AN00156: Interfacing FlashRunner with TI TMS570 Devices

FlashRunner is a Universal In-System Programmer, which uses the principles of In-Circuit Programming to program TI TMS570 family microcontrollers.

This Application Note assumes that you are familiar with both FlashRunner and the main features of the TMS570 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 TMS570 microcontrollers is performed through JTAG 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.
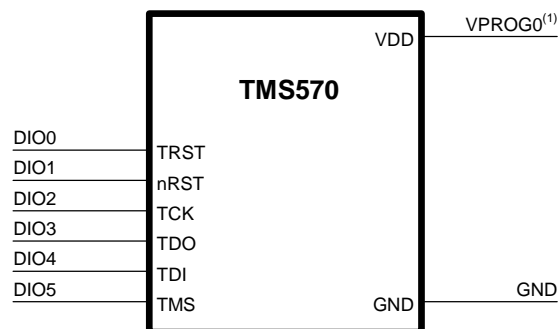
2. Hardware Configuration

The microcontroller lines needed to program an TMS570 device are the following:

- **TRST:** Test Reset.

- **TMS:** Test Mode Select
- **TCK:** Test Clock.
- **TDO:** Test Data Out
- **TDI:** Test Data In
- **RST:** device reset
- **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

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 frequency;
- Oscillator input frequency

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.

TCSETPAR OSCIN

Command syntax:

`TCSETPAR OSCIN <frequency MHz>`

Parameters:

`frequency MHz`: oscillator input frequency, expressed in MHz.

Description:

This command is used as input to the PLL machine, that will produce max internal clock frequency according to the oscillator input.

TCSETPAR RSTTYPE (optional)

Command syntax:

`TCSETPAR RSTTYPE HW`

Description:

This command enables FlashRunner to use RST line to drive the target device. This parameter could be useful especially when the target firmware has fast startup times and could create interference with flashing operations.

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.

TI TMS570 specific target programming commands are the following:

- `TPCMD BLANKCHECK`;
- `TPCMD MASSERASE`;
- `TPCMD PROGRAM`;
- `TPCMD VERIFY`;
- `TPCMD READ`;
- `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:

Compact and Erase flash memory **F**, EEPROM memory **E**, or both (if EEPROM
available) **C**. Also related ECC flash memory region will be erased.

TPCMD PROGRAM

Command syntax:

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

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.

ECC   If not present, only flash memory will be written. If
                    specified, also ECC flash memory will be automatically
                    written based on flash data written.

Description:

Programs `len` byte locations of flash memory starting from the `tgt start addr` address.

According to flash technology implemented, you'll have different programming options for ECC memory:
F035:
Adding `ECC` parameter to the flash programming command, you can program ECC memory automatically by generating ECC data from flash data.
You can also program ECC memory from ECC binary data with a separated command specifying `len` and `tgt start addr` and `src start addr` (`ECC` parameter is not needed).

F021:
You can program ECC memory automatically from programmed flash data adding `ECC` parameter.

TPCMD VERIFY

Command syntax:

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

Command parameters and options:

`F│E`:	Specifies memory type to be verified
`R│S:`	Specifies verify technology. Options availability is flash technology dependent.
`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 byte locations to be verified.
`ECC`	If specified, also ECC flash memory will be verified. Availability is flash technology dependent

Description:

Verifies `len` byte locations of flash memory starting from the `tgt start addr` address. `R│S` parameters select ReadOut verifying method (slow but secure) or Checksum verification method (faster but unsecure).
Checksum method is based on CRC polinomyal comparison and it's available only on F021 flash technology based devices. Be aware that, unlike ReadOut method in which length parameter is automatically resized if binary is shorter than it, Checksum method requires exact length parameter. So if your binary is smaller than indicated on `<len>` parameter you must modify it to match effective binary length

F035:
You can verify target ECC memory during readout flash verifying by generating the corresponding ECC data from flash data binary and comparing it with written ECC data. These steps are accomplished by the exampled command below (where **`tgt start addr`** is flash memory address):

`TPCMD VERIFY F R $0 $0 $100000 ECC`

You can also verify target ECC memory with a separated command by taking ECC data binary and comparing it with written ECC data. These steps are accomplished by the exampled command below (where **`tgt start addr`** is ECC memory address):

`TPCMD VERIFY F R $0 $F0200000 $100000`

F021:
Only flash verify is available. Since ECC write is automatically generated and written by TI API library from target flash data, correctness of target ECC data is already checked by flash data verify command.

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 or ECC flash memory starting from the **`tgt start addr`** address.

TPCMD RUN

Command syntax:

`TPCMD RUN`

Command parameters:

None.

Description:

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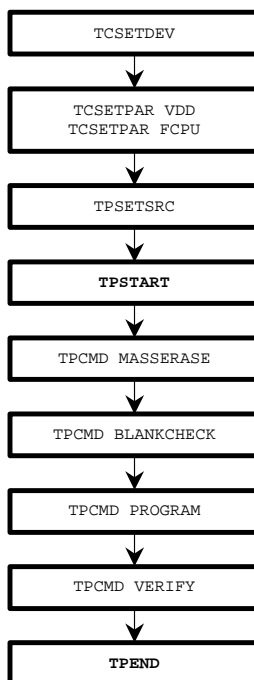
Runs the target application.

5. Typical Programming Flow

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

```
┌─────────────────────────┐
│        TCSETDEV         │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│      TCSETPAR VDD       │
│      TCSETPAR FCPU      │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│        TPSETSRC         │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│        TPSTART          │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│     TPCMD MASSERASE     │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│    TPCMD BLANKCHECK     │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│      TPCMD PROGRAM      │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│      TPCMD VERIFY       │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│         TPEND           │
└─────────────────────────┘
```

6. Script Example

The example below shows a typical programming flow for a TI TMS570 device.

```
;
; FLASHRUNNER SCRIPT EXAMPLE FOR TI 570LS2125
;
; Use this example as a starting point for your specific programming needs
;
; ----------
;
; Hardware connections
;
; DIO0/AO0    (JNTRST)
; DIO1/AO1    (NRST)
; DIO2        (JTCK)
; DIO3        (JTDO)
; DIO4        (JTDI)
; DIO5        (JTMS)
;
; -------------------------------------------------------------------------------------------------------
; 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 570LS2125 TMS570

;------------------------
; 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)
```

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```
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


;----------------------
; TMS570 ALGO Settings
;----------------------


; Set the frequency of the JTAG channel, Hz (change as needed)

TCSETPAR JTCLK 12500000


; Set the oscillator input frequency, MHz (change as needed)

TCSETPAR OSCIN 20


;----------------------------
; 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 $200000


; Programs Flash memory (change source, target address and length as needed)
; To activate ECC feature, add 'ECC' parameter to write automatically Flash ECC during Flash programming,
; Addresses must be 16 byte aligned
TPCMD PROGRAM F $0 $0 $200000


; Verifies ReadOut Flash memory (change source, target address and length as needed)
TPCMD VERIFY F R $0 $0 $200000


; 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 EEPROM emulation memory (E) (change address and length as needed)
TPCMD BLANKCHECK E $F0200000 $10000


; Programs EEPROM emulation memory (change source, target address and length as needed)
; To activate ECC feature, add 'ECC' parameter to write automatically EEPROM emulation ECC during EEPROM emulation
programming,
; Addresses must be 8 byte aligned
TPCMD PROGRAM E $F0200000 $F0200000 $10000


; Verifies ReadOut EEPROM emulation memory (change source, target address and length as needed)
TPCMD VERIFY E R $F0200000 $F0200000 $10000


; End programming block


; Dump selected memory content into a binary file
;TPSETDST FILE DUMP.BIN
;TPCMD DUMP F $0 $0 $200000

TPEND
```

The FlashRunner's system software setup will install script examples specific for each device of the TMS570 family on your PC.

7. Programming Times

The following table shows programming times for selected TI TMS570 family devices.

Device	Mem. Size	Conditions	Operations	Time
570LS2125	2 MB Flash + 64KB EEPROM	JTAG=12 MHz	Masserase + Blankcheck + Program + Verify ReadOut	120,00 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

FlashRunner user's manual

Microcontroller-specific datasheets