

# AN00176: Interfacing FlashRunner with TI TM4C12 Devices

FlashRunner is a Universal In-System Programmer, which uses the principles of In-Circuit Programming to program TI TM4C12 family microcontrollers.

This Application Note assumes that you are familiar with both FlashRunner and the main features of the TM4C12 family. 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 TM4C12 microcontrollers is performed through JTAG or SWD protocol.

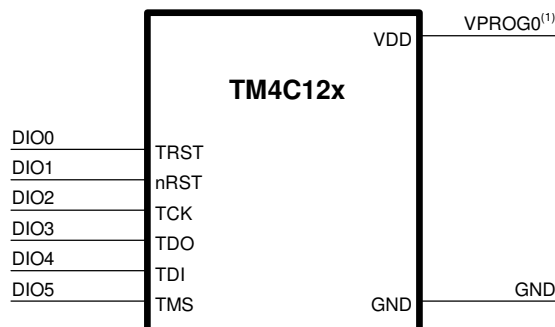
In order to use FlashRunner to perform in-system programming, you need to implement the appropriate in-circuit programming hardware interface on your application board.

## 2. Hardware Configuration

The microcontroller lines needed to program an TM4C12 device through JTAG are the following:

- **TRST:** Test Reset (Optional).
- **TMS:** Test Mode Select
- **TCK:** Test Clock.
- **TDO:** Test Data Out.
- **TDI:** Test Data In.
- **RST:** Device reset.
- **VDD:** Device power supply voltage.
- **GND:** Device power supply ground.

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

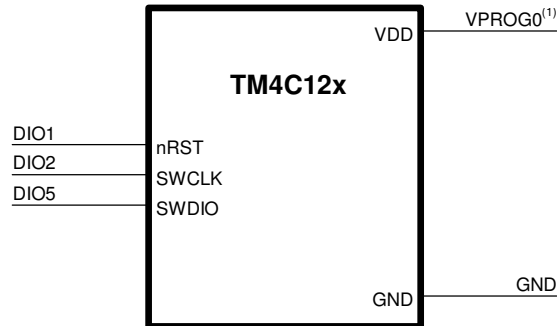


<sup>(1)</sup> Connect this line if you want FlashRunner to automatically power the target device

The microcontroller lines needed to program an TM4C12 device through SWD are the following:

- **RST:** Device reset.
- **SWCLK:** Serial Wire Clock.
- **SWDIO:** Serial Wire Debug Input/Output.
- **VDD:** Device power supply voltage.
- **GND:** 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

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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):

- Communication mode.
- Communication frequency.
- Oscillator input frequency.

#### TCSETPAR CMODE JTAG

Command syntax:

**TCSETPAR CMODE** <communication protocol>

Parameters:

**Communication protocol:** Specifies the communication protocol.

Description:

Specifies the communication protocol used between FlashRunner and target microcontroller. JTAG or SWD.

## **TCSETPAR JTCLK**

Command syntax:

**TCSETPAR JTCLK <frequency Hz>**

Parameters:

**frequency Hz:** communication frequency, expressed in Hertz.

Description:

This command is used to set up the communication frequency between FlashRunner and target microcontroller through JTAG protocol.

## **TCSETPAR SWCLK**

Command syntax:

**TCSETPAR SWCLK <frequency Hz>**

Parameters:

**frequency Hz:** communication frequency, expressed in Hertz.

Description:

This command is used to set up the communication frequency between FlashRunner and target microcontroller through SWD protocol.

## 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.

TI TM4C12 specific target programming commands are the following:

- **TPCMD BLANKCHECK;**
- **TPCMD MASSERASE;**
- **TPCMD ERASE;**
- **TPCMD PROGRAM;**
- **TPCMD VERIFY;**
- **TPCMD PROTECT;**
- **TPCMD UNLOCK;**
- **TPCMD LOCK;**
- **TPCMD READ;**
- **TPCMD DUMP;**
- **TPCMD RUN.**

### TPCMD BLANKCHECK

Command syntax:

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

Command parameters and options:

- F|E:** Specifies memory type to be programmed.
- tgt start address:** Device memory location from where the blankcheck operation will start.
- len:** Number of byte locations to be blankchecked.

Description:

Blankchecks flash memory or EEPROM memory. Blankchecks **len** byte locations starting from the address specified by **tgt start address**.

## TPCMD MASSERASE

Command syntax:

**TPCMD MASSERASE F|E|C**

Command options:

**F|E|C:** Specifies memory type to be programmed

Description:

Erase flash memory **F**, EEPROM memory **E**, or both (if EEPROM available) **C**.

## TPCMD ERASE

Command syntax:

**TPCMD ERASE F <tgt start addr> <len>**

Command options:

**F:** Specifies memory type to be erased

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

**len:** Number of byte locations to be erased.

Description:

Erase flash memory **F** starting from the **tgt start addr** address for the specified **len**.

## TPCMD PROGRAM

Command syntax:

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

Command parameters and options:

**F|E:** Specifies memory type to be programmed

**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 byte locations to be programmed.

Description:

Programs **len** byte locations of flash memory **F** or EEPROM memory **E** starting from the **tgt start addr** address.

## TPCMD VERIFY

Command syntax:

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

Command parameters and options:

<b>F E:</b>	Specifies memory type to be verified
<b>R S:</b>	Specifies verify technology. Options availability is flash technology dependent.
<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 byte locations to be verified.

Description:

Verifies **len** byte locations of flash memory **F** or EEPROM memory **E** starting from the **tgt start addr** address. **R|S** parameters select ReadOut verifying method (slow but secure) or Checksum verification method (faster but unsecure).

## TPCMD PROTECT

Command syntax:

```
TPCMD PROTECT F <protection type>
```

Command parameters and options:

<b>F:</b>	Specifies memory type to be protected.
<b>protection type:</b>	Device protection type: No protection (0) ; Read only protecton,no execution (1) ; Execution only protection, no read and write (2) .

Description:

Protect flash memory **F** with different type of protection.

## TPCMD UNLOCK

Command syntax:

**TPCMD UNLOCK**

Command parameters and options:

None.

Description:

Unlock the device. Start the procedure to unlock the device.

## TPCMD LOCK

Command syntax:

**TPCMD LOCK**

Command parameters and options:

None.

Description:

Lock the device.

In Flash Memory Address register (FMA) is set the BOOTCFG register address, in Flash Memory Data register (FMD) are set the data to be written in BOOTCFG register. The Flash Memory Control register (FMC) is set with the correct value for a write operation. To lock the device DBG0 and DBG1 bit in BOOTCFG are set to 0.

## TPCMD READ

Command syntax:

**TPCMD READ F|E <tgt start addr> <len>**

Command parameters and options:

**F|E:** Specifies memory type to be read.

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

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



Description:

Reads `len` locations of flash memory **F** or EEPROM memory **E** starting from the `tgt start addr` address.

## TPCMD DUMP

Command syntax:

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

Command parameters and options:

<b>F E:</b>	Specifies memory type.
<b>src offset:</b>	Offset from the beginning of the source memory.
<b>tgt start addr:</b>	Device memory location from where the dump operation will start.
<b>len:</b>	Number of locations to be dumped.

Description:

Dumps `len` locations of flash memory **F** or EEPROM memory **E** starting from the `tgt start addr` address.

## TPCMD RUN

Command syntax:

```
TPCMD RUN
```

Command parameters:

None.

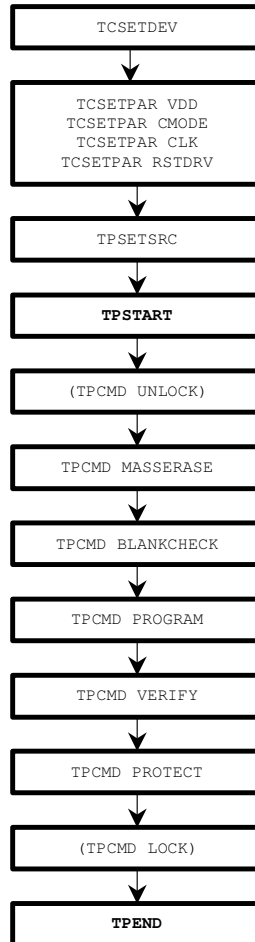
Description:

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

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The example below shows a typical programming flow for a TI TM4C12 device.

```

;
; FLASHRUNNER SCRIPT EXAMPLE FOR TI TM4C1231E6PM
;
; Use this example as a starting point for your specific programming needs
;
; -----
;
; Hardware connections
;
; JTAG Connections
;
; DIO0/A00      (JNTRST - optional)
; DIO1/A01      (NRST)
; DIO2          (JTCK)
; DIO3          (JTDO)
; DIO4          (JTDI)
; DIO5          (JTMS)
;
; -----
;
; SWD Connections
;
; DIO1/A01      (NRST)
; DIO2          (SWCLK)
; DIO5          (SWDIO)
;
;
; -----
; ATTENTION: for more information on the available commands and parameter tuning
; please visit our website: http://www.smh-tech.com, click on 'Support & download' menu, Download Area section and
; 'Application Note' subsection and download the document related to the specific programming algorithm
; -----

; Turns off logging
#LOG_OFF

; Halt on errors
#HALT_ON FAIL

; Sets device
TCSETDEV TI TM4C1231E6PM TI_E

; -----
; FLASHRUNNER I/O Settings
; -----

; Target voltage, mV (change as needed)
TCSETPAR VDD 3600

```

```

; 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

;-----
; TI_E ALGO Settings
;-----

; Set the communication interface to use (JTAG)
TCSETPAR CMODE JTAG
; Set the frequency of the JTAG channel, Hz (change as needed)
; It must be less then HCLK frequency
TCSETPAR JTCLK 10000000

; Set the communication interface to use (SWD)
;TCSETPAR CMODE SWD
; Set the frequency of the SWD channel, Hz (change as needed)
; It must be less then HCLK frequency
;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 (F)
TPCMD MASSERASE F

; Blank checks Flash memory (F) (change address and length as needed)
TPCMD BLANKCHECK F $0 $20000

; Programs Flash memory (change source, target address and length as needed)
TPCMD PROGRAM F $0 $0 $20000

; Verifies ReadOut Flash memory (change source, target address and length as needed)
TPCMD VERIFY F R $0 $0 $20000

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

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

; Mass erases EEPROM Emulation memory (E)
TPCMD MASSERASE E

; Blank checks Data Flash memory (change address and length as needed)
TPCMD BLANKCHECK E $0 $800

; Programs Data Flash memory (change source, target address and length as needed)
TPCMD PROGRAM E $0 $0 $800

; Verifies Data 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 E R $0 $0 $800

;Protect FLASH with the following options;0) Read and Write, used like no protection
;1) Read only protection, no execution
;2) Execution only protection, no read and write
;TPCMD PROTECT F 1

;Ends programming block

; Dump selected memory content into a binary file
;TPSETDST FILE DUMP.BIN
;TPCMD DUMP F $0 $0 $20000

TPEND

```

The FlashRunner's system software setup will install script examples specific for each device of the TM4C12 family on your PC.

## 7. Programming Times

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The following table shows programming times for selected TI TM4C12 family devices.

Device	Mem. Size	Conditions	Operations	Time
TM4C1231E6PM	128KB Flash + 2KB EEPROM	SWD CLK=6.25 MHz	Masserase + Blankcheck + Program + Verify ReadOut	3,68
TM4C1231E6PM	128KB Flash + 2KB EEPROM	JTAG CLK=6.25 MHz	Masserase + Blankcheck + Program + Verify ReadOut	11,13 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.

## 8. References

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FlashRunner user's manual

Microcontroller-specific datasheets