SMH Technologies
UNIVERSAL PRODUCTION
IN–SYSTEM PROGRAMMING

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AN00179: Interfacing FlashRunner with Analog Devices ADP104xx Devices

FlashRunner is a Universal In-System Programmer, which uses the principles of In-Circuit Programming to program Analog Devices ADP104xx family microcontrollers. This Application Notes describes how to properly set up and use FlashRunner to program ADP104xx Flash devices.

This Application Note assumes that you are familiar with both FlashRunner and the main features of the ADP104xx family. Full documentation about these topics is available in the FlashRunner user's manual and in device-specific datasheets.

Systein
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1. Introduction

In-system programming of ADP104xx microcontrollers is performed through PMBus 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.

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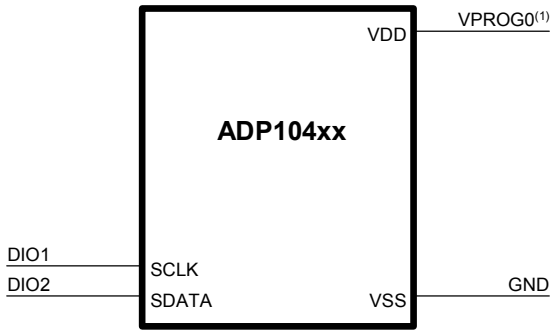
2. Hardware Configuration

The microcontroller's lines needed to program a ADP104xx device are the following:

- **SCLK:** I2C Serial Clock input.
- **SDATA:** I2C Serial Data input/output (Opendrain).
- **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;
- Configuration Data FRB file;
- Communication frequency;
- PMBus address;
- Password;
- New password.

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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 SCLK and SDATA 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.

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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.

TCSETPAR SCLK

Command syntax:

`TCSETPAR SCLK <frequency Hz>`

Parameters:

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

Description:

This command is used to set up the serial clock communication frequency.

TCSETPAR PMB_ADDR

Command syntax:

`TCSETPAR PMB_ADDR <address>`

Parameters:

`address`: device address in PMBus.

Description:

This command is used to specify ADP104xx address in Power Management Bus ("PMBus").

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Address	ADD Pin Resistor Value (kΩ)
0x58	10 (or connect directly to AGND)
0x59	30
0x5A	50
0x5B	69
0x5C	89
0x5D	109
0x5E	128
0x5F	148 (or connect directly to VDD)

The PMBus address is set by connecting an external resistor from the ADD pin to ground.

TCSETPAR EE_PSW

Command syntax:

`TCSETPAR EE_PSW <password>`

Parameters:

`password:` EEPROM password.

Description:

The command sets EEPROM password.

TCSETPAR CHANGE_EE_PSW

Command syntax:

`TCSETPAR CHANGE_EE_PSW <password>`

Parameters:

`password`: new EEPROM password.

Description:

It changes old EEPROM password with the new one.

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4. Specific TPCMD Programming Commands

Overview

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

Analog Devices ADP1048W-specific target programming commands are the following:

- **TPCMD MASSERASE**;
- **TPCMD ERASE**;
- **TPCMD BLANKCHECK**;
- **TPCMD PROGRAM**;
- **TPCMD VERIFY**;
- **TPCMD READ**;
- **TPCMD UNLOCK**;
- **TPCMD LOCK**;
- **TPCMD CHANGE_PWD**;
- **TPCMD EEPROM_CRC_CHECKSUM;**
- **TPCMD RESTORE;**
- **TPCMD SAVE_REGISTER**.

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TPCMD MASSERASE

Command syntax:

```
TPCMD MASSERASE E
```

Command options:

E:	EEPROM (**E**) memory.

Description:

It erases any EEPROM page from Page 2 to Page 15 of the main block.

The EEPROM is partitioned into two major blocks: the INFO block and the main block. The INFO block contains 128 8-bit bytes, and the main block contains 8K 8-bit bytes. The main block is further partitioned into 16 pages, each page containing 512 bytes.

TPCMD ERASE

Command syntax:

```
TPCMD ERASE E < tgt start addr > <len>
```

Command options:

E:	EEPROM (**E**) memory.
tgt start address:	Device memory location from where the erase operation will start.
len:	Number of locations to be erased.

Description:

It erases EEPROM pages corresponding to the specified **len** size, starting from the page corresponding to address specified by **tgt start address**.

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TPCMD BLANKCHECK

Command syntax:

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

Command parameters and options:

`E`:	EEPROM (**`E`**) memory.
`tgt start address`:	Device memory location from where the blankcheck operation will start.
`len`:	Number of locations to be blankchecked.

Description:

It blankchecks EEPROM memory. Blankchecks **`len`** locations starting from the address specified by **`tgt start address`**.

TPCMD PROGRAM

Command syntax:

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

`TPCMD PROGRAM REG <reg addr> <value> B|W`

Command parameters and options:

`E`:	Specify EEPROM (**`E`**) memory.
`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.
`REG`:	Specify register (**`REG`**).

reg addr:	Register address.
value:	Value to be programmed.
B|W:	The value of **value** parameter is expressed in Byte (**B**) or Word (**W**).

Description:

It programs **len** locations of EEPROM memory starting from the **tgt start addr** address or it programs **value** in the **reg addr** register.

It programs register **reg addr** with the value specified by **value**; **value** can be expressed as a byte (**B**) or as a 16-bits word (**W**).

TPCMD VERIFY READ OUT

Command syntax:

TPCMD VERIFY E R <src offset> <tgt start addr> <len>

Command parameters and options:

E:	EEPROM (**E**) memory.
R:	Specify the read out (**R**) verify method.
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

Description:

It verifies through read out method **len** locations of EEPROM memory starting from **tgt start addr** address.

TPCMD VERIFY CHECKSUM

Command syntax:

`TPCMD VERIFY E S`

Command parameters and options:

`E`:	EEPROM (**`E`**) memory.
`S`:	Specifies the checksum (**`S`**) verify method.

Description:

It verifies through checksum method ADP104xx device EEPROM content.

TPCMD READ

Command syntax:

`TPCMD READ E|REG <tgt start addr> <len>`

`TPCMD READ INFO`

Command parameters and options:

`E`:	Specifies EEPROM (**`E`**) memory.
`REG`:	Specify register (**`REG`**).
`tgt start addr`:	Device memory location from where the read operation will start.
`len`:	Number of locations to be read
`INFO`:	Specify INFO memory (**`INFO`**).

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Description:

It reads **len** locations of EEPROM (**E**) memory starting from **tgt start addr** address.

It reads **len** locations of registers (**REG**) area starting from **tgt start addr** address. **len** can assume the value 1 or 2.

It reads the entire INFO (**INFO**) memory.

TPCMD UNLOCK

Command syntax:

TPCMD UNLOCK E

Command parameters:

E: Specifies EEPROM (**E**) memory.

Description:

It unlocks the EEPROM memory performing two consecutive writes with the correct password (default 0x0).

TPCMD LOCK

Command syntax:

TPCMD LOCK E

Command parameters:

E: Specifies EEPROM (**E**) memory.

Description:

It locks the EEPROM memory writing an incorrect password.

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TPCMD CHANGE_PSW

Command syntax:

`TPCMD CHANGE_PSW E`

Command parameters:

`E`: Specifies EEPROM (**`E`**) memory.

Description:

It changes the old password with a new one by writing the old password and the new.

TPCMD EEPROM_CRC_CHECKSUM E

Command syntax:

`TPCMD EEPROM_CRC_CHECKSUM E`

Command parameters:

`E`: Specifies EEPROM (**`E`**) memory.

Description:

It implements a CRC checksum to check that the values downloaded from EEPROM and the internal registers are consistent.

TPCMD RESTORE USER|DEFAULT

Command syntax:

`TPCMD RESTORE USER|DEFAULT`

Command parameters:

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USER|DEFAULT: Specifies user or default settings.

Description:

It forces user or factory default settings from EEPROM main block to be downloaded into the internal registers.

TPCMD SAVE_REGISTER

Command syntax:

TPCMD SAVE_REGISTER

Command parameters:

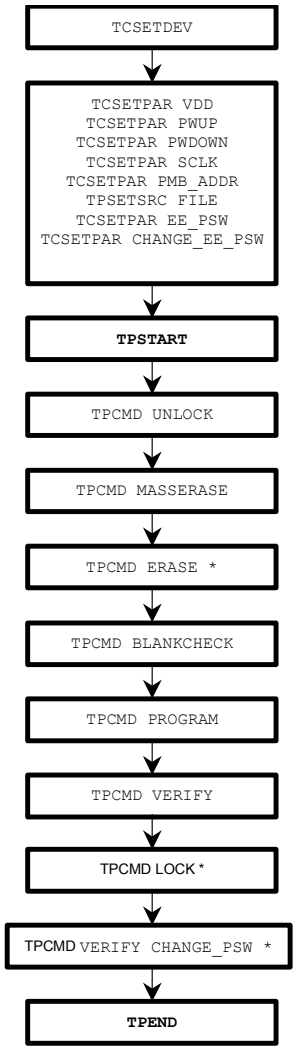
None.

Description:

It saves user settings in EEPROM main block.

5. Typical Programming Flow

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



* Optional commands.

6. Script Example

The example below shows a typical programming flow for an Analog Device ADP104xx ADP1048W device.

```
;
; FLASHRUNNER SCRIPT EXAMPLE FOR ANALOG DEVICES ADP1048W
;
; Use this example as a starting point for your specific programming needs
;
;
; ----------------------
; HARDWARE CONNECTIONS
; ----------------------
; DIO1 (SCLK)
; DIO2 (SDATA)
;

; Turns off logging
#LOG_OFF
; Halt on errors
#HALT_ON FAIL

; Sets device
TCSETDEV ANALOGDEVICES ADP1048W ANDEV_A

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

; VDD Rise-Time, ms (change as needed)
TCSETPAR PWUP 100

; VDD Fall-Time, ms (change as needed)
TCSETPAR PWDOWN 100

; I2C/PMBus clock frequency, Hz (change as needed)
; For this device the maximum clock frequency is 400000 Hz
TCSETPAR SCLK 400000

; PMBus Address Settings
```

```
TCSETPAR PMB_ADDR $58

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

; Sets actual password
TCSETPAR EE_PSW $00

; Sets NEW password (change as needed)
;TCSETPAR CHANGE_EE_PSW $00

;---------------------------
; START PROGRAMMING SESSION
;---------------------------
TPSTART

; Unlocks EEPROM Memory (E)
TPCMD UNLOCK E

; Mass erases complete EEPROM Memory (E)
TPCMD MASSERASE E

; Erases EEPROM page (E) (change address and lenght as needed)
;TPCMD ERASE E $400 $200

; Blank checks EEPROM (E) memory (change address and lenght as needed)
TPCMD BLANKCHECK E $400 $1C00

; Programs EEPROM (E) memory (change addresses and lenght as needed)
TPCMD PROGRAM E $400 $400 $1C00

; Verifies EEPROM (E) memory (change source, target address and length as needed)
; Read-Out method (R) available
TPCMD VERIFY E R $400 $400 $1C00

; Locks EEPROM Memory (E)
;TPCMD LOCK E

; Change EEPROM Memory (E) password
;TPCMD CHANGE_PSW E

; Ends programming block
TPEND
```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The FlashRunner's system software setup will install script examples specific for each device of the ADP104xx family on your PC.

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7. Analog Devices ADP1048W Specific Error

Analog Devices ADP104xx Specific Error	
$6B00	TCSETDEV command: manufacturer not supported
$6B01	TCSETDEV command: algorithm not found on card
$6B02	TCSETDEV command: device not supported
$6B03	TCSETDEV command: internal hardware configuration error
$6B04	TCSETDEV command: invalid parameter
$6B05	TCSETDEV VDD command: invalid or out of range parameter
$6B06	TCSETPAR VDD command: missing parameter
$6B07	TCSETPAR PWUP command: invalid or out of range parameter
$6B08	TCSETPAR PWUP command: missing parameter
$6B09	TCSETPAR PWDOWN command: invalid or out of range parameter
$6B0A	TCSETPAR PWDOWN command: missing parameter
$6B0D	TCSETPAR SCLK command: invalid or out of range parameter
$6B0E	TCSETPAR SCLK command: missing
$6B0F	TCSETPAR PMB_ADDR_VALUE command: invalid or out of range parameter
$6B10	TCSETPAR PMB_ADDR_VALUE command: missing
$6B11	TCSETPAR VDD_AUX command: missing, invalid or out of range parameter
$6B12	TPCMD command: invalid command
$6B13	TPCMD MASSERASE command: missing or invalid parameter
$6B14	TPCMD MASSERASE command: masserase execution error
$6B15	TPCMD BLANKCHECK command: missing or invalid parameter
$6B16	TPCMD BLANKCHECK command: target start address parameter or length parameter out of range
$6B17	TPCMD BLANKCHECK command: blankcheck execution error
$6B18	TPCMD PROGRAM command: missing or invalid parameter
$6B19	TPCMD PROGRAM command: target start address parameter or length parameter out of range
$6B1A	TPCMD PROGRAM command: file smaller that the address requested
$6B1B	TPCMD PROGRAM command: program execution error
$6B1C	TPCMD VERIFY command: missing or invalid parameter
$6B1D	TPCMD VERIFY command: target start address parameter or length parameter out of range
$6B1E	TPCMD VERIFY command: file smaller that the address requested
$6B1F	TPCMD VERIFY command: verify execution error
$6B20	TPCMD READ command: missing or invalid parameter
$6B21	TPCMD READ command: file smaller that the address requested
$6B22	TPCMD READ command: read execution error
$6B23	TPCMD ERASE command: missing or invalid parameter
$6B24	TPCMD ERASE command: erase execution error
$6B25	TPCMD UNLOCK command: unlock execution error
$6B26	TPCMD UNLOCK command: missing or invalid parameter
$6B27	TPSTART command: execution error
$6B28	TPEND command: execution error
$6B29	TPCMD ENTRY command: entry execution error
$6B2A	TPCMD VERIFY DATA MISMATCH command: execution error
$6B2B	TPCMD BLANKCHECK command: EEPROM locked

$6B2C	TPCMD VERIFY command: EEPROM locked
$6B2D	TPCMD READ command: EEPROM locked
$6B2E	TPCMD LOCK command: missing or invalid parameter
$6B2F	TPCMD LOCK command: lock execution error
$6B30	TPCMD CHANGE_PSW command: missing or invalid parameter
$6B31	TPCMD CHANGE_PSW command: change password execution error
$6B32	TPCMD EE_CRC command: missing or invalid parameter
$6B33	TPCMD EE_CRC command: EEPROM CRC checksum execution error
$6B34	TPCMD EE_CRC command: CRC checksum error
$6B35	TPCMD RESTORE command: missing or invalid parameter
$6B36	TPCMD RESTORE command: missing or invalid parameter
$6B37	TPCMD RESTORE command: restore execution error
$6B38	TPCMD SAVE_REGISTER command: save register execution error
$6B39	TPCMD STORE command: store execution error
$6B3A	TPCMD WRITE_REGISTER command: write register execution error
$6B3B	TPCMD READ_INFO command: read info execution error
$6B3C	TPCMD READ_REGISTER command: read register execution error

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8. Programming Times

The following table shows programming times for selected Analog Devices ADP104xx devices.

Device	Mem. Size	Conditions	Operations	Time
Analog Devices ADP1048W	7KB EEPROM	SCLK=400000Hz	Unlock + Erase + Blank Check + Program + Verify	2,35 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 specific datasheets

PMBus™ Power System Management Protocol Specification