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Interfacing FlashRunner with Traveo T1G MCUs (S6J32xx and S6J33xx)

1. Introduction

The Traveo family of microcontrollers, initially developed by **Spansion** (then acquired by **Cypress** and now part of **Infineon**), is a highly regarded and widely-used product line specifically designed for automotive applications. These microcontrollers have made significant strides in the automotive industry due to their exceptional performance, low power consumption, and wide array of advanced features. Traveo microcontrollers use a single ARM Cortex R5 processor and they are designed to handle complex tasks with ease while maintaining optimal energy efficiency, which is vital for automotive applications to avoid draining the vehicle's battery. Their high-speed processing capabilities and generous memory capacity make them ideal for applications such as infotainment systems, instrument clusters, body control modules, and advanced driver-assistance systems (ADAS). These devices are not very new on the market but they are still used mainly by our automotive customers that produce dashboards for cars and motorbikes. Moreover, these Traveo T1G microcontrollers are associated with HyperFlash memories used as external storage to save big-size data such as images and animations. That is why we also offer the possibility to program those HyperFlash memories through the Traveo microcontrollers.
FlashRunner is supporting S6J32xx series and S6J33xx series of Traveo T1G MCUs, which are the most popular and requested from the market.

You can download the latest version of this document from this static link: [Interfacing FlashRunner with Traveo T1G MCUs].

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3. Tips and tricks to flash Traveo T1G MCUs

In this section, we want to explain what operations are performed in the target devices and how these operations work. This knowledge may help you to optimize even more your application.

The FlashRunner uses JTAG to access the memories of these devices, which is one of the most common protocols for microcontrollers and which needs four synchronous lines (TCK, TMS, TDI, and TDO) and an optional asynchronous line (TRST). In addition to standard JTAG lines, the FlashRunner also need to control the reset line of the target device: this line is very important and very critical as well. It is crucial to have no interferences on the reset line because it could cause strange behaviours of the device and the operations could likely fail.

The new driver, combined with an OS > 3.00, can support a clock frequency for JTAG up to 37.5 MHz, which also helps to reduce flashing times. However, the customer needs a good hardware setup to be able to reach such a high frequency, otherwise, the quality of the signals will be bad and operations could fail.

Let us analyse how this can influence the standard commands:

- **Masserase**
  This command erases all the content of the memory (all bits are set to 1). Optionally, it is also possible to send two additional parameters to this command: the address from where to start erasing and the number of bytes to erase. Then the driver will automatically manage the sectors to do that operation as fast as possible according to the user's requests. For TCFLash the minimum sector size allowed is 2 MB for this operation, while for WorkFlash is 8 KB and for external HyperFlash is 256 KB.

  The duration of this operation depends only on the target device characteristics and there is not much that we can do to improve this. For some devices, it could be extremely long, even longer than all the other operations together. For very few devices, this operation may be shorter according to the amount of data programmed in the memory.
  The suggestion is to skip this operation in case the device is virgin. This can be done using a conditional script based on the result of the blankcheck operation:

```
#IFERR TPCMD BLANKCHECK F
#THEN TPCMD MASSERASE F
#THEN TPCMD BLANKCHECK F
```

- **BlankCheck**
  This command checks that all the bits of the selected memory are set to 1. The supported memories for this command are TCFlash, WorkFlash and external HyperFlash. This operation is executed internally by the device and it is typically extremely fast.

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Optionally, it is also possible to send two additional parameters to this command: the address from where to start checking and the number of bytes to check.

The duration of this operation depends on the size of the memory and on the internal speed of the MCU to access data and check them.

- **Program**
  This command takes the customer's data from the FRB file and programs them into the selected memory, the supported memories for this command are: TCFlash, WorkFlash and external HyperFlash.
  Optionally, it is also possible to send two additional parameters to this command: the address from where to start programming and the number of bytes to be programmed.
  The duration of this command depends on many factors which are all important:
  - The target device characteristics, in other words, how much time is needed to write data into the memory.
  - The MCU speed because it determines how fast the device is to process data.
  - The JTAG frequency because it sets the bitrate of the communication between FlashRunner and the target device.

  The suggestion to improve the performance of this command is to set the FRB file with the "IGNORE_BLANK_PAGE" option. This will skip the program operation for any page which contains only 0xFF bytes.

```
#TPSETSRC myData.frb IGNORE_BLANK_PAGE
```

- **Verify Readout**
  This command checks that data contained in the memory of the device corresponds to FRB data. The supported memories for this command are TCFlash, WorkFlash and external HyperFlash.
  Optionally, it is also possible to send two additional parameters to this command: the address from where to start checking and the number of bytes to check.

```
#TPCMD VERIFY E R 0xE000000 0x100
```

  This command works exactly like the program command with the only exception that the device reads (instead of writing) data from the memory and compares that with the data received from FlashRunner.
  Since the mechanism is totally equal to the one used by the program command, if any error was introduced during the program command, it is possible that the same error could be introduced during the verify command and this could lead to a possible undetected error. For this reason, we suggest using the verify checksum instead of the verify readout, or maybe combining them.

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- **Verify CRC32**
  This command asks the target device to calculate the 32-bit checksum of the selected memory region, meanwhile, the FlashRunner calculates the expected checksum according to FRB data and then the two values are compared. The supported memories for this command are TCFlash, WorkFlash and external HyperFlash. This operation is executed internally by the device and it is typically extremely fast, almost like the blankcheck.

```
#TPCMD VERIFY E S
```

  Optionally, it is also possible to send up to three additional parameters to this command: the address from where to start the checksum calculation, the number of bytes to consider in the calculation, and the expected checksum value. This will result faster because the FlashRunner does not need to spend time calculating the checksum of the FRB file.

```
#TPCMD VERIFY E S 0xE000000 0x1000 0x4610E323
```

  To get the value to use as the expected checksum parameter, you can use the command below, which can be executed by FlashRunner without being connected to the target device because it is just an internal calculation and it will return the commands to use in the real-time log.

```
#TPCMD CALC_FRB_CRC32
```

After this explanation should be clear what can be improved by the user, what can be improved by SMH, and what cannot be improved because it depends only on the characteristics of the target device.

Warning: performing the program and verify commands using an FRB which does not contain any data for the selected memory region will return pass. The driver has been designed in this way to be more flexible so, basically, if a customer gives no data to program and verify, then the driver does not perform any operation and just returns pass after completing the research for the data.

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4. WorkFlash ECC

WorkFlash memory is a special memory, which can be used in different ways by customers according to their needs. It is possible to enable or disable ECC on that and the user must pay a lot of attention to properly set the corresponding parameter:

```
#TCSETPAR WORKFLASH_ECC YES
```

By default, the ECC is enabled but some applications require it to be disabled. If that parameter is set wrongly by the user, then the board could behave in a different way than expected. Said in other words, the functional test will not pass and maybe the customer's application will not boot.

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5. Security

When it is needed to re-flash a Traveo T1G and it has the security enabled, FlashRunner allows users to choose between two possibilities:

- **Unlock the device**
  This is automatically done by FlashRunner if no other options are set. FlashRunner will search for a password from Dynamic memory or FRB file and will use the password to unlock the device during the connect command. The password is searched starting from the address 0x019F0090 for the next 32 bytes and FlashRunner is automatically discarding the dummy padding between the actual 16 bytes of the password.
  Example of log:

```
01|2|241014-12:38:54.841|---#TPCMD CONNECT
01|2|241014-12:38:54.943|Using reset line in open-drain
01|1|241014-12:38:54.944|Good samples: 4 [Range 5 ~ 8]
01|3|241014-12:38:55.247|Security enabled (0x105), trying to unlock using password...
01|3|241014-12:38:55.249|> Successfully unlocked using password
01|3|241014-12:38:55.585|Security enabled (0x105), trying to unlock using password...
01|3|241014-12:38:55.587|> Successfully unlocked using password
01|2|241014-12:38:55.596|Protocol clock: 37.50 MHz
01|2|241014-12:38:55.645|Time for CONNECT: 0.81 s
01|2|241014-12:38:55.646|>|
```

- **Unsecure the device**
  This procedure is enabled by the following parameter

```
#TCSETPAR UNSECURE YES
```

  Then, during the connect command, FlashRunner erases the both TCFlash and WorkFlash memories. For this procedure, the MODE pin of the Traveo T1G must be controlled by FlashRunner.
  Example of log:

```
01|2|241014-12:38:33.656|---#TPCMD CONNECT
01|3|241014-12:38:34.063|Security enabled (0x105): erasing TCFlash and WorkFlash memories... (MODE pin must be connected)
01|3|241014-12:38:36.256|Time for erasing TCFlash and WorkFlash memories: 2.19 s
01|2|241014-12:38:36.260|Using reset line in open-drain
01|1|241014-12:38:36.261|Good samples: 3 [Range 5 ~ 7]
01|2|241014-12:38:36.311|Protocol clock: 37.50 MHz
01|2|241014-12:38:36.360|Time for CONNECT: 2.70 s
01|2|241014-12:38:36.360|>|
```


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6. External HyperFlash Memory

Applications that use Traveo T1G MCUs often involve also one or more external HyperFlash memories and these memories must be programmed through the MCU because they do not have test points to be programmed directly. That is why FlashRunner allows customers to program HyperFlash memories via the Traveo T1G MCUs and, to do that, these are the requirements:

- **Select part number**
  Customers must select the correct combination of the MCU part number and HyperFlash part number when creating a project. In the FlashRunner system, they are encoded as "MCU_HYPERFLASH", for example *S6J329CL_S26KL256S* or *S6J332EH_S26HL01GT*.
  Moreover, customers must have a license the proper license to execute that project.

- **Base address of the external memory**
  With this parameter, customers must specify which is the base address of the HyperFlash memory that must be programmed. This parameter is application dependent so it must be set carefully.

```
#TCSETPAR EXT_MEM_BASE_ADDR 0x40000000
```

- **HyperBus channel used by the external memory**
  With this parameter, customers must specify which HyperBus channel to use for the Traveo T1G MCU to communicate with the HyperFlash memory. This parameter is application dependent so it must be set carefully.

```
#TCSETPAR EXT_MEM_CHANNEL 1
```


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- **CS line used by the external memory**
  With this parameter, customers must specify which is the CS line used to select the HyperFlash memory in the HyperBus used by the Traveo T1G MCU to communicate it. This parameter is application dependent so it must be set carefully.

```
#TCSETPAR EXT_MEM_CS_LINE 1
```

- **Additional lines to set high**
  With this optional parameter, customers can specify some lines of the Traveo T1G MCU to be set high. For example, the reset line of the HyperFlash memory or the enable line of some voltage regulator. The lines must be expressed without spaces and comma-separated, as in the example below. This parameter is application dependent so it must be set carefully because it could damage the components.

```
#TCSETPAR MCU_LINES_HIGH P3_20,P0_31
```

Note: It is possible to have more than one HyperFlash memory connected to the same Traveo T1G MCU. If the part numbers of the memories are different, the user must create different projects, while if the part numbers are the same it is possible to manage it in the same project (see the example below).

```
;Project generated by "FlashRunner Workbench 3.09"
;Generated for "FlashRunner NXG"


;DEVICE: S6J328CL_S26KL512S
;DRIVER: TRAVEO 03.00
;PINMAP: DIO0=TRST, DIO1=RST, DIO2=TCK, DIO3=TDO, DIO4=TDI, DIO5=TMS

!ENGINEMASK 0x00000001
#LOADDRIVER libtraveo.so INFINEON S6J3200 S6J328CL_S26KL512S
#TCSETDEV VDDMIN 4500
#TCSETDEV VDDMAX 5500
#TCSETDEV IDCODE 0x100085CF
#TCSETDEV IDCODE_MSK 0xFFFFBFFF
#TCSETDEV CORE R5
#TCSETDEV MEMMAP 0 X 0 0x40000000 0x4FFFFFFF 0x0 0x200 0 0 0x0 0x0 0xFF 0x0 0
#TCSETDEV MEMMAP 0 X 1 0x90000000 0x9FFFFFFF 0x0 0x200 0 0 0x0 0x0 0xFF 0x0 0
#TCSETDEV MEMMAP 1 F 0 0x019F0000 0x01BFFFFF 0x0 0x10000 0 0 0x0 0x0 0xFF 0x0 0
#TCSETDEV MEMMAP 2 E 0 0x0E000000 0x0E01BFFF 0x0 0x400 0 0 0x0 0x0 0xFF 0x0 0
!CRC 0x3540D608
#TCSETPAR EXT_MEM_BASE_ADDR 0x48000000
#TCSETPAR EXT_MEM_CHANNEL 2
#TCSETPAR EXT_MEM_CS_LINE 1
#TCSETPAR MCU_LINES_HIGH P0_31,P2_22
#TCSETPAR PROTCLK 37500000
#TCSETPAR PWDOWN 100
#TCSETPAR PWUP 100
```


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```
#TCSETPAR RSTDOWN 100
#TCSETPAR RSTDRV OPENDRAIN
#TCSETPAR RSTUP 100
#TCSETPAR VPROG0 5000
#TCSETPAR WORKFLASH_ECC YES
#TCSETPAR CMODE JTAG
#TPSETSRC SP2i.frb IGNORE_BLANK_PAGE
#TPSTART
#TPCMD CONNECT
#IFERR TPCMD BLANKCHECK X
#THEN TPCMD MASSERASE X
#THEN TPCMD BLANKCHECK X
#TPCMD PROGRAM X
#TPCMD VERIFY X S
#TCSETPAR EXT_MEM_BASE_ADDR 0x4C000000
#TCSETPAR EXT_MEM_CS_LINE 2
#TPCMD CONNECT
#IFERR TPCMD BLANKCHECK X
#THEN TPCMD MASSERASE X
#THEN TPCMD BLANKCHECK X
#TPCMD PROGRAM X
#TPCMD VERIFY X S
#IFERR TPCMD BLANKCHECK F
#THEN TPCMD MASSERASE F
#THEN TPCMD BLANKCHECK F
#TPCMD PROGRAM F
#TPCMD VERIFY F S
#IFERR TPCMD BLANKCHECK E
#THEN TPCMD MASSERASE E
#THEN TPCMD BLANKCHECK E
#TPCMD DISCONNECT
#TPEND
```


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