

# AN00172: Interfacing FlashRunner with Infineon XMC1000 devices using Serial Wire Debug (SWD) Interface

FlashRunner is a Universal In-System Programmer, which uses the principles of In-Circuit Programming to program Infineon XMC1000 family microcontrollers. This Application Note describes how to properly set up and use FlashRunner to program XMC1000 family Flash devices.

This Application Note assumes that you are familiar with both FlashRunner and the main features of the XMC1000 family devices. Full documentation about these topics is available in the FlashRunner user's manual and in device-specific datasheets.

## 1. Introduction

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In-system programming of Infineon XMC1000 microcontrollers is performed through Serial Wire Debug (SWD) interface/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 capabilities, FlashRunner allows you to program or update the content of the Flash memory when the chip is already plugged on the application board.

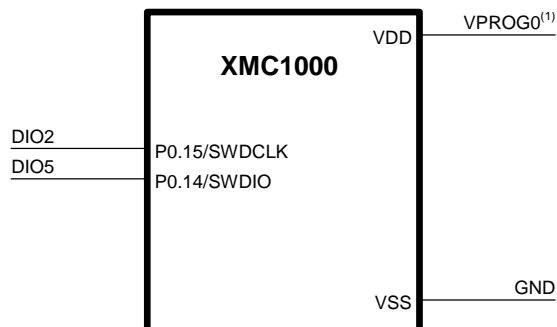
## 2. Hardware Configuration

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The microcontroller's lines needed to program an XMC1000 device are the following:

- **SWDCLK:** Serial wire clock.
- **SWDIO:** Serial wire debug input/output.
- **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:



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

## 3. Specific TCSETPAR Programming Commands

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### 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;
- Reset Drive mode;
- SWDCLK Serial Wire clock frequency;

## TCSETPAR 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 ISP lines. 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.

## TCSETPAR 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.

## TCSETPAR 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.

### TCSETPAR 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.

### TCSETPAR RSTUP

Command syntax:

**TCSETPAR RSTUP <time  $\mu$ s>**

Parameters:

**time  $\mu$ 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.

## TCSETPAR RSTDOWN

Command syntax:

```
TCSETPAR RSTDOWN <time µs>
```

Parameters:

**time µs**: 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 RSTDRV

Command syntax:

```
TCSETPAR RSTDRV <mode>
```

Parameters:

**mode**: Reset drive mode.

Options:

**OPENDRAIN**

**PUSHPULL**

Description:

Sets the Reset line driving mode

## TCSETPAR SWCLK

Command syntax:

```
TCSETPAR SWCLK <Hz>
```



Parameters:

**Hz** : serial wire debug clock frequency in Hertz

Description:

This parameter is used to set up the speed of clock signal on SWD interface. Value must be less than 10.000.000.

The effective frequency of the SWD clock signal driven by FlashRunner is the higher value less or equal to this parameter that can be obtained from the following formula:

SWD Clock = 12.500.000 / div. (where *div* is an integer value).

The maximum clock speed is 6.250.000 Hz.

## 4. Specific TPCMD Programming Commands

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### 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.

XMC1000 specific target programming commands are the following:

- **TPCMD MASSERASE;**
- **TPCMD PAGE\_ERASE**
- **TPCMD BLANKCHECK;**
- **TPCMD PROGRAM;**
- **TPCMD VERIFY;**
- **TPCMD CHANGE\_BMI**
- **TPCMD READ;**
- **TPCMD RUN;**

### TPCMD MASSERASE

Command syntax:

**TPCMD MASSERASE F**



Command options:

**F** Specifies that this command refer to Flash memory (**F**).

Description:

It erases all the device Flash memory (**F**).

## TPCMD PAGE\_ERASE

Command syntax:

```
TPCMD PAGE_ERASE F <page start addr>
```

Command parameters and options:

**F**: Specifies Flash (**F**) memory.

**page start address**: one arbitrary physical address of the page to be erased.

Description:

It erases Flash memory pages. Erases the page in which the address specified by **page start address** is comprised. The start address is the address specified in each single device datasheet or User's Guide.

## TPCMD BLANKCHECK

Command syntax:

```
TPCMD BLANKCHECK F <tgt start addr> <len>
```

Command parameters and options:

**F**: Specifies Flash (**F**) memory.

**tgt start address**: Device memory location from where the blankcheck operation will start.

**len**: Number of locations to be blankchecked.

Description:

It blankchecks Flash memory. Blankchecks **len** locations starting from the address specified by **tgt start address**. The start address is the address specified in each single device datasheet or User's Guide under "Memory" chapter.



## TPCMD PROGRAM

Command syntax:

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

Command parameters and options:

<b>F:</b>	Specifies Flash (F) memory.
<b>src offset:</b>	Offset from the beginning of the source memory.
<b>tgt start addr:</b>	Device memory location from where the program operation will start.
<b>len:</b>	Number of locations to be programmed.

Description:

It programs **len** locations of Flash memory starting from the **tgt start addr** address.

**len** specifies the number of locations to be programmed. **tgt start addr** is the address specified in each single device datasheet or User's Guide under "Memory" chapter.

## TPCMD VERIFY

Command syntax:

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

Command parameters and options:

<b>F:</b>	Specifies Flash (F) memory.
<b>R</b>	Specifies Readout (R) method.
<b>src offset:</b>	Offset from the beginning of the source memory.
<b>tgt start addr:</b>	Device memory location from where the verify operation will start.
<b>len:</b>	Number of locations/option bytes to be verified

Description:

It verifies **len** locations of Flash memory starting from the **tgt start addr** address. **len** specifies the number of locations to be verified.

## TPCMD CHANGE\_BMI

Command syntax:

```
TPCMD CHANGE_BMI F <bmi value>
```

Command parameters and options:

**F:** Specifies Flash (**F**) memory.

**bmi value:** BMI value to be installed.

Description:

It changes the Boot Mode Index from the UM HAR\_SW D0 used to program the device to the **bmi value**. It must be used at the end of the programming flow in order to change the BMI value to the ASC Bootstrap Loader (ASC\_BSL) or to the User Productive Mode (UPM). This command must be handled and used with care

## TPCMD READ

Command syntax:

```
TPCMD READ F <tgt start addr> <len>
```

Command parameters and options:

**F:** Specifies Flash (**F**) memory.

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

**len:** Number of locations to be read.

Description:

It reads **len** locations of Flash memory starting from the **tgt start addr** address. **len** specifies the number of locations to be read.

## TPCMD RUN

Command syntax:

```
TPCMD RUN
```



Command parameters:

None.

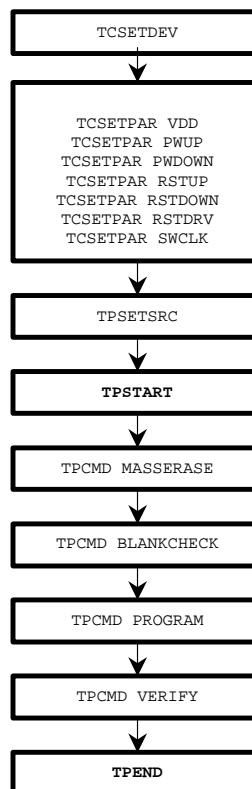
Description:

It runs the target application.

## 5. Typical Programming Flow

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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 XMC1000 device.

```
;  
; FLASHRUNNER SCRIPT EXAMPLE FOR INFINEON XMC1302-T038X0064  
;  
; Use this example as a starting point for your specific programming needs  
;  
; -----  
;  
; Hardware connections  
;  
; DIO2 (SWCLK)  
; DIO5 (SWDIO)  
;  
;  
; Turns off logging  
#LOG_OFF  
; Halt on errors  
#HALT_ON FAIL  
;  
; Sets device  
TCSETDEV INFINEON XMC1302-T038X0064 XMC  
;  
;-----  
; FLASHRUNNER I/O Settings  
;-----  
;  
; Target voltage, mV (change as needed)  
TCSETPAR VDD 5500  
;  
; VPROG1 voltage, mV (from 3000 to 14500, 0 to disable)(change as needed)  
TCSETPAR VDD_AUX 0  
;  
; Clock oscillator frequency driven by FlashRunner, Hz  
; Possible frequencies are: 25000000, 12500000, 6250000, 0 (DISABLED)  
TCSETPAR CLKOUT 0  
;  
; RESET down time (from 0 us to 65535 us)  
TCSETPAR RSTDOWN 1000  
; RESET up time (from 0 us to 65535 us)  
TCSETPAR RSTUP 1000  
; RESET driving mode (PUSHPULL or OPENDRAIN)  
TCSETPAR RSTDRV OPENDRAIN
```



```
; Power down time (from 0 ms to 65535 ms)
TCSETPAR PWDOWN 10
; Power up time (from 0 ms to 65535 ms)
TCSETPAR PWUP 10

;-----
; XMC ALGO Settings
;-----

; Set the frequency of the SWD channel, Hz (change as needed)
TCSETPAR SWCLK 10000000

;-----
; Start Programming operation
;-----

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

; Starts programming block
TPSTART

;-----
; FLASH commands
;-----

; Mass erases Flash memory
TPCMD MASSERASE F

; Blank checks Flash memory (change address and length as needed)
TPCMD BLANKCHECK F $10001000 $10000

; Programs Flash memory (change source, target address and length as needed)
TPCMD PROGRAM F $10001000 $10001000 $10000

; Verifies Flash memory (change source, target address and length as needed)
; If you want you can choose between two type of verify:
; 1) Read-Out method (R). Slow but secure
; 2) CheckSum method (S). Fast but not secure
TPCMD VERIFY F R $10001000 $10001000 $10000

; Ends programming block
TPEND
```



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The FlashRunner's system software setup will install script examples specific for each device of the XMC1000 family on your PC.



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## 7. Infineon XMC1000 Specific Errors

Infineon XMC1000 - Specific Errors	
\$5900	TCSETDEV command: manufacturer not supported
\$5901	TCSETDEV command: algorithm not found on card
\$5902	TCSETDEV command: device not supported
\$5903	TCSETDEV command: internal hardware configuration error
\$5904	TCSETDEV command: corrupted algorithm file
\$5905	TCSETDEV command: programming algorithm requires FlashRunner firmware version 01.01.00.00 or newer
\$5906	TCSETPAR command: parameter not supported
\$5907	TCSETPAR CLKOUT command: missing, invalid or out of range parameter
\$5908	TCSETPAR RSTDOWN command: missing, invalid or out of range parameter
\$5909	TCSETPAR RSTUP command: missing, invalid or out of range parameter
\$590A	TCSETPAR RSTDRV command: missing or invalid command option
\$590B	TCSETPAR PWDOWN command: missing, invalid or out of range parameter
\$590C	TCSETPAR PWUP command: missing, invalid or out of range parameter
\$590D	TCSETPAR VDD command: missing, invalid or out of range parameter
\$590E	TCSETPAR VDD_AUX command: missing, invalid or out of range parameter
\$5910	TCSETPAR SWCLK command: missing, invalid or out of range parameter
\$5911	TPCMD command: missing parameter
\$5912	TPCMD command: parameter not supported
\$5913	TPCMD RUN command: execution error
\$5914	TPCMD MASSERASE command: missing parameter
\$5915	TPCMD MASSERASE command: invalid parameter
\$5916	TPCMD MASSERASE command: Flash masserase error
\$5918	TPCMD PAGE_ERASE command: missing parameter
\$5919	TPCMD PAGE_ERASE command: invalid parameter
\$591A	TPCMD PAGE_ERASE command: Flash erase error
\$591C	TPCMD BLANKCHECK command: missing parameter
\$591D	TPCMD BLANKCHECK command: invalid parameter
\$591E	TPCMD BLANKCHECK command: Flash blankcheck error
\$5920	TPCMD PROGRAM command: missing parameter
\$5921	TPCMD PROGRAM command: invalid parameter
\$5922	TPCMD PROGRAM command: source offset parameter out of range
\$5923	TPCMD PROGRAM command: Flash program error
\$5925	TPCMD VERIFY command: missing parameter
\$5926	TPCMD VERIFY command: invalid parameter
\$5927	TPCMD VERIFY command: source offset parameter out of range
\$5928	TPCMD VERIFY command: Flash verify error
\$592A	TPCMD READ command: missing or invalid parameter
\$592B	TPCMD READ command: Flash read error
\$592C	TPCMD CHANGE_BMI command: missing parameter
\$592E	TPCMD CHANGE_BMI command: change BMI error
\$592F	TPSTART command: execution error
\$5930	TPSTART command: one or more required TCSETPAR commands have not been sent
\$5931	TPEND command: execution error



## 8. Programming Times

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The following table shows programming times for selected Infineon XMC1000 device.

Device	Mem. Size	Conditions	Operations	Time
XMC1302-T038X0064	64KB	FR01LAN	Masserase+Blank Check+Program+Verify	9,45 s

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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

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FlashRunner User's Manual.  
Microcontroller-specific Datasheets and User's Guides.



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