
STM32F427AG, STM32F427AI, STM32F427IG, STM32F427II,
STM32F427VG, STM32F427VI, STM32F427ZG, STM32F427ZI,
STM32F429AG, STM32F429AI, STM32F429BE, STM32F429BG,

STM32F429BI, STM32F429IE, STM32F429IG, STM32F429II,
STM32F429NE, STM32F429NG, STM32F429NI, STM32F429VE,
STM32F429VG, STM32F429VI, STM32F429ZE, STM32F429ZG,
STM32F429ZI, STM32F437AI, STM32F437IG, STM32F437II,
STM32F437VG, STM32F437VI, STM32F437ZG, STM32F437ZI,
STM32F439AI, STM32F439BG, STM32F439BI, STM32F439IG,
STM32F439II, STM32F439NG, STM32F439NI, STM32F439VG,
STM32F439VI, STM32F439ZG, STM32F439ZI, STM32F446MC,
STM32F446ME, STM32F446RC, STM32F446RE, STM32F446VC,
STM32F446VE, STM32F446ZC, STM32F446ZE, STM32F469AE,
STM32F469AG, STM32F469AI, STM32F469BE, STM32F469BG,
STM32F469BI, STM32F469IE, STM32F469IG, STM32F469II,
STM32F469NE, STM32F469NG, STM32F469NI, STM32F469VE,
STM32F469VG, STM32F469VI, STM32F469ZE, STM32F469ZG,
STM32F469ZI, STM32F479AG, STM32F479AI, STM32F479BG,
STM32F479BI, STM32F479IG, STM32F479II, STM32F479NG,
STM32F479NI, STM32F479VG, STM32F479VI, STM32F479ZG,
STM32F479ZI

1.6 STM32F7

Connection via JTAG or SWD interface.

Supported controllers:

STM32F722IC, STM32F722IE, STM32F722RC, STM32F722RE,
STM32F722VC, STM32F722VE, STM32F722ZC, STM32F722ZE,
STM32F723IC, STM32F723IE, STM32F723VE, STM32F723ZC,
STM32F723ZE, STM32F732IE, STM32F732RE, STM32F732VE,
STM32F732ZE, STM32F733IE, STM32F733VE, STM32F733ZE,
STM32F745IE, STM32F745IG, STM32F745VE, STM32F745VG,
STM32F745ZE, STM32F745ZG, STM32F746BE, STM32F746BG,
STM32F746IE, STM32F746IG, STM32F746NE, STM32F746NG,

STM32F746VE, STM32F746VG, STM32F746ZE, STM32F746ZG,
STM32F756BG, STM32F756IG, STM32F756NG, STM32F756VG,
STM32F756ZG, STM32F765BG, STM32F765BI, STM32F765IG,
STM32F765II, STM32F765NG, STM32F765NI, STM32F765VG,
STM32F765VI, STM32F765ZG, STM32F765ZI, STM32F767BG,
STM32F767BI, STM32F767IG, STM32F767II, STM32F767NG,
STM32F767NI, STM32F767VG, STM32F767VI, STM32F767ZG,
STM32F767ZI, STM32F769AI, STM32F769BG, STM32F769BI,
STM32F769IG, STM32F769II, STM32F769NG, STM32F769NI,
STM32F777BI, STM32F777II, STM32F777NI, STM32F777VI,
STM32F777ZI, STM32F778AI, STM32F779AI, STM32F779BI,
STM32F779II, STM32F779NI,

1.7 STM32H7

Connection via JTAG or SWD interface.

Supported controllers:

STM32H743AI, STM32H743BI, STM32H743II, STM32H743VI,
STM32H743XI, STM32H743ZI, STM32H753AI, STM32H753BI,
STM32H753II, STM32H753VI, STM32H753XI, STM32H753ZI,

1.8 STM32L0

Connection via SWD interface.

Supported controllers:

STM32L010C6, STM32L010F4, STM32L010K4, STM32L010K8,
STM32L010R8, STM32L010RB, STM32L011D3, STM32L011D4,
STM32L011E3, STM32L011E4, STM32L011F3, STM32L011F4,
STM32L011G3, STM32L011G4, STM32L011K3, STM32L011K4,
STM32L021D4, STM32L021F4, STM32L021G4, STM32L021K4,
STM32L031C4, STM32L031C6, STM32L031E4, STM32L031E6,

STM32L031F4, STM32L031F6, STM32L031G4, STM32L031G6,
 STM32L031K4, STM32L031K6, STM32L041C6, STM32L041E6,
 STM32L041F6, STM32L041G6, STM32L041K6, STM32L051C6,
 STM32L051C8, STM32L051K6, STM32L051K8, STM32L051R6,
 STM32L051R8, STM32L051T6, STM32L051T8, STM32L052C6,
 STM32L052C8, STM32L052K6, STM32L052K8, STM32L052R6,
 STM32L052R8, STM32L052T6, STM32L052T8, STM32L053C6,
 STM32L053C8, STM32L053R6, STM32L053R8, STM32L062K8,
 STM32L063C8, STM32L063R8, STM32L071C8, STM32L071CB,
 STM32L071CZ, STM32L071K8, STM32L071KB, STM32L071KZ,
 STM32L071RB, STM32L071RZ, STM32L071V8, STM32L071VB,
 STM32L071VZ, STM32L072CB, STM32L072CZ, STM32L072KB,
 STM32L072KZ, STM32L072RB, STM32L072RZ, STM32L072V8,
 STM32L072VB, STM32L072VZ, STM32L073CB, STM32L073CZ,
 STM32L073RB, STM32L073RZ, STM32L073V8, STM32L073VB,
 STM32L073VZ, STM32L081CB, STM32L081CZ, STM32L081KZ,
 STM32L082CZ, STM32L082KB, STM32L082KZ, STM32L083CB,
 STM32L083CZ, STM32L083RB, STM32L083RZ, STM32L083V8,
 STM32L083VB, STM32L083VZ

1.9 STM32L1

Connection via JTAG or SWD interface.

Supported controllers:

STM32L100C6,	STM32L100C6-A,	STM32L100R8,
STM32L100R8-A,	STM32L100RB,	STM32L100RB-A,
STM32L100RC,	STM32L151C6,	STM32L151C6-A,
STM32L151C8,	STM32L151C8-A,	STM32L151CB,
STM32L151CB-A,	STM32L151CC,	STM32L151QC,
STM32L151QD,	STM32L151QE,	STM32L151R6,

STM32L151R6 -A,	STM32L151R8,	STM32L151R8 -A,
STM32L151RB,	STM32L151RB -A,	STM32L151RC,
STM32L151RC -A,	STM32L151RD,	STM32L151RE,
STM32L151UC,	STM32L151V8,	STM32L151V8 -A,
STM32L151VB,	STM32L151VB -A,	STM32L151VC,
STM32L151VC -A,	STM32L151VD,	STM32L151VD -X,
STM32L151VE,	STM32L151ZC,	STM32L151ZD,
STM32L151ZE,	STM32L152C6,	STM32L152C6 -A,
STM32L152C8,	STM32L152C8 -A,	STM32L152CB,
STM32L152CB -A,	STM32L152CC,	STM32L152QC,
STM32L152QD,	STM32L152QE,	STM32L152R6,
STM32L152R6 -A,	STM32L152R8,	STM32L152R8 -A,
STM32L152RB,	STM32L152RB -A,	STM32L152RC,
STM32L152RC -A,	STM32L152RD,	STM32L152RE,
STM32L152UC,	STM32L152V8,	STM32L152V8 -A,
STM32L152VB,	STM32L152VB -A,	STM32L152VC,
STM32L152VC -A,	STM32L152VD,	STM32L152VD -X,
STM32L152VE,	STM32L152ZC,	STM32L152ZD,
STM32L152ZE,	STM32L162QD,	STM32L162RC,
STM32L162RC -A,	STM32L162RD,	STM32L162RE,
STM32L162VC,	STM32L162VC -A,	STM32L162VD,
STM32L162VD -X,	STM32L162VE,	STM32L162ZD,
STM32L162ZE		

1.10 STM32L4

Connection via JTAG or SWD interface.

Supported controllers:

STM32L431CB, STM32L431CC, STM32L431KB, STM32L431KC,
STM32L431RB, STM32L431RC, STM32L431VC, STM32L432KB,

STM32L432KC, STM32L433CB, STM32L433CC, STM32L433RB,
STM32L433RC, STM32L433VC, STM32L442KC, STM32L443CC,
STM32L443RC, STM32L443VC, STM32L451CC, STM32L451CE,
STM32L451RC, STM32L451RE, STM32L451VC, STM32L451VE,
STM32L452CC, STM32L452CE, STM32L452RC, STM32L452RE,
STM32L452VC, STM32L452VE, STM32L462CE, STM32L462RE,
STM32L462VE, STM32L471QE, STM32L471QG, STM32L471RE,
STM32L471RG, STM32L471VE, STM32L471VG, STM32L471ZE,
STM32L471ZG, STM32L475RC, STM32L475RE, STM32L475RG,
STM32L475VC, STM32L475VE, STM32L475VG, STM32L476JE,
STM32L476JG, STM32L476ME, STM32L476MG, STM32L476QE,
STM32L476QG, STM32L476RC, STM32L476RE, STM32L476RG,
STM32L476VC, STM32L476VE, STM32L476VG, STM32L476ZE,
STM32L476ZG, STM32L486JG, STM32L486QG, STM32L486RG,
STM32L486VG, STM32L486ZG, STM32L496AE, STM32L496AG,
STM32L496QE, STM32L496QG, STM32L496RE, STM32L496RG,
STM32L496VE, STM32L496VG, STM32L496ZE, STM32L496ZG,
STM32L4A6AG, STM32L4A6QG, STM32L4A6RG, STM32L4A6VG,
STM32L4A6ZG

1.11 STM32L4+

Connection via JTAG or SWD interface.

Supported controllers:

STM32L4R5AG, STM32L4R5AI, STM32L4R5QG, STM32L4R5QI,
STM32L4R5VG, STM32L4R5VI, STM32L4R5ZG, STM32L4R5ZI,
STM32L4R7AI, STM32L4R7VI, STM32L4R7ZI, STM32L4R9AG,
STM32L4R9AI, STM32L4R9VG, STM32L4R9VI, STM32L4R9ZG,
STM32L4R9ZI, STM32L4S5AI, STM32L4S5QI, STM32L4S5VI,
STM32L4S5ZI, STM32L4S7AI, STM32L4S7VI, STM32L4S7ZI,

STM32L4S9AI, STM32L4S9VI, STM32L4S9ZI

1.12 STM32G0

Connection via SWD interface.

Supported controllers:

STM32G030C6, STM32G030C8, STM32G030F6, STM32G030J6,
STM32G030K6, STM32G030K8, STM32G031C6, STM32G031C8,
STM32G031F6, STM32G031F8, STM32G031G6, STM32G031G8,
STM32G031J6, STM32G031K6, STM32G031K8, STM32G041C8,
STM32G070CB, STM32G070KB, STM32G070RB, STM32G071C8,
STM32G071CB, STM32G071EB, STM32G071G8, STM32G071GB,
STM32G071K8, STM32G071KB, STM32G071R8, STM32G071RB,
STM32G081CB, STM32G081EB, STM32G081GB, STM32G081KB,
STM32G081RB

1.13 STM32WB

Connection via JTAG or SWD interface.

Supported controllers:

STM32WB55CC, STM32WB55CE, STM32WB55CG, STM32WB55RC,
STM32WB55RE, STM32WB55RG, STM32WB55VC, STM32WB55VE,
STM32WB55VG

2 Supported Controllers from Atmel

The following controllers are known to the database. The names listed here can be used with `db_getHandle`.

2.1 AVR (ISP Interface)

Connection via ISP interface.

Supported Controllers:

AT90CAN128,	AT90CAN32,	AT90CAN64,
AT90PWM1,	AT90PWM2,	AT90PWM216,
AT90PWM2B,	AT90PWM3,	AT90PWM316,
AT90PWM3B,	AT90PWM81,	AT90S1200,
AT90S2313,	AT90S2323,	AT90S2343,
AT90S4414,	AT90S4433,	AT90S4434,
AT90S8515,	AT90S8535,	AT90SCR100H,
AT90USB1286,	AT90USB1287,	AT90USB162,
AT90USB646,	AT90USB647,	AT90USB82,
ATmega103,	ATmega128,	ATmega1280,
ATmega1281,	ATmega1284,	ATmega1284P,
ATmega1284RFR2,	ATmega128A,	ATmega128RFA1,
ATmega128RFR2,	ATmega16,	ATmega161,
ATmega162,	ATmega163,	ATmega164A,
ATmega164P,	ATmega164PA,	ATmega165,
ATmega165A,	ATmega165P,	ATmega165PA,
ATmega168,	ATmega168A,	ATmega168P,
ATmega168PA,	ATmega168PB,	ATmega169,
ATmega169A,	ATmega169P,	ATmega169PA,
ATmega16A,	ATmega16HVA,	ATmega16HVA2,
ATmega16HVB,	ATmega16HVBrevB,	ATmega16M1,
ATmega16U2,	ATmega16U4,	ATmega2560,
ATmega2561,	ATmega2564RFR2,	ATmega256RFR2,
ATmega32,	ATmega323,	ATmega324A,
ATmega324P,	ATmega324PA,	ATmega324PB,
ATmega325,	ATmega3250,	ATmega3250A,

ATmega3250P,	ATmega3250PA,	ATmega325A,
ATmega325P,	ATmega325PA,	ATmega328,
ATmega328P,	ATmega328PB,	ATmega329,
ATmega3290,	ATmega3290A,	ATmega3290P,
ATmega3290PA,	ATmega329A,	ATmega329P,
ATmega329PA,	ATmega32A,	ATmega32C1,
ATmega32HVB,	ATmega32HVBrevB,	ATmega32M1,
ATmega32U2,	ATmega32U4,	ATmega32U6,
ATmega48,	ATmega48A,	ATmega48P,
ATmega48PA,	ATmega48PB,	ATmega64,
ATmega640,	ATmega644,	ATmega644A,
ATmega644P,	ATmega644PA,	ATmega644RFR2,
ATmega645,	ATmega6450,	ATmega6450A,
ATmega6450P,	ATmega645A,	ATmega645P,
ATmega649,	ATmega6490,	ATmega6490A,
ATmega6490P,	ATmega649A,	ATmega649P,
ATmega64A,	ATmega64C1,	ATmega64HVE,
ATmega64HVE2,	ATmega64M1,	ATmega64RFR2,
ATmega8,	ATmega8515,	ATmega8535,
ATmega88,	ATmega88A,	ATmega88P,
ATmega88PA,	ATmega88PB,	ATmega8A,
ATmega8HVA,	ATmega8U2,	ATtiny12,
ATtiny13,	ATtiny13A,	ATtiny15,
ATtiny1634,	ATtiny167,	ATtiny22,
ATtiny2313,	ATtiny2313A,	ATtiny24,
ATtiny24A,	ATtiny25,	ATtiny26,
ATtiny261,	ATtiny261A,	ATtiny4313,
ATtiny43U,	ATtiny44,	ATtiny441,
ATtiny44A,	ATtiny45,	ATtiny461,
ATtiny461A,	ATtiny48,	ATtiny80,

ATtiny828,	ATtiny84,	ATtiny840,
ATtiny841,	ATtiny84A,	ATtiny85,
ATtiny861,	ATtiny861A,	ATtiny87,
ATtiny88		

2.2 AVR (TPI Interface)

Connection via TPI interface.

Supported Controllers:

ATtiny10,	ATtiny102,	ATtiny104,
ATtiny20,	ATtiny4,	ATtiny40,
ATtiny5,	ATtiny9	

2.3 AVR (PDI Interface)

Connection via PDI interface.

Supported Controllers:

ATxmega128A1,	ATxmega128A1U,	ATxmega128A3,
ATxmega128A3U,	ATxmega128A4U,	ATxmega128B1,
ATxmega128B3,	ATxmega128C3,	ATxmega128D3,
ATxmega128D4,	ATxmega16A4,	ATxmega16A4U,
ATxmega16C4,	ATxmega16D4,	ATxmega16E5,
ATxmega192A3,	ATxmega192A3U,	ATxmega192C3,
ATxmega192D3,	ATxmega256A3,	ATxmega256A3B,
ATxmega256A3BU,	ATxmega256A3U,	ATxmega256C3,
ATxmega256D3,	ATxmega32A4,	ATxmega32A4U,
ATxmega32C3,	ATxmega32C4,	ATxmega32D3,
ATxmega32D4,	ATxmega32E5,	ATxmega384C3,
ATxmega384D3,	ATxmega64A1,	ATxmega64A1U,
ATxmega64A3,	ATxmega64A3U,	ATxmega64A4U,
ATxmega64B1,	ATxmega64B3,	ATxmega64C3,
ATxmega64D3,	ATxmega64D4,	ATxmega8E5

2.4 AVR (UPDI Interface)

Connection via UPDI interface.

Supported Controllers:

ATmega3208,	ATmega3209,	ATmega4808,
ATmega4809,	ATtiny1604,	ATtiny1606,
ATtiny1607,	ATtiny1614,	ATtiny1616,
ATtiny1617,	ATtiny202,	ATtiny204,
ATtiny212,	ATtiny214,	ATtiny3214,
ATtiny3216,	ATtiny3217,	ATtiny402,
ATtiny404,	ATtiny406,	ATtiny412,
ATtiny414,	ATtiny416,	ATtiny417,
ATtiny804,	ATtiny806,	ATtiny807,
ATtiny814,	ATtiny816,	ATtiny817

2.5 AVR32 (aWire Interface)

Connection via aWire interface.

Supported Controllers:

AT32UC3C0128C,	AT32UC3C0256C,	AT32UC3C0512C,
AT32UC3C064C,	AT32UC3C1128C,	AT32UC3C1256C,
AT32UC3C1512C,	AT32UC3C164C,	AT32UC3C2128C,
AT32UC3C2256C,	AT32UC3C2512C,	AT32UC3C264C,
ATUC128D3,	ATUC128D4,	ATUC64D3,
ATUC64D4,	AT32UC3L0128,	AT32UC3L016,
AT32UC3L0256,	AT32UC3L032,	AT32UC3L064

3 Technical Data

- Supported controllers of STM32 series via JTAG or SWD interface:
 - STM32F0: alle Derivate (SWD-Interface only)
 - STM32F1: alle Derivate
 - STM32F2: alle Derivate
 - STM32F3: alle Derivate
 - STM32F4: alle Derivate
 - STM32F7: alle Derivate
 - STM32H7: alle Derivate
 - STM32L0: alle Derivate (SWD-Interface only)
 - STM32L1: alle Derivate
 - STM32L4: alle Derivate
 - STM32L4+: alle Derivate
 - STM32G0: alle Derivate (SWD-Interface only)
 - STM32WB: alle Derivate
- Supported controllers of Atmel AVR series with ISP interface:
 - AT90
 - ATtiny
 - ATmega
- Supported controllers of Atmel AVR series with TPI interface:
 - all derivatives
- Supported controllers of Atmel AVR XMega series with PDI interface:
 - all derivatives
- Supported controllers of Atmel AVR series with UPDI interface:
 - all derivatives
- Supported controllers of Atmel AVR32 series with aWire interface:
 - all derivatives
- Flash programming of the target microcontroller via 10-pin, 2-row female connector and appropriate adapters for JTAG / SWD / ISP / TPI / PDI / UPDI / aWire. Adapters sold separately.
- JTAG: JTAG-chain support with up to 10 devices
- Power supply via the microcontroller to be programmed (2.0 - 5.5 volts).
- Writing of and reading from:
 - Flash
 - EEPROM (Atmel)
 - RAM (STM32 only)
 - Fuse-bits (Atmel)
 - Lock-bits (Atmel)

- Supported file system on microSD card: FAT32
- Internal flash disk with 640 kBytes and internal flash vars with 16 kBytes
- Supported file formats:
 - Intel HEX („.HEX“) (I8HEX, I16HEX, I32HEX) (ASCII file)
 - Motorola SREC (S19, S28, S37) (ASCII file)
 - RAW (binary file with raw data and no explicit address)
- Supported memory card formats: microSD, microSDHC
- Physical dimensions (without Universal Connector): height 46 mm, width 22 mm, depth 10 mm