

AN00169: Interfacing FlashRunner with Freescale S08P Devices

FlashRunner is a Universal In-System Programmer, which uses the principles of In-Circuit Programming to program Freescale S08P family microcontrollers. This Application Notes describes how to properly set up and use FlashRunner to program S08P Flash devices

This Application Note assumes that you are familiar with both FlashRunner and the main features of the S08P family. Full documentation about these topics is available in the FlashRunner user's manual and in device-specific datasheets.

1. Introduction

In-system programming of S08P microcontrollers is performed through Background Debug Mode (BDM) standard protocol.

In order to use FlashRunner to perform in-system programming, you need to implement the appropriate in-circuit programming hardware interface on your application board.

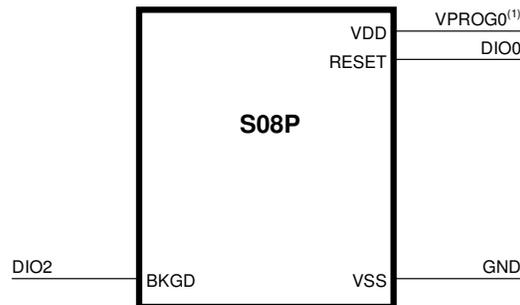
Thanks to its in-system programming capability, FlashRunner allows you to program or update the content of the Flash memory when the chip is already plugged on the application board.

2. Hardware Configuration

The microcontroller's lines needed to program a S08P device are the following:

- **BKGD:** Single-wire background interface pin. The BKGD pin is used for bidirectional communication of active background mode commands and data between FlashRunner and the target MCU.
- **RESET:** Device reset input/output pin.
- **VDD:** Device power supply voltage.
- **VSS:** Device power supply ground.

The lines mentioned above must be connected to the FlashRunner's "ISP" connector according to the following diagram:



⁽¹⁾ Connect this line if you want FlashRunner to automatically power the target device

3. Specific TCSETPAR Programming Commands

Overview

TCSETPAR commands set device-specific and programming algorithm-specific parameters. These commands must be sent after the **TCSETDEV** command and before a **TPSTART** / **TPEND** command block.

All of the following parameters must be correctly specified through the relative **TCSETPAR** commands (although the order with which these parameters are set is not important):

- VDD voltage;
- VDD_AUX voltage;
- Power Up time;
- Power Down time;
- Reset Up time;
- Reset Down time;
- BDM entry mode;
- Reset drive mode;
- FLL frequency;
- Clock oscillator frequency driven by FlashRunner.

TPSETPAR VDD

Command syntax:

```
TCSETPAR VDD <voltage mV>
```

Parameters:

voltage mV: Target device supply voltage, expressed in millivolts.

Description:

This command is used to properly generate the voltage level of the RESET and BKGD signals. Additionally, the specified voltage is routed to the VPROG0 line of the FlashRunner's "ISP" connector, which can be used as a supply voltage for the target board.

TPSETPAR VDD_AUX

Command syntax:

```
TCSETPAR VDD_AUX <voltage mV>
```

Parameters:

voltage mV: Auxiliary supply voltage, expressed in millivolts, in the range 3000-14500mV.

Description:

This command is used to generate an optional, auxiliary voltage level for user purposes. The specified voltage is routed to the VPROG1 line of the FlashRunner "ISP" connector.

A value of 0 drives the VPROG1 line to GND. If the **TCSETPAR VDD_AUX** is not sent, the VPROG1 line is driven to HiZ.

TPSETPAR PWUP

Command syntax:

TCSETPAR PWUP <time ms>

Parameters:

time ms: Power rising time, expressed in milliseconds.

Description:

This command is necessary because, to enter the programming mode, FlashRunner must properly drive the V_{DD} line during the power-on reset.

The V_{DD} rising time (PWUP) is expressed in milliseconds and depends on the features of your target board. Make sure to choose a value large enough to ensure that the V_{DD} signal reaches the high logic level within the specified time. Note that, if the V_{DD} line has a high load, a longer time is required for the V_{DD} signal to reach the high logic level. If PWUP is not long enough, FlashRunner could not be able to enter the programming mode.

TPSETPAR PWDOWN

Command syntax:

TCSETPAR PWDOWN <time ms>

Parameters:

time ms: Power falling time, expressed in milliseconds.

Description:

The V_{DD} falling time (PWDOWN) is expressed in milliseconds and depends on the features of your target board. Make sure to choose a value large enough to ensure that the V_{DD} signal reaches the low logic level within the specified time. Note that, if the V_{DD} line has a high load, a longer time is required for the V_{DD} signal to reach the low logic level.

TPSETPAR RSTUP

Command syntax:

TCSETPAR RSTUP <time μ s>

Parameters:

time μ s: Reset rising time, expressed in microseconds.

Description:

The Reset rising time (RSTUP) is expressed in microseconds and depends on the features of your target board. Make sure to choose a value large enough to ensure that the Reset signal reaches the high logic level within the specified time. Note that, if the Reset line has a high load, a longer time is required for the Reset signal to reach the high logic level. If RSTUP isn't long enough, FlashRunner could not be able to enter the BDM programming mode.

TPSETPAR RSTDOWN

Command syntax:

TCSETPAR RSTDOWN <time μ s>

Parameters:

time μ s: Reset falling time, expressed in microseconds.

Description:

The Reset falling time (RSTDOWN) is expressed in microseconds and depends on the features of your target board. Make sure to choose a value large enough to ensure that the Reset signal reaches the low logic level within the specified time. Note that, if the Reset line has a high load, a longer time is required for the Reset signal to reach the low logic level.

TCSETPAR BDM_ENTRY_MODE

Command syntax:

TCSETPAR BDM_ENTRY_MODE HW_RST | PWUP_RST | SW_RST

Command options:

Specify the reset to apply to enter in BDM mode.

Description:

This command is used to set up the BDM entry mode. HW_RST select the hardware reset given by the programmer to the MCU. With HW_RST, MCU RESET pin must be connected to the programmer. With PWUP_RST the programmer will apply a Power On Reset to enter in BDM mode: the power supply must be provided to the MCU directly by the programmer. SW_RST give a reset to the MCU through the setting of SYS_SBD FR.BDFR bit.

TCSETPAR RSTDRV

Command syntax:

TCSETPAR RSTDRV OPENDRAIN | PUSHPULL

Options:

OPENDRAIN: Reset line is driven in open-drain mode.

PUSHPULL: Reset line is driven in push-pull mode.

Description:

Specify in which way FlashRunner drives the Reset line.

TCSETPAR FLL_OSC

Command syntax:

TCSETPAR FLL_OSC <frequency Hz>

Parameter:

Specify the frequency to use for ICSOUT, expressed in Hertz.

Description:

Set a value for the ICSOUT frequency. If this command is not present, ICSOUT frequency is calculated by the algorithm starting from the trim frequency indicated in the apposite command; the BDIV bits are set to 000 to choose 1 as divisor of the selected clock.

TCSETPAR CLKOUT

Command syntax:

TCSETPAR CLKOUT 25000000 | 12500000 | 6250000 | 0

Command options:

Specify the frequency of the clock signal generated at the CLOCKOUT pin of FlashRunner “ISP” connector, expressed in Hertz.

Description:

Generates an auxiliary clock signal at the CLOCKOUT pin of the FlashRunner “ISP” connector. Make sure that the clock frequency you select isn't greater than the maximum allowed frequency for your device. If the target device has an internal frequency divider, the actual device's frequency will be a fraction of the CLKOUT frequency.

If you specify 0 as the CLKOUT frequency, no clock signal is generated.

4. Specific TPCMD Programming Commands

Overview

TPCMD commands perform a programming operation (i.e. mass erase, program, verify, etc.) These command must be sent within a **TPSTART** / **TPEND** command block.

Freescale S08P-specific target programming commands are the following:

- **TPCMD UNSECURE;**
- **TPCMD MASSERASE;**
- **TPCMD SECTORERASE;**
- **TPCMD BLANKCHECK;**
- **TPCMD PROGRAM;**
- **TPCMD VERIFY;**
- **TPCMD TRIM;**
- **TPCMD READ;**
- **TPCMD IS_DEVICE_SECURED;**
- **TPCMD DUMP;**
- **TPCMD SET_MARGIN_LEVEL;**
- **TPCMD GET_FREQ_VAL;**
- **TPCMD RUN.**

TPCMD UNSECURE

Command syntax:

TPCMD UNSECURE

Description:

It unsecures the target device. This command will erase the whole Flash and EEPROM memory too.

TPCMD MASSERASE

Command syntax:

TPCMD MASSERASE C|F|E

Command options:

C|F|E: Specifies all blocks (C), Flash (F), EEPROM (E) memory.

Description:

It erases all the blocks of memory, Flash or EEPROM. 'C' parameter erases the entire Flash and EEPROM memory space. 'F' parameter erases all Flash data. 'E' erases EEPROM memory.

TPCMD SECTORERASE

Command syntax:

TPCMD SECTORERASE F|E <tgt start addr>

Command options:

F|E: Specifies Flash (F), EEPROM (E) memory.

tgt start address: Device memory location to identify the sector to be erased.

Description:

It erases a sector of Flash or EEPROM. 'F' parameter erases all Flash data. 'E' erases EEPROM memory. The parameter **tgt start address** specify a sector to be erased.

TPCMD BLANKCHECK

Command syntax:

```
TPCMD BLANKCHECK S F|E <tgt start addr> <len>
```

```
TPCMD BLANKCHECK C|F|E
```

Command parameters and options:

- F|E:** Specifies Flash (F) or EEPROM (E) memory.
- C:** Specifies all Flash and EEPROM blocks of memory.
- S:** Specifies Flash or EEPROM section of memory.
- tgt start address:** Device memory location from where the blankcheck operation will start.
- len:** Number of locations to be blankchecked, expressed in longwords units.

Description:

It blankchecks the whole Flash or EEPROM or both Flash and EEPROM memory. It is possible to blankchecks also a section of Flash or EEPROM memory. Blankchecks **len** locations starting from the address specified by **tgt start address**.

TPCMD PROGRAM

Command syntax:

```
TPCMD PROGRAM F|E|O <src offset> <tgt start addr> <len>
```

Command parameters and options:

- F|E|O:** Specifies Flash (F), EEPROM (E) memory or program once area (O).
- src offset:** Offset from the beginning of the source memory.
- tgt start addr:** Device memory location from where the program operation will start.
- len:** Number of locations to be programmed, expressed in byte.

Description:

It programs **len** locations of Flash or EEPROM memory starting from the **tgt start addr** address. 'O' permits to program the reserved 64 bytes field (8 phrases) in the nonvolatile information register located in Flash or a part of it. In Program Once area, the **tgt start addr** is the address of the first phrase to program.

TPCMD VERIFY

Command syntax:

```
TPCMD VERIFY F|E|O R <src offset> <tgt start addr> <len>
```

Command parameters and options:

- F|E|O:** Specifies Flash (F) or EEPROM (E) memory or program once area (O).
- R:** Specifies Read out method (R).
- src offset:** Offset from the beginning of the source memory.

tgt start addr: Device memory location from where the verify operation will start.

len: Number of locations to be verified, expressed in byte.

Description:

It verifies through read out method **len** locations of Flash or EEPROM memory starting from the **tgt start addr** address. 'o' permits to verify the reserved 64 bytes field (8 phrases) in the nonvolatile information register located in Flash or a part of it. In Read Once area, the **tgt start addr** is the address of the first phrase to verify.

TPCMD TRIM

Command syntax:

TPCMD TRIM <frequency Hz> <address> <tolerance_pct>

Command parameters:

address: Address of the memory location where the trimming value is to be programmed.

frequency Hz: Value of the desired frequency, expressed in Hz.

tolerance_pct: Precision of trimming value calculation, expressed as a percentage (1 to 100).

Description:

This command trims (calibrates) the device's internal reference clock.

It calculates the trimming value for the frequency specified by the **frequency Hz** parameter (to a precision specified by the **tolerance_pct** parameter), and prepares to program it at the **address** address.

TPCMD READ

Command syntax:

```
TPCMD READ F|E|O <tgt start addr> <len>
```

Command parameters and options:

- F|E|O:** Specifies Flash (F), EEPROM (E) memory or read once (O) area.
- tgt start addr:** Device memory location from where the read operation will start.
- len:** Number of locations to be verified

Description:

It reads **len** locations of Flash or EEPROM memory starting from the **tgt start addr** address. It reads locations of a reserved 64 bytes field (8 phrases) (O) in the nonvolatile information register located in Flash. In Read Once area, the **tgt start addr** is the address of the first phrase to read.

TPCMD IS_DEVICE_SECURED

Command syntax:

```
TPCMD IS_DEVICE_SECURED
```

Description:

Return whether the device is secured (1) or not (0).

TPCMD DUMP

Command syntax:

```
TPCMD DUMP F|E <dst start addr> <tgt start addr> <len>
```

Command parameters and options:

- F|E:** Specifies Flash (**F**), EEPROM (**E**) memory.
- dst start addr:** Destination file location from where the dump operation will store data.
- tgt start addr:** Device memory location from where the dump operation will start.
- len:** Number of locations to be read and stored

Description:

This command will create a file with the memory content of the location specified starting from **tgt start addr** for a size of **len**. The parameter **dst start addr** is the starting address in the dump file.

TPCMD SET_MARGIN_LEVEL

Command syntax:

```
TPCMD SET_MARGIN_LEVEL F|E <tgt start addr> <margin value>
```

Command parameters and options:

- F|E:** Specifies Flash (**F**), EEPROM (**E**) memory.
- tgt start addr:** Device memory location to identify Flash or EEPROM block.
- margin value:** Value for the margin level settings.

Description:

Set the **margin value** indicated for the Flash block identified by the **tgt start addr** used. The set user margin level command causes the memory controller to set the margin level for future read operations of the Flash (**F**) or EEPROM (**E**) block.

CCOB (CCOBIX = 010)	Level description
0x0000	Return to normal level
0x0001	User margin-1 level
0x0002	User margin-0 level

TPCMD GET_FREQ_VAL

Command syntax:

TPCMD GET_FREQ_VAL

Description:

This command will show the Bus frequency value, the value programmed in the NVM_FCLKDIV register and the value for the NVM_FCLKDIV register calculated by the algorithm.

TPCMD RUN

Command syntax:

TPCMD RUN

Command parameters:

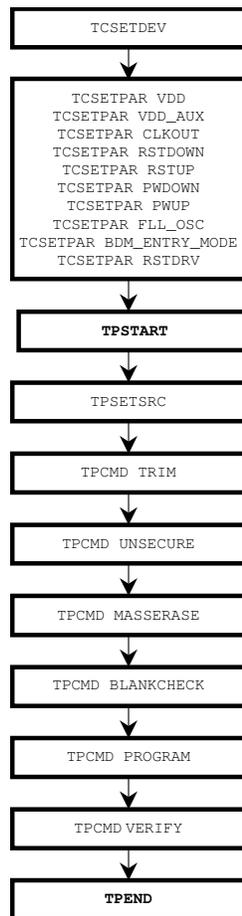
None.

Description:

It runs the target application.

5. Typical Programming Flow

The following flow chart illustrates typical steps to help you write your own script file.



6. Script Example

The example below shows a typical programming flow for a Freescale S08P device.

```
;
; FLASHRUNNER SCRIPT EXAMPLE FOR FREESCALE MC9S08PA32
;
; Use this example as a starting point for your specific programming needs
;
; -----
;
; Hardware connections
;
; DIO0/AO0 (RESET)
; DIO2 (BKGD)
; CLKOUT (CLOCK - optional)
;

; Turns off logging
#LOG_OFF
; Halt on errors
#HALT_ON_FAIL

; Sets device
TCSETDEV FREESCALE MC9S08PA32 HCS08_B

; Target voltage, mV (change as needed)
TCSETPAR VDD 5500

; Clock oscillator frequency, Hz
; The possible frequencies are: 25000000, 12500000, 6250000, 0 (DISABLED)
TCSETPAR CLKOUT 0

; Reset rising time, us
TCSETPAR RSTUP 100

; Reset falling time, us
TCSETPAR RSTDOWN 100

; Power rising time, ms
TCSETPAR PWUP 10

; Power falling time, ms
```

```
TCSETPAR PWDOWN 10

; Sets the BDM entry mode
TCSETPAR BDM_ENTRY_MODE HW_RST

; Speeds up programming by driving the internal FLL circuitry
; to the maximum bus frequency.
; The maximum bus frequency depends on the supply voltage.
; (Change the FLL frequency as needed. 0 disables the FLL.)
TCSETPAR FLL_OSC 12000000

; Starts programming block
TPSTART

; Image file to be programmed (must be placed in the \BINARIES directory)
TPSETSRC FILE TEST.FRB

; Mass erases Flash memory
TPCMD MASSERASE F

; Trims internal reference oscillator (change frequency, trimming location and tolerance as needed)
; For this device the typical internal reference frequency is 32768 Hz.
; You can calibrate the internal reference from 31250 to 39062 Hz.
TPCMD TRIM 32768 $FFAE 1

; Blank checks Flash memory (change address and length as needed)
TPCMD BLANKCHECK F $8000 32768

; Programs Flash memory (change addresses and length as needed)
TPCMD PROGRAM F $8000 $8000 32768

; Verifies Flash memory, read-out method (change addresses and length as needed)
TPCMD VERIFY F R $8000 $8000 32768

; Mass erases EEPROM memory
TPCMD MASSERASE E

; Blank checks EEPROM memory (change addresses and length as needed)
TPCMD BLANKCHECK E $3100 256

; Programs EEPROM memory (change addresses and length as needed)
TPCMD PROGRAM E $3100 $3100 256

; Verifies EEPROM memory, read-out method (change addresses and length as needed)
TPCMD VERIFY E R $3100 $3100 256
```

```
; Programs Once: len is the number of bytes to program (change addresses and length as needed) .  
; TPCMD PROGRAM 0 $0000 $0000 $40  
  
; Verifies Program Once Area: len is the number of bytes to verify (change addresses and length as needed) .  
; TPCMD VERIFY 0 $0000 $0000 $40  
  
; Reads Once: len is the number of bytes to read (change addresses and length as needed) .  
; TPCMD READ 0 $0000 $40  
  
; Ends programming block  
TPEND
```

The FlashRunner's system software setup will install script examples specific for each device of the S08P family on your PC.

7. Freescale S08P Specific Error

Freescale S08P-Specific Errors	
\$5100	TCSETDEV command: manufacturer not supported
\$5101	TCSETDEV command: algorithm not found on card
\$5102	TCSETDEV command: device not supported
\$5103	TCSETDEV command: internal error in algorithm closure
\$5104	TCSETDEV command: internal hardware configuration error
\$5110	TCSETPAR command: missing or wrong parameter
\$5111	TCSETPAR CLKOUT command: missing parameter
\$5112	TCSETPAR PWDOWN command: invalid or out of range parameter
\$5113	TCSETPAR PWDOWN command: missing parameter
\$5114	TCSETPAR PWUP command: invalid or out of range parameter
\$5115	TCSETPAR PWUP command: missing parameter
\$5116	TCSETPAR RSTDOWN command: missing, invalid or out of range parameter
\$5117	TCSETPAR RSTDOWN command: invalid or out of range parameter
\$5118	TCSETPAR RSTUP command: invalid or out of range parameter
\$5119	TCSETPAR RSTUP command: missing parameter
\$511A	TCSETPAR VDD command: invalid or out of range parameter
\$511B	TCSETPAR VDD command: missing parameter
\$511C	TCSETPAR BDM_ENTRY_MODE command: invalid or out of range parameter
\$511D	TCSETPAR BDM_ENTRY_MODE command: missing parameter
\$511E	TCSETPAR FLL_OSC command: invalid or out of range parameter
\$511F	TCSETPAR FLL_OSC command: missing parameter
\$5120	TPCMD command: missing parameter
\$5121	TPCMD RUN command: execution error
\$5122	TPCMD IS_DEVICE_SECURED command: execution error
\$5123	TPCMD TRIM command: invalid or out of range parameter
\$5124	TPCMD TRIM command: command not supported
\$5125	TPCMD TRIM command: execution error
\$5126	TPCMD VERIFY command: missing or invalid parameter
\$5127	TPCMD VERIFY command: target start address parameter or length parameter out of range
\$5128	TPCMD VERIFY command: source offset parameter out of range
\$5129	TPCMD VERIFY command: Flash verify error
\$512A	TPCMD VERIFY command: EEPROM verify error
\$512B	TPCMD PROGRAM command: missing or invalid parameter
\$512C	TPCMD PROGRAM command: target start address parameter or length parameter out of range
\$512D	TPCMD PROGRAM command: source offset parameter out of range
\$512E	TPCMD PROGRAM command: Flash program error
\$512F	TPCMD PROGRAM command: EEPROM program error
\$5130	TPCMD VERIFY command: Program Once area verify execution error
\$5131	TPCMD UNSECURE command: unsecure error
\$5132	TPCMD BLANKCHECK command: missing or invalid parameter
\$5133	TPCMD BLANKCHECK command: target start address parameter or length parameter out of range
\$5134	TPCMD BLANKCHECK command: blankcheck Flash execution error
\$5135	TPCMD BLANKCHECK command: blankcheck EEPROM execution error
\$5136	TPCMD MASSERASE command: masserase All execution error

\$5137	TPCMD UNSECURE command: unsecure MCU command execution error
\$5138	TPCMD SECTORERASE command: missing or invalid parameter
\$5139	TPCMD SECTORERASE command: sector erase Flash execution error
\$513A	TPCMD SECTORERASE command: sector erase EEPROM execution error
\$513B	TPCMD MASSERASE command: missing or invalid parameter
\$513C	TPCMD MASSERASE command: masserase EEPROM execution error
\$513D	TPCMD BLANKCHECK command: blankcheck All execution error
\$513E	TPCMD SET_MARGIN_LEVEL command: missing or invalid parameter
\$513F	TPCMD SET_MARGIN_LEVEL command: set margin level execution error
\$5140	TPSTART command: execution error
\$5141	TPEND command: execution error
\$5142	TCSETPAR VDD_AUX command: invalid or out of range parameter
\$5143	TPCMD VERIFY command: device protected
\$5144	TPCMD READ command: missing or invalid parameter
\$5145	TPCMD READ command: target start address parameter or length parameter out of range
\$5146	TPCMD READ command: device protected
\$5147	TPCMD READ command: read execution error
\$5148	TPCMD DUMP command: missing or invalid parameter
\$5149	TPCMD DUMP command: target start address parameter or length parameter out of range
\$514A	TPCMD DUMP command: destination start address parameter or length parameter out of range
\$514B	TPCMD DUMP command: dump Flash execution error
\$514C	TPCMD DUMP command: dump EEPROM execution error
\$514D	TPCMD DUMP command: device protected
\$514E	TPCMD DUMP command: command not supported
\$514F	TCSETPAR RSTDRV command: invalid or out of range parameter
\$5150	TPCMD GET_FREQ_VAL command: execution error
\$5154	TPCMD MASSERASE command: masserase Flash execution error
\$5155	TPCMD BLANKCHECK command: sector blankcheck execution error
\$5159	TPCMD UNSECURE command: internal parameter setting or unsecure execution error
\$515A	TPCMD SECTORERASE command: internal parameter setting or sector erase Flash execution error
\$515B	TPCMD BLANKCHECK command: internal parameter setting or sector blankcheck execution error
\$515C	TPCMD READ command: read Once execution error
\$515D	TPCMD command: syntax memory type error
\$515E	TPCMD command: syntax memory range error
\$5160	TPCMD MASSERASE command: internal parameter setting or masserase Flash execution error
\$5161	TPCMD BLANKCHECK command: internal parameter setting or blankcheck Flash execution error
\$5162	TPCMD VERIFY command: internal parameter setting or verify Flash execution error
\$5163	TPCMD PROGRAM command: internal parameter setting or program Flash execution error
\$5164	TPCMD VERIFY command: internal parameter setting or verify Flash execution error
\$5165	TPCMD READ command: internal parameter setting or read execution error
\$5166	TPCMD BLANKCHECK command: internal parameter setting or blankcheck EEPROM execution error
\$5167	TPCMD VERIFY command: internal parameter setting or verify EEPROM execution error
\$5168	TPCMD PROGRAM command: internal parameter setting or program EEPROM execution error
\$5169	TPCMD IS_DEVICE_SECURED command: entry execution error
\$516A	TPCMD RUN command: run execution error
\$516B	TPCMD command: set FLL execution error
\$516D	TPCMD command: wrong FLL value
\$516E	TPCMD TRIM command: trim instruction execution error
\$5174	TPCMD command: device protected
\$517F	TPCMD VERIFY command: data mismatch

8. Programming Times

The following table shows programming times for selected Freescale S08P devices.

Device	Mem. Size	Conditions	Operations	Time
Freescale MC9S08PA32	32KB Flash 256B EEPROM	TRIM=31250Hz FR01LAN	Unsecure + Erase + Blank Check + Program + Verify	7,71 s

Programming times depend on Programming Algorithm version, target board connections, communication mode, target microcontroller mask, and other conditions. Programming times for your actual system may therefore be different than the ones listed here. SMH Technologies reserves the right to modify Programming Algorithms at any time.

9. References

FlashRunner User's Manual

Microcontroller's specific datasheet