RZ/A2M Group

RZ/A2M OSTM Driver

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Introduction

This application note describes the operation of the software OSTM Driver for the RZ/A2 device on the RZ/A2M CPU Board.

It provides a comprehensive overview of the driver. For further details please refer to the software driver itself.

The user is assumed to have knowledge of e^2 studio and to be equipped with an RZ/A2M CPU Board.

Target Device

RZ/A2M Group

Driver Dependencies

This driver depends on:

- Drivers
  - STDIO
  - INTC (Interrupt Controller)
  - CPG (Clock Pulse Generator)
  - STB (Standby Module)

Referenced Documents

Document Type	Document Name	Document No.
User's Manual	RZ/A2M Hardware Manual	R01UH0746EJ

List of Abbreviations and Acronyms

Abbreviation	Full Form
ANSI	American National Standards Institute
API	Application Programming Interface
ARM	Advanced RISC Machines
CPG	Clock Pulse Generator
CPU	Central Processing Unit
HLD	High Layer Driver
IDE	Integrated Development Environment
INTC	Interrupt Controller
LLD	Low Layer Driver
OS	Operating System
OSTM	Operating System Timer Module
STB	Standby
STDIO	Standard Input/Output

Table 1-1 List of Abbreviations and Acronyms

Contents

1. Outline of Software Driver

The OSTM (Operating System Timer Module) driver controls the 3 timer channels provided by the RZ/A2M MPU.

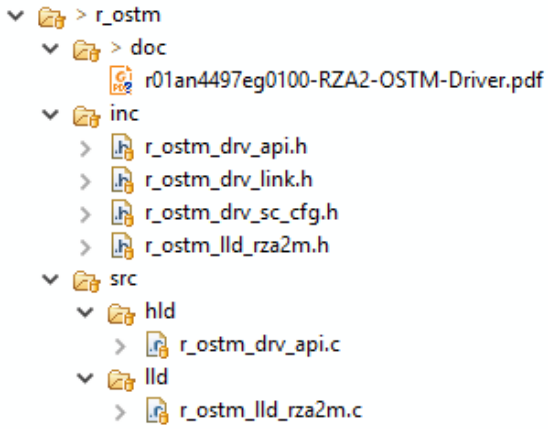
2. Description of the Software Driver

The key features of the driver include:

- Setting a timer into free-running mode for generating interrupts at non-fixed intervals
- Setting a timer into interval timer mode for generating interrupt requests at a fixed interval

2.1 Structure

The OSTM driver is split into two parts: the High Layer Driver (HLD) and the Low Layer Driver (LLD). The HLD includes platform independent features of the driver, implemented via the STDIO standard functions. The LLD includes all the hardware specific functions.



2.2 Description of each file

Each file's description can be seen in the following table.

Filename	Usage	Description
Application-Facing Driver API		
r_ostm_drv_api.h	Application	The only API header file to include in application code
High Layer Driver (HLD) Source		
r_ostm_hld_prv.h	Private (HLD only)	Private header file intended ONLY for use in High Layer Driver (HLD) source. NOT for application or Low Layer Driver (LLD) use
r_ostm_drv_api.c	Private (HLD only)	High Layer Driver (HLD) source code enabling the driver API functions
r_ostm_hld_prv.c	Private (HLD only)	High Layer Driver (HLD) private source code enabling the functionality of the driver, abstracted from the low level access
High Layer to Low Level API		
r _ostm_lld_xxxx.h	Private (HLD/LLD only)	Low Layer Driver (LLD) header file (where "xxxx" is a device and board-specific identification). Intended ONLY to provide access for High Layer Driver (HLD) to required Low Layer Driver functions (LLD). Not for use in application, not to define any device specific enumerations or structures
r_ostm_lld_cfg_xxxx.h	Private (HLD/LLD only)	Low Layer Driver (LLD) header file (where "xxxx" is a device and board-specific identification). Intended for definitions of device specific settings (in the form of enumerations and structures). No LLD functions to be defined in this file
Abstraction Link between High and Low Layer Drivers (HLD/LLD Link)		
r_ostm_drv_link.h	Private (HLD/LLD only)	Header file intended as an abstraction between low and high layer. This header will include the device specific configuration file "r_ostm_lld_xxxx.h"
r_ostm_device_cfg.h	Should be included in "r_ostm_drv_api.h"	Header file intended as an abstraction between low and high layer. This header will include the device specific configuration file "r_ostm_lld_cfg_xxxx.h"
Low Layer Driver (LLD) Source		
r_ostm_lld_xxxx.c	Private (LLD only)	(Where "xxxx" is a device and board specific identification). Provides the definitions for the Low Layer Driver interface.
Smart Configurator		
r_ostm_drv_sc_cfg.h	Private (HLD/LLD only)	This file is intended to be used by Smart Configurator to pass setup information to the driver. This is not for application use

2.3 High Layer Driver

The High Layer Driver can be either used through STDIO or through direct access. It is recommended not to mix both access methods.

The driver layer functions can be seen in the table below:

Return Type	Function	Description	Arguments	Return
int_t	**ostm_hld_open(***st_stream_ptr_t* p_stream**)**	Driver initialisation interface is mapped to open function called directly using the st_r_driver_t OSTM driver handle g_ostm_driver: i.e. **g_ostm_driver.open()**	[in] **p_stream** driver handle	>0: the handle to the driver **DRV_ERROR** Open failed
void	**ostm_hld_close(** *st_stream_ptr_t* p_stream**)**	Driver close interface is mapped to close function. Called directly using the st_r_driver_t OSTM driver structure g_ostm_driver: i.e. **g_ostm_driver.close()**	[in] **p_stream** driver handle	**None**
int_t	**ostm_hld_control(** *st_stream_ptr_t* p_stream**,** *uint32_t* ctl_code**,** *void* * p_ctl_struct**)**	Driver control interface function. Maps to ANSI library low level control function. Called directly using the st_r_driver_t OSTM driver structure g_ostm_driver: i.e. **g_ostm_driver.control()**	[in] **p_stream** driver handle. [in] **ctl_code** the type of control function to use. [in/out] **p_ctl_struct** Required parameter is dependent upon the control function.	**DRV_SUCCESS** Operation succeeded **DRV_ERROR** Operation failed
int_t	**ostm_get_version(** *st_stream_ptr_t* p_stream**,** *st_ver_info_ptr_t* p_ver_info**)**	Driver get_version interface function. Maps to extended non-ANSI library low level get_version function. Called directly using the st_r_driver_t OSTM driver structure g_ostm_driver: i.e. **g_ostm_driver.get_version()**	[in] **p_stream** Handle to the (pre-opened) channel. [out] **p_ver_info** Pointer to a version information structure.	**DRV_SUCCESS** Operation succeeded

These High Layer functions can be accessed either executed directly or through STDIO.

2.4 Low Layer Driver

The Low Layer Driver provides the functions to configure the hardware.

Return Type	Function	Description	Arguments	Return
int_t	**R_OSTM_Init**(e_r_drv_ostm_channel_t channel, const st_r_drv_ostm_config_t *p_config)	Configure the OSTM channel	**channel:** [in] channel number **p_config:** [in] configuration for the channel	**DRV_SUCCESS or DRV_ERROR**
int_t	**R_OSTM_Close**(e_r_drv_ostm_channel_t channel)	Close the OSTM channel	**channel:** [in] channel number	**DRV_SUCCESS or DRV_ERROR**
int_t	**R_OSTM_GetCount**(e_r_drv_ostm_channel_t channel, uint32_t * p_data)	Gets the count value for the specified OSTM channel	**channel:** [in] channel number **p_data:** [out] the count value	**DRV_SUCCESS or DRV_ERROR**
int_t	**R_OSTM_Start**(e_r_drv_ostm_channel_t channel)	Starts the timer for the specified channel	**channel:** [in] channel number	**DRV_SUCCESS**
int_t	**R_OSTM_Stop**(e_r_drv_ostm_channel_t channel)	Stops the timer for the specified channel	**channel:** [in] channel number	**DRV_SUCCESS**
uint32_t	**R_OSTM_GetVersion(**st_drv_info_t *pinfo**)**	Get Low Layer Driver version information	**pinfo:** [out] pointer to version information structure	**DRV_SUCCESS**

3. Accessing the High Layer Driver

3.1 STDIO

The HLD's API can be accessed through the ANSI 'C' library <stdio.h>. The following table details the operation of each function:

Operation	Return	Function Details
open	gs_stdio_handle, unique handle to driver	open(DEVICE_IDENTIFIER "ostm", O_RDWR);
close	DRV_SUCCESS successful operation, or driver specific error	close(gs_stdio_handle);
read	DRV_ERROR (read is not implemented in this OSTM driver)	read(gs_stdio_handle, buffer, buffer_length)
write	DRV_ERROR (write is not implemented in this OSTM driver)	write(gs_stdio_handle, buffer, data_length)
control	DRV_SUCCESS control was process, or driver specific error	control(gs_stdio_handle, CTRL, &struct);
get_version	DRV_SUCCESS drv_info was updated, or DRV_ERROR drv_info was not updated	get_version(DEVICE_IDENTIFIER "ostm", &drv_info);

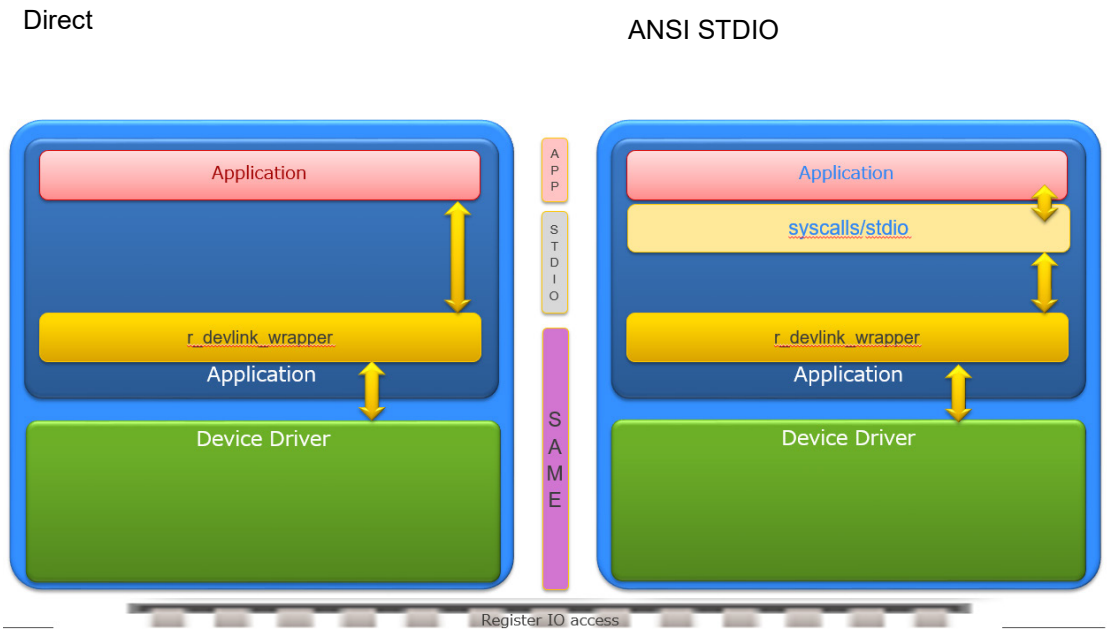
3.2 Direct

The following table shows the available direct functions.

Operation	Return	Function details
open	gs_direct_handle unique handle to driver	direct_open("ostm", 0);
close	DRV_SUCCESS successful operation, or driver specific error	direct_close(gs_direct_handle);
read	DRV_ERROR (read is not implemented in this OSTM driver)	direct_read(gs_direct_handle, buff, data_length);
write	DRV_ERROR (write not implemented in this OSTM driver)	direct_write(gs_direct_handle, buff, data_length);
control	DRV_SUCCESS control was processed, or driver specific error	direct_control(gs_direct_handle, CTRL, &struct);
get_version	DRV_SUCCESS drv_info was updated, or DRV_ERROR drv_info was not updated	direct_get_version("ostm", &drv_info);

3.3 Comparison

The diagram below illustrates the difference between the direct and ANSI STDIO methods.



4. Example of Use

This section gives simple examples for opening the driver, starting a timer, stopping a timer, reconfiguring a timer, closing the driver, and finally getting the driver version.

4.1 Open

```
int_t gs_ostm_handle;
char_t *drv_name = "ostm";

gs_ostm_handle = open(drv_name, O_RDWR);
```

4.2 Control – Start Timer

```
e_stb_module_t module;
int_t result;

module = MODULE_JCU;

result = control(gs_ostm_handle, CTRL_OSTM_START_TIMER, (void *) &module);
```

4.3 Control – Stop Timer

```
result = control(gs_ostm_handle, CTRL_OSTM_STOP_TIMER, (void *) &module);
```

4.4 Control – Reconfigure

```
result = control(gs_ostm_handle, CTRL_OSTM_RECONFIGURE, (void *) &module);
```

4.5 Write

```
The stdio write() function is not supported by the OSTM device driver.
```

4.6 Read

```
The stdio read() function is not supported by the OSTM device driver.
```

4.7 Close

```
close(gs_ostm_handle);
```

4.8 Get Version

```
st_ver_info_t info;
result = get_version(gs_ostm_handle, &info);
```

5. OS Support

This driver supports any OS through using the OS abstraction module. For more details about the abstraction module please refer to the OS abstraction module application note.

6. How to Import the Driver

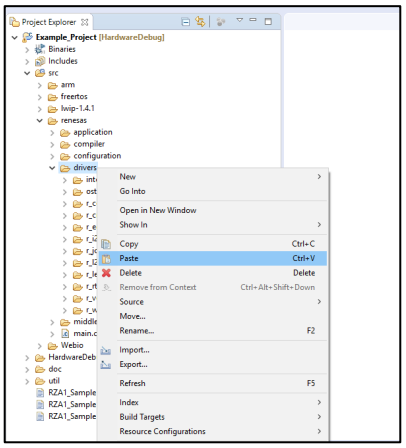
This section describes how to import the driver into your project. Generally, there are two steps in any IDE:

1) Copy the software driver to the location in the source tree that you require for your project.
2) Add the include path of the driver to the compiler.

6.1 e² studio

To import the driver into your project please follow the instructions below.

1) In Windows Explorer, right-click on the r_ostm folder, and click **Copy**.
2) In e² studio Project Explorer view, select the folder where you wish the driver project to be located; right-click and click **Paste**.
3) Right-click on the parent project folder (in this case 'Example_Project') and click **Properties ...**
4) In 'C/C++ Build → Settings → Cross ARM Compiler → Includes', add the include folder of the newly added driver, e.g. '${ProjDirPath}\src\renesas\drivers\r_ostm\inc'



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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Sept 18, 2018	All	Created document.

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   ¾ The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   ¾ The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   ¾ The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   ¾ When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

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   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

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