

## AT32M412/416 Firmware BSP&Pack

---

## Introduction

This application note is written to give a brief description of how to use AT32M412/416 series BSP (Board Support Package) and install AT32 pack.

## Contents

<b>1</b>	<b>Overview .....</b>	<b>42</b>
<b>2</b>	<b>How to install Pack .....</b>	<b>43</b>
2.1	IAR Pack installation.....	43
2.2	Keil_v5 Pack installation.....	45
2.3	Keil_v4 Pack installation.....	46
2.4	Segger Pack installation.....	48
<b>3</b>	<b>Flash algorithm file .....</b>	<b>51</b>
3.1	How to use Keil algorithm file .....	51
3.2	How to use IAR algorithm files.....	53
<b>4</b>	<b>BSP introduction.....</b>	<b>56</b>
4.1	Quick start .....	56
4.1.1	Template project.....	56
4.1.2	BSP macro definitions .....	57
4.2	BSP specifications .....	59
4.2.1	List of abbreviations for peripherals .....	59
4.2.2	Naming rules .....	59
4.2.3	Encoding rules.....	60
4.3	BSP structure .....	62
4.3.1	BSP folder structure .....	62
4.3.2	BSP function library structure.....	63
4.3.3	Initialization and configuration for peripherals .....	64
4.3.4	Peripheral functions format description.....	65
<b>5</b>	<b>AT32M412/416 peripheral library functions .....</b>	<b>66</b>
5.1	Analog-to-digital converter (ADC).....	66
5.1.1	adc_reset function.....	69
5.1.2	adc_enable function .....	69
5.1.3	adc_base_default_para_init function .....	70
5.1.4	adc_base_config function .....	70

5.1.5	adc_common_default_para_init function .....	71
5.1.6	adc_common_config function .....	72
5.1.7	adc_resolution_set function .....	74
5.1.8	adc_dma_mode_enable function.....	74
5.1.9	adc_dma_request_repeat_enable function .....	75
5.1.10	adc_interrupt_enable function.....	75
5.1.11	adc_calibration_init function.....	76
5.1.12	adc_calibration_init_status_get function.....	77
5.1.13	adc_calibration_start function .....	77
5.1.14	adc_calibration_status_get function.....	78
5.1.15	adc_voltage_monitor_enable function .....	78
5.1.16	adc_voltage_monitor_threshold_value_set function .....	79
5.1.17	adc_voltage_monitor_single_channel_select function .....	80
5.1.18	adc_ordinary_channel_set function .....	81
5.1.19	adc_preempt_channel_length_set function .....	82
5.1.20	adc_preempt_channel_set function.....	82
5.1.21	adc_ordinary_conversion_trigger_set function .....	83
5.1.22	adc_preempt_conversion_trigger_set function.....	84
5.1.23	adc_preempt_offset_value_set function .....	85
5.1.24	adc_ordinary_part_count_set function.....	86
5.1.25	adc_ordinary_part_mode_enable function .....	86
5.1.26	adc_preempt_part_mode_enable function .....	87
5.1.27	adc_preempt_auto_mode_enable function .....	87
5.1.28	adc_conversion_stop function .....	88
5.1.29	adc_conversion_stop_status_get function.....	88
5.1.30	adc_occe_each_conversion_enable function.....	89
5.1.31	adc_ordinary_software_trigger_enable function.....	89
5.1.32	adc_ordinary_software_trigger_status_get function.....	90
5.1.33	adc_preempt_software_trigger_enable function.....	90
5.1.34	adc_preempt_software_trigger_status_get function.....	91
5.1.35	adc_ordinary_conversion_data_get function .....	91
5.1.36	adc_combine_ordinary_conversion_data_get function .....	92
5.1.37	adc_preempt_conversion_data_get function.....	92
5.1.38	adc_flag_get function .....	93
5.1.39	adc_interrupt_flag_get function.....	93

5.1.40	adc_flag_clear function .....	94
5.1.41	adc_ordinary_oversample_enable function .....	94
5.1.42	adc_preempt_oversample_enable function.....	95
5.1.43	adc_oversample_ratio_shift_set function .....	95
5.1.44	adc_ordinary_oversample_trig_enable function .....	96
5.1.45	adc_ordinary_oversample_restart_set function.....	97
5.1.46	adc_convert_fail_auto_abort_enable function.....	98
5.1.47	adc_common_ordinary_data_get function.....	98
5.2	Controller area network (CAN) .....	99
5.2.1	can_reset function.....	101
5.2.2	can_software_reset_function .....	102
5.2.3	can_fd_iso_mode_enable function .....	102
5.2.4	can_mode_set function .....	103
5.2.5	can_standby_mode_enable function .....	103
5.2.6	can_restricted_operation_enable function.....	104
5.2.7	can_bittime_default_para_init function .....	104
5.2.8	can_bittime_set function .....	105
5.2.9	can_retransmission_limit_set function.....	107
5.2.10	can_rearbitration_limit_set function .....	108
5.2.11	can_timestamp_enable function .....	108
5.2.12	can_timestamp_position_set function.....	109
5.2.13	can_transmit_timestamp_get function .....	109
5.2.14	can_txbuf_write function .....	110
5.2.15	can_txbuf_transmit function .....	112
5.2.16	can_transmit_abort function.....	113
5.2.17	can_stb_transmit_mode_set function .....	113
5.2.18	can_stb_status_get function .....	114
5.2.19	can_transmit_status_get_ function .....	114
5.2.20	can_stb_clear function .....	115
5.2.21	can_rxbuf_overflow_mode_set function .....	116
5.2.22	can_receive_all_enable function.....	116
5.2.23	can_rxbuf_read function.....	117
5.2.24	can_rxbuf_release function.....	119
5.2.25	can_rxbuf_status_get function .....	119
5.2.26	can_filter_default_para_init function .....	120

5.2.27	can_filter_set function .....	122
5.2.28	can_filter_enable function .....	125
5.2.29	can_arbitration_lost_position_get function .....	126
5.2.30	can_rxbuf_warning_set function .....	127
5.2.31	can_error_warning_set function.....	127
5.2.32	can_kind_error_get function.....	128
5.2.33	can_receive_error_counter_get function .....	128
5.2.34	can_transmit_error_counter_get function .....	129
5.2.35	can_busoff_get function .....	129
5.2.36	can_busoff_reset function .....	130
5.2.37	can_ttcancan_ref_message_set function .....	131
5.2.38	can_ttcancan_timer_div_set function .....	132
5.2.39	can_ttcancan_enable function .....	133
5.2.40	can_ttcancan_trigger_type_set function .....	134
5.2.41	can_ttcancan_trigger_set function.....	135
5.2.42	can_ttcancan_watch_trigger_set function .....	136
5.2.43	can_ttcancan_transmit_window_set function .....	136
5.2.44	can_ttcancan_txbuf_enable function .....	137
5.2.45	can_ttcancan_txbuf_status_set function.....	138
5.2.46	can_ttcancan_txbuf_status_get function .....	139
5.2.47	can_ttcancan_txbuf_transmit_set function .....	140
5.2.48	can_ttcancan_txbuf_write function .....	141
5.2.49	can_interrupt_enable function.....	143
5.2.50	can_flag_get function .....	144
5.2.51	can_interrupt_flag_get function.....	145
5.2.52	can_flag_clear function .....	146
5.3	CRC calculation unit (CRC).....	147
5.3.1	crc_data_reset function.....	148
5.3.2	crc_one_word_calculate function.....	148
5.3.3	crc_block_calculate function .....	149
5.3.4	crc_data_get function.....	149
5.3.5	crc_common_data_set function .....	150
5.3.6	crc_common_data_get function.....	150
5.3.7	crc_init_data_set function .....	151
5.3.8	crc_reverse_input_data_set function.....	151

5.3.9	crc_reverse_output_data_set function.....	152
5.3.10	crc_poly_value _set function.....	152
5.3.11	crc_poly_value _get function.....	153
5.3.12	crc_poly_size _set function.....	153
5.3.13	crc_poly_size _get function.....	154
5.4	Clock and reset management (CRM) .....	155
5.4.1	crm_reset function.....	157
5.4.2	crm_lext_bypass function.....	157
5.4.3	crm_hext_bypass function .....	158
5.4.4	crm_flag_get function.....	158
5.4.5	crm_interrupt_flag_get function .....	159
5.4.6	crm_hext_stable_wait function.....	160
5.4.7	crm_hick_clock_trimming_set function .....	160
5.4.8	crm_hick_clock_calibration_set function .....	161
5.4.9	crm_periph_clock_enable .....	161
5.4.10	crm_periph_reset function.....	162
5.4.11	crm_periph_lowpower_mode_enable function .....	162
5.4.12	crm_clock_source_enable function.....	163
5.4.13	crm_flag_clear function .....	164
5.4.14	crm_etc_clock_select function.....	165
5.4.15	crm_etc_clock_enable function .....	165
5.4.16	crm_ahb_div_set function .....	166
5.4.17	crm_apb1_div_set function .....	166
5.4.18	crm_apb2_div_set function .....	167
5.4.19	crm_hext_sclk_div_set function .....	167
5.4.20	crm_hick_sclk_div_set function .....	168
5.4.21	crm_clock_failure_detection_enable function.....	169
5.4.22	crm_batteryPowered_domain_reset function.....	169
5.4.23	crm_auto_step_mode_enable function.....	170
5.4.24	crm_hick_sclk_frequency_select function .....	170
5.4.25	crm_can_clock_select function .....	171
5.4.26	crm_can_clock_get function.....	171
5.4.27	crm_pll_config function .....	172
5.4.28	crm_sysclk_switch function.....	173
5.4.29	crm_sysclk_switch_status_get function .....	173

5.4.30	crm_clocks_freq_get function .....	174
5.4.31	crm_clock_out_set function.....	175
5.4.32	crm_clkout_div_set function.....	175
5.4.33	crm_interrupt_enable function .....	176
5.4.34	crm_pll_parameter_calculate function .....	177
5.4.35	crm_apb3_div_set function .....	177
5.4.36	crm_vbath_div_set function .....	178
5.4.37	crm_lextdrv_set function .....	178
5.4.38	crm_hextdrv_set function .....	179
5.5	Digital-to-analog converter (DAC).....	180
5.5.1	dac_reset function.....	181
5.5.2	dac_enable function .....	181
5.5.3	dac_trigger_enable function.....	182
5.5.4	dac_trigger_select function .....	182
5.5.5	dac_software_trigger_generate function .....	183
5.5.6	dac_dual_software_trigger_generate function.....	183
5.5.7	dac_dma_enable function .....	184
5.5.8	dac_data_output_get function.....	184
5.5.9	dac_1_data_set function .....	185
5.5.10	dac_2_data_set function .....	185
5.5.11	dac_dual_data_set function .....	186
5.5.12	dac_udr_enable function.....	186
5.5.13	dac_udr_flag_get function.....	187
5.5.14	dac_udr_interrupt_flag_get function .....	187
5.5.15	dac_udr_flag_clear function .....	188
5.5.16	dac_reference_voltage_select function .....	188
5.5.17	dac_output_enable function .....	189
5.6	Debug.....	190
5.6.1	debug_device_id_get function .....	190
5.6.2	debug_low_power_mode_set function .....	191
5.6.3	debug_apb1_periph_mode_set function .....	191
5.6.4	debug_apb2_periph_mode_set function .....	192
5.6.5	debug_apb3_periph_mode_set function .....	193
5.7	DMA controller.....	194
5.7.1	dma_default_para_init function.....	196

5.7.2	dma_init function .....	197
5.7.3	dma_reset function.....	199
5.7.4	dma_data_number_set function .....	199
5.7.5	dma_data_number_get function .....	200
5.7.6	dma_interrupt_enable function .....	200
5.7.7	dma_channel_enable function .....	201
5.7.8	dma_flag_get function .....	201
5.7.9	dma_flag_clear function .....	203
5.7.10	dma_flexible_config function.....	204
5.7.11	dmamux_enable function .....	205
5.7.12	dmamux_init.....	206
5.7.13	dmamux_sync_default_para_init function .....	206
5.7.14	dmamux_sync_config function.....	207
5.7.15	dmamux_generator_default_para_init function .....	209
5.7.16	dmamux_generator_config function.....	209
5.7.17	dmamux_sync_interrupt_enable function .....	211
5.7.18	dmamux_generator_interrupt_enable function .....	212
5.7.19	dmamux_sync_flag_get function .....	212
5.7.20	dmamux_sync_flag_clear function.....	213
5.7.21	dmamux_generator_flag_get function .....	214
5.7.22	dmamux_generator_flag_clear function.....	215
5.8	Real-time clock (ERTC).....	216
5.8.1	ertc_num_to_bcd function.....	218
5.8.2	ertc_bcd_to_num function.....	218
5.8.3	ertc_write_protect_enable function .....	219
5.8.4	ertc_write_protect_disable function .....	219
5.8.5	ertc_wait_update function .....	220
5.8.6	ertc_wait_flag function .....	220
5.8.7	ertc_init_mode_enter function.....	221
5.8.8	ertc_init_mode_exit function .....	221
5.8.9	ertc_reset function.....	222
5.8.10	ertc_divider_set function .....	222
5.8.11	ertc_hour_mode_set function .....	223
5.8.12	ertc_date_set function .....	223
5.8.13	ertc_time_set function .....	224

5.8.14 ertc_calendar_get function.....	224
5.8.15 ertc_sub_second_get function .....	225
5.8.16 ertc_alarm_mask_set function .....	226
5.8.17 ertc_alarm_week_date_select function .....	227
5.8.18 ertc_alarm_set function.....	228
5.8.19 ertc_alarm_sub_second_set function .....	229
5.8.20 ertc_alarm_enable function.....	230
5.8.21 ertc_alarm_get function.....	230
5.8.22 ertc_alarm_sub_second_get function .....	232
5.8.23 ertc_wakeup_clock_set function .....	232
5.8.24 ertc_wakeup_counter_set function .....	233
5.8.25 ertc_wakeup_counter_get function .....	233
5.8.26 ertc_wakeup_enable function .....	234
5.8.27 ertc_smooth_calibration_config function .....	234
5.8.28 ertc_cal_output_select function .....	235
5.8.29 ertc_cal_output_enable function .....	235
5.8.30 ertc_time_adjust function .....	236
5.8.31 ertc_daylight_set function .....	236
5.8.32 ertc_daylight_bpr_get function .....	237
5.8.33 ertc_refer_clock_detect_enable function .....	237
5.8.34 ertc_direct_read_enable function.....	238
5.8.35 ertc_output_set function.....	238
5.8.36 ertc_timestamp_pin_select function.....	239
5.8.37 ertc_timestamp_valid_edge_set function .....	239
5.8.38 ertc_timestamp_enable function .....	240
5.8.39 ertc_timestamp_get function .....	240
5.8.40 ertc_timestamp_sub_second_get function .....	241
5.8.41 ertc_tamper_1_pin_select function .....	242
5.8.42 ertc_tamper_pull_up_enable function.....	242
5.8.43 ertc_tamper_precharge_set function .....	243
5.8.44 ertc_tamper_filter_set function.....	243
5.8.45 ertc_tamper_detect_freq_set function .....	244
5.8.46 ertc_tamper_valid_edge_set function .....	245
5.8.47 ertc_tamper_timestamp_enable function.....	245
5.8.48 ertc_tamper_enable function.....	246

5.8.49 ertc_interrupt_enable function .....	246
5.8.50 ertc_interrupt_get function .....	247
5.8.51 ertc_flag_get function.....	247
5.8.52 ertc_interrupt_flag_get function .....	248
5.8.53 ertc_flag_clear function .....	249
5.8.54 ertc_bpr_data_write function.....	249
5.8.55 ertc_bpr_data_read function .....	250
5.9 External interupt/event controller (EXINT) .....	251
5.9.1 exint_reset function .....	252
5.9.2 exint_default_para_init function .....	252
5.9.3 exint_init function.....	253
5.9.4 exint_flag_clear function .....	254
5.9.5 exint_flag_get function .....	254
5.9.6 exint_interrupt_flag_get function.....	255
5.9.7 exint_software_interrupt_event_generate function.....	255
5.9.8 exint_interrupt_enable function.....	256
5.9.9 exint_event_enable function .....	256
5.10 Flash memory controller (FLASH) .....	257
5.10.1 flash_flag_get function .....	259
5.10.2 flash_flag_clear function .....	260
5.10.3 flash_operation_status_get function .....	260
5.10.4 flash_operation_wait_for function .....	261
5.10.5 flash_unlock function.....	261
5.10.6 flash_lock function.....	262
5.10.7 flash_sector_erase function .....	262
5.10.8 flash_internal_all_erase function .....	263
5.10.9 flash_user_system_data_erase function .....	263
5.10.10 flash_word_program function.....	264
5.10.11 flash_halfword_program function.....	264
5.10.12 flash_byte_program function.....	265
5.10.13 flash_user_system_data_program function.....	266
5.10.14 flash_epp_set function .....	266
5.10.15 flash_epp_status_get function .....	267
5.10.16 flash_fap_enable function .....	267
5.10.17 flash_fap_status_get function .....	268

5.10.18 flash_fap_high_level_enable .....	268
5.10.19 flash_fap_high_level_status_get.....	269
5.10.20 flash_ssb_set function.....	269
5.10.21 flash_ssb_status_get function.....	270
5.10.22 flash_interrupt_enable function.....	271
5.10.23 flash_slib_enable function.....	271
5.10.24 flash_slib_disable function .....	272
5.10.25 flash_slib_state_get function.....	272
5.10.26 flash_slib_start_sector_get function.....	273
5.10.27 flash_slib_inststart_sector_get function .....	273
5.10.28 flash_slib_end_sector_get function.....	274
5.10.29 flash_crc_calibrate function.....	274
5.10.30 flash_boot_memory_extension_mode_enable .....	275
5.10.31 flash_extension_memory_slib_enable.....	275
5.10.32 flash_extension_memory_slib_state_get.....	276
5.10.33 flash_em_slib_inststart_sector_get.....	276
5.11 General-purpose I/Os and multiplexed I/Os (GPIO/IOMUX) .....	277
5.11.1 gpio_reset function.....	278
5.11.2 gpio_init function .....	278
5.11.3 gpio_default_para_init function .....	280
5.11.4 gpio_input_data_bit_read function.....	280
5.11.5 gpio_input_data_read function.....	281
5.11.6 gpio_output_data_bit_read function.....	281
5.11.7 gpio_output_data_read function .....	282
5.11.8 gpio_bits_set function .....	282
5.11.9 gpio_bits_reset function .....	283
5.11.10 gpio_bits_write function.....	283
5.11.11 gpio_bits_write function.....	284
5.11.12 gpio_port_write function .....	284
5.11.13 gpio_pin_wp_config function.....	285
5.11.14 gpio_pins_huge_driven_config function .....	285
5.11.15 gpio_pin_mux_config function .....	286
5.12 I2C interfaces .....	288
5.12.1 i2c_reset function .....	290
5.12.2 i2c_init function.....	291

5.12.3 i2c_own_address1_set function.....	291
5.12.4 i2c_own_address2_set function.....	292
5.12.5 i2c_own_address2_enable function.....	292
5.12.6 i2c_smbus_enable function.....	293
5.12.7 i2c_enable function .....	294
5.12.8 i2c_clock_stretch_enable function .....	294
5.12.9 i2c_ack_enable function.....	295
5.12.10 i2c_addr10_mode_enable function.....	295
5.12.11 i2c_transfer_addr_set function.....	296
5.12.12 i2c_transfer_addr_get function .....	296
5.12.13 i2c_transfer_dir_set function .....	297
5.12.14 i2c_transfer_dir_get function.....	297
5.12.15 i2c_matched_addr_get function.....	298
5.12.16 i2c_auto_stop_enable function .....	298
5.12.17 i2c_reload_enable function .....	299
5.12.18 i2c_cnt_set function.....	299
5.12.19 i2c_addr10_header_enable function.....	300
5.12.20 i2c_general_call_enable function.....	300
5.12.21 i2c_smbus_alert_set function .....	301
5.12.22 i2c_slave_data_ctrl_enable function.....	301
5.12.23 i2c_pec_calculate_enable function .....	302
5.12.24 i2c_pec_transmit_enable function .....	302
5.12.25 i2c_pec_value_get function.....	303
5.12.26 i2c_timeout_set function .....	303
5.12.27 i2c_timeout_detct_set function .....	304
5.12.28 i2c_timeout_enable function .....	304
5.12.29 i2c_ext_timeout_set function.....	305
5.12.30 i2c_ext_timeout_enable function .....	305
5.12.31 i2c_interrupt_enable function .....	306
5.12.32 i2c_interrupt_get function.....	307
5.12.33 i2c_dma_enable function .....	307
5.12.34 i2c_transmit_set function .....	308
5.12.35 i2c_start_generate function.....	309
5.12.36 i2c_stop_generate function .....	309
5.12.37 i2c_data_send function .....	310

5.12.38 i2c_data_receive function .....	310
5.12.39 i2c_flag_get function .....	311
5.12.40 i2c_interrupt_flag_get function.....	312
5.12.41 i2c_flag_clear function .....	313
5.12.42 i2c_config function.....	314
5.12.43 i2c_lowlevel_init function.....	316
5.12.44 i2c_wait_end function.....	316
5.12.45 i2c_wait_flag function.....	317
5.12.46 i2c_master_transmit function .....	318
5.12.47 i2c_master_receive function .....	319
5.12.48 i2c_slave_transmit function.....	320
5.12.49 i2c_slave_receive function .....	320
5.12.50 i2c_master_transmit_int function .....	321
5.12.51 i2c_master_receive_int function .....	322
5.12.52 i2c_slave_transmit_int function.....	322
5.12.53 i2c_slave_receive_int function .....	323
5.12.54 i2c_master_transmit_dma function.....	324
5.12.55 i2c_master_receive_dma function .....	325
5.12.56 i2c_slave_transmit_dma function.....	325
5.12.57 i2c_slave_receive_dma function.....	326
5.12.58 i2c_smbus_master_transmit function .....	326
5.12.59 i2c_smbus_master_receive function.....	327
5.12.60 i2c_smbus_slave_transmit function .....	328
5.12.61 i2c_smbus_slave_receive function .....	329
5.12.62 i2c_memory_write function .....	329
5.12.63 i2c_memory_write_int function .....	330
5.12.64 i2c_memory_write_dma function .....	331
5.12.65 i2c_memory_read function.....	332
5.12.66 i2c_memory_read_int function .....	333
5.12.67 i2c_memory_read_dma function.....	334
5.12.68 i2c_evt_irq_handler function .....	335
5.12.69 i2c_err_irq_handler function.....	335
5.12.70 i2c_dma_tx_irq_handler function .....	336
5.12.71 i2c_dma_rx_irq_handler function .....	336
5.13 Nested vectored interrupt controller (NVIC).....	337

5.13.1	nvic_system_reset function .....	338
5.13.2	nvic_irq_enable function .....	338
5.13.3	nvic_irq_disable function .....	339
5.13.4	nvic_priority_group_config function .....	339
5.13.5	nvic_vector_table_set function .....	340
5.13.6	nvic_lowpower_mode_config function .....	341
5.14	Operational amplifier (OP) .....	342
5.14.1	op_enable function .....	343
5.14.2	op_set_mode function .....	343
5.14.3	op_set_functional_mode function .....	344
5.14.4	op_set_gain function .....	344
5.14.5	op_set_highspeed_mode function .....	345
5.14.6	op_set_input_non_inverting function .....	345
5.14.7	op_set_input_inverting function .....	346
5.14.8	op_input_non_inverting_switch function .....	346
5.14.9	op_input_nverting_switch function .....	347
5.14.10	op_input_mux_enable function .....	347
5.14.11	op_internal_output_select function .....	348
5.14.12	op_set_trimming_mode function .....	348
5.14.13	op_calibration_select function .....	349
5.14.14	op_calout_status_get function .....	350
5.14.15	op_set_triming_value function .....	350
5.14.16	op_wpc_enable function .....	351
5.15	Power controller (PWC) .....	352
5.15.1	pwc_reset function .....	353
5.15.2	pwc_batteryPowered_domain_access function .....	353
5.15.3	pwc_pvm_level_select function .....	354
5.15.4	pwc_power_voltage_monitor_enable function .....	354
5.15.5	pwc_wakeup_pin_polarity_select function .....	355
5.15.6	pwc_wakeup_pin_enable function .....	356
5.15.7	pwc_flag_clear function .....	356
5.15.8	pwc_flag_get function .....	357
5.15.9	pwc_sleep_mode_enter function .....	357
5.15.10	pwc_deep_sleep_mode_enter function .....	358
5.15.11	pwc_voltage_regulate_set function .....	358

5.15.12 pwc_ldo_output_voltage_set function.....	359
5.15.13 pwc_standby_mode_enter function .....	360
5.16 System configuration controller (SCFG).....	361
5.16.1 scfg_reset function .....	362
5.16.2 scfg_infrared_config function .....	362
5.16.3 scfg_mem_map_get function .....	363
5.16.4 scfg_pa11pa12_pin_remap function .....	363
5.16.5 scfg_pvm_lock_enable function.....	364
5.16.6 scfg_lockup_enable function.....	364
5.16.7 scfg_can_timestamp_source_set function.....	365
5.16.8 scfg_exint_line_config function .....	365
5.16.9 scfg_pins_ultra_driven_enable function .....	366
5.16.10 scfg_nrst_rmp_config function .....	367
5.17 Serial peripheral interface (SPI)/ I <sup>2</sup> S .....	368
5.17.1 spi_i2s_reset function .....	369
5.17.2 spi_default_para_init function .....	369
5.17.3 spi_init function.....	370
5.17.4 spi_ti_mode_enable function .....	372
5.17.5 spi_crc_next_transmit function .....	372
5.17.6 spi_crc_polynomial_set function .....	373
5.17.7 spi_crc_polynomial_get function.....	373
5.17.8 spi_crc_enable function .....	374
5.17.9 spi_crc_value_get function.....	374
5.17.10 spi_hardware_cs_output_enable function .....	375
5.17.11 spi_software_cs_internal_level_set function .....	375
5.17.12 spi_frame_bit_num_set function .....	376
5.17.13 spi_half_duplex_direction_set function .....	376
5.17.14 spi_enable function .....	377
5.17.15 i2s_default_para_init function .....	377
5.17.16 i2s_init function.....	378
5.17.17 i2s_enable function .....	379
5.17.18 spi_i2s_interrupt_enable function .....	380
5.17.19 spi_i2s_dma_transmitter_enable function .....	380
5.17.20 spi_i2s_dma_receiver_enable function.....	381
5.17.21 spi_i2s_data_transmit function .....	381

5.17.22 spi_i2s_data_receive function.....	382
5.17.23 spi_i2s_flag_get function.....	382
5.17.24 spi_i2s_interrupt_flag_get function .....	383
5.17.25 spi_i2s_flag_clear function.....	384
5.18 SysTick.....	385
5.18.1 systick_clock_source_config function.....	385
5.18.2 SysTick_Config function.....	386
5.19 TMR .....	387
5.19.1 tmr_reset function.....	390
5.19.2 tmr_counter_enable function.....	390
5.19.3 tmr_output_default_para_init function.....	391
5.19.4 tmr_input_default_para_init function.....	391
5.19.5 tmr_brkdt_default_para_init function.....	392
5.19.6 tmr_blk_default_para_init function .....	393
5.19.7 tmr_base_init function .....	393
5.19.8 tmr_clock_source_div_set function.....	394
5.19.9 tmr_cnt_dir_set function.....	394
5.19.10 tmr_cnt_dir_get function.....	395
5.19.11 tmr_repetition_counter_set function.....	395
5.19.12 tmr_counter_value_set function.....	396
5.19.13 tmr_counter_value_get function.....	396
5.19.14 tmr_div_value_set function .....	397
5.19.15 tmr_div_value_get function .....	397
5.19.16 tmr_output_channel_config function .....	398
5.19.17 tmr_output_channel_mode_select function .....	400
5.19.18 tmr_period_value_set function .....	401
5.19.19 tmr_period_value_get function .....	401
5.19.20 tmr_channel_value_set function .....	402
5.19.21 tmr_channel_value_get function .....	403
5.19.22 tmr_period_buffer_enable function .....	403
5.19.23 tmr_output_channel_buffer_enable function .....	404
5.19.24 tmr_output_channel_immediately_set function .....	405
5.19.25 tmr_output_channel_switch_set function.....	406
5.19.26 tmr_one_cycle_mode_enable function .....	406
5.19.27 tmr_overflow_request_source_set function .....	407

5.19.28 tmr_overflow_event_disable function.....	408
5.19.29 tmr_input_channel_init function .....	408
5.19.30 tmr_channel_enable function.....	410
5.19.31 tmr_input_channel_filter_set function .....	411
5.19.32 tmr_pwm_input_config function .....	411
5.19.33 tmr_channel1_input_select function .....	412
5.19.34 tmr_input_channel_divider_set function .....	413
5.19.35 tmr_primary_mode_select function.....	414
5.19.36 tmr_sub_mode_select function .....	415
5.19.37 tmr_channel_dma_select function .....	416
5.19.38 tmr_hall_select function .....	416
5.19.39 tmr_channel_buffer_enable function.....	417
5.19.40 tmr_trgout2_enable function .....	417
5.19.41 tmr_trigger_input_select function.....	418
5.19.42 tmr_sub_sync_mode_set function .....	418
5.19.43 tmr_dma_request_enable function .....	419
5.19.44 tmr_interrupt_enable function .....	419
5.19.45 tmr_interrupt_flag_get function .....	420
5.19.46 tmr_flag_get function.....	421
5.19.47 tmr_flag_clear function.....	422
5.19.48 tmr_event_sw_trigger function .....	422
5.19.49 tmr_output_enable function.....	423
5.19.50 tmr_internal_clock_set function .....	423
5.19.51 tmr_output_channel_polarity_set function .....	424
5.19.52 tmr_external_clock_enable function .....	425
5.19.53 tmr_external_clock_config function.....	425
5.19.54 tmr_external_clock_mode1_config function .....	426
5.19.55 tmr_external_clock_mode2_config function .....	427
5.19.56 tmr_encoder_mode_config function.....	428
5.19.57 tmr_force_output_set function .....	429
5.19.58 tmr_dma_control_config function.....	430
5.19.59 tmr_brkdt_config function.....	431
5.19.60 tmr_brk_filter_value_set function .....	433
5.19.61 tmr_brk2_config function.....	433
5.19.62 tmr_input_channel_blk_config function .....	434

5.19.63 tmr_overflow_flag_remap function.....	435
5.19.64 tmr_primary_mode2_select function.....	436
5.19.65 tmr_coraw_clear_set function .....	437
5.19.66 tmr_overflow_cpy_get function .....	437
5.19.67 tmr_brk_bidir_enable function.....	438
5.19.68 tmr_brk_release function.....	439
5.19.69 tmr_brk_release_check function .....	439
5.19.70 tmr_ch5_combined_set function .....	440
5.19.71 tmr_brk_input_config function.....	440
5.19.72 tmr_external_source_select function .....	441
5.19.73 tmr_input_ch_select function .....	442
5.19.74 tmr_iasym_mode_enable function .....	444
5.20 Universal synchronous/asynchronous receiver/transmitter (USART) .....	445
5.20.1 usart_reset function.....	446
5.20.2 usart_init function .....	447
5.20.3 usart_parity_selection_config function.....	448
5.20.4 usart_enable function.....	448
5.20.5 usart_transmitter_enable function.....	449
5.20.6 usart_receiver_enable function.....	449
5.20.7 usart_clock_config function.....	450
5.20.8 usart_clock_enable function.....	451
5.20.9 usart_interrupt_enable function .....	451
5.20.10 usart_dma_transmitter_enable function.....	452
5.20.11 usart_dma_receiver_enable function.....	452
5.20.12 usart_wakeup_id_set function .....	453
5.20.13 usart_wakeup_mode_set function .....	453
5.20.14 usart_receiver_mute_enable function.....	454
5.20.15 usart_break_bit_num_set function.....	454
5.20.16 usart_lin_mode_enable function .....	455
5.20.17 usart_data_transmit function.....	455
5.20.18 usart_data_receive function .....	456
5.20.19 usart_break_send function .....	456
5.20.20 usart_smartcard_guard_time_set function .....	457
5.20.21 usart_irda_smartcard_division_set function .....	457
5.20.22 usart_smartcard_mode_enable function .....	458

5.20.23 usart_smartcard_nack_set function .....	458
5.20.24 usart_single_line_halfduplex_select function .....	459
5.20.25 usart_irda_mode_enable function .....	459
5.20.26 usart_irda_low_power_enable function .....	460
5.20.27 usart_hardware_flow_control_set function .....	460
5.20.28 usart_flag_get function .....	461
5.20.29 usart_interrupt_flag_get function .....	462
5.20.30 usart_flag_clear function .....	463
5.20.31 usart_rs485_delay_time_config function .....	463
5.20.32 usart_transmit_receive_pin_swap function .....	464
5.20.33 usart_id_bit_num_set function .....	464
5.20.34 usart_de_polarity_set function .....	465
5.20.35 usart_rs485_mode_enable function .....	465
5.20.36 usart_msb_transmit_first_enable function .....	466
5.20.37 usart_dt_polarity_reverse function .....	466
5.20.38 usart_transmit_pin_polarity_reverse function .....	467
5.20.39 usart_receive_pin_polarity_reverse function .....	467
5.20.40 usart_receiver_timeout_detection_enable function .....	468
5.20.41 usart_receiver_timeout_value_set function .....	468
5.21 Watchdog timer (WDT) .....	469
5.21.1 wdt_enable function .....	470
5.21.2 wdt_counter_reload function .....	470
5.21.3 wdt_reload_value_set function .....	471
5.21.4 wdt_divider_set function .....	471
5.21.5 wdt_register_write_enable function .....	472
5.21.6 wdt_flag_get function .....	472
5.21.7 wdt_window_counter_set function .....	473
5.22 Window watchdog timer (WWDT) .....	474
5.22.1 wwdt_reset function .....	475
5.22.2 wwdt_divider_set function .....	475
5.22.3 wwdt_enable function .....	476
5.22.4 wwdt_interrupt_enable function .....	476
5.22.5 wwdt_counter_set function .....	476
5.22.6 wwdt_window_counter_set function .....	477
5.22.7 wwdt_flag_get function .....	477

5.22.8	wwdt_interrupt_flag_get function .....	478
5.22.9	wwdt_flag_clear function.....	478
5.23	Comparator (CMP) .....	479
5.23.1	cmp_init function .....	480
5.23.2	cmp_default_para_initfunction .....	481
5.23.3	cmp_enable function .....	482
5.23.4	cmp_output_value_get function .....	482
5.23.5	cmp_write_protect_enable function .....	483
5.23.6	cmp_filter_config function .....	483
5.23.7	cmp_blankng_config function.....	484
<b>6</b>	<b>Precautions .....</b>	<b>485</b>
6.1	Device model replacement .....	485
6.1.1	KEIL environment.....	485
6.1.2	IAR environment.....	486
6.2	Unable to identify IC by JLink software in Keil .....	488
6.3	How to change HEXT crystal .....	490
<b>7</b>	<b>Revision history .....</b>	<b>492</b>

## List of tables

Table 1. Summary of macro definitions .....	57
Table 2. List of abbreviations for peripherals.....	59
Table 3. Summary of BSP function library files .....	64
Table 4. Function format description for peripherals .....	65
Table 5. Summary of ADC registers .....	66
Table 6. List of ADCCOM registers.....	66
Table 7. Summary of ADC library functions.....	67
Table 8. adc_reset function.....	69
Table 9. adc_enable function.....	69
Table 10. adc_base_default_para_init function .....	70
Table 11. adc_base_config function .....	70
Table 12. adc_common_default_para_init function .....	71
Table 13. adc_common_config function .....	72
Table 14. adc_resolution_set function .....	74
Table 15. adc_dma_mode_enable function.....	74
Table 16. adc_dma_request_repeat_enable function .....	75
Table 17. adc_interrupt_enable function .....	75
Table 18. adc_calibration_init function.....	76
Table 19. adc_calibration_init_status_get function.....	77
Table 20. adc_calibration_start function .....	77
Table 21. adc_calibration_status_get function .....	78
Table 22. adc_voltage_monitor_enable function .....	78
Table 23. adc_voltage_monitor_threshold_value_set function .....	79
Table 24. adc_voltage_monitor_single_channel_select function .....	80
Table 25. adc_ordinary_channel_set function .....	81
Table 26. adc_preempt_channel_length_set function .....	82
Table 27. adc_preempt_channel_set function.....	82
Table 28. adc_ordinary_conversion_trigger_set function.....	83
Table 29. adc_preempt_conversion_trigger_set function.....	84
Table 30. adc_preempt_offset_value_set function.....	85
Table 31. adc_ordinary_part_count_set function.....	86
Table 32. adc_ordinary_part_mode_enable function .....	86
Table 33. adc_preempt_part_mode_enable function .....	87
Table 34. adc_preempt_auto_mode_enable function .....	87

Table 35. adc_conversion_stop function .....	88
Table 36. adc_conversion_stop_status_get function .....	88
Table 37. adc_occe_each_conversion_enable function.....	89
Table 38. adc_ordinary_software_trigger_enable function.....	89
Table 55. adc_ordinary_software_trigger_status_get function.....	90
Table 40. adc_preempt_software_trigger_enable function .....	90
Table 41. adc_preempt_software_trigger_status_get function .....	91
Table 42. adc_ordinary_conversion_data_get function.....	91
Table 43. adc_combine_ordinary_conversion_data_get function .....	92
Table 44. adc_preempt_conversion_data_get function.....	92
Table 45. adc_flag_get function.....	93
Table 46. adc_interrupt_flag_get function .....	93
Table 47. adc_flag_clear function .....	94
Table 48. adc_ordinary_oversample_enable function.....	94
Table 49. adc_preempt_oversample_enable function.....	95
Table 50. adc_oversample_ratio_shift_set function .....	95
Table 51. adc_ordinary_oversample_trig_enable function.....	96
Table 52. adc_ordinary_oversample_restart_set function.....	97
Table 53. adc_ordinary_oversample_restart_set function.....	98
Table 54. adc_common_ordinary_data_get function .....	98
Table 55. Summary of CAN registers .....	99
Table 56. Summary of CAN library functions.....	100
Table 57. can_reset function.....	101
Table 58. can_software_reset function.....	102
Table 59. fd_iso_mode_enable function.....	102
Table 60. can_mode_set function.....	103
Table 61. can_standby_mode_enable function .....	103
Table 62. can_restricted_operation_enable function .....	104
Table 63. can_bittime_default_para_init function .....	104
Table 64. can_bittime_set function .....	105
Table 65. can_retransmission_limit_set function .....	107
Table 66. can_rearbitration_limit_set function .....	108
Table 67. can_timestamp_enable function .....	108
Table 68. can_timestamp_position_set function.....	109
Table 69. can_transmit_timestamp_get function .....	109

Table 70. can_txbuf_write function .....	110
Table 71. can_txbuf_transmit function .....	112
Table 72. can_transmit_abort function.....	113
Table 73. can_stb_transmit_mode_set function.....	113
Table 74. can_stb_status_get function .....	114
Table 75. can_transmit_status_get function .....	114
Table 76. can_stb_clear function .....	115
Table 77. can_rxbuf_overflow_mode_set function .....	116
Table 78. can_receive_all_enable function .....	116
Table 79. can_rxbuf_read function .....	117
Table 80. can_rxbuf_release function.....	119
Table 81. can_rxbuf_status_get function.....	119
Table 82. can_filter_default_para_init function .....	120
Table 83. can_filter_set function .....	122
Table 83. can_filter_enable function .....	125
Table 85. can_arbitration_lost_position_get function .....	126
Table 86. can_rxbuf_warning_set function .....	127
Table 87. can_error_warning_set function .....	127
Table 88. can_kind_error_get function .....	128
Table 89. can_receive_error_counter_get function .....	128
Table 90. can_transmit_error_counter_get function.....	129
Table 91. can_busoff_get function.....	129
Table 92. can_busoff_reset function.....	130
Table 93. can_ttcancan_ref_message_set function .....	131
Table 94. can_ttcancan_timer_div_set function .....	132
Table 95. can_ttcancan_enable function .....	133
Table 96. can_ttcancan_trigger_type_set function.....	134
Table 97. can_ttcancan_trigger_set function.....	135
Table 98. can_ttcancan_watch_trigger_set function .....	136
Table 99. can_ttcancan_transmit_window_set function .....	136
Table 100. can_ttcancan_txbuf_enable function .....	137
Table 101. can_ttcancan_txbuf_status_set function .....	138
Table 101. can_ttcancan_txbuf_status_get function .....	139
Table 103. can_ttcancan_txbuf_transmit_set function .....	140
Table 104. can_ttcancan_txbuf_write function .....	141

Table 105. can_interrupt_enable function .....	143
Table 106. can_flag_get function.....	144
Table 107. can_interrupt_flag_get function .....	145
Table 108. can_flag_clear function.....	146
Table 109. Summary of CRC registers.....	147
Table 110. Summary of CRC library functions.....	147
Table 111. crc_data_reset function .....	148
Table 112. crc_one_word_calculate function.....	148
Table 113. crc_block_calculate function .....	149
Table 114. crc_data_get function.....	149
Table 115. crc_common_data_set function .....	150
Table 116. crc_common_data_get function .....	150
Table 117. crc_init_data_set function .....	151
Table 118. crc_reverse_input_data_set function .....	151
Table 119. crc_reverse_output_data_set function.....	152
Table 120. crc_poly_value_set function.....	152
Table 121. crc_poly_value_get function .....	153
Table 122. crc_poly_size_set function.....	153
Table 123. crc_poly_size_get function.....	154
Table 124. Summary of CRM registers.....	155
Table 125. Summary of CRM library functions .....	156
Table 126. crm_reset function.....	157
Table 127. crm_lext_bypass function .....	157
Table 128. crm_hext_bypass function .....	158
Table 129. crm_flag_get function.....	158
Table 130. crm_interrupt_flag_get function .....	159
Table 131. crm_hext_stable_wait function .....	160
Table 132. crm_hick_clock_trimming_set function .....	160
Table 133. crm_hick_clock_calibration_set function .....	161
Table 134. crm_periph_clock_enable function .....	161
Table 135. crm_periph_reset function .....	162
Table 136. crm_periph_lowpower_mode_enable function .....	162
Table 137. crm_clock_source_enable function .....	163
Table 138. crm_flag_clear function.....	164
Table 139. crm_ertc_clock_select function.....	165

Table 140. crm_erc_clock_enable function .....	165
Table 141. crm_ahb_div_set function .....	166
Table 142. crm_apb1_div_set function .....	166
Table 143. crm_apb2_div_set function .....	167
Table 144. crm_hext_sclk_div_set function .....	167
Table 145. crm_hick_sclk_div_set function .....	168
Table 146. crm_clock_failure_detection_enable function .....	169
Table 147. crm_batteryPowered_domain_reset .....	169
Table 148. crm_auto_step_mode_enable function .....	170
Table 149. crm_hick_sclk_frequency_select function .....	170
Table 150. crm_can_clock_select function .....	171
Table 151. crm_can_clock_get function .....	171
Table 152. crm_pll_config function .....	172
Table 153. crm_sysclk_switch function .....	173
Table 154. crm_sysclk_switch_status_get function .....	173
Table 155. crm_clocks_freq_get function .....	174
Table 156. crm_clock_out_set function .....	175
Table 157. crm_clkout_div_set function .....	175
Table 158. crm_interrupt_enable function .....	176
Table 159. crm_pll_parameter_calculate function .....	177
Table 160. crm_apb3_div_set function .....	177
Table 161. crm_vbath_div_set function .....	178
Table 162. crm_lextdrv_set function .....	178
Table 163. crm_lextdrv_set function .....	179
Table 164. Summary of DAC registers .....	180
Table 165. Summary of DAC library functions .....	180
Table 166. dac_reset function .....	181
Table 167. dac_enable function .....	181
Table 168. dac_trigger_enable function .....	182
Table 169. dac_trigger_select function .....	182
Table 170. dac_software_trigger_generate function .....	183
Table 171. dac_dual_software_trigger_generate function .....	183
Table 172. dac_dma_enable function .....	184
Table 173. dac_data_output_get function .....	184
Table 174. dac_1_data_set function .....	185

Table 175. dac_2_data_set function.....	185
Table 176. dac_dual_data_set function .....	186
Table 177. dac_udr_enable function.....	186
Table 178. dac_udr_flag_get function.....	187
Table 179. dac_udr_interrupt_flag_get function .....	187
Table 180. dac_udr_flag_clear function.....	188
Table 181. dac_reference_voltage_select function .....	188
Table 182. dac_output_enable function.....	189
Table 183. Summary of DEBUG registers.....	190
Table 184. Summary of DEBUG library functions .....	190
Table 185. debug_device_id_get function .....	190
Table 186. debug_low_power_mode_set function .....	191
Table 187. debug_apb1_periph_mode_set function .....	191
Table 188. debug_apb2_periph_mode_set function .....	192
Table 189. debug_apb3_periph_mode_set function .....	193
Table 190. Summary of DMA registers.....	194
Table 191. Summary of DMA library functions .....	195
Table 192. dma_default_para_init function.....	196
Table 193. dma_init_struct default values .....	196
Table 194. dma_init function.....	197
Table 195. dma_reset function .....	199
Table 196. dma_data_number_set function .....	199
Table 197. dma_data_number_get function .....	200
Table 198. dma_interrupt_enable function .....	200
Table 199. dma_channel_enable function.....	201
Table 200. dma_flag_get function.....	201
Table 201. dma_flag_clear function.....	203
Table 202. dma_flexible_config function .....	204
Table 203. DMAMUX channel request source ID.....	204
Table 204. dmamux_enable function.....	205
Table 205. dmamux_init function .....	206
Table 206. dmamux_sync_default_para_init function .....	206
Table 207. dmamux_sync_init_struct default values .....	206
Table 208. dmamux_sync_config function .....	207
Table 209. dmamux_generator_default_para_init function .....	209

Table 210. dmamux_gen_init_struct default values .....	209
Table 211. dmamux_generator_config function.....	209
Table 212. dmamux_sync_interrupt_enable function.....	211
Table 213. dmamux_generator_interrupt_enable function.....	212
Table 214. dmamux_sync_flag_get function .....	212
Table 215. dmamux_sync_flag_clear function .....	213
Table 216. dmamux_generator_flag_get function .....	214
Table 217. dmamux_generator_flag_clear function .....	215
Table 218. Summary of ERTC registers .....	216
Table 219. Summary of ERTC library functions .....	216
Table 220. ertc_num_to_bcd function.....	218
Table 221. ertc_bcd_to_num function.....	218
Table 222. ertc_write_protect_enable function.....	219
Table 223. ertc_write_protect_disable function .....	219
Table 224. ertc_wait_update function.....	220
Table 225. ertc_wait_flag function .....	220
Table 226. ertc_init_mode_enter function .....	221
Table 227. ertc_init_mode_exit function .....	221
Table 228. ertc_reset function.....	222
Table 229. ertc_divider_set function.....	222
Table 230. ertc_hour_mode_set function .....	223
Table 231. ertc_date_set function.....	223
Table 232. ertc_time_set function.....	224
Table 233. ertc_calendar_get function.....	224
Table 234. ertc_sub_second_get function .....	225
Table 235. ertc_alarm_mask_set function .....	226
Table 236. ertc_alarm_week_date_select function .....	227
Table 237. ertc_alarm_set function.....	228
Table 238. ertc_alarm_sub_second_set function .....	229
Table 239. ertc_alarm_enable function.....	230
Table 240. ertc_alarm_get function .....	230
Table 241. ertc_alarm_sub_second_get function .....	232
Table 242. ertc_wakeup_clock_set function .....	232
Table 243. ertc_wakeup_counter_set function .....	233
Table 244. ertc_wakeup_counter_get function .....	233

Table 245. ertc_wakeup_enable function .....	234
Table 246. ertc_smooth_calibration_config function .....	234
Table 247. ertc_cal_output_select function .....	235
Table 248. ertc_cal_output_enable function .....	235
Table 249. ertc_time_adjust function .....	236
Table 250. ertc_daylight_set function .....	236
Table 251. ertc_daylight_bpr_get function .....	237
Table 252. ertc_refer_clock_detect_enable function .....	237
Table 253. ertc_direct_read_enable function .....	238
Table 254. ertc_output_set function .....	238
Table 255. ertc_timestamp_pin_select function .....	239
Table 256. ertc_timestamp_valid_edge_set function .....	239
Table 257. ertc_timestamp_enable function .....	240
Table 258. ertc_timestamp_get function .....	240
Table 259. ertc_timestamp_sub_second_get function .....	241
Table 260. ertc_tamper_1_pin_select function .....	242
Table 261. ertc_tamper_pull_up_enable function .....	242
Table 262. ertc_tamper_preamble_set function .....	243
Table 263. ertc_tamper_filter_set function .....	243
Table 264. ertc_tamper_detect_freq_set function .....	244
Table 265. ertc_tamper_valid_edge_set function .....	245
Table 266. ertc_tamper_timestamp_enable function .....	245
Table 267. ertc_tamper_enable function .....	246
Table 268. ertc_interrupt_enable function .....	246
Table 269. ertc_interrupt_get function .....	247
Table 270. ertc_flag_get function .....	247
Table 271. ertc_interrupt_flag_get function .....	248
Table 272. ertc_flag_clear function .....	249
Table 273. ertc_bpr_data_write function .....	249
Table 274. ertc_bpr_data_read function .....	250
Table 275. Summary of EXINT registers .....	251
Table 276. Summary of EXINT library functions .....	251
Table 277. exint_reset function .....	252
Table 278. exint_default_para_init function .....	252
Table 279. exint_init function .....	253

Table 280. exint_flag_clear function .....	254
Table 281. exint_flag_get function .....	254
Table 282. exint_interrupt_flag_get function.....	255
Table 283. exint_software_interrupt_event_generate function .....	255
Table 284. exint_interrupt_enable function.....	256
Table 285. exint_event_enable function .....	256
Table 286. Summary of FLASH registers .....	257
Table 287. Summary of FLASH library functions.....	258
Table 288. flash_flag_get function .....	259
Table 289. flash_flag_clear function .....	260
Table 290. flash_operation_status_get function.....	260
Table 291. flash_operation_wait_for function .....	261
Table 292. flash_unlock function .....	261
Table 293. flash_lock function.....	262
Table 294. flash_sector_erase function .....	262
Table 295. flash_internal_all_erase function .....	263
Table 296. flash_user_system_data_erase function .....	263
Table 297. flash_word_program function .....	264
Table 298. flash_halfword_program function.....	264
Table 299. flash_byte_program function.....	265
Table 300. flash_user_system_data_program function.....	266
Table 301. flash_epp_set function .....	266
Table 302. flash_epp_status_get function .....	267
Table 303. flash_fap_enable function.....	267
Table 304. flash_fap_status_get function .....	268
Table 305. flash_fap_high_level_enable function.....	268
Table 306. flash_fap_high_level_status_get function.....	269
Table 307. flash(ssb)_set function .....	269
Table 308. flash(ssb)_status_get function .....	270
Table 309. flash_interrupt_enable function.....	271
Table 310. flash_slib_enable function.....	271
Table 311. flash_slib_disable function .....	272
Table 312. flash_slib_state_get function .....	272
Table 313. flash_slib_start_sector_get function .....	273
Table 314. flash_slib_inststart_sector_get function.....	273

Table 315. flash_slib_end_sector_get function .....	274
Table 316. flash_crc_calibrate function .....	274
Table 317. flash_boot_memory_extension_mode_enable.....	275
Table 318. flash_extension_memory_slib_enable .....	275
Table 319. flash_extension_memory_slib_state_get .....	276
Table 320. flash_em_slib_inststart_sector_get .....	276
Table 321. Summary of GPIO registers.....	277
Table 322. GPIO and IOMUX library functions.....	277
Table 323. gpio_reset function.....	278
Table 324. gpio_init function .....	278
Table 325. gpio_default_para_init function .....	280
Table 326. gpio_init_struct default values .....	280
Table 327. gpio_input_data_bit_read function.....	280
Table 328. gpio_input_data_read function .....	281
Table 329. gpio_output_data_bit_read function .....	281
Table 330. gpio_output_data_read function .....	282
Table 331. gpio_bits_set function .....	282
Table 332. gpio_bits_reset function .....	283
Table 333. gpio_bits_write function .....	283
Table 334. gpio_bits_write function .....	284
Table 335. gpio_port_write function.....	284
Table 336. gpio_pin_wp_config function .....	285
Table 337. gpio_pins_huge_driven_config function .....	285
Table 338. gpio_pin_mux_config function .....	286
Table 339. Summary of I2C register .....	288
Table 340. Summary of I2C library functions.....	288
Table 341. I2C application-layer library functions.....	289
Table 342. i2c_reset function .....	290
Table 343. i2c_init function .....	291
Table 344. i2c_own_address1_set function .....	291
Table 345. i2c_own_address2_set function .....	292
Table 346. i2c_own_address2_enable function .....	292
Table 347. i2c_smbus_enable function .....	293
Table 348. i2c_enable function .....	294
Table 349. i2c_clock_stretch_enable function.....	294

Table 350. i2c_ack_enable function .....	295
Table 351. i2c_addr10_mode_enable function.....	295
Table 352. i2c_transfer_addr_set function .....	296
Table 353. i2c_transfer_addr_get function .....	296
Table 354. i2c_transfer_dir_set function.....	297
Table 355. i2c_transfer_dir_get function.....	297
Table 356. i2c_matched_addr_get function.....	298
Table 357. i2c_auto_stop_enable function.....	298
Table 358. i2c_reload_enable function.....	299
Table 359. i2c_cnt_set function .....	299
Table 360. i2c_addr10_header_enable function .....	300
Table 361. i2c_general_call_enable function .....	300
Table 362. i2c_smbus_alert_set function .....	301
Table 363. i2c_start_generate function.....	301
Table 364. i2c_pec_calculate_enable.....	302
Table 365. i2c_pec_transmit_enable function .....	302
Table 366. i2c_pec_value_get function .....	303
Table 367. i2c_timeout_set function .....	303
Table 368. i2c_timeout_detcet_set function .....	304
Table 369. i2c_timeout_enable function .....	304
Table 370. i2c_ext_timeout_set function .....	305
Table 371. i2c_ext_timeout_enable function .....	305
Table 372. i2c_interrupt_enable function.....	306
Table 373. i2c_interrupt_get function.....	307
Table 374. i2c_dma_enable function .....	307
Table 375. i2c_transmit_set function .....	308
Table 376. i2c_slave_transmit function.....	309
Table 377. i2c_stop_generate function.....	309
Table 378. i2c_data_send function .....	310
Table 379. i2c_data_receive function .....	310
Table 380. i2c_flag_get function .....	311
Table 381. i2c_interrupt_flag_get function.....	312
Table 382. i2c_flag_clear function .....	313
Table 383. i2c_config function .....	314
Table 384. i2c_lowlevel_init function .....	316

Table 385. i2c_wait_end function .....	316
Table 386. i2c_wait_flag function.....	317
Table 387. i2c_master_transmit function.....	318
Table 388. i2c_master_receivefunction .....	319
Table 389. i2c_slave_transmit function.....	320
Table 390. i2c_slave_receive function.....	320
Table 391. i2c_master_transmit_int function .....	321
Table 392. i2c_master_receive_int function .....	322
Table 393. i2c_master_receive_int function .....	322
Table 394. i2c_master_receive_int function .....	323
Table 395. i2c_master_transmit_dma function.....	324
Table 396. i2c_master_receive_dma function.....	325
Table 397. i2c_slave_transmit_dma function .....	325
Table 398. i2c_slave_transmit_dma function .....	326
Table 399. i2c_smbus_master_transmit function .....	326
Table 400. i2c_smbus_master_receive function .....	327
Table 401. i2c_smbus_slave_transmit function.....	328
Table 402. i2c_smbus_slave_receive function .....	329
Table 403. i2c_memory_write function .....	329
Table 404. i2c_memory_write_int function .....	330
Table 405. i2c_memory_write_dma function .....	331
Table 406. i2c_memory_write_dma function .....	332
Table 407. i2c_memory_write_dma function .....	333
Table 408. i2c_memory_write_dma function .....	334
Table 409. i2c_evt_irq_handler function .....	335
Table 410. i2c_err_irq_handler function .....	335
Table 411. i2c_dma_tx_irq_handler function .....	336
Table 412. i2c_dma_rx_irq_handler function.....	336
Table 413. Summary of PWC registers .....	337
Table 414. Summary of PWC library functions.....	337
Table 415. nvic_system_reset function.....	338
Table 416. nvic_irq_enable function .....	338
Table 417. nvic_irq_disable function.....	339
Table 418. nvic_priority_group_config function .....	339
Table 419. nvic_vector_table_set function .....	340

Table 420. nvic_lowpower_mode_config function .....	341
Table 421. Summary of OP registers.....	342
Table 422. Summary of OP library functions .....	342
Table 423. op_enable function.....	343
Table 424. op_set_mode function.....	343
Table 425. op_set_functional_modefunction .....	344
Table 426. op_set_gain function .....	344
Table 427. op_set_highspeed_mode function.....	345
Table 428. op_set_input_non_inverting function .....	345
Table 429. op_set_input_inverting function .....	346
Table 430. op_input_non_inverting_switch function.....	346
Table 430. op_input_inverting_switch function.....	347
Table 432. op_input_mux_enable function.....	347
Table 433. op_internal_output_select function .....	348
Table 434. op_set_trimming_mode function.....	348
Table 435. op_calibration_select function .....	349
Table 436. op_calout_status_get function .....	350
Table 437. op_set_trimming_value function .....	350
Table 438. op_wpc_enable function .....	351
Table 439. Summary of PWC registers .....	352
Table 440. Summary of PWC library functions .....	352
Table 441. pwc_reset function .....	353
Table 442. pwc_batteryPowered_domain_access function.....	353
Table 443. pwc_pvm_level_select function .....	354
Table 444. pwc_power_voltage_monitor_enable function .....	354
Table 445. pwc_wakeup_pin_polarity_select function .....	355
Table 446. pwc_wakeup_pin_enable function.....	356
Table 447. pwc_flag_clear function .....	356
Table 448. pwc_flag_get function .....	357
Table 449. pwc_sleep_mode_enter function .....	357
Table 450. pwc_deep_sleep_mode_enter function .....	358
Table 451. pwc_voltage_regulate_set function .....	358
Table 452. pwc_ldo_output_voltage_set function.....	359
Table 453. pwc_standby_mode_enter function .....	360
Table 454. Summary of SCFG registers.....	361

Table 455. Summary of SCFG library functions .....	361
Table 456. scfg_reset function.....	362
Table 457. scfg_infrared_config function.....	362
Table 458. scfg_mem_map_get function.....	363
Table 459. scfg_pa11pa12_pin_remap function.....	363
Table 460. scfg_adc_dma_channel_remap function.....	364
Table 461. scfg_usart1_tx_dma_channel_remap function.....	364
Table 462. scfg_can_timestamp_source_set function .....	365
Table 463. scfg_exint_line_config function.....	365
Table 464. scfg_pins_ultra_driven_enable function .....	366
Table 465. scfg_nrst_rmp_config function.....	367
Table 466. Summary of SPI registers .....	368
Table 467. Summary of SPI library functions .....	368
Table 468. spi_i2s_reset function .....	369
Table 469. spi_default_para_init function .....	369
Table 470. spi_init function .....	370
Table 471. spi_ti_mode_enable function .....	372
Table 472. spi_crc_next_transmit function .....	372
Table 473. spi_crc_polynomial_set function.....	373
Table 474. spi_crc_polynomial_get function.....	373
Table 475. spi_crc_enable function .....	374
Table 476. spi_crc_value_get function .....	374
Table 477. spi_hardware_cs_output_enable function .....	375
Table 478. spi_software_cs_internal_level_set function .....	375
Table 479. spi_frame_bit_num_set function .....	376
Table 480. spi_half_duplex_direction_set function.....	376
Table 481. spi_enable function .....	377
Table 482. i2s_default_para_init function .....	377
Table 483. i2s_init function .....	378
Table 484. i2s_enable function .....	379
Table 485. spi_i2s_interrupt_enable function .....	380
Table 486. spi_i2s_dma_transmitter_enable function .....	380
Table 487. spi_i2s_dma_receiver_enable function .....	381
Table 488. spi_i2s_data_transmit function .....	381
Table 489. spi_i2s_data_receive function .....	382

Table 490. spi_i2s_flag_get function .....	382
Table 491. spi_i2s_interrupt_flag_get function .....	383
Table 492. spi_i2s_flag_clear function.....	384
Table 493. Summary of SysTick registers .....	385
Table 494. Summary of SysTick library functions.....	385
Table 495. systick_clock_source_config function.....	385
Table 496. SysTick_Config function.....	386
Table 497. Summary of TMR registers .....	387
Table 498. Summary of TMR library functions .....	388
Table 499. tmr_reset function .....	390
Table 500. tmr_counter_enable function .....	390
Table 501. tmr_output_default_para_init function .....	391
Table 502. tmr_output_struct default values.....	391
Table 503. tmr_input_default_para_init function.....	391
Table 504. tmr_input_struct default values .....	392
Table 505. tmr_brkdt_default_para_init function .....	392
Table 506. tmr_brkdt_struct default values.....	392
Table 507. tmr_blk_default_para_init function.....	393
Table 508. tmr_brkdt_struct default values.....	393
Table 509. tmr_base_init function.....	393
Table 510. tmr_clock_source_div_set function.....	394
Table 511. tmr_cnt_dir_set function.....	394
Table 512. tmr_cnt_dir_get function .....	395
Table 513. tmr_repetition_counter_set function .....	395
Table 514. tmr_counter_value_set function.....	396
Table 515. tmr_counter_value_get function .....	396
Table 516. tmr_div_value_set function .....	397
Table 517. tmr_div_value_get function .....	397
Table 518. tmr_output_channel_config function.....	398
Table 519. tmr_output_channel_mode_select function.....	400
Table 520. tmr_period_value_set function.....	401
Table 521. tmr_period_value_get function .....	401
Table 522. tmr_channel_value_set function .....	402
Table 523. tmr_channel_value_get function .....	403
Table 524. tmr_period_buffer_enable function .....	403

Table 492. tmr_output_channel_buffer_enable function .....	404
Table 526. tmr_output_channel_immediately_set function .....	405
Table 527. tmr_output_channel_switch_set function .....	406
Table 528. tmr_one_cycle_mode_enable function.....	406
Table 529. tmr_overflow_request_source_set function.....	407
Table 530. tmr_overflow_event_disable function .....	408
Table 531. tmr_input_channel_init function.....	408
Table 532. tmr_channel_enable function.....	410
Table 533. tmr_input_channel_filter_set function.....	411
Table 534. tmr_pwm_input_config function .....	411
Table 535. tmr_channel1_input_select function .....	412
Table 536. tmr_input_channel_divider_set function .....	413
Table 537. tmr_primary_mode_select function.....	414
Table 538. tmr_sub_mode_select function.....	415
Table 539. tmr_channel_dma_select function .....	416
Table 540. tmr_hall_select function .....	416
Table 541. tmr_channel_buffer_enable function .....	417
Table 542. tmr_trgout2_enable function .....	417
Table 543. tmr_trigger_input_select function.....	418
Table 544. tmr_sub_sync_mode_set function .....	418
Table 545. tmr_dma_request_enable function .....	419
Table 546. tmr_interrupt_enable function .....	419
Table 547. tmr_interrupt_flag_get function .....	420
Table 548. tmr_flag_get function .....	421
Table 549. tmr_flag_clear function.....	422
Table 550. tmr_event_sw_trigger function.....	422
Table 551. tmr_output_enable function .....	423
Table 552. tmr_internal_clock_set function .....	423
Table 553. tmr_output_channel_polarity_set function.....	424
Table 554. tmr_external_clock_enable function .....	425
Table 555. tmr_external_clock_config function .....	425
Table 556. tmr_external_clock_mode1_config function .....	426
Table 557. tmr_external_clock_mode2_config function .....	427
Table 558. tmr_encoder_mode_config function .....	428
Table 559. tmr_force_output_set function .....	429

Table 560. tmr_dma_control_config function.....	430
Table 561. tmr_brkdt_config function.....	431
Table 562. tmr_brk_filter_value_set function.....	433
Table 563. tmr_brk2_config function.....	433
Table 564. tmr_input_channel_blk_config function .....	434
Table 565. tmr_overflow_flag_remap function.....	435
Table 566. tmr_primary_mode2_select function.....	436
Table 567. tmr_coraw_clear_set function.....	437
Table 568. tmr_overflow_cpy_get function .....	437
Table 569. tmr_brk_bidir_enable function .....	438
Table 570. tmr_brk_release function .....	439
Table 571. tmr_brk_release_check function.....	439
Table 572. tmr_ch5_combined_set function.....	440
Table 573. tmr_brk_input_config function.....	440
Table 574. tmr_external_source_select function.....	441
Table 575. tmr_input_ch_select function .....	442
Table 576. tmr_iasym_mode_enable function.....	444
Table 577. Summary of USART registers.....	445
Table 578. Summary of USART library functions .....	445
Table 579. usart_reset function .....	446
Table 580. usart_init function .....	447
Table 581. usart_parity_selection_config function .....	448
Table 582. usart_enable function.....	448
Table 583. usart_transmitter_enable function .....	449
Table 584. usart_receiver_enable function.....	449
Table 585. usart_clock_config function.....	450
Table 586. usart_clock_enable function .....	451
Table 587. usart_interrupt_enable function .....	451
Table 588. usart_dma_transmitter_enable function .....	452
Table 589. usart_dma_receiver_enable function.....	452
Table 590. usart_wakeup_id_set function .....	453
Table 591. usart_wakeup_mode_set function .....	453
Table 592. usart_receiver_mute_enable function.....	454
Table 593. usart_break_bit_num_set function.....	454
Table 548. usart_lin_mode_enable function.....	455

Table 595. usart_data_transmit function.....	455
Table 596. usart_data_receive function.....	456
Table 597. usart_break_send function.....	456
Table 598. usart_smartcard_guard_time_set function .....	457
Table 599. usart_irda_smartcard_division_set function .....	457
Table 600. usart_smartcard_mode_enable function .....	458
Table 601. usart_smartcard_nack_set function.....	458
Table 602. usart_single_line_halfduplex_select function .....	459
Table 603. usart_irda_mode_enable function .....	459
Table 604. usart_irda_low_power_enable function .....	460
Table 605. usart_hardware_flow_control_set function .....	460
Table 606. usart_flag_get function.....	461
Table 607. usart_interrupt_flag_get function .....	462
Table 608. usart_flag_clear function.....	463
Table 609. usart_flag_clear function.....	463
Table 610. usart_transmit_receive_pin_swap function .....	464
Table 611. usart_transmit_receive_pin_swap function.....	464
Table 612. usart_de_polarity_set function.....	465
Table 613. usart_rs485_mode_enable function .....	465
Table 614. usart_msb_transmit_first_enable function.....	466
Table 615. usart_dt_polarity_reverse function.....	466
Table 616. usart_dt_polarity_reverse function.....	467
Table 617. usart_receive_pin_polarity_reverse function .....	467
Table 618. usart_receiver_timeout_detection_enable function .....	468
Table 619. usart_receiver_timeout_value_set function .....	468
Table 620. Summary of WDT registers.....	469
Table 621. Summary of WDT library functions .....	469
Table 622. wdt_enable function .....	470
Table 623. wdt_counter_reload function.....	470
Table 624. wdt_reload_value_set function .....	471
Table 625. wdt_divider_set function .....	471
Table 626. wdt_register_write_enable function .....	472
Table 627. wdt_flag_get function .....	472
Table 628. wdt_window_counter_set function .....	473
Table 629. Summary of WWDT registers .....	474

Table 630. Summary of WWDT library functions.....	474
Table 631. wwdt_reset function .....	475
Table 632. wwdt_divider_set function.....	475
Table 633. wwdt_enable function .....	476
Table 634. wwdt_interrupt_enable function.....	476
Table 635. wwdt_counter_set function .....	476
Table 636. wwdt_window_counter_set function .....	477
Table 637. wwdt_flag_get function .....	477
Table 638. wwdt_interrupt_flag_get function .....	478
Table 639. wwdt_flag_clear function.....	478
Table 640. Summary of CMP registers.....	479
Table 641. Summary of CMP library functions .....	479
Table 642. cmp_init function .....	480
Table 643. cmp_default_para_init function.....	481
Table 644. cmp_init_type default values.....	481
Table 645. cmp_enable function.....	482
Table 646. cmp_output_value_get function.....	482
Table 647. cmp_write_protect_enable function .....	483
Table 648. cmp_filter_config function .....	483
Table 649. cmp_blinking_config function .....	484
Table 650. Clock configuration guideline .....	491
Table 651. Document revision history.....	492

## List of figures

Figure 1. Pack kit .....	43
Figure 2. IAR Pack installation window .....	43
Figure 3. IAR Pack installation window .....	44
Figure 4. View IAR Pack installation status .....	44
Figure 5. View Keil_v5 Pack installation status .....	45
Figure 6. Keil_v4 Pack installation.....	46
Figure 7. Keil_v4 Pack installation process .....	47
Figure 8. Keil_v4 Pack installation complete .....	47
Figure 9. View Keil_v4 Pack installation status .....	48
Figure 10. Segger pack installation window .....	49
Figure 11. Segger pack installation process.....	49
Figure 12. Open J-Flash .....	50
Figure 13. Create a new project using J-Flash.....	50
Figure 14. View Device information.....	50
Figure 15. Keil algorithm file settings.....	51
Figure 16. Keil algorithm file configuration .....	52
Figure 17. Select algorithm files using Keil .....	52
Figure 18. Add algorithm files using Keil .....	53
Figure 19. IAR project name.....	53
Figure 20. IAR algorithm file configuration .....	54
Figure 21. IAR Flash Loader overview .....	54
Figure 22. IAR Flash Loader configuration.....	55
Figure 23. IAR Flash Loader configuration success .....	55
Figure 24. Template content .....	56
Figure 25. Keil_v5 template project example .....	56
Figure 26. Peripheral enable macro definitions.....	58
Figure 27. BSP folder structure .....	62
Figure 28. BSP function library structure .....	63
Figure 29. Change device part number in Keil .....	485
Figure 30. Change macro definition in Keil .....	486
Figure 31. Change device part number in IAR .....	487
Figure 32. Change macro definition in IAR .....	488
Figure 33. Error warning 1 .....	488
Figure 34. Error warning 2 .....	488

Figure 35. Error warning 3 .....	489
Figure 36. JLinkLog and JLinkSettings.....	489
Figure 37. Unspecified Cortex-M4 .....	489
Figure 38. AT32_New_Clock_Configuration window .....	490

## 1 Overview

In order to help users make efficient use of Artery MCU, we provide a complete set of BSP & Pack tools to speed up development. They include peripheral driver library, core-related documents and application cases as well as Pack documents supporting a variety of development environments such as Keil\_v5, Keil\_v4, IAR\_v6, IAR\_v7 and IAR\_v8. The BSP and Pack are available on Artery official website.

This application note is written to present how to use BSP and Pack.

## 2 How to install Pack

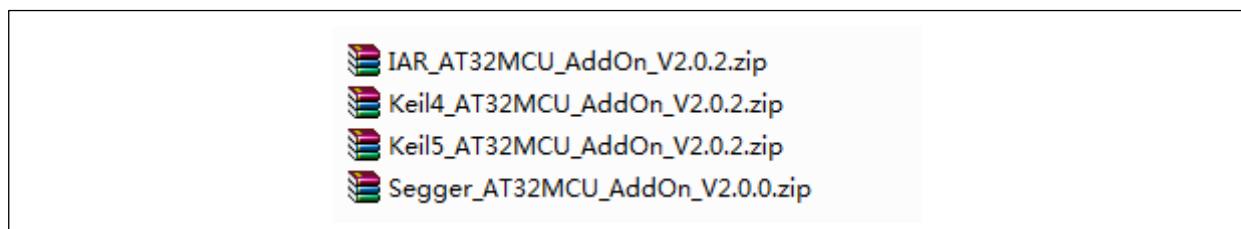
Artery Pack supports various development environment such as Keil\_v5, Keil\_v4, IAR\_v6, IAR\_v7 and IAR\_v8.

Double click on the corresponding Pack to finish installation.

**Note:** This section takes AT32F403A as an example, and other AT32 MCUs have similar Pack installation methods.

The installation package is shown in Figure 1 (the specific version information is subject to the actual conditions).

Figure 1. Pack kit

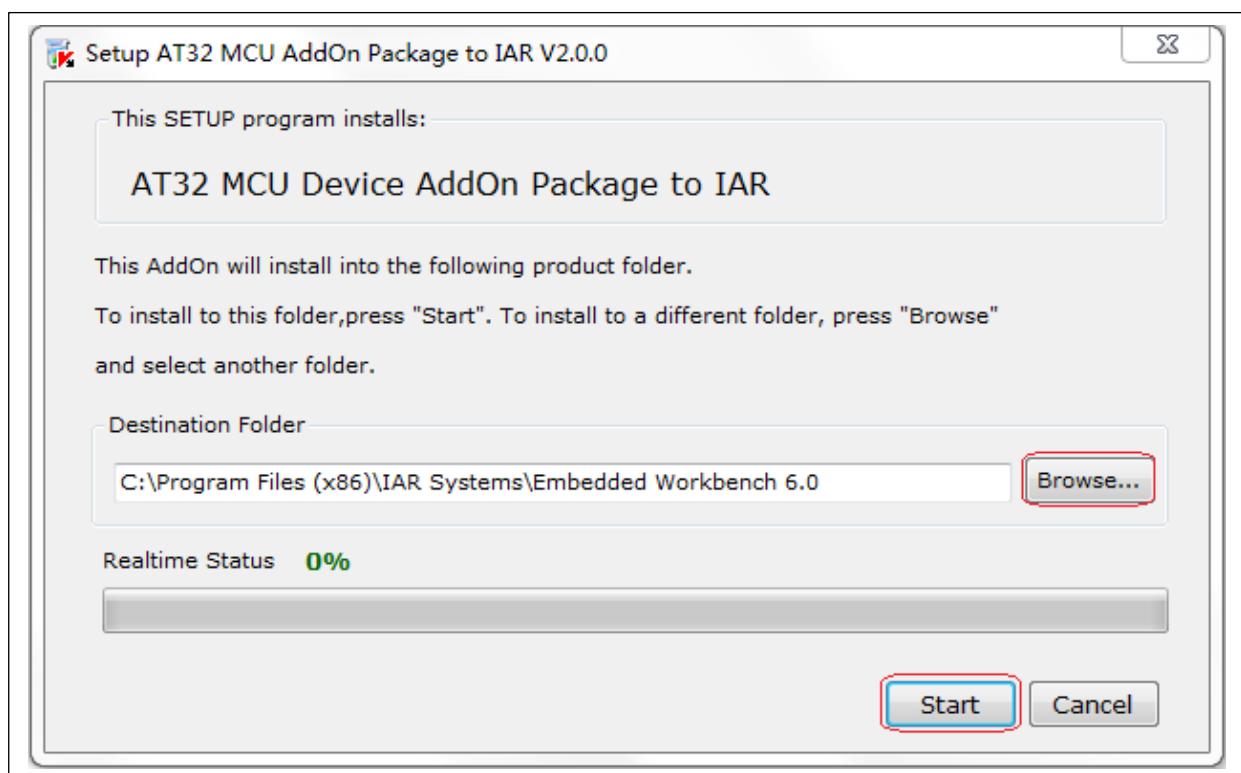


### 2.1 IAR Pack installation

**IAR\_AT32MCU\_AddOn.zip:** This is a zip file supporting IAR\_V6, IAR\_V7 and IAR\_V8. Follow the steps below to install:

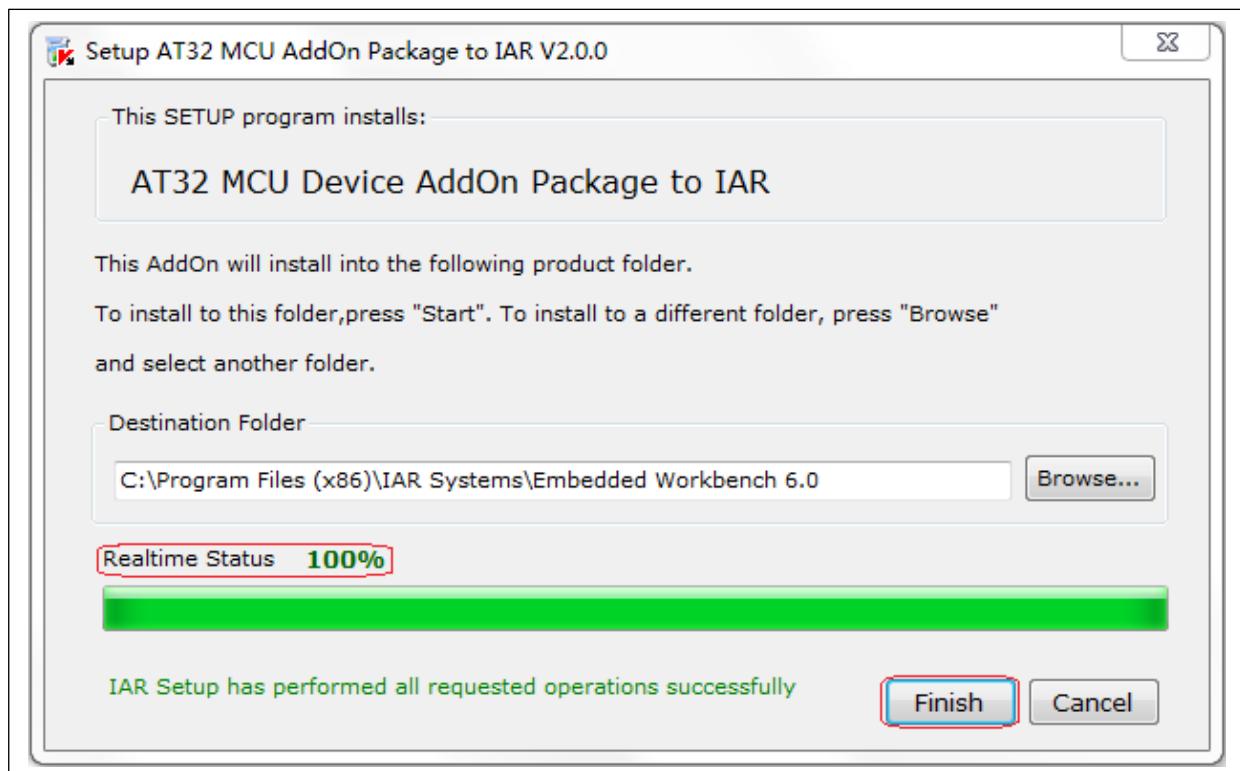
- ① Unzip *IAR\_AT32MCU\_AddOn.zip*;
- ② Double click on *IAR\_AT32MCU\_AddOn.exe*, and a dialog box pops up below (the specific version information is subject to the actual conditions).

Figure 2. IAR Pack installation window



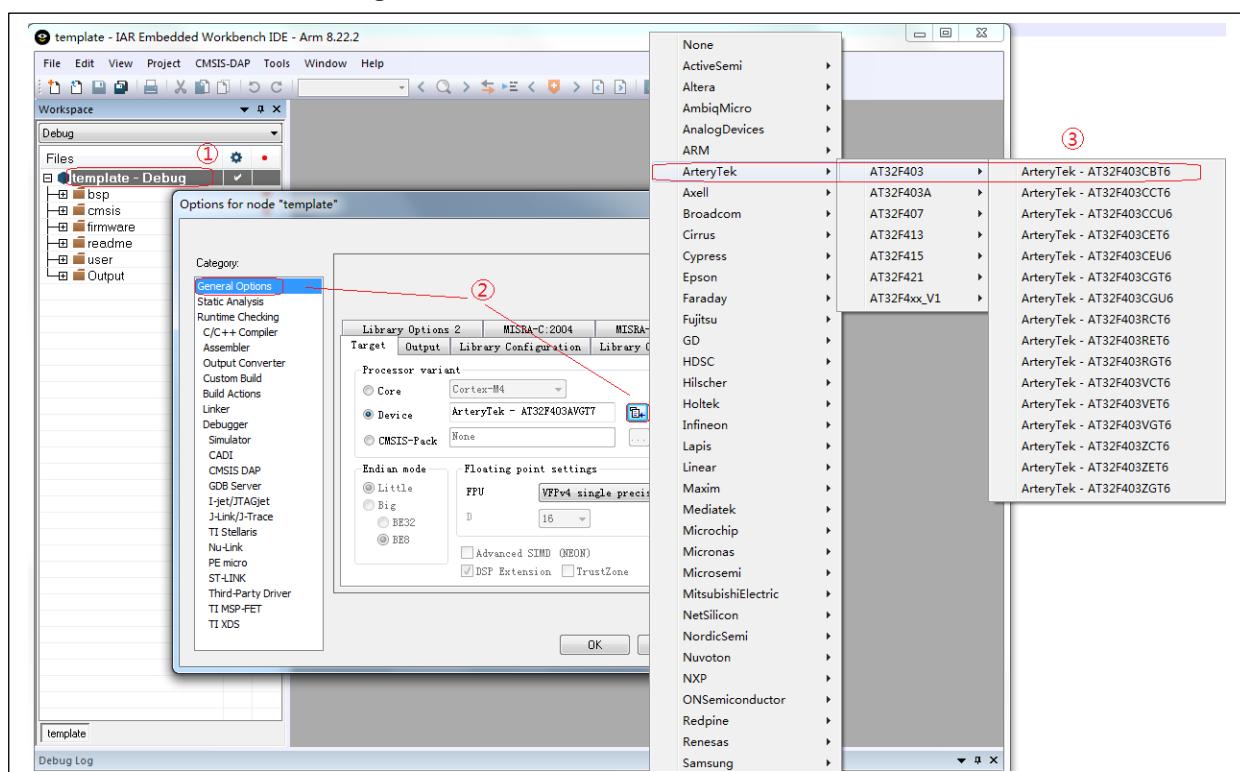
**Note:** If the installation path of IAR does not match the Destination Folder, click on "Browse" to select a correct path, then click on "Start", as shown below.

Figure 3. IAR Pack installation window



- ③ Click on “Finish”;
- ④ To check whether the IAR Pack is installed successfully or not, open an IAR project and follow the steps below:
  - Right click on a project name, and select “Options...”;
  - Select “General Options”, and click on the check box;
  - Click on “ArteryTek” and view AT32 MCU-related information.

Figure 4. View IAR Pack installation status

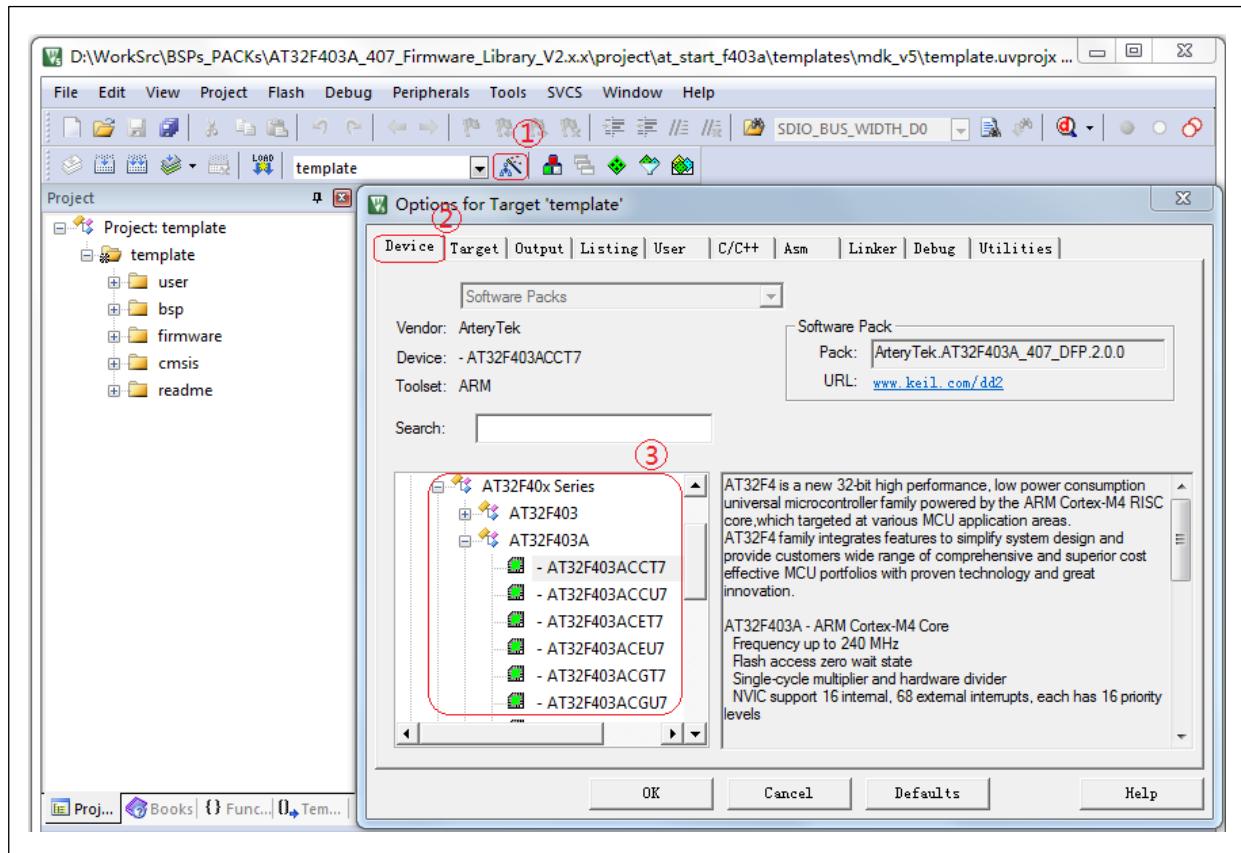


## 2.2 Keil\_v5 Pack installation

**Keil5\_AT32MCU\_AddOn.zip:** This is a zip file supporting Keil\_v5. Follow the steps below to install:

- ① Unzip *Keil5\_AT32MCU\_AddOn.zip*. This zip file includes all Keil5 packs supported, all of which are standard Keil\_v5 DFP installation files.
- ② Select the desired Pack, and double click on *ArteryTek.AT32xxxx\_DFP.2.x.x.pack* to get one-stop installation.
- ⑤ To check whether the Keil\_v5 Pack is installed successfully or not, follow the steps below:
  - Click on wand;
  - Select “Device”;
  - View AT32 MCU-related information.

**Figure 5. View Keil\_v5 Pack installation status**

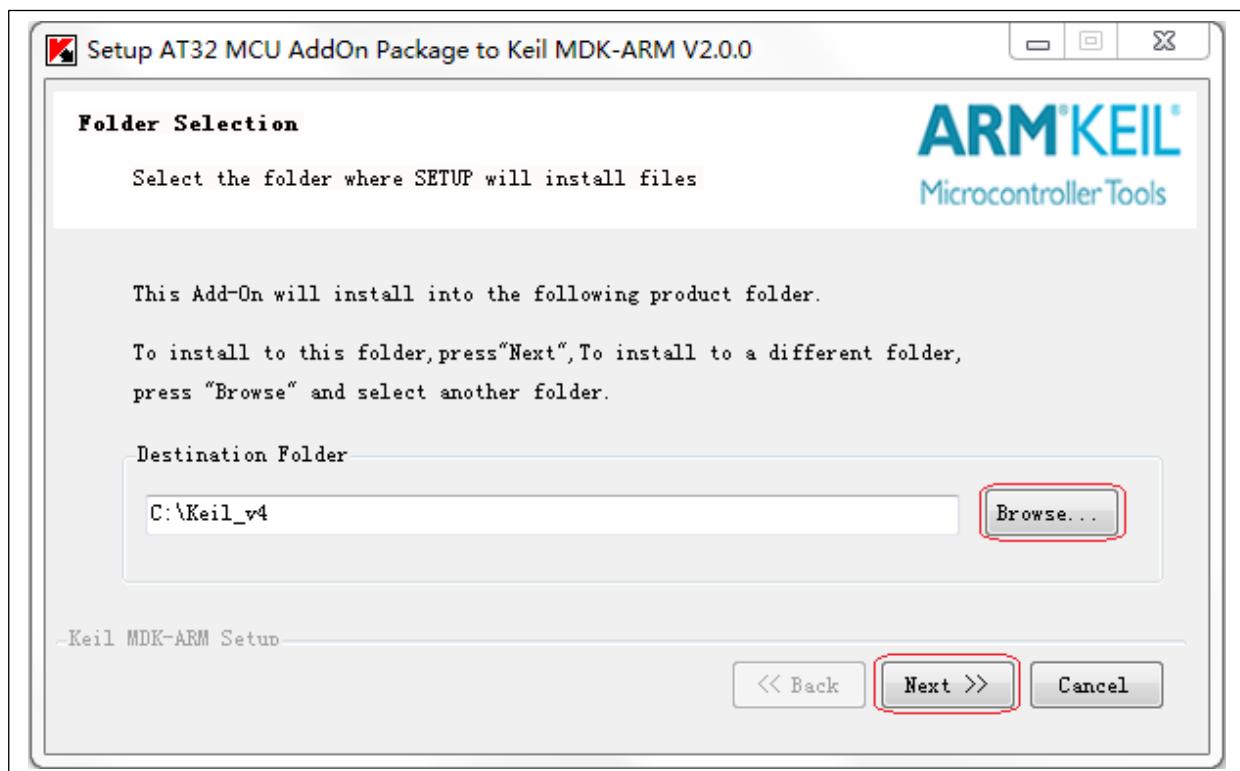


## 2.3 Keil\_v4 Pack installation

**Keil4\_AT32MCU\_AddOn.zip:** This is a zip file supporting Keil\_v4. Follow the steps below to install:

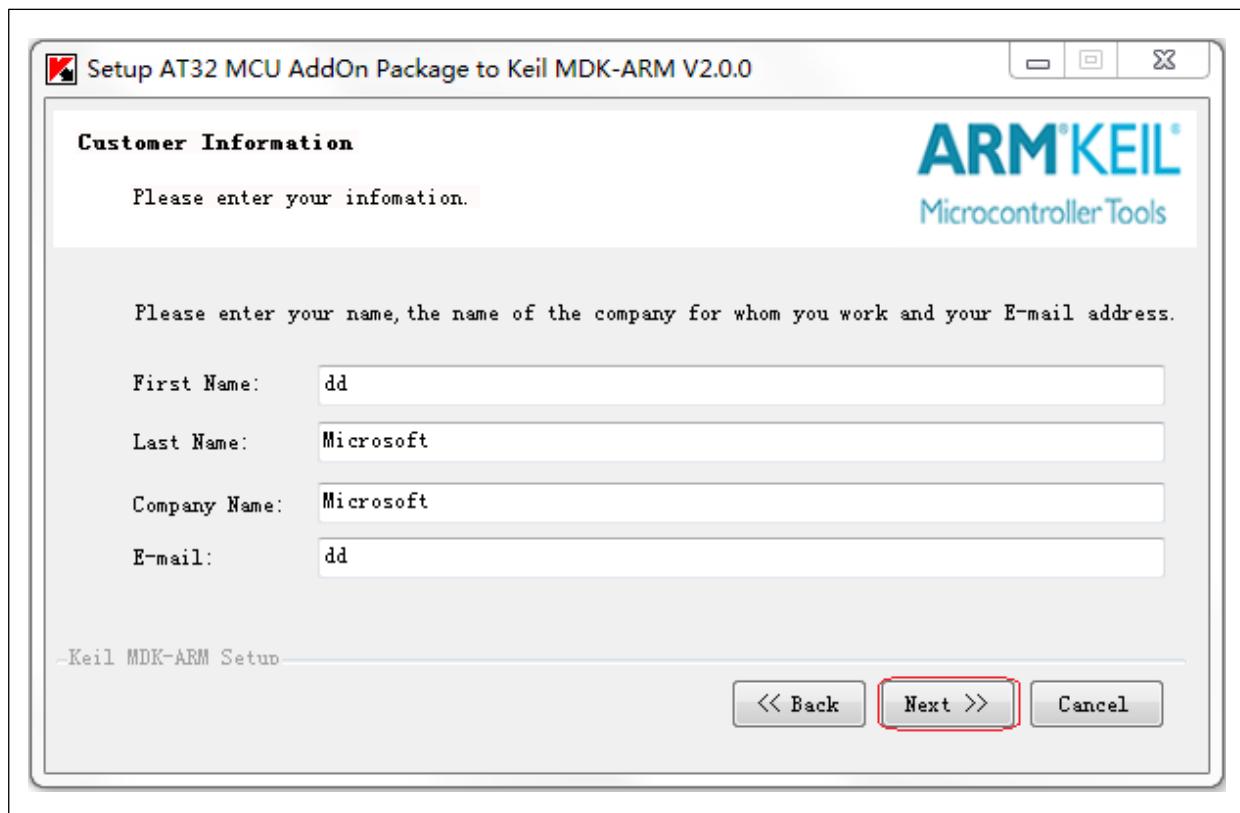
- ① Unzip *Keil4\_AT32MCU\_AddOn.zip*;
- ② Double click on *Keil4\_AT32MCU\_AddOn.exe*, and a dialog box pops up below (the specific version information is subject to the actual conditions).

Figure 6. Keil\_v4 Pack installation



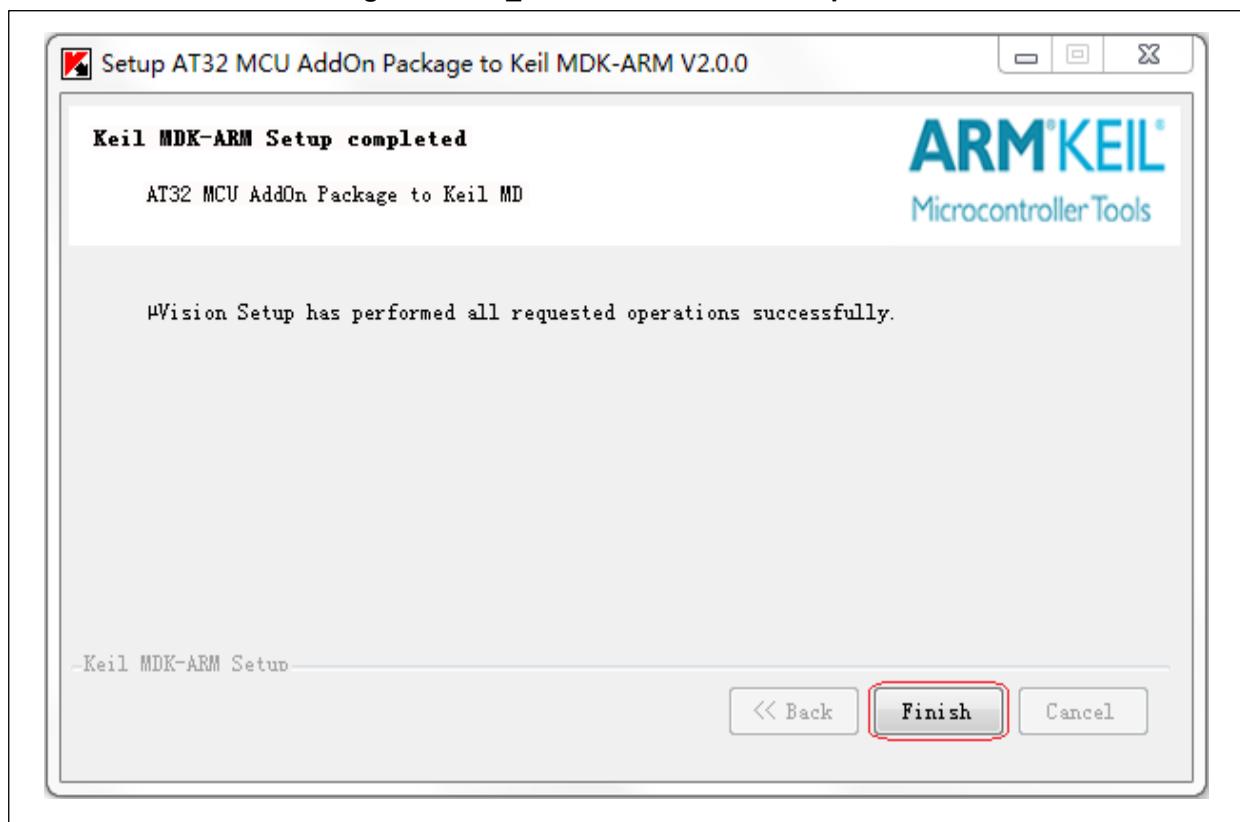
- ③ If the installation path of Keil\_v4 does not match the “Destination Folder”, click on “Browse” to select the actual correct path, then click on “Next”, as shown below.

Figure 7. Keil\_v4 Pack installation process



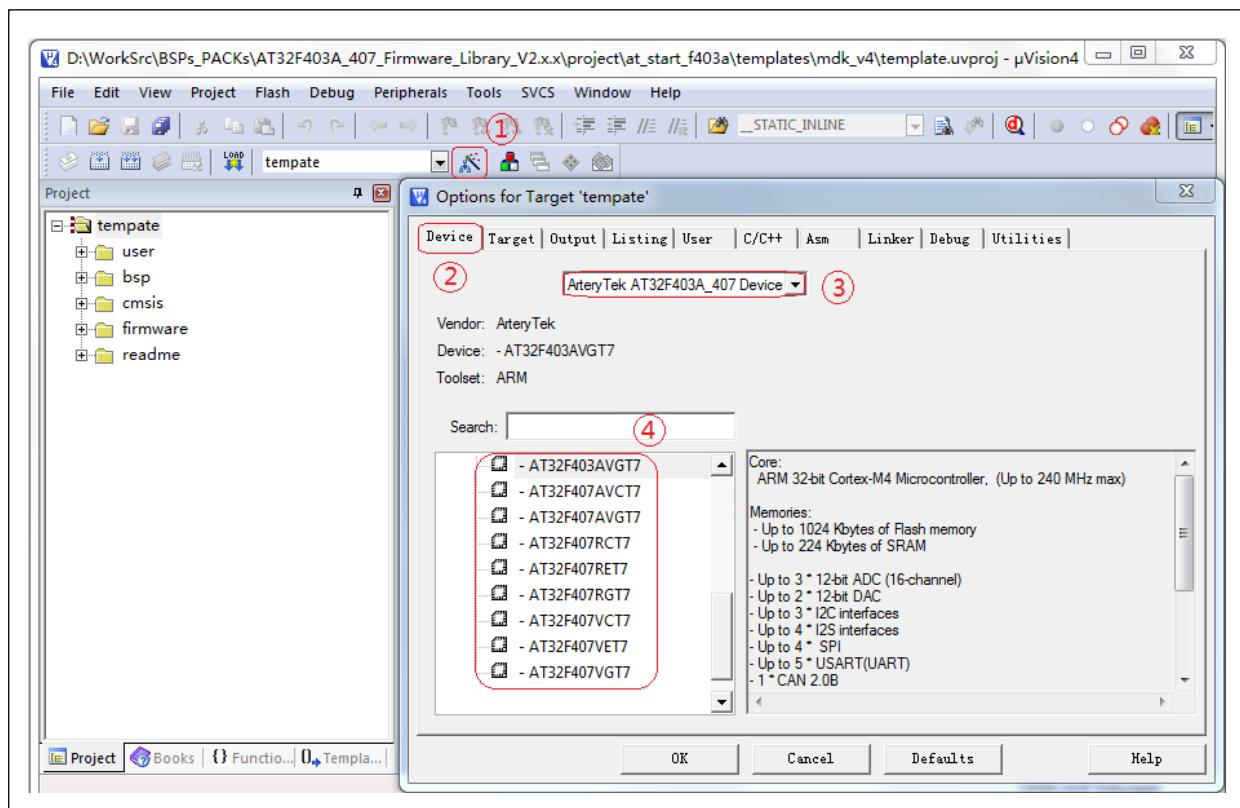
- ④ In the above “Customer Information” window, you can make some changes, but usually it is unnecessary. Then click on “Next” to start installation. The installation result is as follows.

Figure 8. Keil\_v4 Pack installation complete



- ⑤ Click on “Finish”. To check whether Keil\_v4 Pack is installed successfully or not, follow the below steps:
- Click on wand;
  - Select “Device”;
  - Select the desired pack file;
  - View ArteryTek-related information.

Figure 9. View Keil\_v4 Pack installation status

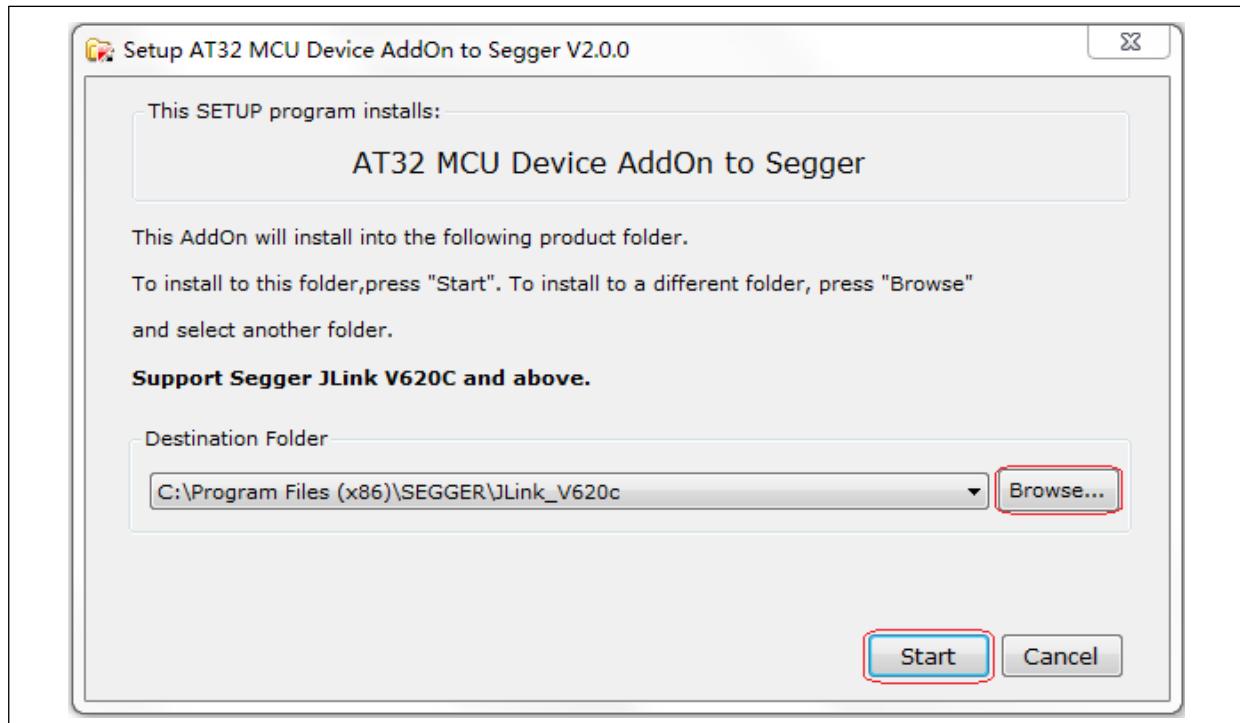


## 2.4 Segger Pack installation

**Segger\_AT32MCU\_AddOn.zip:** This is used to download J-Flash. Follow the steps below to install:

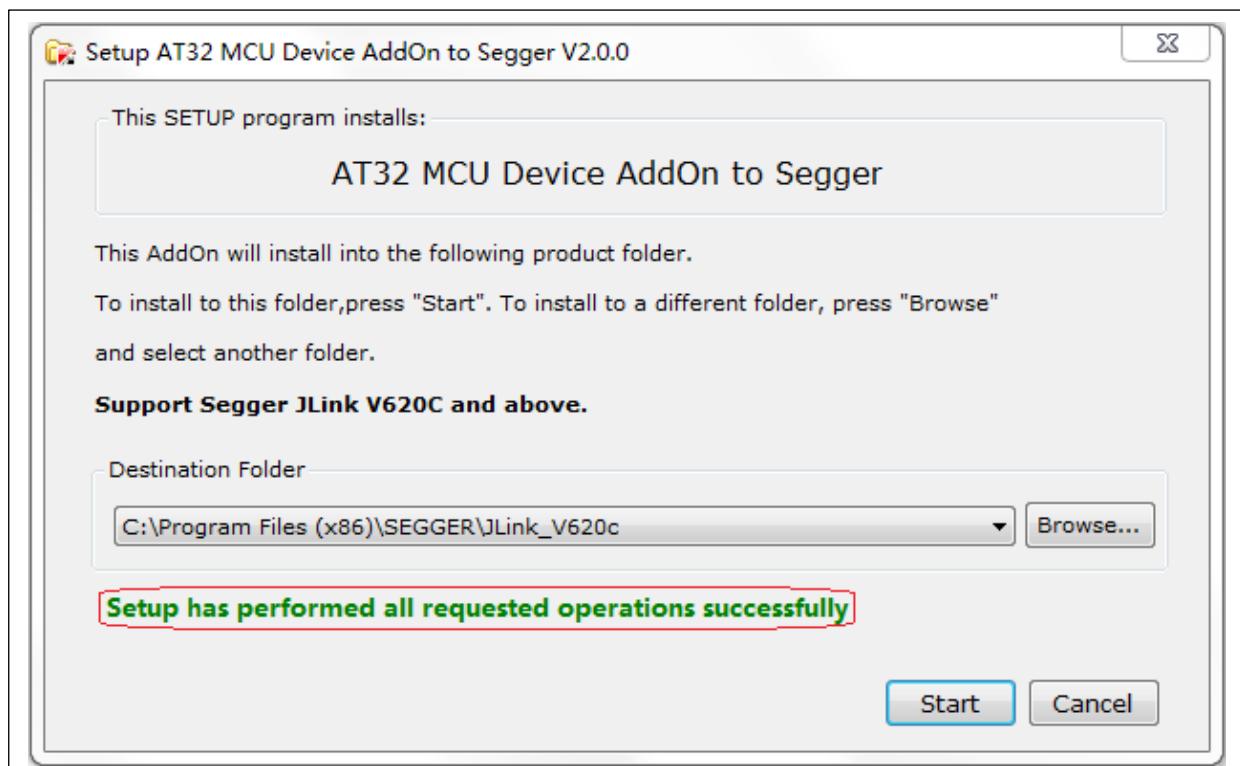
- ① Unzip **Segger\_AT32MCU\_AddOn.zip**;
- ② Double click on **Segger\_AT32MCU\_AddOn.exe**, and a dialog box pops up below (the specific version information is subject to the actual conditions).

Figure 10. Segger pack installation window



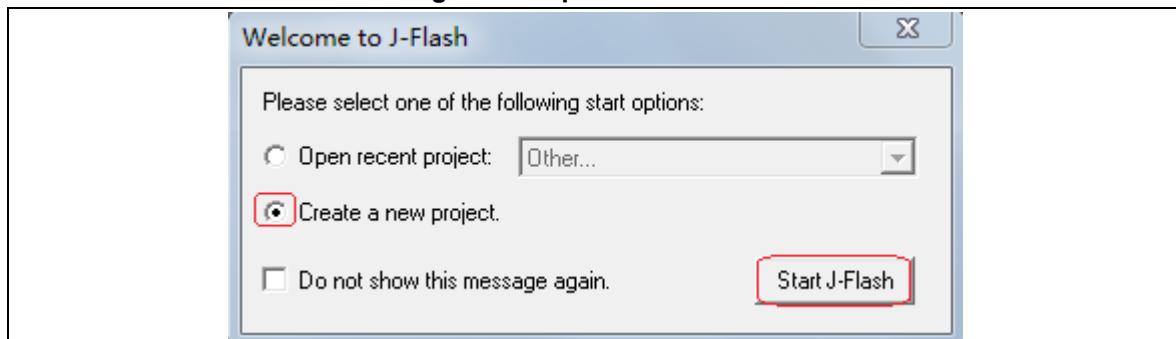
Note: If the installation path of Segger does not match the “Destination Folder”, click on “Browse” to select a correct path, then click on “Start”, as shown below.

Figure 11. Segger pack installation process



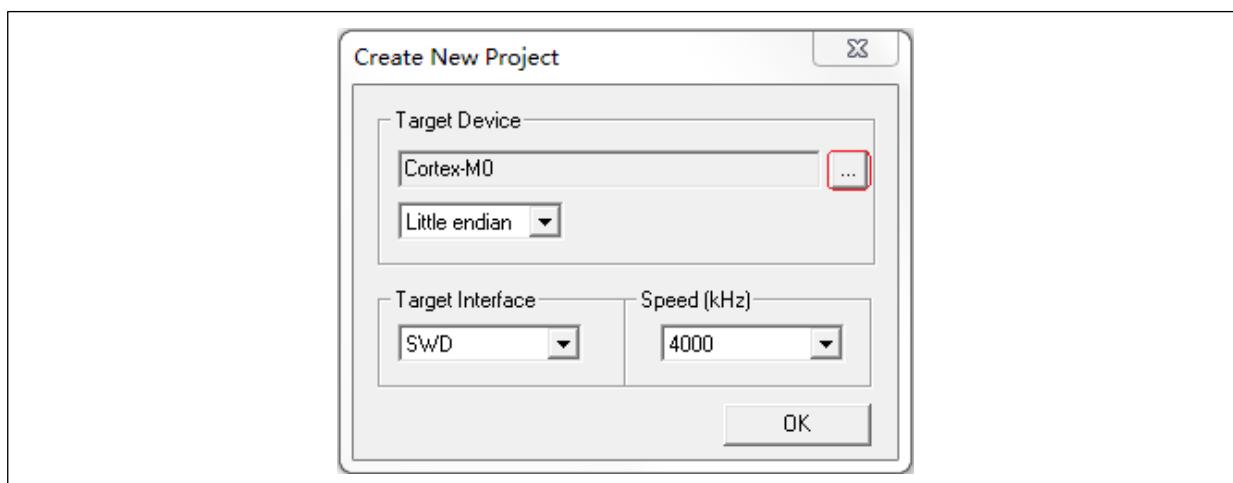
- ③ If the “Setup has performed all requested operations successfully” appears, it indicates successful installation. To check whether the installation is successful or not, follow the steps below:
- Open J-Flash.exe, a dialog box appears; tick “Create a new project” and click on “Start J-Flash”:

Figure 12. Open J-Flash



- After “Start J-Flash”, click on the check box under “Target Device”.

Figure 13. Create a new project using J-Flash



- Drag the scroll bar up and down in the check box. If the ArteryTek-related information and algorithm documents can be found, the installation is successful, as shown below:

Figure 14. View Device information

Select device

Manufacturer	Device	Core	Flash size	RAM size
ArteryTek	AT32F403_EXT_TYPE1_1MB	Cortex-M4	1024 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE1_2MB	Cortex-M4	2048 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE1_4MB	Cortex-M4	4096 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE1_8MB	Cortex-M4	8192 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE2_16MB	Cortex-M4	16 MB	224 KB
ArteryTek	AT32F403_EXT_TYPE2_1MB	Cortex-M4	1024 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE2_2MB	Cortex-M4	2048 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE2_4MB	Cortex-M4	4096 KB	224 KB
ArteryTek	AT32F403_EXT_TYPE2_8MB	Cortex-M4	8192 KB	224 KB
ArteryTek	AT32F403_UNIVERSAL_TYPE1_1...	Cortex-M4	128 KB + 16 MB	224 KB
ArteryTek	AT32F403_UNIVERSAL_TYPE1_2...	Cortex-M4	1024 KB + 16 MB	224 KB
ArteryTek	AT32F403_UNIVERSAL_TYPE2_1...	Cortex-M4	128 KB + 16 MB	224 KB
ArteryTek	AT32F403_UNIVERSAL_TYPE2_2...	Cortex-M4	1024 KB + 16 MB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	16 MB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	1024 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	2048 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	4096 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	8192 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	16 MB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	1024 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	2048 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	4096 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE1_REAMP...	Cortex-M4	8192 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE2_REAMP...	Cortex-M4	16 MB	224 KB
ArteryTek	AT32F403A_EXT_TYPE2_REAMP...	Cortex-M4	1024 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE2_REAMP...	Cortex-M4	2048 KB	224 KB
ArteryTek	AT32F403A_EXT_TYPE2_REAMP...	Cortex-M4	4096 KB	224 KB
ArteryTek	AT32F403A_FXT_TYPE2_RFAMP	Cortex-M4	2048 KB	224 KB

### 3 Flash algorithm file

Flash algorithm files are included in the Pack for online download through IDE tools such as KEIL/IAR. This section describes how to use Flash algorithm files.

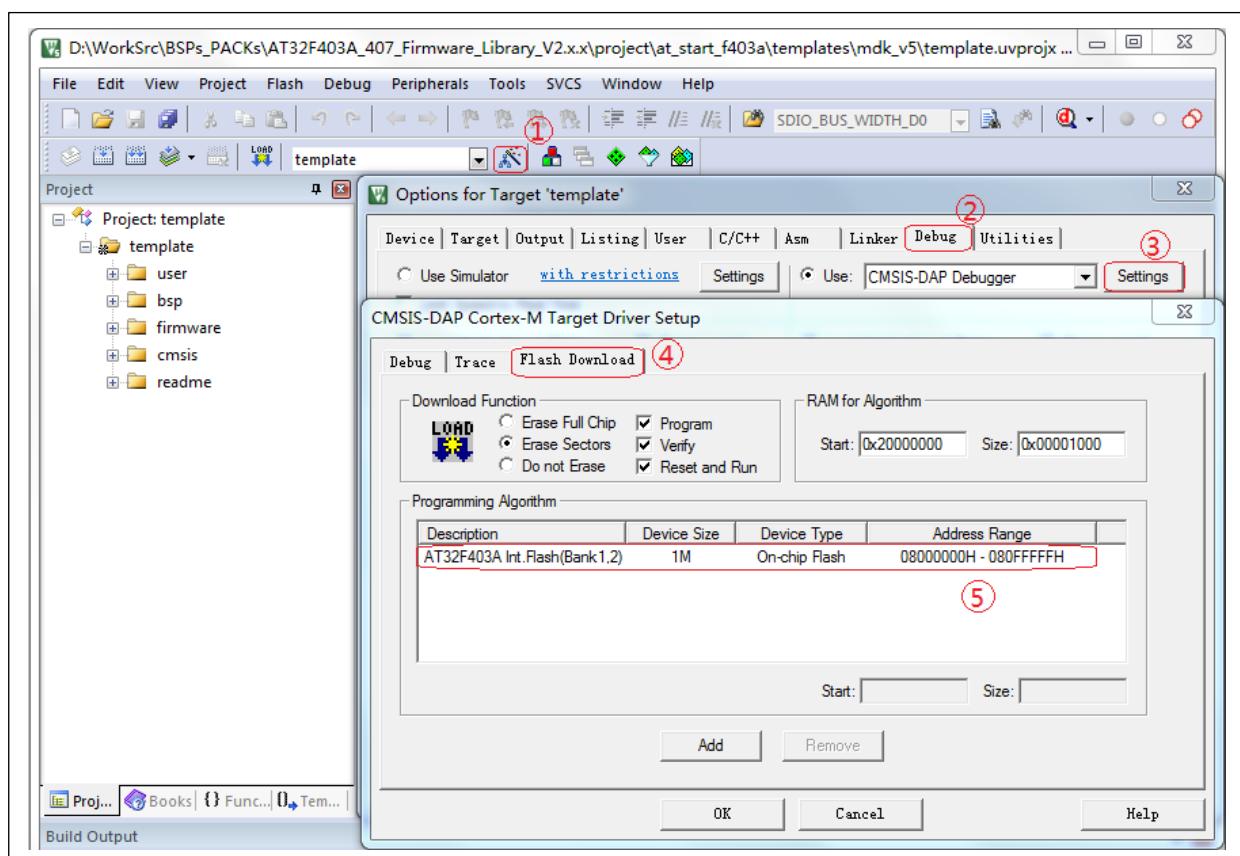
**Note:** AT32 MCUs have similar Flash algorithms, and this section uses AT32F403A as an example.

#### 3.1 How to use Keil algorithm file

Common IDE tools such as Keil\_v4 and Keil\_v5 adopt a similar method to select and use the algorithm files. Here we take Keil\_v5 as an example.

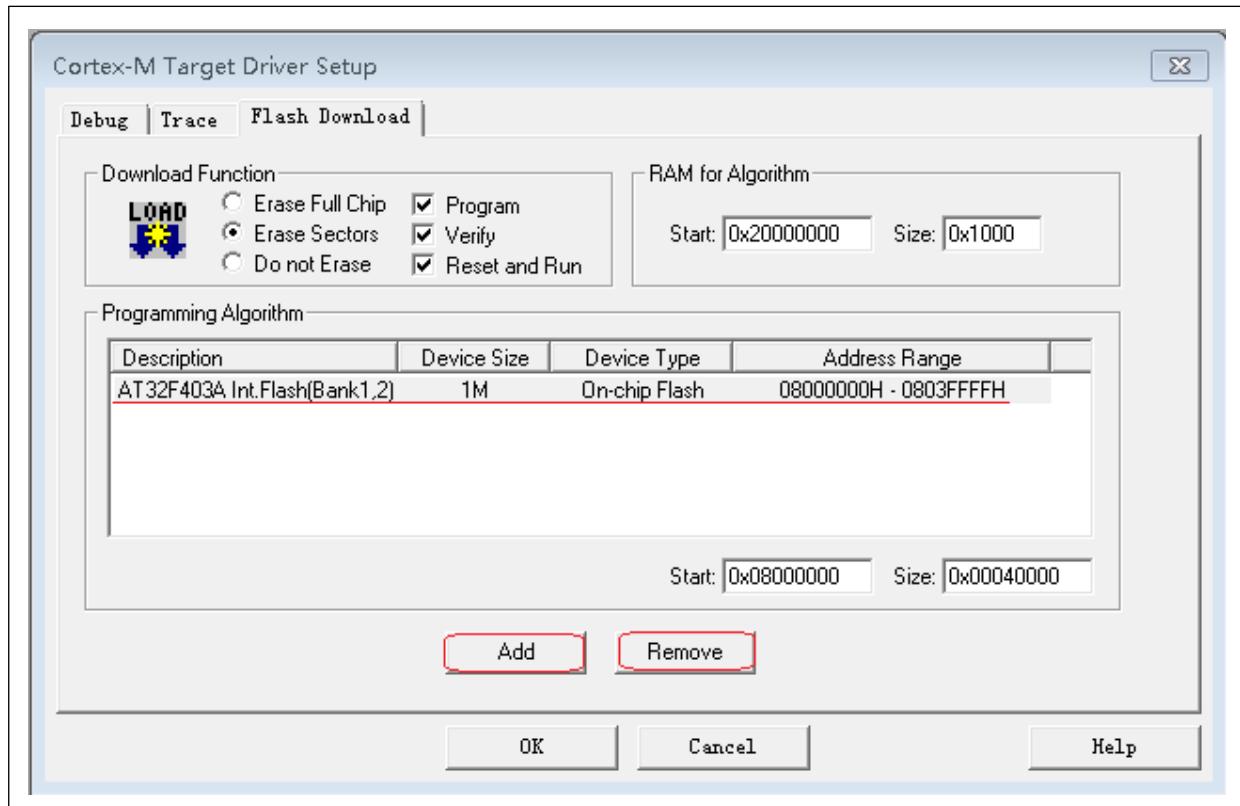
After creating a Keil IDE development tool project, the user can start Debug configuration and select the Flash algorithms. Go to *wand*—>*Debug*—>*Settings*—>*Flash Download*, as shown below:

Figure 15. Keil algorithm file settings



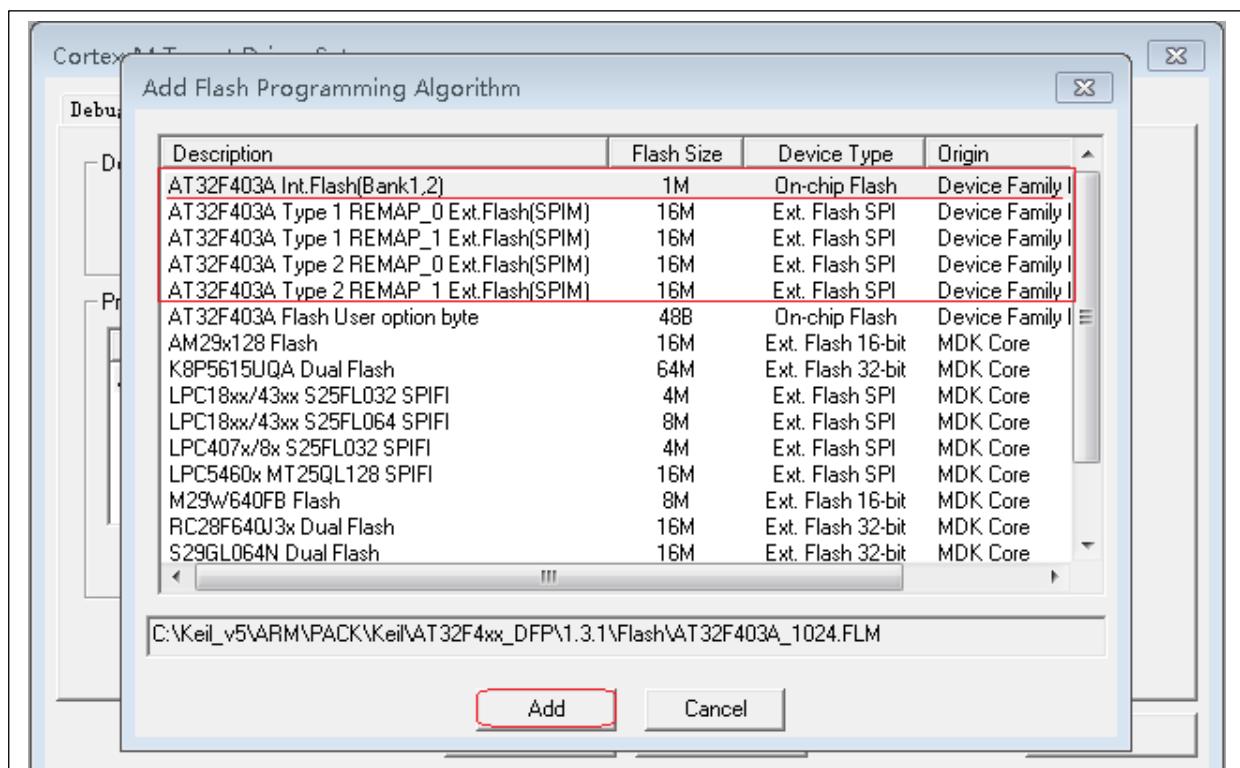
In this example, the selected Flash algorithm file is the default one. To change or remove it, click on this algorithm file, then click on *Add* or *Remove*. If the selected algorithm does not match the MCU, please follow the method below to modify.

Figure 16. Keil algorithm file configuration



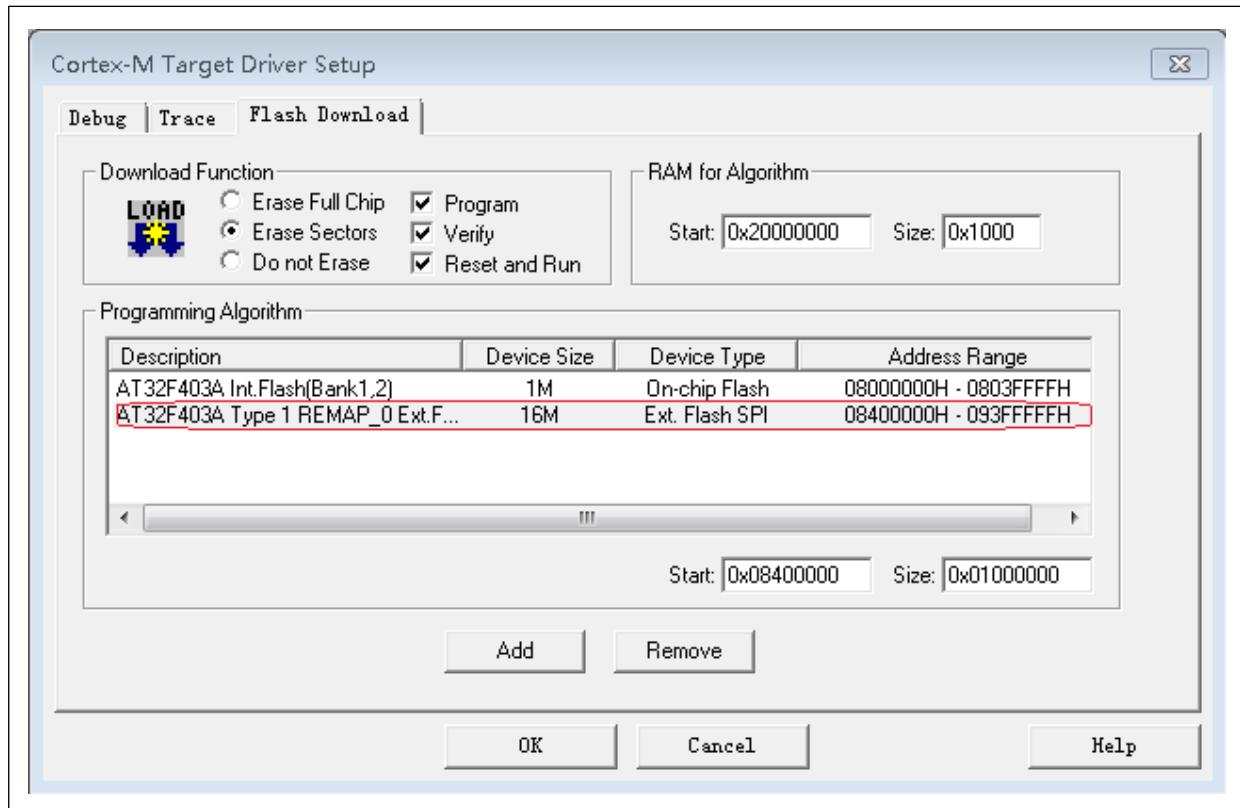
Click on *Remove* to remove the existing algorithm from the configuration, then click on *Add* to view the algorithm files associated with a MCU model and select them, as shown below:

Figure 17. Select algorithm files using Keil



After selection, click on *Add* to add the selected algorithm files into the current configuration. For example, a new SPIFI algorithm is added into the project.

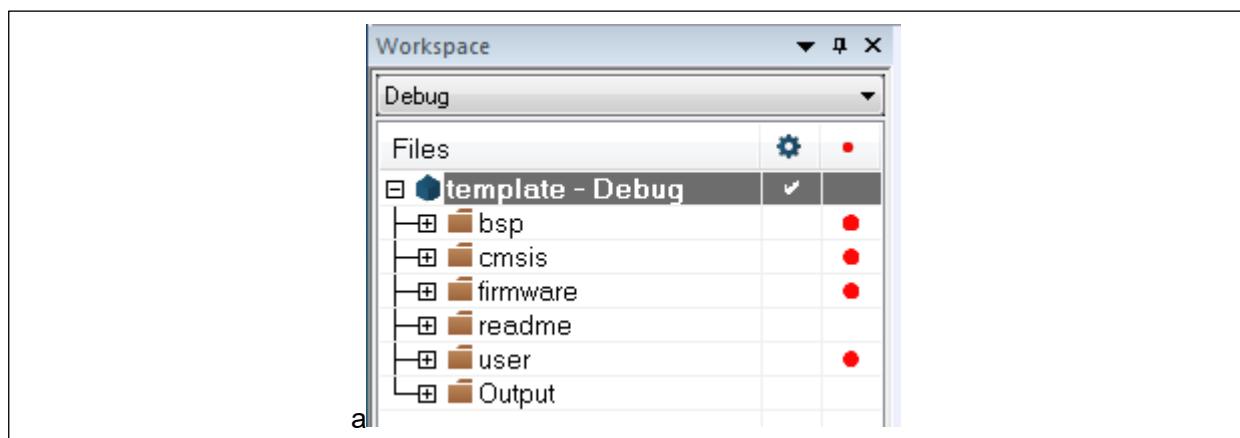
Figure 18. Add algorithm files using Keil



## 3.2 How to use IAR algorithm files

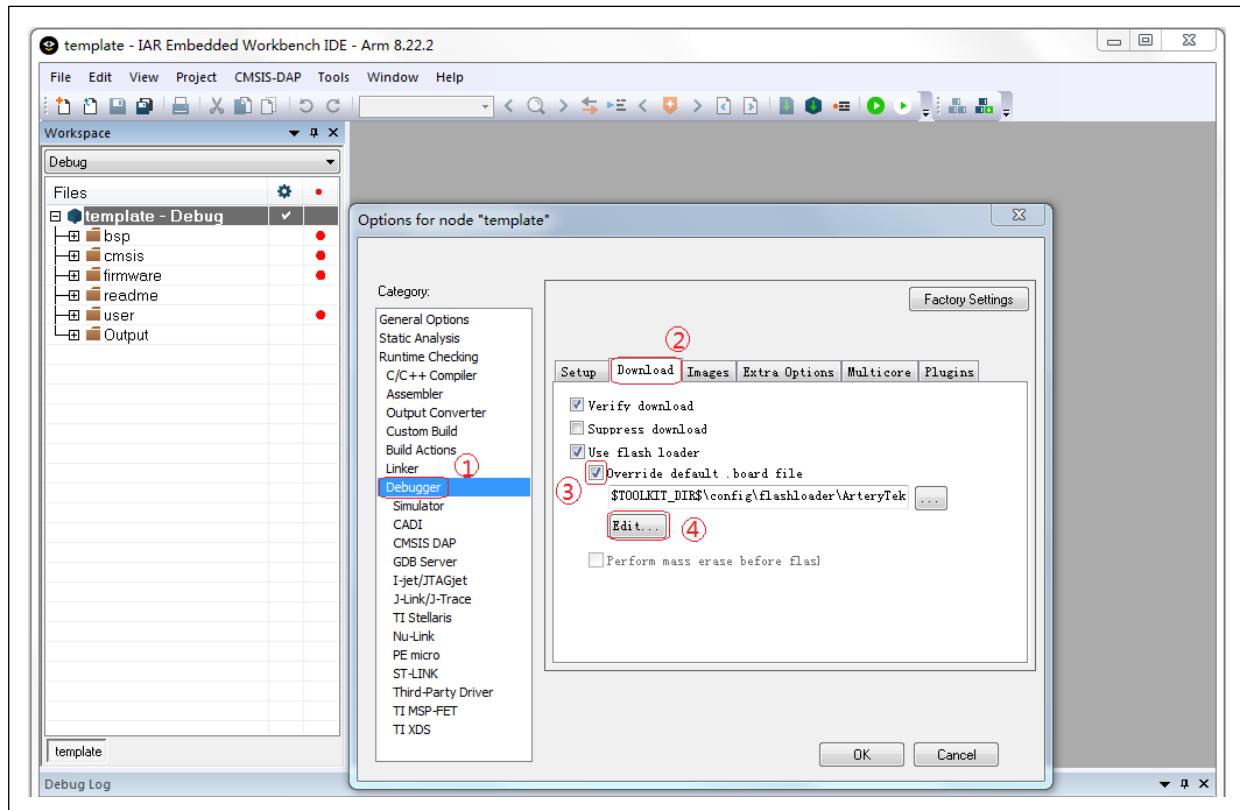
In IAR environment, the Flash algorithm files are automatically selected according to the selected MCU model during a new project configuration. To configure/modify an algorithm file manually, right-click on the file name (after an IAR project is created) in the following gray box:

Figure 19. IAR project name



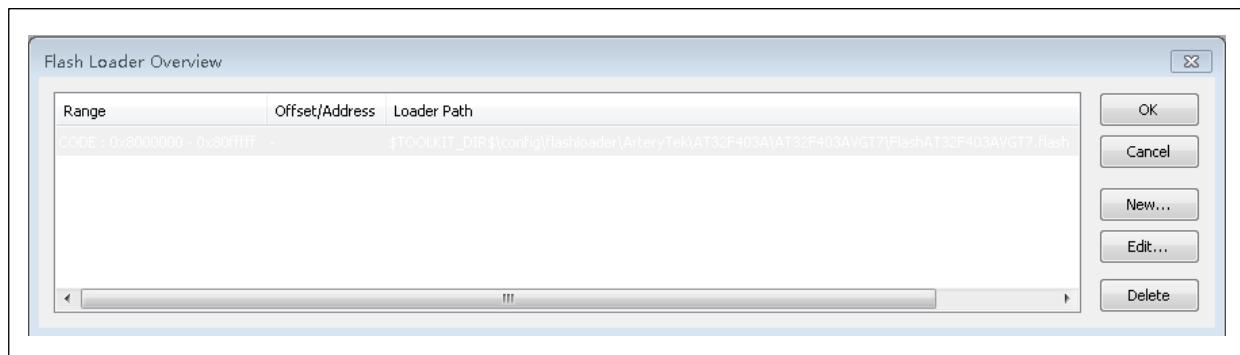
Go to Options—>Debugger—>Download—>Tick Override default .board file—>Click on Edit, as shown below:

Figure 20. IAR algorithm file configuration



Then the following window will be displayed.

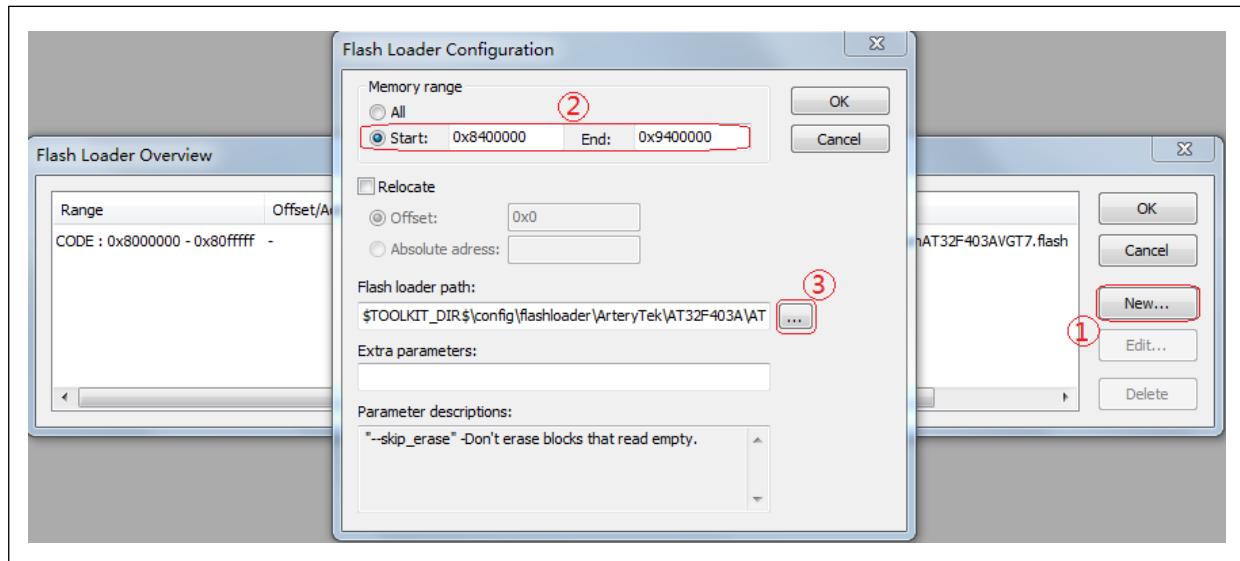
Figure 21. IAR Flash Loader overview



Flash algorithm configuration is designated by default after selecting a MCU part number. To modify it, click on *New/Edit/Delete*.

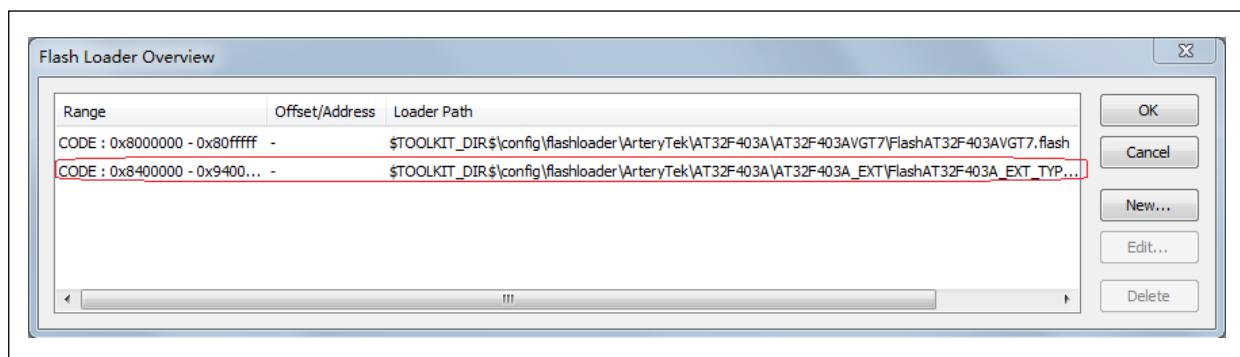
For example, click on *New*—>*Memory range*—> Select a Flash algorithm file, as shown below:

Figure 22. IAR Flash Loader configuration



This example shows how to add a SPIM Flash algorithm file. The user needs to select the corresponding MCU part number and a correct Flash algorithm file. The selected Flash algorithm configuration file is installed into IAR development environment using IAR\_AT32MCU\_AddOn tool. After a successful configuration, a new SPIM Flash algorithm is shown below:

Figure 23. IAR Flash Loader configuration success



### 1. Description of SPIM algorithms

Some Artery MCUs support Bank3 (refer to the Reference Manual or Datasheet on Artery official website for details), which can be used as an expansion of Flash memory in case of insufficient internal Flash or special application requirements. When the compiling addresses of some code or data are stored in the SPIM, these algorithm files are used for external Flash programming during online IDE tool download.

Naming rules of Artery SPIM algorithm file: AT32F4xxTypeNREMAP\_P Ext.Flash.

N=1,2

P=0,1

**TYPEN:** External SPI Flash. Select it according to the external Flash type and part number. Refer to the FLASH\_SELECT register section of the corresponding MCU Reference Manual.

**REMAP\_P:** Select multiplex-function MCU SPIM PIN. Select it according to the connection method of pins connected to external Flash. Refer to the external SPIF remapping section in the corresponding MCU reference manual.

REMAP0: EXT\_SPIF\_GRMP=000

REMAP1: EXT\_SPIF\_GRMP=001

## 4 BSP introduction

### 4.1 Quick start

#### 4.1.1 Template project

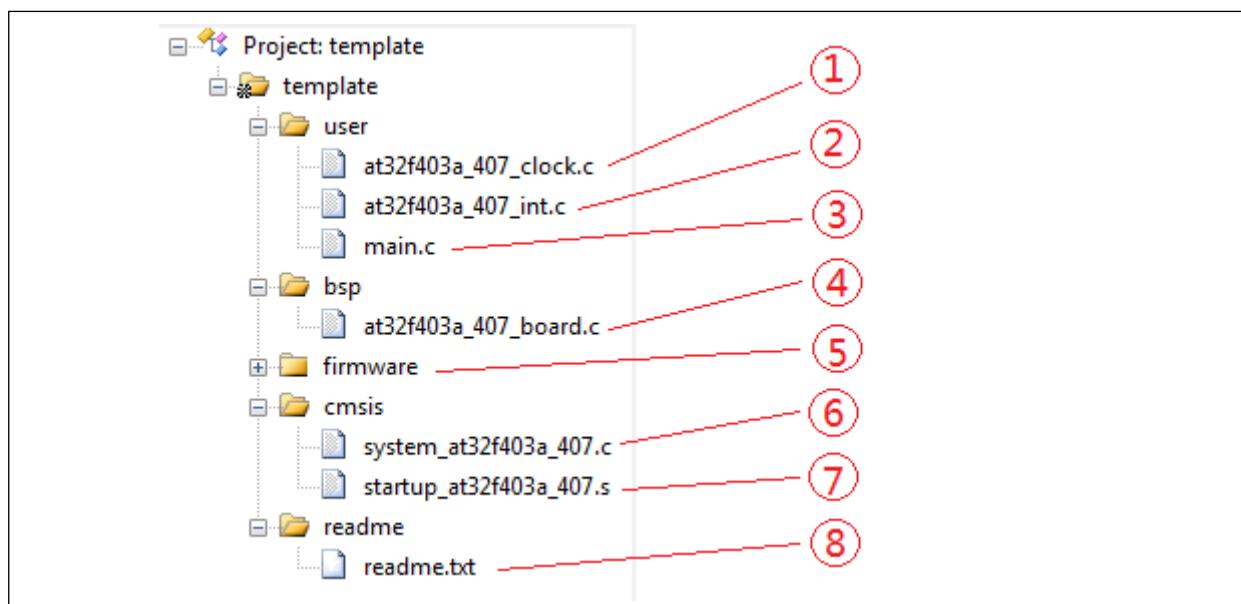
Artery firmware library BSP comes with a series of template projects built around Keil and IAR. For example, the template project of AT32F403A/407 is located in `AT32F403A_407_Firmware_Library_V2.x.x/project/at_start_xxx/templates`.

Figure 24. Template content

iar_v6.10	21/05/24 16:03	文件夹
iar_v7.4	21/05/24 16:03	文件夹
iar_v8.2	21/05/24 16:03	文件夹
inc	21/05/24 16:03	文件夹
mdk_v4	21/05/24 16:03	文件夹
mdk_v5	21/05/24 16:03	文件夹
src	21/05/24 16:03	文件夹
readme.txt	21/05/21 11:15	TXT 文件

The above template project includes various versions such as Keil\_v5, Keil\_v4, IAR\_6.10, IAR\_7.4 and IAR\_8.2. Of those, “inc” and “src” folders contain header files and source code files, respectively. Open a corresponding folder and click on the corresponding file to open an IDE project. Figure 25 presents an example of Keil\_v5 template project (its details and version are subject to the actual firmware library).

Figure 25. Keil\_v5 template project example



The contents in a project include: (using AT32F403A/407 as an example, other products are similar)

- ① `at32f403a_407_clock.c` (clock configuration file) defines the default clock frequency and clock paths.
- ② `at32f403a_407_int.c` (interrupt file) contains some interrupt handling codes.
- ③ `main.c` contains the main code files.

- ④ at32f403a\_407\_board.c (board configuration file) contains common hardware configurations such as buttons and LEDs on the AT-START-Evaluation Board.
- ⑤ at32f403a\_407\_xx.c under firmware folder contains driver files of on-chip peripherals.
- ⑥ system\_at32f403a\_407.c is the system initialization file.
- ⑦ startup\_at32f403a\_407.s is a startup file.
- ⑧ readme.txt is a readme file, containing functional description and configuration information.

Note: AT32 MUCs share similar BSP usage method, and this section uses AT32F403A as an example.

## 4.1.2 BSP macro definitions

- ① To create a project, it is necessary to enable a startup code (startup\_at32f403a\_407.s) and open the appropriate macro definitions according to MCU part number before compiling code. Table 1 presents the correspondence between the MCU and their macro definitions.

**Table 1. Summary of macro definitions**

MCU part numbers	Macro definitions	PINs	Flash size (KB)
AT32F403ACCT7	AT32F403ACCT7	48	256
AT32F403ACET7	AT32F403ACET7	48	512
AT32F403ACGT7	AT32F403ACGT7	48	1024
AT32F403ACCU7	AT32F403ACCU7	48	256
AT32F403ACEU7	AT32F403ACEU7	48	512
AT32F403ACGU7	AT32F403ACGU7	48	1024
AT32F403ARCT7	AT32F403ARCT7	64	256
AT32F403ARET7	AT32F403ARET7	64	512
AT32F403ARGT7	AT32F403ARGT7	64	1024
AT32F403AVCT7	AT32F403AVCT7	100	256
AT32F403AVET7	AT32F403AVET7	100	512
AT32F403AVGT7	AT32F403AVGT7	100	1024
AT32F407RCT7	AT32F407RCT7	64	256
AT32F407RET7	AT32F407RET7	64	512
AT32F407RGT7	AT32F407RGT7	64	1024
AT32F407VCT7	AT32F407VCT7	100	256
AT32F407VET7	AT32F407VET7	100	512
AT32F407VGT7	AT32F407VGT7	100	1024
AT32F407AVCT7	AT32F407AVCT7	100	256
AT32F407AVGT7	AT32F407AVGT7	100	1024

- ② In the header file (at32f403a\_407.h), USE\_STDPERIPH\_DRIVER (macro definition) is used to determine whether the Keil RTE feature is used or not. Enabling this definition while Keil RTE is unused can prevent some versions of Keil-MDK from opening \_RTE\_ accidentally.
- ③ The configuration header file (at32f403a\_407\_conf.h) defines macro definitions that enable peripherals. The file can be used to control the use of peripherals. The peripherals can be disabled simply by masking \_MODULE\_ENABLED pertaining to peripherals, as shown below:

**Figure 26. Peripheral enable macro definitions**

```
#define CRM_MODULE_ENABLED  
#define TMR_MODULE_ENABLED  
#define RTC_MODULE_ENABLED  
#define BPR_MODULE_ENABLED  
#define GPIO_MODULE_ENABLED  
#define I2C_MODULE_ENABLED  
#define USART_MODULE_ENABLED  
#define PWC_MODULE_ENABLED  
#define CAN_MODULE_ENABLED  
#define ADC_MODULE_ENABLED  
#define DAC_MODULE_ENABLED  
#define SPI_MODULE_ENABLED  
#define DMA_MODULE_ENABLED  
#define DEBUG_MODULE_ENABLED  
#define FLASH_MODULE_ENABLED  
#define CRC_MODULE_ENABLED  
#define WWDT_MODULE_ENABLED  
#define WDT_MODULE_ENABLED  
#define EXINT_MODULE_ENABLED  
#define SDIO_MODULE_ENABLED  
#define XMC_MODULE_ENABLED  
#define USB_MODULE_ENABLED  
#define ACC_MODULE_ENABLED  
#define MISC_MODULE_ENABLED  
#define EMAC_MODULE_ENABLED
```

*at32f403a\_407\_conf.h* also defines the HEXT\_VALUE (high-speed external clock value), which should be modified accordingly when changing an external high-speed crystal oscillator.

- ④ The system clock configuration file (*at32f403a\_407\_clock.c/.h*) defines the default system clock frequency and clock paths. The user, if needed, can customize the frequency multiplication process and factors, or generate corresponding clock configuration files using the clock configuration host of ArteryTek.

## 4.2 BSP specifications

The subsequent sections give a description of BSP specifications.

### 4.2.1 List of abbreviations for peripherals

Table 2. List of abbreviations for peripherals

Abbreviations	Description
ADC	Analog-to-digital converter
BPR	Battery powered register
CAN	Controller area network
CRC	CRC calculation unit
CRM	Clock and reset manage
DAC	Digital-to-analog converter
DMA	Direct memory access
DEBUG	Debug
EXINT	External interrupt/event controller
GPIO	General-purpose I/Os
IOMUX	Multiplexed I/Os
I2C	Inter-integrated circuit interface
NVIC	Nested vectored interrupt controller
PWC	Power controller
RTC	Real-time clock
SPI	Serial peripheral interface
I2S	Inter-IC Sound
SysTick	System tick timer
TMR	Timer
USART	Universal synchronous/asynchronous receiver transmitter
WDT	Watchdog timer
WWDT	Window watchdog timer
XMC	External memory controller

### 4.2.2 Naming rules

The naming rules for BSP are described as follows:

“ip” indicates an abbreviation of a peripheral, for example, ADC, TMR, GPIO, etc., regardless of upper and lower case letters, such as, adc, tmr, gpio...

- **Source code file**

The file name starts with “at32fxxx\_ip.c”, for example, at32f403a\_407\_adc.c

- **Header file**

The file name starts with “at32fxxx\_ip.h”, such as, at32f403a\_407\_adc.h

- **Constant**

If it is used in a single one file, the constant is then defined in this file; if it is used in multiple files, the constant is defined in corresponding header file.

All constants are in written in English capital letters.

- **Variable**

If it is used in a single one file, the variable is then defined in this file; if it is used in multiple files, the variable is declared with extern in the corresponding header file.

- **Naming rules for functions**

The peripheral functions are named based on the rule of “**peripheral abbreviatio\_attribute\_action**” or “**peripheral abbreviation\_attribute\_action**”.

The commonly used functions are as follows:

Function type	Naming rule	Example
Peripheral reset	ip_reset	adc_reset
Peripheral enable	ip_enable	adc_enable
Peripheral structure parameter initialize	ip_default_para_init	spi_default_para_init
Peripheral initialize	ip_init	spi_init
Peripheral interrupt enable	ip_interrupt_enable	adc_interrupt_enable
Peripheral flag get	ip_flag_get	adc_flag_get
Peripheral flag clear	ip_flag_clear	adc_flag_clear

### 4.2.3 Encoding rules

This section describes the encoding rules related to firmware function library.

Type of variables:

```

typedef int32_t INT32;
typedef int16_t INT16;
typedef int8_t INT8;
typedef uint32_t UINT32;
typedef uint16_t UINT16;
typedef uint8_t UINT8;

typedef int32_t s32;
typedef int16_t s16;
typedef int8_t s8;

typedef const int32_t sc32; /*!< read only */
typedef const int16_t sc16; /*!< read only */
typedef const int8_t sc8; /*!< read only */

typedef __IO int32_t vs32;
typedef __IO int16_t vs16;
typedef __IO int8_t vs8;

typedef __I int32_t vsc32; /*!< read only */
typedef __I int16_t vsc16; /*!< read only */
typedef __I int8_t vsc8; /*!< read only */

typedef uint32_t u32;
typedef uint16_t u16;
typedef uint8_t u8;

typedef const uint32_t uc32; /*!< read only */
typedef const uint16_t uc16; /*!< read only */
typedef const uint8_t uc8; /*!< read only */

```

```

typedef __IO uint32_t vu32;
typedef __IO uint16_t vu16;
typedef __IO uint8_t vu8;

typedef __I uint32_t vuc32; /*!< read only */
typedef __I uint16_t vuc16; /*!< read only */
typedef __I uint8_t vuc8; /*!< read only */

```

#### 4.2.3.1 Flag type

```
typedef enum {RESET = 0, SET = !RESET} flag_status;
```

#### 4.2.3.2 Function status type

```
typedef enum {FALSE = 0, TRUE = !FALSE} confirm_state;
```

#### 4.2.3.3 Error status type

```
typedef enum {ERROR = 0, SUCCESS = !ERROR} error_status;
```

#### 4.2.3.4 Peripheral type

##### ① Peripherals

Define the base address of peripheral in the at32fxxx\_ip.h, for example, in the at32f403a\_407.h:

#define ADC1_BASE	(APB2PERIPH_BASE + 0x2400)
#define ADC2_BASE	(APB2PERIPH_BASE + 0x2800)

Define the type of a peripheral in the at32fxxx\_ip.h, for example, in the at32f403a\_407\_adc.h:

#define ADC1	((adc_type *) ADC1_BASE)
#define ADC2	((adc_type *) ADC2_BASE)

##### ② Peripheral registers and bits

Define the type of a peripheral in the at32fxxx\_ip.h, for example, in the at32f403a\_407\_adc.h

```

/*
 * @brief type define adc register all
 */
typedef struct
{

    /**
     * @brief adc sts register, offset:0x00
     */
    union
    {
        __IO uint32_t sts;
        struct
        {
            __IO uint32_t vmor : 1; /* [0] */

```

```

    __IO uint32_t cce          : 1; /* [1] */
    __IO uint32_t pcce         : 1; /* [2] */
    __IO uint32_t pccs         : 1; /* [3] */
    __IO uint32_t occs         : 1; /* [4] */
    __IO uint32_t reserved1    : 27; /* [31:5] */

} sts_bit;

};

...
...
...
...

/***
 * @brief adc odt register, offset:0x4C
 */
union
{
    __IO uint32_t odt;
    struct
    {
        __IO uint32_t odt          : 16; /* [15:0] */
        __IO uint32_t adc2odt      : 16; /* [31:16] */
    } odt_bit;
};

} adc_type;

```

③ Examples of peripheral register access

Read peripheral	i = ADC1->ctrl1;
Write peripheral	ADC1->ctrl1 = i;
Read bit 5 in bit-field mode	i = ADC1->ctrl1.cceien;
Write 1 to bit 5 in bit-field mode	ADC1->ctrl1.cceien= TRUE;
Write 1 to bit 5	ADC1->ctrl1  = 1<<5;
Write 0 to bit 5	ADC1->ctrl1&= ~(1<<5);

## 4.3 BSP structure

### 4.3.1 BSP folder structure

BSP(Board Support Package) structure is shown in Figure 27.

Figure 27. BSP folder structure

 document	21/05/18 10:32	文件夹
 libraries	21/05/18 10:32	文件夹
 middlewares	21/05/18 10:32	文件夹
 project	21/05/18 10:32	文件夹
 utilities	21/05/14 11:35	文件夹

**Document:**

- AT32Fxxx firmware library BSP&Pack user guide.pdf: refer to BSP/Pack user manual
- ReleaseNotes\_AT32F403A\_407\_Firmware\_Library.pdf: document revision history

**Libraries:**

- **Drivers:** driver library for peripherals  
Src folder: low-level driver source file for peripherals, such as, at32fxxx\_ip.c  
inc folder: low-level driver header file for peripherals, such as, at32fxxx\_ip.h
- **Cmsis:** Core-related files  
cm4 folder: core-related files, including cortex-m4 library, system initialization file, startup file, etc.  
dsp folder: dsp-related files

**Middlewares:**

Third-party software or public protocols, including USB protocol layer driver, network protocol driver, operating system source code, etc.

**Project:**

Examples: demo

Templates: template projects, including Keil4, keil5, IAR6, IAR7, IAR8 and eclipse\_gcc

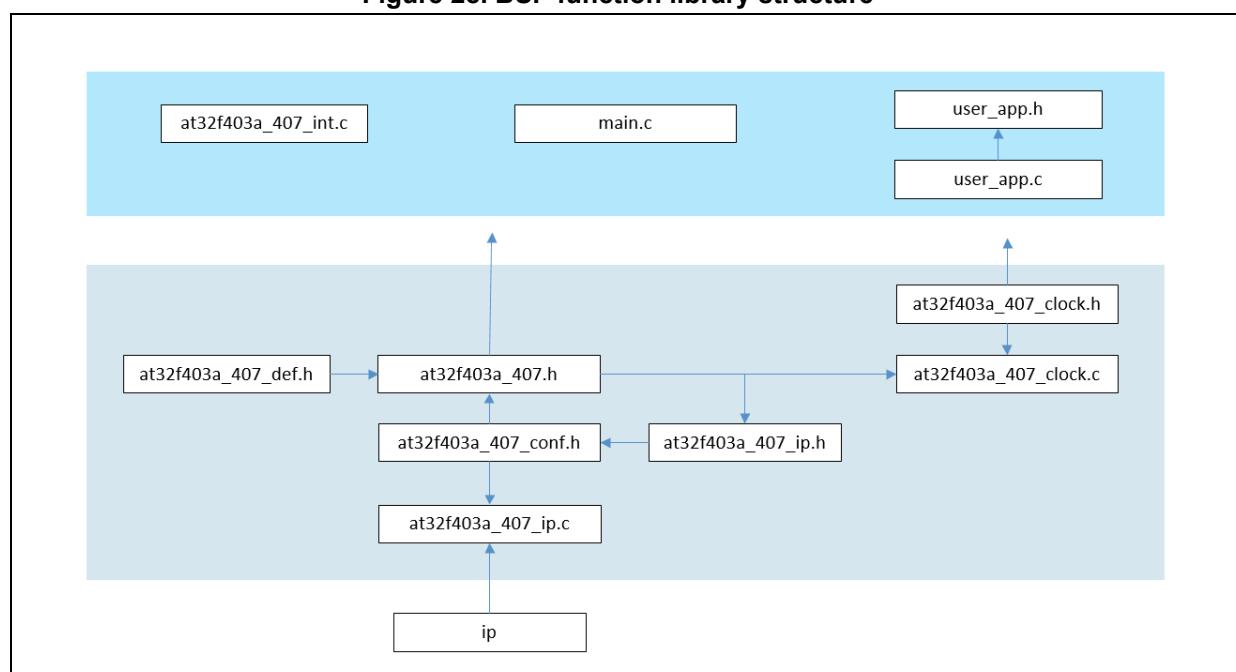
**Utilities:**

Store application cases

### 4.3.2 BSP function library structure

Figure 28 shows the architecture of BSP function library.

Figure 28. BSP function library structure



BSP function library files are described in Table 3.

**Table 3. Summary of BSP function library files**

<b>File name</b>	<b>Description</b>
at32f403a_407_conf.h	Macro definition for peripheral enable, and external high-speed clock HEXT_VALUE
main.c	Main function
at32f403a_407_ip.c	Driver source file for a peripheral, for example, at32f403a_407_adc.c
at32f403a_407_ip.h	Driver header file for a peripheral, for example, at32f403a_407_adc.h
at32f403a_407.h	In the header file (at32f403a_407.h), the definition USE_STDPERIPH_DRIVER is used to determine whether the Keil RTE is used or not. Enabling the definition while Keil RTE is unused can prevent Keil-MDK from enabling _RTE_ accidentally.
at32f403a_407_clock.c	This is a clock configuration file used to configure default clock frequency and clock path.
at32f403a_407_clock.h	This is a clock configure header file.
at32f403a_407_int.c	This is a source file for interrupt functions that programs interrupt handling code.
at32f403a_407_int.h	This is a header file for interrupt functions.
at32f403a_407_misc.c	This is a source file for other configurations, such as, nvic configuration function, systick clock source selection.
at32f403a_407_misc.h	This is a header file for other configurations.
startup_at32f403a_407.s	This is a startup file.

### 4.3.3 Initialization and configuration for peripherals

This section describes how to initialize and configure peripherals using GPIO as an example.

#### GPIO initialization

- Step 1: Define the gpio\_init\_type, for example, gpio\_init\_type gpio\_init\_struct;
- Step 2: Enable GPIO clock using the function crm\_periph\_clock\_enable;
- Step 3: De-initialize the structure gpio\_init\_struct to allow the values of other members (mostly default values) to be correctly written, for example, gpio\_default\_para\_init(&gpio\_init\_struct);
- Step 4: Configure member of the structure, and write structure parameters into GPIO registers through the gpio\_init, for example,

```
gpio_init_struct.gpio_pins = GPIO_PINS_2 | GPIO_PINS_3;
gpio_init_struct.gpio_mode = GPIO_MODE_OUTPUT;
gpio_init_struct.gpio_out_type = GPIO_OUTPUT_PUSH_PULL;
gpio_init_struct.gpio_pull = GPIO_PULL_NONE;
gpio_init_struct.gpio_drive_strength = GPIO_DRIVE_STRENGTH_STRONGER;
gpio_init(GPIOA, &gpio_init_struct);
```

For more information on peripheral initialization procedure, refer to the section of peripherals of the reference manual, and the section of peripherals of the AT32Fxxx\_Firmware\_Library\_V2.x.x.zip\project\at\_start\_fxxx\examples.

#### 4.3.4 Peripheral functions format description

Table 4. Function format description for peripherals

Name	Description
Function name	The name of a peripheral function
Function prototype	Prototype declaration
Function description	Brief description of how the function is executed
Input parameter (n)	Description of the input parameters
Output parameter (n)	Description of the output parameters
Return value	Value returned by the function
Required preconditions	Requirements before calling the function
Called functions	Other library functions called

## 5 AT32M412/416 peripheral library functions

### 5.1 Analog-to-digital converter (ADC)

ADC register structure adc\_type is defined in the “at32m412\_416\_adc.h”.

```
/*
 * @brief type define adc register all
 */
typedef struct
{
    .....
} adc_type;
```

The table below gives a list of the ADC registers.

**Table 5. Summary of ADC registers**

Register	Description
sts	ADC status register
ctrl1	ADC control register 1
ctrl2	ADC control register 2
spt1	ADC sample time register 1
spt2	ADC sample time register 2
pcdto1	ADC preempted channel data offset register 1
pcdto2	ADC preempted channel data offset register 2
pcdto3	ADC preempted channel data offset register 3
pcdto4	ADC preempted channel data offset register 4
vmhb	ADC voltage monitor high boundary register
vmlb	ADC voltage monitor low boundary register
osq1	ADC ordinary sequence register 1
osq2	ADC ordinary sequence register 2
osq3	ADC ordinary sequence register 3
psq	ADC preempted sequence register
pdt1	ADC preempted data register 1
pdt2	ADC preempted data register 2
pdt3	ADC preempted data register 3
pdt4	ADC preempted data register 4
odt	ADC ordinary data register
ovsp	ADC oversampling register

**Table 6. List of ADCCOM registers**

Register	Description
csts	ADC common status register
cctrl	ADC common control register
codt	ADC common data register
adc1_odt1	ADC1 ordinary data register 1

Register	Description
adc1_0dt2	ADC1 ordinary data register 2
adc1_0dt3	ADC1 ordinary data register 3
adc1_0dt4	ADC1 ordinary data register 4
adc1_0dt5	ADC1 ordinary data register 5
adc1_0dt6	ADC1 ordinary data register 6
adc1_0dt7	ADC1 ordinary data register 7
adc1_0dt8	ADC1 ordinary data register 8
adc1_0dt9	ADC1 ordinary data register 9
adc1_0dt10	ADC1 ordinary data register 10
adc1_0dt11	ADC1 ordinary data register 11
adc1_0dt12	ADC1 ordinary data register 12
adc1_0dt13	ADC1 ordinary data register 13
adc1_0dt14	ADC1 ordinary data register 14
adc1_0dt15	ADC1 ordinary data register 15
adc1_0dt16	ADC1 ordinary data register 16
adc2_0dt1	ADC2 ordinary data register 1
adc2_0dt2	ADC2 ordinary data register 2
adc2_0dt3	ADC2 ordinary data register 3
adc2_0dt4	ADC2 ordinary data register 4
adc2_0dt5	ADC2 ordinary data register 5
adc2_0dt6	ADC2 ordinary data register 6
adc2_0dt7	ADC2 ordinary data register 7
adc2_0dt8	ADC2 ordinary data register 8
adc2_0dt9	ADC2 ordinary data register 9
adc2_0dt10	ADC2 ordinary data register 10
adc2_0dt11	ADC2 ordinary data register 11
adc2_0dt12	ADC2 ordinary data register 12
adc2_0dt13	ADC2 ordinary data register 13
adc2_0dt14	ADC2 ordinary data register 14
adc2_0dt15	ADC2 ordinary data register 15
adc2_0dt16	ADC2 ordinary data register 16

**Table 7. Summary of ADC library functions**

Function name	Description
adc_reset	Reset all ADC registers to their reset values
adc_enable	Enable A/D converter
adc_base_default_para_init	Define an initial value for adc_base_struct
adc_base_config	Configure ADC registers with the initialized parameters of the adc_base_struct
adc_common_default_para_init	Define an initial value for the adc_common_struct
adc_common_config	Configure ADC common register with the initialized parameters of the adc_common_struct
adc_resolution_set	Set ADC conversion resolution

Function name	Description
adc_dma_mode_enable	Enable DMA transfer for ordinary group
adc_dma_request_repeat_enable	Enable DMA request repetition mode for ordinary group conversion
adc_interrupt_enable	Enable the selected ADC event interrupt
adc_calibration_value_set	Set calibration value by software
adc_calibration_init	Initialization calibration
adc_calibration_init_status_get	Get initialization calibration status
adc_calibration_start	Start calibration
adc_calibration_status_get	Get calibration status
adc_voltage_monitor_enable	Enable voltage monitoring for ordinary/preempted channels and a single channel
adc_voltage_monitor_threshold_value_set	Set the threshold of voltage monitoring
adc_voltage_monitor_single_channel_select	Select a single channel for voltage monitoring
adc_ordinary_channel_set	Configure ordinary channels, including channel selection, conversion sequence number and sampling time
adc_preempt_channel_length_set	Configure the length of preempted group conversion sequence
adc_preempt_channel_set	Configure preempted channels, including channel selection, conversion sequence number and sampling time
adc_ordinary_conversion_trigger_set	Enable trigger mode and trigger event selection for ordinary group conversion
adc_preempt_conversion_trigger_set	Enable trigger mode and trigger event selection for preempted group conversion
adc_preempt_offset_value_set	Set data offset for preempted conversion
adc_ordinary_part_count_set	Set the number of ordinary channels for each triggered conversion in partition mode
adc_ordinary_part_mode_enable	Enable partition mode for ordinary channels
adc_preempt_part_mode_enable	Enable partition mode for preempted channels
adc_preempt_auto_mode_enable	Enable auto conversion of preempted group at the end of ordinary conversion
adc_conversion_stop	Stop on-going ADC conversion
adc_conversion_stop_status_get	Get the status of stop conversion command
adc_occe_each_conversion_enable	Enable OCCE flag for each ordinary channel conversion
adc_ordinary_software_trigger_enable	Software trigger ordinary group conversion
adc_ordinary_software_trigger_status_get	Get the status of ordinary group conversion triggered by software
adc_preempt_software_trigger_enable	Software trigger preempted group conversion
adc_preempt_software_trigger_status_get	Get the status of preempted group conversion triggered by software
adc_ordinary_conversion_data_get	Get data of ordinary group conversion in non-master-slave mode
adc_combine_ordinary_conversion_data_get	Get converted data from ordinary group in combined master-slave mode
adc_preempt_conversion_data_get	Get the converted data of preempted group
adc_flag_get	Get the status of flag bits
adc_interrupt_flag_get	Get interrupt flag
adc_flag_clear	Clear flag bits

Function name	Description
adc_ordinary_oversample_enable	Enable oversampling of ordinary group
adc_preempt_oversample_enable	Enable oversampling of preempted group
adc_oversample_ratio_shift_set	Set oversampling ratio and its shift length
adc_ordinary_oversample_trig_enable	Enable oversampling trigger mode of ordinary group
adc_ordinary_oversample_restart_set	Enable oversampling restart mode of ordinary group
adc_convert_fail_auto_abort_enable	Enable ADC auto abort after conversion failure
adc_common_ordinary_data_get	Get converted data from common ordinary group

### 5.1.1 **adc\_reset function**

The table below describes the function adc\_reset.

**Table 8. adc\_reset function**

Name	Description
Function name	adc_reset
Function prototype	void adc_reset(void)
Function description	Reset all ADC registers to their reset values
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset()

**Example:**

```
/* deinitialize adc1 */
adc_reset(ADC1);
```

### 5.1.2 **adc\_enable function**

The table below describes the function adc\_enable.

**Table 9. adc\_enable function**

Name	Description
Function name	adc_enable
Function prototype	void adc_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable/disable A/D converter
Input parameter 1	adc_x: the selected ADC This parameter is used to select ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of A/D converter This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable adc1 */
adc_enable(ADC1, TRUE);
```

### 5.1.3 adc\_base\_default\_para\_init function

The table below describes the function adc\_base\_default\_para\_init.

**Table 10. adc\_base\_default\_para\_init function**

Name	Description
Function name	adc_base_default_para_init
Function prototype	void adc_base_default_para_init(adc_base_config_type *adc_base_struct)
Function description	Set the initial value for the adc_base_struct.
Input parameter	adc_base_struct: adc_base_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The default values of members in the adc\_base\_struct:

sequence_mode:	FALSE
repeat_mode:	FALSE
data_align:	ADC_RIGHT_ALIGNMENT
ordinary_channel_length:	1

**Example:**

```
/* initialize a adc_base_config_type structure */
adc_base_config_type adc_base_struct;
adc_base_default_para_init(&adc_base_struct);
```

### 5.1.4 adc\_base\_config function

The table below describes the function adc\_base\_config.

**Table 11. adc\_base\_config function**

Name	Description
Function name	adc_base_config
Function prototype	void adc_base_config(adc_type *adc_x, adc_base_config_type *adc_base_struct);
Function description	Initialize ADC registers with the specified parameters in the adc_base_struct.
Input parameter 1	adc_x: the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	adc_base_struct: adc_base_config_type structure pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_base\_config\_type structure**

The adc\_base\_config\_type is defined in the at32m412\_416\_adc.h:

```
typedef struct
{
    confirm_state          sequence_mode;
    confirm_state          repeat_mode;
    adc_data_align_type   data_align;
```

```

    uint8_t          ordinary_channel_length;
} adc_base_config_type; the member parameters are described as follows
sequence_mode
Set ADC sequence mode.
FALSE: Select a single channel for conversion
TRUE: Select multiple channels for conversion
repeat_mode
Set ADC repeat mode.
FALSE: when SQEN=0, trigger a single channel conversion each time; when SQEN=1, trigger the
       conversion of a group of channels each time
TRUE: when SQEN =0, repeatedly convert a single channel at each trigger; when SQEN=1,
       repeatedly convert a group of channels at each trigger until the ADCEN bit is cleared.
data_align
Set data alignment of ADC
ADC_RIGHT_ALIGNMENT: right-aligned
ADC_LEFT_ALIGNMENT: left-aligned
ordinary_channel_length
Set the length of ordinary group ADC conversion
Example:
adc_base_config_type adc_base_struct;
adc_base_struct.sequence_mode = TRUE;
adc_base_struct.repeat_mode = FALSE;
adc_base_struct.data_align = ADC_RIGHT_ALIGNMENT;
adc_base_struct.ordinary_channel_length = 3;
adc_base_config(ADC1, &adc_base_struct);

```

## 5.1.5 adc\_common\_default\_para\_init function

The table below describes the function adc\_common\_default\_para\_init.

**Table 12. adc\_common\_default\_para\_init function**

Name	Description
Function name	adc_common_default_para_init
Function prototype	void adc_common_default_para_init(adc_common_config_type *adc_common_struct)
Function description	Set the initial value for the adc_common_struct
Input parameter	adc_common_struct: adc_common_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The devalue values of members in the adc\_common\_struct:

combine_mode:	ADC_INDEPENDENT_MODE
div:	ADC_HCLK_DIV_2
common_dma_mode:	ADC_COMMON_DMAMODE_DISABLE
common_dma_request_repeat_state:	FALSE
sampling_interval:	ADC_SAMPLING_INTERVAL_5CYCLES
tempervinrv_state:	FALSE

**Example:**

```
/* initialize a adc_common_config_type structure */
adc_common_config_type adc_common_struct;
adc_common_default_para_init(&adc_common_struct);
```

## 5.1.6 adc\_common\_config function

The table below describes the function adc\_common\_config.

**Table 13. adc\_common\_config function**

Name	Description
Function name	adc_common_config
Function prototype	void adc_common_config(adc_common_config_type *adc_common_struct)
Function description	Initialize ADC common register with the parameters programmed in the adc_common_struct
Input parameter	adc_common_struct: adc_common_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_common\_config\_type structure**

The adc\_common\_config\_type is defined in the at32m412\_416\_adc.h:

typedef struct

```
{
    adc_combine_mode_type        combine_mode;
    adc_div_type                 div;
    adc_common_dma_mode_type     common_dma_mode;
    confirm_state                common_dma_request_repeat_state;
    adc_sampling_interval_type   sampling_interval;
    confirm_state                tempevintrv_state;
}
```

adc\_common\_config\_type; see the descriptions below for its members:

**combine\_mode**

Set ADC master-slave combined mode.

ADC\_INDEPENDENT\_MODE: Non-combined mode

ADC\_ORDINARY\_SMLT\_PREEMPT\_SMLT\_ONESLAVE\_MODE:

Ordinary simultaneous + preempted simultaneous (single slave)

ADC\_ORDINARY\_SMLT\_PREEMPT\_INTERLTRIG\_ONESLAVE\_MODE:

Ordinary simultaneous + alternate preempted trigger (single slave)

ADC\_PREEMPT\_SMLT\_ONLY\_ONESLAVE\_MODE: Preempted simultaneous (single slave)

ADC\_ORDINARY\_SMLT\_ONLY\_ONESLAVE\_MODE: Ordinary simultaneous (single slave)

ADC\_ORDINARY\_SHIFT\_ONLY\_ONESLAVE\_MODE: Ordinary shift (single slave)

ADC\_PREEMPT\_INTERLTRIG\_ONLY\_ONESLAVE\_MODE:

Alternate preempted trigger (single slave)

**div**

Set ADC frequency division factor.

ADC\_HCLK\_DIV\_2: ADCCLK is clocked by HCLK/2

ADC\_HCLK\_DIV\_3: ADCCLK is clocked by HCLK/3

ADC\_HCLK\_DIV\_4: ADCCLK is clocked by HCLK/4

ADC_HCLK_DIV_5:	ADCCLK is clocked by HCLK/5
ADC_HCLK_DIV_6:	ADCCLK is clocked by HCLK/6
ADC_HCLK_DIV_7:	ADCCLK is clocked by HCLK/7
ADC_HCLK_DIV_8:	ADCCLK is clocked by HCLK/8
ADC_HCLK_DIV_9:	ADCCLK is clocked by HCLK/9
ADC_HCLK_DIV_10:	ADCCLK is clocked by HCLK/10
ADC_HCLK_DIV_11:	ADCCLK is clocked by HCLK/11
ADC_HCLK_DIV_12:	ADCCLK is clocked by HCLK/12
ADC_HCLK_DIV_13:	ADCCLK is clocked by HCLK/13
ADC_HCLK_DIV_14:	ADCCLK is clocked by HCLK/14
ADC_HCLK_DIV_15:	ADCCLK is clocked by HCLK/15
ADC_HCLK_DIV_16:	ADCCLK is clocked by HCLK/16
ADC_HCLK_DIV_17:	ADCCLK is clocked by HCLK/17

#### **common\_dma\_mode**

Set ordinary channel DMA transfer mode in master/slave mode.

ADC_COMMON_DMAMODE_DISABLE:	No DMA transfer
ADC_COMMON_DMAMODE_1:	DMA mode 1
ADC_COMMON_DMAMODE_2:	DMA mode 2
ADC_COMMON_DMAMODE_3:	DMA mode 3

#### **common\_dma\_request\_repeat\_state**

Enable or disable ordinary channel DMA request continuation in master/slave mode.

FALSE:	Disabled (after the completion of the programmed number of DMA transfers, no DMA request generated at the end of ordinary conversion)
TRUE:	Enabled (don't care about the programmed number of DMA transfers; each channel sends DMA request at the end of ordinary conversion)

#### **sampling\_interval**

Set the adjacent ADC sampling interval in ordinary shift mode.

ADC_SAMPLING_INTERVAL_5CYCLES:	5 * TADCCLK
ADC_SAMPLING_INTERVAL_6CYCLES:	6 * TADCCLK
ADC_SAMPLING_INTERVAL_7CYCLES:	7 * TADCCLK
ADC_SAMPLING_INTERVAL_8CYCLES:	8 * TADCCLK
ADC_SAMPLING_INTERVAL_9CYCLES:	9 * TADCCLK
ADC_SAMPLING_INTERVAL_10CYCLES:	10 * TADCCLK
ADC_SAMPLING_INTERVAL_11CYCLES:	11 * TADCCLK
ADC_SAMPLING_INTERVAL_12CYCLES:	12 * TADCCLK
ADC_SAMPLING_INTERVAL_13CYCLES:	13 * TADCCLK
ADC_SAMPLING_INTERVAL_14CYCLES:	14 * TADCCLK
ADC_SAMPLING_INTERVAL_15CYCLES:	15 * TADCCLK
ADC_SAMPLING_INTERVAL_16CYCLES:	16 * TADCCLK
ADC_SAMPLING_INTERVAL_17CYCLES:	17 * TADCCLK
ADC_SAMPLING_INTERVAL_18CYCLES:	18 * TADCCLK
ADC_SAMPLING_INTERVAL_19CYCLES:	19 * TADCCLK

#### **tempervintrv\_state**

Enable or disable ADC internal temperature sensor and  $V_{INTRV}$

FALSE:	Internal temperature sensor and $V_{INTRV}$ disabled
TRUE:	Internal temperature sensor and $V_{INTRV}$ enabled

**Example:**

```
adc_common_config_type adc_common_struct;
adc_common_struct.combine_mode = ADC_INDEPENDENT_MODE;
adc_common_struct.div = ADC_HCLK_DIV_4;
adc_common_struct.common_dma_mode = ADC_COMMON_DMAMODE_DISABLE;
adc_common_struct.common_dma_request_repeat_state = FALSE;
adc_common_struct.sampling_interval = ADC_SAMPLING_INTERVAL_5CYCLES;
adc_common_struct.tempervintry_state = TRUE;
adc_common_config(&adc_common_struct);
```

### 5.1.7 **adc\_resolution\_set function**

The table below describes the function adc\_resolution\_set.

**Table 14. adc\_resolution\_set function**

Name	Description
Function name	adc_resolution_set
Function prototype	void adc_resolution_set(adc_type *adc_x, adc_resolution_type resolution)
Function description	Set ADC conversion resultion
Input parameter 1	adc_x: indicates the selected ADC This parameter is used to select ADC1 or ADC2
Input parameter 2	Resolution: the selected ADC conversion resolution This parameter can be any enumerated value in the adc_resolution_type.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**resolution**

The resolution is used to select ADC conversion resolution, including:

- ADC\_RESOLUTION\_12B: 12-bit resolution
- ADC\_RESOLUTION\_10B: 10-bit resolution
- ADC\_RESOLUTION\_8B: 8-bit resolution
- ADC\_RESOLUTION\_6B: 6-bit resolution

**Example:**

```
/* set conversion resolution */
adc_resolution_set(ADC1, ADC_RESOLUTION_12B);
```

### 5.1.8 **adc\_dma\_mode\_enable function**

The table below describes the function adc\_dma\_mode\_enable.

**Table 15. adc\_dma\_mode\_enable function**

Name	Description
Function name	adc_dma_mode_enable
Function prototype	void adc_dma_mode_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable DMA transfer for ordinary group conversion
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	new_state: pre-configured status of ordinary group in DMA transfer mode

Name	Description
	This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable dma transfer adc ordinary conversion data */
adc_dma_mode_enable(ADC1, TRUE);
```

### 5.1.9 adc\_dma\_request\_repeat\_enable function

The table below describes the function adc\_dma\_request\_repeat\_enable.

**Table 16. adc\_dma\_request\_repeat\_enable function**

Name	Description
Function name	adc_dma_request_repeat_enable
Function prototype	void adc_dma_request_repeat_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable DMA request repetition mode for ordinary group conversion
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of DMA request repetition mode This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* config dma request repeat,it's not useful when common dma mode is use */
adc_dma_request_repeat_enable(ADC1, TRUE);
```

### 5.1.10 adc\_interrupt\_enable function

The table below describes the function adc\_interrupt\_enable.

**Table 17. adc\_interrupt\_enable function**

Name	Description
Function name	adc_interrupt_enable
Function prototype	void adc_interrupt_enable(adc_type *adc_x, uint32_t adc_int, confirm_state new_state)
Function description	Enable the selected ADC event interrupt
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	adc_int: the selected ADC event interrupt This parameter is used to select any event interrupt supported by ADC.
Input parameter3	new_state: indicates the pre-configured status of ADC event interrupts This parameter can be TRUE or FALSE.
Output parameter	NA

Name	Description
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_int**

The adc\_int is used to select and set event interrupts, with the following parameters:

- ADC\_OCCE\_INT: Interrupt enabled at the end of ordinary group conversion
- ADC\_VMOR\_INT: Interrupt enabled when voltage monitor is outside a threshold
- ADC\_PCCE\_INT: Interrupt enabled at the end of preempted group conversion
- ADC\_OCCO\_INT: Overflow interrupt for ordinary group conversion
- ADC\_TCF\_INT: Triggered conversion failure interrupt

**Example:**

```
/* enable voltage monitoring out of range interrupt */
adc_interrupt_enable(ADC1, ADC_VMOR_INT, TRUE);
```

### 5.1.11 adc\_calibration\_init function

The table below describes the function adc\_calibration\_init.

**Table 18. adc\_calibration\_init function**

Name	Description
Function name	adc_calibration_init
Function prototype	void adc_calibration_init(adc_type *adc_x)
Function description	Initialization calibration
Input parameter	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* initialize A/D calibration */
adc_calibration_init(ADC1);
```

## 5.1.12 adc\_calibration\_init\_status\_get function

The table below describes the function adc\_calibration\_init\_status\_get.

**Table 19. adc\_calibration\_init\_status\_get function**

Name	Description
Function name	adc_calibration_init_status_get
Function prototype	flag_status adc_calibration_init_status_get(adc_type *adc_x)
Function description	Get the status of initialization calibration
Input parameter	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	flag_status: indicates the status of calibration initialization Return SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
/* wait initialize A/D calibration success */
while(adc_calibration_init_status_get(ADC1));
```

## 5.1.13 adc\_calibration\_start function

The table below describes the function adc\_calibration\_start.

**Table 20. adc\_calibration\_start function**

Name	Description
Function name	adc_calibration_start
Function prototype	void adc_calibration_start(adc_type *adc_x)
Function description	Start calibration
Input parameter	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* start calibration process */
adc_calibration_start(ADC1);
```

## 5.1.14 adc\_calibration\_status\_get function

The table below describes the function adc\_calibration\_status\_get.

**Table 21. adc\_calibration\_status\_get function**

Name	Description
Function name	adc_calibration_status_get
Function prototype	flag_status adc_calibration_status_get(adc_type *adc_x)
Function description	Get the status of calibration
Input parameter	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	flag_status: indicates the status of calibration Return SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
/* wait calibration success */
while(adc_calibration_status_get(ADC1));
```

## 5.1.15 adc\_voltage\_monitor\_enable function

The table below describes the function adc\_voltage\_monitor\_enable.

**Table 22. adc\_voltage\_monitor\_enable function**

Name	Description
Function name	adc_voltage_monitor_enable
Function prototype	void adc_voltage_monitor_enable(adc_type *adc_x, adc_voltage_monitoring_type adc_voltage_monitoring)
Function description	Enable voltage monitor for ordinary/preempted group and a single channel
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	adc_voltage_monitoring: select ordinary group, preempted group or a single channel for voltage monitoring This parameter can be any enumerated value in the adc_voltage_monitoring_type.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### adc\_voltage\_monitoring

The adc\_voltage\_monitoring is used to select one or more channels of ordinary group/preempted group for voltage monitoring, including:

ADC\_VMONITOR\_SINGLE\_ORDINARY:

Select a single ordinary channel for voltage monitoring

ADC\_VMONITOR\_SINGLE\_PREEMPT:

Select a single preempted channel for voltage monitoring

ADC\_VMONITOR\_SINGLE\_ORDINARY\_PREEMPT:

Select a single channel from ordinary or preempted group for voltage monitoring

ADC\_VMONITOR\_ALL\_ORDINARY:

Select all ordinary channels for voltage monitoring

ADC\_VMONITOR\_ALL\_PREEMPT:

Select all preempted channels for voltage monitoring

ADC\_VMONITOR\_ALL\_ORDINARY\_PREEMPT:

Select all ordinary and preempted channels for voltage monitoring

ADC\_VMONITOR\_NONE:

No channels need voltage monitoring

**Example:**

```
/* enable the voltage monitoring on all ordinary and preempt channels */
adc_voltage_monitor_enable(ADC1, ADC_VMONITOR_ALL_ORDINARY_PREEMPT);
```

### 5.1.16 adc\_voltage\_monitor\_threshold\_value\_set function

The table below describes the function adc\_voltage\_monitor\_threshold\_value\_set.

**Table 23. adc\_voltage\_monitor\_threshold\_value\_set function**

Name	Description
Function name	adc_voltage_monitor_threshold_value_set
Function prototype	void adc_voltage_monitor_threshold_value_set(adc_type *adc_x, uint16_t adc_high_threshold, uint16_t adc_low_threshold)
Function description	Configure the threshold of voltage monitoring
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	adc_high_threshold: indicates the upper limit for voltage monitoring This parameter can be any value between 0x000 and 0xFFFF.
Input parameter3	adc_low_threshold: indicates the lower limit for voltage monitoring This parameter can be any value between 0x000 and 0xFFFF, but not exceed the adc_high_threshold
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set voltage monitoring's high and low thresholds value */
adc_voltage_monitor_threshold_value_set(ADC1, 0xBBB, 0xAAA);
```

## 5.1.17 adc\_voltage\_monitor\_single\_channel\_select function

The table below describes the function adc\_voltage\_monitor\_single\_channel\_select.

**Table 24. adc\_voltage\_monitor\_single\_channel\_select function**

Name	Description
Function name	adc_voltage_monitor_single_channel_select
Function prototype	void adc_voltage_monitor_single_channel_select(adc_type *adc_x, adc_channel_select_type adc_channel)
Function description	Select a single channel for voltage monitoring
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	adc_channel: select a single channel for voltage monitoring Refer to <a href="#">adc_channel</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### adc\_channel

The adc\_channel is used to select a single channel for voltage monitoring, including:

- ADC\_CHANNEL\_0: ADC channel 0
- ADC\_CHANNEL\_1: ADC channel 1
- ADC\_CHANNEL\_2: ADC channel 2
- ADC\_CHANNEL\_3: ADC channel 3
- ADC\_CHANNEL\_4: ADC channel 4
- ADC\_CHANNEL\_5: ADC channel 5
- ADC\_CHANNEL\_6: ADC channel 6
- ADC\_CHANNEL\_7: ADC channel 7
- ADC\_CHANNEL\_8: ADC channel 8
- ADC\_CHANNEL\_9: ADC channel 9
- ADC\_CHANNEL\_10: ADC channel 10
- ADC\_CHANNEL\_11: ADC channel 11
- ADC\_CHANNEL\_12: ADC channel 12
- ADC\_CHANNEL\_14: ADC channel 14
- ADC\_CHANNEL\_15: ADC channel 15
- ADC\_CHANNEL\_16: ADC channel 16
- ADC\_CHANNEL\_17: ADC channel 17
- ADC\_CHANNEL\_19: ADC channel 19
- ADC\_CHANNEL\_20: ADC channel 20
- ADC\_CHANNEL\_21: ADC channel 21
- ADC\_CHANNEL\_22: ADC channel 22
- ADC\_CHANNEL\_23: ADC channel 23
- ADC\_CHANNEL\_24: ADC channel 24
- ADC\_CHANNEL\_26: ADC channel 26

### Example:

```
/* select the voltage monitoring's channel */
adc_voltage_monitor_single_channel_select(ADC1, ADC_CHANNEL_5);
```

## 5.1.18 adc\_ordinary\_channel\_set function

The table below describes the function adc\_ordinary\_channel\_set.

**Table 25. adc\_ordinary\_channel\_set function**

Name	Description
Function name	adc_ordinary_channel_set
Function prototype	void adc_ordinary_channel_set(adc_type *adc_x, adc_channel_select_type adc_channel, uint8_t adc_sequence, adc_sampletime_select_type adc_sampletime)
Function description	Configure ordinary channels, including parameters such as channel selection, conversion sequence number and sampling time
Input parameter 1	adc_x: indicates the selected ADC peripheral This parameter can be ADC1 or ADC2
Input parameter 2	adc_channel: indicates the selected channel Refer to <a href="#">adc_channel</a> for details.
Input parameter3	adc_sequence: defines the sequence of channel conversion This parameter can be any value from 1 to 16
Input parameter4	adc_sampletime: defines the sampling time for channel Refer to <a href="#">adc_sampletime</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### adc\_sampletime

The adc\_sampletime is used to configure the sampling time of channels, including:

ADC\_SAMPLETIME\_1\_5: sampling time is 15 ADCCLK cycles

ADC\_SAMPLETIME\_7\_5: sampling time is 7.5 ADCCLK cycles

ADC\_SAMPLETIME\_13\_5: sampling time is 13.5 ADCCLK cycles

ADC\_SAMPLETIME\_28\_5: sampling time is 28.5 ADCCLK cycles

ADC\_SAMPLETIME\_41\_5: sampling time is 41.5 ADCCLK cycles

ADC\_SAMPLETIME\_55\_5: sampling time is 55.5 ADCCLK cycles

ADC\_SAMPLETIME\_71\_5: sampling time is 71.5 ADCCLK cycles

ADC\_SAMPLETIME\_239\_5: sampling time is 239.5 ADCCLK cycles

### Example:

```
/* set ordinary channel's corresponding rank in the sequencer and sample time */
adc_ordinary_channel_set(ADC1, ADC_CHANNEL_4, 1, ADC_SAMPLETIME_239_5);
adc_ordinary_channel_set(ADC1, ADC_CHANNEL_5, 2, ADC_SAMPLETIME_239_5);
```

## 5.1.19 adc\_preempt\_channel\_length\_set function

The table below describes the function adc\_preempt\_channel\_length\_set.

**Table 26. adc\_preempt\_channel\_length\_set function**

Name	Description
Function name	adc_preempt_channel_length_set
Function prototype	void adc_preempt_channel_length_set(adc_type *adc_x, uint8_t adc_channel_lenght)
Function description	Set the length of preempted channel conversion
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_channel_lenght: set the length of preempted channel conversion This parameter can be any value from 0x1 to 0x4.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set preempt channel lenght */
adc_preempt_channel_length_set(ADC1, 3);
```

## 5.1.20 adc\_preempt\_channel\_set function

The table below describes the function adc\_preempt\_channel\_set.

**Table 27. adc\_preempt\_channel\_set function**

Name	Description
Function name	adc_preempt_channel_set
Function prototype	void adc_preempt_channel_set(adc_type *adc_x, adc_channel_select_type adc_channel, uint8_t adc_sequence, adc_sampletime_select_type adc_sampletime)
Function description	Configure preempted group, including parameters such as channel selection, conversion sequence number and sampling time
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_channel: indicates the selected channel Refer to <a href="#">adc_channel</a> for details.
Input parameter3	adc_sequence: set the sequence number for channel conversion This parameter can be any value from 1 to 4.
Input parameter4	adc_sampletime: set the sampling time for channels Refer to <a href="#">adc_sampletime</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set ordinary channel's corresponding rank in the sequencer and sample time */
```

```
adc_preempt_channel_set(ADC1, ADC_CHANNEL_7, 1, ADC_SAMPLETIME_239_5);
adc_preempt_channel_set(ADC1, ADC_CHANNEL_8, 2, ADC_SAMPLETIME_239_5);
```

### 5.1.21 adc\_ordinary\_conversion\_trigger\_set function

The table below describes the function adc\_ordinary\_conversion\_trigger\_set.

**Table 28. adc\_ordinary\_conversion\_trigger\_set function**

Name	Description
Function name	adc_ordinary_conversion_trigger_set
Function prototype	void adc_ordinary_conversion_trigger_set(adc_type *adc_x, adc_ordinary_trig_select_type adc_ordinary_trig, adc_ordinary_trig_edge_type adc_ordinary_trig_edge)
Function description	Enable trigger mode and select trigger events for ordinary group conversion
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_ordinary_trig: indicates the selected trigger event for ordinary group This parameter can be any enumerated value in the adc_ordinary_trig_select_type.
Input parameter3	adc_ordinary_trig_edge: indicates the pre-configured status of external trigger edge for ordinary group This parameter can be any enumerated value in the adc_ordinary_trig_edge_type.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### adc\_ordinary\_trig

The adc\_ordinary\_trig is used to select a trigger event for ordinary group conversion, including:

ADC_ORDINARY_TRIG_TMR1CH1:	TMR1 CH1 event
ADC_ORDINARY_TRIG_TMR1CH2:	TMR1 CH2 event
ADC_ORDINARY_TRIG_TMR1CH3:	TMR1 CH3 event
ADC_ORDINARY_TRIG_TMR9CH2:	TMR9 CH2 event
ADC_ORDINARY_TRIG_TMR9TRGOUT:	TMR9 TRGOUT event
ADC_ORDINARY_TRIG_TMR3CH1:	TMR3 CH1 event
ADC_ORDINARY_TRIG_TMR3TRGOUT:	TMR3 TRGOUT event
ADC_ORDINARY_TRIG_TMR4CH4:	TMR4 CH4 event
ADC_ORDINARY_TRIG_TMR1CH4:	TMR1 CH4 event
ADC_ORDINARY_TRIG_EXINT11:	EXINT 11 event
ADC_ORDINARY_TRIG_TMR1TRGOUT2:	TMR1 TRGOUT2 event
ADC_ORDINARY_TRIG_TMR4TRGOUT:	TMR4 TRGOUT event
ADC_ORDINARY_TRIG_TMR6TRGOUT:	TMR6 TRGOUT event
ADC_ORDINARY_TRIG_TMR3CH4:	TMR3 CH4 event
ADC_ORDINARY_TRIG_TMR4CH1:	TMR4 CH1 event
ADC_ORDINARY_TRIG_TMR1TRGOUT:	TMR1 TRGOUT event
ADC_ORDINARY_TRIG_TMR9CH1:	TMR9 CH1 event
ADC_ORDINARY_TRIG_TMR7TRGOUT:	TMR7 TRGOUT event

**adc\_ordinary\_trig\_edge**

ADC_ORDINARY_TRIG_EDGE_NONE:	Edge trigger disabled
ADC_ORDINARY_TRIG_EDGE_RISING:	Rising edge
ADC_ORDINARY_TRIG_EDGE_FALLING:	Falling edge
ADC_ORDINARY_TRIG_EDGE_RISING_FALLING:	Any edge (Rising edge/ Falling edge)

**Example:**

```
/* set ordinary external trigger event */
adc_ordinary_conversion_trigger_set(ADC1, ADC_ORDINARY_TRIG_TMR1CH1,
ADC_ORDINARY_TRIG_EDGE_NONE);
```

**5.1.22 adc\_preempt\_conversion\_trigger\_set function**

The table below describes the function adc\_preempt\_conversion\_trigger\_set.

**Table 29. adc\_preempt\_conversion\_trigger\_set function**

Name	Description
Function name	adc_preempt_conversion_trigger_set
Function prototype	void adc_preempt_conversion_trigger_set(adc_type *adc_x, adc_preempt_trig_select_type adc_preempt_trig, adc_preempt_trig_edge_type adc_preempt_trig_edge)
Function description	Enable trigger mode and trigger events for preempted group conversion
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_preempt_trig: indicates the selected trigger event for preempted group This parameter can be any enumerated value in the adc_preempt_trig_select_type.
Input parameter3	adc_preempt_trig_edge: indicates the pre-configured status of external trigger edge for preempted group This parameter can be any enumerated value in the adc_preempt_trig_edge_type.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_preempt\_trig**

The adc\_preempt\_trig is used to select a trigger event for preempted group conversion, including:

ADC_PREAMPT_TRIG_TMR1CH4:	TMR1 CH4 event
ADC_PREAMPT_TRIG_TMR1TRGOUT:	TMR1 TRGOUT event
ADC_PREAMPT_TRIG_TMR9CH1:	TMR9 CH1 event
ADC_PREAMPT_TRIG_TMR9TRGOUT:	TMR9 TRGOUT event
ADC_PREAMPT_TRIG_TMR3CH2:	TMR3 CH2 event
ADC_PREAMPT_TRIG_TMR3CH4:	TMR3 CH4 event
ADC_PREAMPT_TRIG_TMR4CH1:	TMR4 CH1 event
ADC_PREAMPT_TRIG_TMR4CH2:	TMR4 CH2 event
ADC_PREAMPT_TRIG_TMR4CH3:	TMR4 CH3 event
ADC_PREAMPT_TRIG_TMR4TRGOUT:	TMR4 TRGOUT event
ADC_PREAMPT_TRIG_TMR1CH2:	TMR1 CH2 event
ADC_PREAMPT_TRIG_EXINT15:	EXINT15 event

ADC_PREAMPT_TRIG_TMR1TRGOUT2:	TMR1 TRGOUT2 event
ADC_PREAMPT_TRIG_TMR3CH3:	TMR3 CH3 event
ADC_PREAMPT_TRIG_TMR3TRGOUT:	TMR3 TRGOUT event
ADC_PREAMPT_TRIG_TMR3CH1:	TMR3 CH1 event
ADC_PREAMPT_TRIG_TMR6TRGOUT:	TMR6 TRGOUT event
ADC_PREAMPT_TRIG_TMR4CH4:	TMR4 CH4 event
ADC_PREAMPT_TRIG_TMR1CH3:	TMR1 CH3 event
ADC_PREAMPT_TRIG_TMR7TRGOUT:	TMR7 TRGOUT event
<b>adc_preampt_trig_edge</b>	
ADC_PREAMPT_TRIG_EDGE_NONE:	Edge trigger disabled
ADC_PREAMPT_TRIG_EDGE_RISING:	Rising edge
ADC_PREAMPT_TRIG_EDGE_FALLING:	Falling edge
ADC_PREAMPT_TRIG_EDGE_RISING_FALLING:	Any edge (Rising edge/ Falling edge)

**Example:**

```
/* set preempt external trigger event */
adc_preampt_conversion_trigger_set(ADC1, ADC_PREAMPT_TRIG_TMR1CH4,
ADC_PREAMPT_TRIG_EDGE_NONE);
```

### 5.1.23 adc\_preampt\_offset\_value\_set function

The table below describes the function adc\_preampt\_offset\_value\_set.

**Table 30. adc\_preampt\_offset\_value\_set function**

Name	Description
Function name	adc_preampt_offset_value_set
Function prototype	void adc_preampt_offset_value_set(adc_type *adc_x, adc_preampt_channel_type adc_preampt_channel, uint16_t adc_offset_value)
Function description	Set the offset value of preempted group conversion
Input parameter 1	adc_x: selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_preampt_channel: indicates the selected channel Refer to <a href="#">adc_preampt_channel</a> for details.
Input parameter3	adc_offset_value: set the offset value for the selected channel This parameter can be any value from 0x000 to 0xFFFF.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_preampt\_channel**

The adc\_preampt\_channel is used to set an offset value for the selected channel, including:

ADC_PREAMPT_CHANNEL_1:	Preempted channel 1
ADC_PREAMPT_CHANNEL_2:	Preempted channel 2
ADC_PREAMPT_CHANNEL_3:	Preempted channel 3
ADC_PREAMPT_CHANNEL_4:	Preempted channel 4

**Example:**

```
/* set preempt channel's conversion value offset */
adc_preampt_offset_value_set(ADC1, ADC_PREAMPT_CHANNEL_1, 0x111);
```

```
adc_preempt_offset_value_set(ADC1, ADC_PREEMPT_CHANNEL_2, 0x222);
adc_preempt_offset_value_set(ADC1, ADC_PREEMPT_CHANNEL_3, 0x333);
```

### 5.1.24 adc\_ordinary\_part\_count\_set function

The table below describes the function adc\_ordinary\_part\_count\_set.

**Table 31. adc\_ordinary\_part\_count\_set function**

Name	Description
Function name	adc_ordinary_part_count_set
Function prototype	void adc_ordinary_part_count_set(adc_type *adc_x, uint8_t adc_channel_count)
Function description	Set the number of ordinary channels at each triggered conversion in partition mode
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_channel_count: indicates the number of ordinary group in partition mode This parameter can be any value from 0x1 to 0x8.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set partitioned mode channel count */
adc_ordinary_part_count_set(ADC1, 2);
```

*Note: In partition mode, only the number of ordinary group is settable, and that of preempted group is fixed 1.*

### 5.1.25 adc\_ordinary\_part\_mode\_enable function

The table below describes the function adc\_ordinary\_part\_mode\_enable.

**Table 32. adc\_ordinary\_part\_mode\_enable function**

Name	Description
Function name	adc_ordinary_part_mode_enable
Function prototype	void adc_ordinary_part_mode_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable partition mode for ordinary channels
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status for partition mode of ordinary channels This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable the partitioned mode on ordinary channel */
adc_ordinary_part_mode_enable(ADC1, TRUE);
```

## 5.1.26 adc\_preempt\_part\_mode\_enable function

The table below describes the function adc\_preempt\_part\_mode\_enable.

**Table 33. adc\_preempt\_part\_mode\_enable function**

Name	Description
Function name	adc_preempt_part_mode_enable
Function prototype	void adc_preempt_part_mode_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable partition mode for preempted channels
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status for partition mode of preempted channels This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable the partitioned mode on preempt channel */
adc_preempt_part_mode_enable(ADC1, TRUE);
```

## 5.1.27 adc\_preempt\_auto\_mode\_enable function

The table below describes the function adc\_preempt\_auto\_mode\_enable.

**Table 34. adc\_preempt\_auto\_mode\_enable function**

Name	Description
Function name	adc_preempt_auto_mode_enable
Function prototype	void adc_preempt_auto_mode_enable(adc_type *adc_x, confirm_state,new_state)
Function description	Enable auto preempted group conversion at the end of ordinary group conversion
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status for auto preempted group conversion This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable automatic preempt group conversion */
adc_preempt_auto_mode_enable(ADC1, TRUE);
```

## 5.1.28 adc\_conversion\_stop function

The table below describes the function adc\_conversion\_stop.

**Table 35. adc\_conversion\_stop function**

Name	Description
Function name	adc_conversion_stop
Function prototype	void adc_conversion_stop(adc_type *adc_x)
Function description	Stop on-going ADC conversion
Input parameter	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* stop the ongoing conversion */
adc_conversion_stop(ADC1);
```

## 5.1.29 adc\_conversion\_stop\_status\_get function

The table below describes the function adc\_conversion\_stop\_status\_get.

**Table 36. adc\_conversion\_stop\_status\_get function**

Name	Description
Function name	adc_conversion_stop_status_get
Function prototype	flag_status adc_conversion_stop_status_get(adc_type *adc_x)
Function description	Get the status of stop conversion command
Input parameter	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	flag_status: get the operational status of stop conversion command This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
/* wait stop conversion's */
while(adc_conversion_stop_status_get(ADC1));
```

### 5.1.30 adc\_occe\_each\_conversion\_enable function

The table below describes the function adc\_occe\_each\_conversion\_enable.

**Table 37. adc\_occe\_each\_conversion\_enable function**

Name	Description
Function name	adc_occe_each_conversion_enable
Function prototype	void adc_occe_each_conversion_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable OCCE flag for each ordinary channel conversion
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of OCCE flag This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* each ordinary channel conversion set occe flag */
adc_occe_each_conversion_enable(ADC1, TRUE);
```

### 5.1.31 adc\_ordinary\_software\_trigger\_enable function

The table below describes the function adc\_ordinary\_software\_trigger\_enable.

**Table 38. adc\_ordinary\_software\_trigger\_enable function**

Name	Description
Function name	adc_ordinary_software_trigger_enable
Function prototype	void adc_ordinary_software_trigger_enable(adc_type *adc_x, confirm_state new_state)
Function description	Trigger ordinary group conversion by software
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status for software-triggered ordinary group conversion This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable ordinary software start conversion */
adc_ordinary_software_trigger_enable(ADC1, TRUE);
```

### 5.1.32 adc\_ordinary\_software\_trigger\_status\_get function

The table below describes the function adc\_ordinary\_software\_trigger\_status\_get

**Table 39. adc\_ordinary\_software\_trigger\_status\_get function**

Name	Description
Function name	adc_ordinary_software_trigger_status_get
Function prototype	flag_status adc_ordinary_software_trigger_status_get(adc_type *adc_x)
Function description	Get the status of software-triggered ordinary group conversion
Input parameter	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	flag_status: indicates the status of software-triggered ordinary group conversion This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
/* wait ordinary software start conversion */
while(adc_ordinary_software_trigger_status_get(ADC1));
```

### 5.1.33 adc\_preempt\_software\_trigger\_enable function

The table below describes the function adc\_preempt\_software\_trigger\_enable

**Table 40. adc\_preempt\_software\_trigger\_enable function**

Name	Description
Function name	adc_preempt_software_trigger_enable
Function prototype	void adc_preempt_software_trigger_enable(adc_type *adc_x, confirm_state new_state)
Function description	Preempted group conversion triggered by software
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of software-triggered preempted group conversion This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable preempt software start conversion */
adc_preempt_software_trigger_enable(ADC1, TRUE);
```

### 5.1.34 adc\_preempt\_software\_trigger\_status\_get function

The table below describes the function adc\_preempt\_software\_trigger\_status\_get.

**Table 41. adc\_preempt\_software\_trigger\_status\_get function**

Name	Description
Function name	adc_preempt_software_trigger_status_get
Function prototype	flag_status adc_preempt_software_trigger_status_get(adc_type *adc_x)
Function description	Get the status of software-triggered preempted group conversion
Input parameter	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	flag_status: indicates the status of software-triggered preempted group conversion This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
/* wait preempt software start conversion */
while(adc_preempt_software_trigger_status_get(ADC1));
```

### 5.1.35 adc\_ordinary\_conversion\_data\_get function

The table below describes the function adc\_ordinary\_conversion\_data\_get.

**Table 42. adc\_ordinary\_conversion\_data\_get function**

Name	Description
Function name	adc_ordinary_conversion_data_get
Function prototype	uint16_t adc_ordinary_conversion_data_get(adc_type *adc_x)
Function description	Get the converted data of ordinary group in non-master/slave mode
Input parameter	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Output parameter	NA
Return value	16-bit converted data by ordinary group
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t adc1_ordinary_index = 0;
adc1_ordinary_index = adc_ordinary_conversion_data_get(ADC1);
```

### 5.1.36 adc\_combine\_ordinary\_conversion\_data\_get function

The table below describes the function adc\_combine\_ordinary\_conversion\_data\_get.

**Table 43. adc\_combine\_ordinary\_conversion\_data\_get function**

Name	Description
Function name	adc_combine_ordinary_conversion_data_get
Function prototype	uint32_t adc_combine_ordinary_conversion_data_get(void)
Function description	Get converted data from ordinary group in combined master-slave mode
Input parameter	NA
Output parameter	NA
Return value	32-bit converted data from ordinary group
Required preconditions	NA
Called functions	NA

**Example:**

```
uint32_t common_ordinary_index = 0;
common_ordinary_index = adc_combine_ordinary_conversion_data_get();
```

### 5.1.37 adc\_preempt\_conversion\_data\_get function

The table below describes the function adc\_preempt\_conversion\_data\_get.

**Table 44. adc\_preempt\_conversion\_data\_get function**

Name	Description
Function name	adc_preempt_conversion_data_get
Function prototype	uint16_t adc_preempt_conversion_data_get(adc_type *adc_x, adc_preempt_channel_type adc_preempt_channel)
Function description	Get the converted data of preempted group
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_preempt_channel: the selected preempted channel Refer to <a href="#">adc_preempt_channel</a> for details.
Output parameter	NA
Return value	16-bit converted data by preempted group
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t adc1_preempt_valuetab[3] = {0};
adc1_preempt_valuetab[0] = adc_preempt_conversion_data_get(ADC1, ADC_PREEMPT_CHANNEL_1);
adc1_preempt_valuetab[1] = adc_preempt_conversion_data_get(ADC1, ADC_PREEMPT_CHANNEL_2);
adc1_preempt_valuetab[2] = adc_preempt_conversion_data_get(ADC1, ADC_PREEMPT_CHANNEL_3);
```

### 5.1.38 adc\_flag\_get function

The table below describes the function adc\_flag\_get.

**Table 45. adc\_flag\_get function**

Name	Description
Function name	adc_flag_get
Function prototype	flag_status adc_flag_get(adc_type *adc_x, uint8_t adc_flag)
Function description	Get the status of the flag bit
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_flag: indicates the selected flag Refer to <a href="#">adc_flag</a> for details.
Output parameter	NA
Return value	flag_status: the status for the selected flag bit. This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

#### adc\_flag

The adc\_flag is used to select a flag to get its status, including:

ADC_VMOR_FLAG:	Voltage monitor outside threshold
ADC_OCCE_FLAG:	End of ordinary channel conversion
ADC_PCCE_FLAG:	End of preempted channel conversion
ADC_PCCS_FLAG:	Start of preempted channel conversion
ADC_OCCS_FLAG:	Start of ordinary channel conversion
ADC_OCCO_FLAG:	Overflow flag for ordinary channel conversion
ADC_RDY_FLAG:	ADC ready to conversion flag
ADC_TCF_FLAG:	Triggered conversion failure flag

#### Example:

```
/* check if wakeup preempted channelsconversion end flag is set */
if(adc_flag_get(ADC1, ADC_PCCE_FLAG) != RESET)
```

### 5.1.39 adc\_interrupt\_flag\_get function

The table below describes the function adc\_interrupt\_flag\_get.

**Table 46. adc\_interrupt\_flag\_get function**

Name	Description
Function name	adc_interrupt_flag_get
Function prototype	flag_status adc_interrupt_flag_get(adc_type *adc_x, uint8_t adc_flag)
Function description	Get ADC interrupt flag status
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_flag: select a flag to clear Refer to <a href="#">adc_flag</a>
Output parameter	NA
Return value	flag_status: SET or RESET.
Required preconditions	NA

Name	Description
Called functions	NA

**adc\_flag**

The adc\_flag is used to select a flag to get its status, including:

- ADC\_VMOR\_FLAG: Voltage monitor outside threshold
- ADC\_OCCE\_FLAG: End of ordinary channel conversion
- ADC\_PCCE\_FLAG: End of preempted channel conversion
- ADC\_OCCO\_FLAG: Overflow flag for ordinary channel conversion

**Example:**

```
/* check if wakeup preempted channelsconversion end flag is set */
if(adc_interrupt_flag_get(ADC1, ADC_PCCE_FLAG) != RESET)
```

### 5.1.40 adc\_flag\_clear function

The table below describes the function adc\_flag\_clear.

**Table 47. adc\_flag\_clear function**

Name	Description
Function name	adc_flag_clear
Function prototype	void adc_flag_clear(adc_type *adc_x, uint32_t adc_flag)
Function description	Clear the flag bits that have been set.
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_flag: select a flag to clear Refer to <a href="#">adc_flag</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* preempted channelsconversion end flag clear */
adc_flag_clear(ADC1, ADC_PCCE_FLAG);
```

### 5.1.41 adc\_ordinary\_oversample\_enable function

The table below describes the function adc\_ordinary\_oversample\_enable.

**Table 48. adc\_ordinary\_oversample\_enable function**

Name	Description
Function name	adc_ordinary_oversample_enable
Function prototype	void adc_ordinary_oversample_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable oversampling for ordinary group
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of oversampling of ordinary group This parameter can be TRUE or FALSE.
Output parameter	NA

Name	Description
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable ordinary oversampling */
adc_ordinary_oversample_enable(ADC1, TRUE);
```

### 5.1.42 adc\_preempt\_oversample\_enable function

The table below describes the function adc\_preempt\_oversample\_enable.

**Table 49. adc\_preempt\_oversample\_enable function**

Name	Description
Function name	adc_preempt_oversample_enable
Function prototype	void adc_preempt_oversample_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable oversampling for preempted group
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of oversampling of preempted group This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable preempt oversampling */
adc_preempt_oversample_enable(ADC1, TRUE);
```

### 5.1.43 adc\_oversample\_ratio\_shift\_set function

The table below describes the function adc\_oversample\_ratio\_shift\_set.

**Table 50. adc\_oversample\_ratio\_shift\_set function**

Name	Description
Function name	adc_oversample_ratio_shift_set
Function prototype	void adc_oversample_ratio_shift_set(adc_type *adc_x, adc_oversample_ratio_type adc_oversample_ratio, adc_oversample_shift_type adc_oversample_shift)
Function description	Set oversampling ratio and shift mode
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_oversample_ratio: indicates the oversampling rate This parameter can be any enumerated value in the adc_oversample_ratio_type.
Input parameter3	adc_oversample_shift: indicates the oversampling shift mode This parameter can be any enumerated value in the adc_oversample_shift_type.

Name	Description
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_oversample\_ratio**

The adc\_oversample\_ratio is used for ADC oversampling ratio selection, including:

ADC_OVERSAMPLE_RATIO_2:	2 x oversampling
ADC_OVERSAMPLE_RATIO_4:	4 x oversampling
ADC_OVERSAMPLE_RATIO_8:	5 x oversampling
ADC_OVERSAMPLE_RATIO_16:	16 x oversampling
ADC_OVERSAMPLE_RATIO_32:	32 x oversampling
ADC_OVERSAMPLE_RATIO_64:	64 x oversampling
ADC_OVERSAMPLE_RATIO_128:	128 x oversampling
ADC_OVERSAMPLE_RATIO_256:	256 x oversampling

**adc\_oversample\_shift**

The adc\_oversample\_shift is used for ADC oversampling bit width selection, including:

ADC_OVERSAMPLE_SHIFT_0:	No shift
ADC_OVERSAMPLE_SHIFT_1:	1-bit shift
ADC_OVERSAMPLE_SHIFT_2:	2-bit shift
ADC_OVERSAMPLE_SHIFT_3:	3-bit shift
ADC_OVERSAMPLE_SHIFT_4:	4-bit shift
ADC_OVERSAMPLE_SHIFT_5:	5-bit shift
ADC_OVERSAMPLE_SHIFT_6:	6-bit shift
ADC_OVERSAMPLE_SHIFT_7:	7-bit shift
ADC_OVERSAMPLE_SHIFT_8:	8-bit shift

**Example:**

```
/* set oversampling ratio and shift */
adc_oversample_ratio_shift_set(ADC1, ADC_OVERSAMPLE_RATIO_8, ADC_OVERSAMPLE_SHIFT_3);
```

### 5.1.44 adc\_ordinary\_oversample\_trig\_enable function

The table below describes the function adc\_ordinary\_oversample\_trig\_enable.

**Table 51. adc\_ordinary\_oversample\_trig\_enable function**

Name	Description
Function name	adc_ordinary_oversample_trig_enable
Function prototype	void adc_ordinary_oversample_trig_enable(adc_type *adc_x, confirm_state new_state)
Function description	Enable oversampling trigger mode for ordinary group
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: indicates the pre-configured status of oversampling trigger mode of ordinary group. This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA

Name	Description
Called functions	NA

**Example:**

```
/* disable ordinary oversampling trigger mode */
adc_ordinary_oversample_trig_enable(ADC1, FALSE);
```

### 5.1.45 adc\_ordinary\_oversample\_restart\_set function

The table below describes the function adc\_ordinary\_oversample\_restart\_set.

**Table 52. adc\_ordinary\_oversample\_restart\_set function**

Name	Description
Function name	adc_ordinary_oversample_restart_set
Function prototype	void adc_ordinary_oversample_restart_set(adc_type *adc_x, adc_ordinary_oversample_restart_type adc_ordinary_oversample_restart)
Function description	Select oversampling restart mode for ordinary group
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_ordinary_oversample_restart: indicates the pre-configurated status of oversampling restart mode for ordinary group This parameter can be any enumerated value in the adc_ordinary_oversample_restart_type.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**adc\_ordinary\_oversample\_restart**

The adc\_ordinary\_oversample\_restart is used to select oversampling restart mode for ordinary group ADC conversion, including:

**ADC\_OVERSAMPLE\_CONTINUE:**

Continuous mode (the oversampling buffer area of ordinary group is preserved)

**ADC\_OVERSAMPLE\_RESTART:**

Restart mode (the oversampling buffer area of ordinary group is cleared, that is, the sampling times of the current channel is cleared)

**Example:**

```
/* set ordinary oversample restart mode */
adc_ordinary_oversample_restart_set(ADC1, ADC_OVERSAMPLE_CONTINUE);
```

## 5.1.46 adc\_convert\_fail\_auto\_abort\_enable function

The table below describes the function adc\_convert\_fail\_auto\_abort\_enable.

**Table 53. adc\_ordinary\_oversample\_restart\_set function**

Name	Description
Function name	adc_convert_fail_auto_abort_enable
Function prototype	void adc_convert_fail_auto_abort_enable(adc_type *adc_x, confirm_state new_state)
Function description	ADC auto abort after triggered conversion failure
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	new_state: ADC auto abort state after triggered conversion failure This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable adc trigger conversion fail auto conversion abort */
adc_convert_fail_auto_abort_enable(ADC1, TRUE);
```

## 5.1.47 adc\_common\_ordinary\_data\_get function

The table below describes the function adc\_common\_ordinary\_data\_get.

**Table 54. adc\_common\_ordinary\_data\_get function**

Name	Description
Function name	adc_common_ordinary_data_get
Function prototype	uint16_t adc_common_ordinary_data_get(adc_type *adc_x, uint16_t adc_sequence_number)
Function description	Get converted data from common ordinary group
Input parameter 1	adc_x: indicates the selected ADC This parameter can be ADC1 or ADC2
Input parameter 2	adc_sequence_number: conversion sequence number This parameter can be set to any value between 0x1 and 0x10.
Output parameter	NA
Return value	16-bit converted data from ordinary group
Required preconditions	NA
Called functions	NA

**Example:**

```
adc1_ordinary_valuetab[1] = adc_common_ordinary_data_get(ADC1, 2);
```

## 5.2 Controller area network (CAN)

CAN register structure can\_type is defined in the “at32m412\_416\_can.h”:

```
/*
 * @brief type define can register all
 */
typedef struct
{
    ...
} can_type;
```

The table below gives a list of the CAN registers.

**Table 55. Summary of CAN registers**

Register	Description
tncfg	Time stamp and node control register
actime	Classic-CAN bit timing register
fdtime	CAN-FD bit timing register
lbtcfg	Limit and bit timing configuration register
sts	Interrupt status register
tstat	Transmit status register
tts	Transmit timestamp register
ctrlstat	Control and status register
err	Error configuration and status register
refmsg	TTCAN reference message register
ttcfg	TTCAN trigger configuration register
tttrig	TTCANtrigger timing configuration register
acfctrl	Acceptance filter control register
fcid	Filter identifier ID area
fcfmt	Filter identifier format area
fctyp	Filter identifier type area
fcacf	Filter identifier acceptance field
fmid	Filter mask ID area
fmfmt	Filter mask format area
fmtyp	Filter mask type area
fmacf	Filter mask acceptance field
rbid	Receive buffer ID area
rbfmt	Receive buffer format area
rbtyp	Receive buffer type area
rbacf	Receive buffer acceptance filed
rbdat[0..18]	Receive buffer data area
tbid	Trasmit buffer ID area
tbfmt	Trasmit buffer format area
tbtyp	Trasmit buffer type area
tbacf	Trasmit buffer acceptance field
tbdat[0..15]	Trasmit buffer data area

Register	Description
llcformat	LLC frame calculation input register
llcsize	LLC frame calculation output register
inten	Interrupt enable register

The table below gives a list of CAN library functions.

**Table 56. Summary of CAN library functions**

Function name	Description
can_reset	Reset all CAN registers to their reset values
can_software_reset	CAN software reset
can_fd_iso_mode_enable	Enable CAN-FD ISO mode (for CAN-FD only)
can_mode_set	Set CAN operating mode
can_standby_mode_enable	Enable transceiver standby mode
can_restricted_operation_enable	Enable CAN restricted operation mode
can_bittime_default_para_init	Set initial default value for the can_bittime_struct
can_bittime_set	Set CAN bittime and baud rate
can_retransmission_limit_set	Set CAN retransmission limit
can_rearbitration_limit_set	Set CAN rearbitration limit
can_timestamp_enable	Enable CAN timestamp
can_timestamp_position_set	Set CAN timestamp position
can_transmit_timestamp_get	Get CAN transmit timestamp
can_txbuf_write	Write CAN transmit buffer
can_txbuf_transmit	Transmit data from transmit buffer
can_transmit_abort	Abort CAN data transmission
can_stb_transmit_mode_set	Set transmit mode of secondary transmission buffer
can_stb_status_get	Get secondar transmit buffer status
can_transmit_status_get	Get transmit status
can_stb_clear	Clear secondar transmit buffer data
can_rxbuf_overflow_mode_set	Set overflow mode of receive buffer
can_receive_all_enable	Enable CAN receive all
can_rxbuf_read	Read data of receive buffer
can_rxbuf_release	Release receiver buffer
can_rxbuf_status_get	Get receive buffer status
can_filter_default_para_init	Set initial default value for the filter_config_struct
can_filter_set	Set CAN receive filter
can_filter_enable	Enable receiver filter
can_arbitration_lost_capture_get	Get arbitration lost position
can_rxbuf_warning_set	Set receive buffer almost full warning level value
can_error_warning_set	Set error count warning level value
can_kind_error_get	Get error type
can_receive_error_counter_get	Get receive error count
can_transmit_error_counter_get	Get transmit error count
can_busoff_get	Get bus-off status
can_busoff_reset	Reset bus-off status
can_ttcanc_ref_message_set	Set TTCAN reference message

can_ttcancan_timer_div_set	Set TTCAN clock timer division
can_ttcancan_enable	Enable TTCAN
can_ttcancan_trigger_type_set	Set TTCAN trigger type
can_ttcancan_trigger_set	Set TTCAN trigger time
can_ttcancan_watch_trigger_set	Set TTCAN window trigger time
can_ttcancan_transmit_window_set	Set TTCAN transmit enable widow
can_ttcancan_txbuf_enable	Enable TTCAN transmit buffer slot mode
can_ttcancan_txbuf_status_set	Set TTCAN transmit buffer slot state
can_ttcancan_txbuf_status_get	Get TTCAN transmit buffer slot status
can_ttcancan_txbuf_transmit_set	Set TTCAN transmit buffer slot to be sent
can_ttcancan_txbuf_write	Write TTCAN transmit buffer slot
can_interrupt_enable	Enable CAN interrupts
can_flag_get	Get CAN flags
can_interrupt_flag_get	Get CAN interrupt flags
can_flag_clear	Clear CAN interrupt flags

## 5.2.1 can\_reset function

The table below describes the function can\_reset.

Table 57. can\_reset function

Name	Description
Function name	can_reset
Function prototype	void can_reset(can_type* can_x);
Function description	Reset all CAN registers to their default values.
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

can_reset(CAN1);
------------------

## 5.2.2 can\_software\_reset function

The table below describes the function can\_software\_reset.

**Table 58. can\_software\_reset function**

Name	Description
Function name	can_software_reset
Function prototype	void can_software_reset(can_type* can_x, confirm_state new_state);
Function description	Reset partial CAN registers to their default values and these register can be configurable only when software resets
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
can_software_reset(CAN1);
```

## 5.2.3 can\_fd\_iso\_mode\_enable function

The table below describes the function can\_fd\_iso\_mode\_enable.

**Table 59. fd\_iso\_mode\_enable function**

Name	Description
Function name	can_fd_iso_mode_enable
Function prototype	void can_fd_iso_mode_enable(can_type* can_x, confirm_state new_state);
Function description	Enable CAN-FD ISO mode (for CAN-FD only)
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	This mode can be used only when software resets.
Called functions	NA

**Example:**

```
can_software_reset(CAN1, TRUE);
can_fd_iso_mode_enable(CAN1, TRUE);
can_software_reset(CAN1, FALSE);
```

## 5.2.4 can\_mode\_set function

The table below describes the function can\_mode\_set.

**Table 60. can\_mode\_set function**

Name	Description
Function name	can_mode_set
Function prototype	void can_mode_set(can_type* can_x, can_mode_type mode_selection);
Function description	Set CAN communication mode
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>mode_selection</i> : operating mode selection
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of the can_base_type before starting.
Called functions	NA

### mode\_selection

CAN_MODE_COMMUNICATE:	Communication mode
CAN_MODE_EXT_LOOPBACK:	External loopback mode
CAN_MODE_EXT_LOOPBACK_ACK:	External loopback + acknowledge mode
CAN_MODE_INT_LOOPBACK:	Internal loopback mode
CAN_MODE_LISTENONLY:	Listen-only mode
CAN_MODE_LISTENONLY_EXT:	Listen only + external loopback mode
CAN_MODE_LISTENONLY_EXT_ACK:	Listener only + external loopback + acknowledge mode

### Example:

```
can_mode_set(CAN1, CAN_MODE_COMMUNICATE);
```

## 5.2.5 can\_standby\_mode\_enable function

The table below describes the function can\_standby\_mode\_enable.

**Table 61. can\_standby\_mode\_enable function**

Name	Description
Function name	can_standby_mode_enable
Function prototype	error_status can_standby_mode_enable(can_type* can_x, confirm_state new_state);
Function description	Enable CAN transceiver standby mode
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	error_status: setting success or setting failure
Required preconditions	NA
Called functions	NA

### Example:

```
can_standby_mode_enable (CAN1, TRUE);
```

## 5.2.6 can\_restricted\_operation\_enable function

The table below describes the function can\_restricted\_operation\_enable.

**Table 62. can\_restricted\_operation\_enable function**

Name	Description
Function name	can_restricted_operation_enable
Function prototype	void can_restricted_operation_enable(can_type* can_x, confirm_state new_state);
Function description	Enable CAN restricted operation mode
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of can_filter_init_type before starting.
Called functions	NA

**Example:**

```
can_restricted_operation_enable(CAN1, TRUE);
```

## 5.2.7 can\_bittime\_default\_para\_init function

The table below describes the function can\_bittime\_default\_para\_init.

**Table 63. can\_bittime\_default\_para\_init function**

Name	Description
Function name	can_bittime_default_para_init
Function prototype	void can_bittime_default_para_init(can_bittime_type* can_bittime_struct);
Function description	Set an initial default value for the can_bittime_struct
Input parameter 1	can_bittime_struct: pointer to the <a href="#">can_bittime_type</a>
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of the can_bittime_type before starting.
Called functions	NA

**can\_bittime\_type** is defined in the AT32M412\_416\_can.h:

```
typedef struct
{
    uint8_t bittime_div;
    uint8_t ac_rsaw_size;
    uint16_t ac_bts1_size;
    uint8_t ac_bts2_size;
#ifndef SUPPORT_CAN_FD
    uint8_t fd_rsaw_size;
    uint16_t fd_bts1_size;
    uint8_t fd_bts2_size;
    uint8_t fd_ssp_offset;
#endif
}can_bittime_struct;
```

```

} can_bittime_type;
bittime_div
CAN clock division factor
Value range: 0x01~0x20
ac_rsaw_size
classic-can resynchronization jump width: the maximum limit for shortening or lengthening the bit time for resynchronization
Value range: 0x01~0x80
ac_bts1_size
classic-can segment1 time
Value range: 0x02~0x201
ac_bts2_size
classic-can segment2 time
Value range: 0x01~0x80
fd_rsaw_size
can-fd resynchronization jump width: the maximum limit for shortening or lengthening the bit time for resynchronization
Value range: 0x01~0x80
fd_bts1_size
can-fd segment1 time
Value range: 0x02~0x101
fd_bts2_size
can-fd segment2 time
Value range: 0x01~0x80
fd_ssp_offset
can-fd secondary sample point offset
Value range: 0x00~0xFF

```

**Example:**

```

/* initialize a can_bittime_type structure */
can_bittime_type can_bittime_struct;
can_bittime_default_para_init(&can_bittime_struct);

```

## 5.2.8 can\_bittime\_set function

The table below describes the function can\_bittime\_set.

Table 64. can\_bittime\_set function

Name	Description
Function name	can_bittime_set
Function prototype	void can_bittime_set(can_type* can_x, can_bittime_type* can_bittime_struct);
Function description	Set CAN baud rate
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	can_bittime_struct: pointer to the <a href="#">can_bittime_type</a>
Output parameter	NA
Return value	NA
Required preconditions	1. It is necessary to define the can_bittime_type variable 2. This feature can be used only when software resets

Name	Description
Called functions	NA

**can\_bittime\_type** is defined in the AT32M412\_416\_can.h:

typedef struct

```
{
    uint8_t bittime_div;
    uint8_t ac_rsaw_size;
    uint16_t ac_bts1_size;
    uint8_t ac_bts2_size;
#define SUPPORT_CAN_FD
    uint8_t fd_rsaw_size;
    uint16_t fd_bts1_size;
    uint8_t fd_bts2_size;
    uint8_t fd_ssp_offset;
#endif
}
```

**can\_bittime\_type;**

#### **bittime\_div**

CAN clock division factor

Value range: 0x01~0x20

#### **ac\_rsaw\_size**

classic-can resynchronization jump width: the maximum limit for shortening or lengthening the bit time for resynchronization

Value range: 0x01~0x80

#### **ac\_bts1\_size**

classic-can segment1 time

Value range: 0x02~0x201

#### **ac\_bts2\_size**

classic-can segment2 time

Value range: 0x01~0x80

#### **fd\_rsaw\_size**

can-fd resynchronization jump width: the maximum limit for shortening or lengthening the bit time for resynchronization

Value range: 0x01~0x80

#### **fd\_bts1\_size**

can-fd segment1 time

Value range: 0x02~0x101

#### **fd\_bts2\_size**

can-fd segment2 time

Value range: 0x01~0x80

#### **fd\_ssp\_offset**

can-fd secondary sample point offset

Value range: 0x00~0xFF

#### **Example:**

```
can_software_reset(CAN1, TRUE);
/* set can bit time */
can_bittime_struct.bittime_div = 1;
```

```

can_bittime_struct.ac_bts1_size = 96;
can_bittime_struct.ac_bts2_size = 24;
can_bittime_struct.ac_rsaw_size = 24;
can_bittime_struct.fd_bts1_size = 19;
can_bittime_struct.fd_bts2_size = 5;
can_bittime_struct.fd_rsaw_size = 5;
can_bittime_struct.fd_ssp_offset = 20;
can_bittime_set(CAN1, &can_bittime_struct);
can_software_reset(CAN1, FALSE);

```

## 5.2.9 can\_retransmission\_limit\_set function

The table below describes the function can\_retransmission\_limit\_set

**Table 65. can\_retransmission\_limit\_set function**

Name	Description
Function name	can_retransmission_limit_set
Function prototype	void can_retransmission_limit_set(can_type* can_x, can_retransmission_times_type re_trans_times);
Function description	Set CAN retransmission limit
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>re_trans_times</i> : retransmission times
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### re\_trans\_times

- |                             |                          |
|-----------------------------|--------------------------|
| CAN_RE_TRANS_TIMES_0:       | No retransmission        |
| CAN_RE_TRANS_TIMES_1:       | Retransmission 1 time    |
| .....                       |                          |
| CAN_RE_TRANS_TIMES_6:       | Retransmission 6 times   |
| CAN_RE_TRANS_TIMES_UNLIMIT: | Retransmission unlimited |

### Example:

```
can_retransmission_limit_set(CAN1, CAN_RE_TRANS_TIMES_UNLIMIT);
```

## 5.2.10 can\_rearbitration\_limit\_set function

The table below describes the function can\_rearbitration\_limit\_set.

**Table 66. can\_rearbitration\_limit\_set function**

Name	Description
Function name	can_rearbitration_limit_set
Function prototype	void can_rearbitration_limit_set(can_type* can_x, can_rearbitration_times_type re_arbi_times);
Function description	Set rearbitration limit
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>re_arbi_times</i> : rearbitration times
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### re\_trans\_times

CAN_RE_TRANS_TIMES_0:	No retransmission
CAN_RE_TRANS_TIMES_1:	Retransmission 1 time
.....	
CAN_RE_TRANS_TIMES_6:	Retransmission 6 times
CAN_RE_TRANS_TIMES_UNLIMIT:	Retransmission unlimited

### Example:

```
can_rearbitration_limit_set(CAN1, CAN_RE_ARBI_TIMES_UNLIMIT);
```

## 5.2.11 can\_timestamp\_enable function

The table below describes the function can\_timestamp\_enable.

**Table 67. can\_timestamp\_enable function**

Name	Description
Function name	can_timestamp_enable
Function prototype	void can_timestamp_enable(can_type* can_x, confirm_state new_state);
Function description	Enable timestamp
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### Example:

```
can_timestamp_enable(CAN1, TRUE);
```

## 5.2.12 can\_timestamp\_position\_set function

The table below describes the function can\_timestamp\_position\_set.

**Table 68. can\_timestamp\_position\_set function**

Name	Description
Function name	can_timestamp_position_set
Function prototype	void can_timestamp_position_set(can_type* can_x, can_timestamp_position_type timestamp_position);
Function description	Set timestamp position
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>timestamp_position</i> : timestamp position
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### timestamp\_position

CAN\_TIMESTAMP\_AT\_SOF: Timestamp at SOF

CAN\_TIMESTAMP\_AT\_EOF: Timestamp at EOF

#### Example:

```
can_timestamp_position_set(CAN1, CAN_TIMESTAMP_AT_SOF);
```

## 5.2.13 can\_transmit\_timestamp\_get function

The table below describes the function can\_transmit\_timestamp\_get.

**Table 69. can\_transmit\_timestamp\_get function**

Name	Description
Function name	can_transmit_timestamp_get
Function prototype	uint32_t can_transmit_timestamp_get(can_type* can_x);
Function description	Get transmit timestamp
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	Transmit timestamp Range: depends on TMR counter
Required preconditions	NA
Called functions	NA

#### Example:

```
uint32_t transmit_timestamp;  
transmit_timestamp = can_transmit_timestamp_get (CAN1);
```

## 5.2.14 can\_txbuf\_write function

The table below describes the function can\_txbuf\_write.

**Table 70. can\_txbuf\_write function**

Name	Description
Function name	can_txbuf_write
Function prototype	error_status can_txbuf_write(can_type* can_x, can_txbuf_select_type txbuf_type, can_txbuf_type* can_txbuf_struct);
Function description	Write transmit buffer
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>txbuf_type</i> : transmit buffer selection
Input parameter 3	can_txbuf_struct: write data, refere to the pointer of <i>can_txbuf_type</i>
Output parameter	NA
Return value	error_status: success or failure
Required preconditions	NA
Called functions	NA

### txbuf\_type

Select a transmit buffer type.

CAN\_TXBUF\_PTB: Primary transmit buffer  
CAN\_TXBUF\_STB: Secondary transmit buffer

**can\_txbuf\_type** is defined in the AT32M412\_416\_can.h:

typedef struct

```
{
    uint32_t id;
    can_identifier_type id_type;
    can_frame_type frame_type;

#ifndef SUPPORT_CAN_FD
    can_format_type fd_format;
    can_rate_switch_type fd_rate_switch;
    uint8_t data[64];
#endif
}
```

#else

```
    uint8_t data[8];
#endif
```

#endif

```
    confirm_state tx_timestamp;
```

```
    uint8_t handle;
```

```
} can_txbuf_type;
```

### id

Standard identifier (11bit) or extended identifier (29bit)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFF

### id\_type

Identifier type.

CAN\_ID\_STANDARD: Standard identifier

CAN\_ID\_EXTENDED: Extended identifier

### frame\_type

Frame type.

CAN\_FRAME\_DATA: Data frame

CAN\_FRAME\_REMOTE: Remote frame

#### **fd\_format\_type**

Format type.

CAN\_FORMAT\_CLASSIC: Classic CAN2.0A/B

CAN\_FORMAT\_FD: CAN-FD

#### **fd\_rate\_switch**

baud rate switch type.

CAN\_BRS\_OFF: baud rate switch OFF

CAN\_BRS\_ON: baud rate switch ON

#### **tx\_timestamp**

Enable or disable transmit timestamp

FALSE: Disable transmit timestamp

TRUE: Enable transmit timestamp

#### **data\_length**

data field length

CAN\_DLC\_BYTES\_0: 0 bytes

.....

CAN\_DLC\_BYTES\_8: 8 bytes

CAN\_DLC\_BYTES\_12: 12 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_16: 16 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_20: 20 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_24: 24 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_32: 32 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_48: 48 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_64: 64 bytes (for CAN-FD only)

#### **data[64]**

Data to write transmit buffer (for CAN-FD only)

Value range: 0x00~0xFF

#### **data[8]**

Data to write transmit buffer

Value range: 0x00~0xFF

#### **handle**

Handle that is used to identify frames.

Value range: 0x00~0xFF

#### **Example:**

```
can_txbuf_type can_txbuf_struct;

/* write the primary transmit buffer */
can_txbuf_struct.id = 0x400;
can_txbuf_struct.id_type = CAN_ID_STANDARD;
can_txbuf_struct.frame_type = CAN_FRAME_DATA;
can_txbuf_struct.format_type = CAN_FORMAT_FD;
can_txbuf_struct.switch_type = CAN_BRS_ON;
can_txbuf_struct.data_length = CAN_DLC_BYTES_64;
can_txbuf_struct.data[0] = 0x00;
```

```

can_txbuf_struct.data[1] = 0x11;
can_txbuf_struct.data[2] = 0x22;
can_txbuf_struct.data[3] = 0x33;
can_txbuf_struct.data[4] = 0x44;
can_txbuf_struct.data[5] = 0x55;
can_txbuf_struct.data[6] = 0x66;
can_txbuf_struct.data[7] = 0x77;
can_txbuf_struct.data[63] = 0x63;
can_txbuf_struct.tx_timestamp = TRUE;
while(can_txbuf_write(CAN1, CAN_TXBUF_PTB, &can_txbuf_struct) != SUCCESS);

```

## 5.2.15 can\_txbuf\_transmit function

The table below describes the function can\_txbuf\_transmit

**Table 71. can\_txbuf\_transmit function**

Name	Description
Function name	can_txbuf_transmit
Function prototype	error_status can_txbuf_transmit(can_type* can_x, can_transmit_txbuf_type transmit_type);
Function description	Transmit data of transmit buffer
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>transmit_type</i> : transmit type
Output parameter	NA
Return value	error_status: transmit enable is successful or not
Required preconditions	NA
Called functions	NA

### transmit\_type

Transmit type

- |                       |  |
|-----------------------|--|
| CAN_TRANSMIT_PTB:     | transmit data of primary transmit buffer             |
| CAN_TRANSMIT_STB_ONE: | transmit one frame data of secondary transmit buffer |
| CAN_TRANSMIT_STB_ALL: | transmit all data of primary transmit buffer         |

### Example:

```

/* transmit the primary transmit buffer */
can_txbuf_transmit(CAN1, CAN_TRANSMIT_PTB);

```

## 5.2.16 can\_transmit\_abort function

The table below describes the function can\_transmit\_abort.

**Table 72. can\_transmit\_abort function**

Name	Description
Function name	can_transmit_abort
Function prototype	void can_transmit_abort(can_type* can_x, can_abort_transmit_type abort_type);
Function description	Transmit abort
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>abort_type</i> : abort type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### abort\_type

Abort type

CAN\_ABORT\_TRANSMIT\_PTB: Abort primary transmit buffer  
CAN\_ABORT\_TRANSMIT\_STB: Abort secondary transmit buffer

### Example:

```
can_transmit_abort (CAN1, CAN_ABORT_TRANSMIT_PTB);
```

## 5.2.17 can\_stb\_transmit\_mode\_set function

The table below describes the function can\_stb\_transmit\_mode\_set

**Table 73. can\_stb\_transmit\_mode\_set function**

Name	Description
Function name	can_stb_transmit_mode_set
Function prototype	void can_stb_transmit_mode_set(can_type* can_x, can_stb_transmit_mode_type stb_transmit_mode);
Function description	Set secondary transmit buffer transmit mode
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>stb_transmit_mode</i> : select secondary transmit buffer transmit mode
Output parameter	NA
Return value	This function is configured only when software resets.
Required preconditions	NA
Called functions	NA

### stb\_transmit\_mode

Secondary transmit buffer transmit mode

CAN\_STB\_TRANSMIT\_BY\_FIFO: transmit secondary transmit buffer by FIFO

CAN\_STB\_TRANSMIT\_BY\_ID: transmit secondary transmit buffer by ID

### Example:

```
can_software_reset(CAN1, TRUE);
can_stb_transmit_mode_set(CAN1, CAN_STB_TRANSMIT_BY_FIFO);
can_software_reset(CAN1, FALSE);
```

## 5.2.18 can\_stb\_status\_get function

The table below describes the function can\_stb\_status\_get.

**Table 74. can\_stb\_status\_get function**

Name	Description
Function name	can_stb_status_get
Function prototype	can_stb_status_type can_stb_status_get(can_type* can_x);
Function description	Get secondary transmit buffer status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	<a href="#">can_stb_status</a> : secondary transmit buffer status
Required preconditions	NA
Called functions	NA

### can\_stb\_status

Select secondary transmit buffer status

CAN\_STB\_STATUS\_EMPTY: secondary transmit buffer is empty

CAN\_STB\_STATUS\_LESS: secondary transmit buffer is less than or equal to half full

CAN\_STB\_STATUS\_MORE: secondary transmit buffer is more than half full

CAN\_STB\_STATUS\_FULL: secondary transmit buffer is full

### Example:

```
can_stb_status_type stb_status;
stb_status = can_stb_status_get(CAN1);
```

## 5.2.19 can\_transmit\_status\_get\_function

The table below describes the function can\_transmit\_status\_get.

**Table 75. can\_transmit\_status\_get function**

Name	Description
Function name	can_transmit_status_get
Function prototype	void can_transmit_status_get(can_type* can_x, can_transmit_status_type* transmit_status_struct);
Function description	Get transmit status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	transmit_status_struct: to-be-written data, see the pointer of the <a href="#">can_transmit_status_type</a>
Return value	NA
Required preconditions	NA
Called functions	NA

**can\_transmit\_status\_type** is defined at the AT32M412\_416\_can.h:

```
typedef struct
{
    uint8_t current_handle;
    can_tstat_encoding_type current_tstat;
    uint8_t final_handle;
```

```

    can_tstat_encoding_type final_tstat;
} can_transmit_status_type;

```

**current\_handle**

The handle (identifier) of the current transmit frame.

Value range: 0x00~0xFF

**current\_tstat**

The status of the current transmit frame.

CAN_TSTAT_IDLE:	transmit is in idle state
CAN_TSTAT_ONGOING:	transmit is ongoing
CAN_TSTAT_LOST_ARBITRATION:	transmit lost arbitration (retransmission limit is reached)
CAN_TSTAT_TRANSMITTED:	transmit is complete
CAN_TSTAT_ABORTED:	transmit is aborted
CAN_TSTAT_DISTURBED:	transmit is disturbed (retransmission limit is reached)
CAN_TSTAT_REJECTED:	transmit data configuration is rejected

**final\_handle**

The handle (identifier) of the transmit frame that is complete

Value range: 0x00~0xFF

**final\_tstat**

The status of the transmit frame that is complete

CAN_TSTAT_IDLE:	transmit is in idle state
CAN_TSTAT_ONGOING:	transmit is ongoing
CAN_TSTAT_LOST_ARBITRATION:	transmit lost arbitration (retransmission limit is reached)
CAN_TSTAT_TRANSMITTED:	transmit is complete
CAN_TSTAT_ABORTED:	transmit is aborted
CAN_TSTAT_DISTURBED:	transmit is disturbed (retransmission limit is reached)
CAN_TSTAT_REJECTED:	transmit data configuration is rejected

**Example:**

```

can_transmit_status_type transmit_status;
can_transmit_status_get(CAN1, &transmit_status);

```

## 5.2.20 can\_stb\_clear function

The table below describes the function can\_stb\_clear

Table 76. can\_stb\_clear function

Name	Description
Function name	can_stb_clear
Function prototype	error_status can_stb_clear(can_type* can_x, can_clear_stb_type clear_type);
Function description	Clear secondary transmit buffer
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>clear_type</i> : clear type
Output parameter	NA
Return value	error_status: clear operation is successful or not
Required preconditions	NA
Called functions	NA

**clear\_type**

clear type

- CAN\_CLEAR\_STB\_ONE: clear one frame of secondary transmit buffer  
 CAN\_CLEAR\_STB\_ALL: clear all data of secondary transmit buffer

**Example:**

```
can_stb_clear(CAN1, CAN_CLEAR_STB_ALL);
```

**5.2.21 can\_rdbuf\_overflow\_mode\_set function**

The table below describes the function can\_rdbuf\_overflow\_mode\_set.

**Table 77. can\_rdbuf\_overflow\_mode\_set function**

Name	Description
Function name	can_rdbuf_overflow_mode_set
Function prototype	void can_rdbuf_overflow_mode_set(can_type* can_x, can_rdbuf_overflow_mode_type rdbuf_overflow_mode);
Function description	Set receive buffer overflow mode
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>rdbuf_overflow_mode</i> : select receive buffer overflow mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**rdbuf\_overflow\_mode**

Select receive buffer overflow mode

CAN\_RXBUF\_OVERFLOW\_BE\_OVERWRITTEN: the oldest frame will be overwritten

CAN\_RXBUF\_OVERFLOW\_BE\_LOSE: the new frame is not restored

**Example:**

```
can_rdbuf_overflow_mode_set(CAN1,CAN_RXBUF_OVERFLOW_BE_LOSE);
```

**5.2.22 can\_receive\_all\_enable function**

The table below describes the function can\_receive\_all\_enable.

**Table 78. can\_receive\_all\_enable function**

Name	Description
Function name	can_receive_all_enable
Function prototype	void can_receive_all_enable(can_type* can_x, confirm_state new_state);
Function description	Enable receive all data (including error data)
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
can_receive_all_enable(CAN1, TRUE);
```

## 5.2.23 can\_rxbuf\_read function

The table below describes the function can\_rxbuf\_read.

**Table 79. can\_rxbuf\_read function**

Name	Description
Function name	can_rxbuf_read
Function prototype	error_status can_rxbuf_read(can_type* can_x, can_rxbuf_type* can_rxbuf_struct);
Function description	Read receive buffer
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	can_rxbuf_struct: data to read, see the pointer of the <a href="#">can_rxbuf_type</a>
Output parameter	NA
Return value	error_status: operation is successful or not
Required preconditions	NA
Called functions	NA

**can\_rxbuf\_type** is defined in the AT32M412\_416\_can.h:

```
typedef struct
{
    uint32_t id;
    can_identifier_type id_type;
    can_frame_type frame_type;
    can_data_length_type data_length;
#define SUPPORT_CAN_FD
    can_format_type fd_format_type;
    can_rate_switch_type fd_rate_switch;
    can_error_state_type fd_error_state;
    uint8_t data[64];
#else
    uint8_t data[8];
#endif
    can_recv_frame_type recv_frame;
    can_error_type kind_error;
    uint32_t rx_timestamp;
    uint16_t cycle_time;
} can_rxbuf_type;
```

### **id**

Standard identifier (11bits) or extended identifier (29bits)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFFF

### **id\_type**

Identifier type

CAN\_ID\_STANDARD: Standard identifier

CAN\_ID\_EXTENDED: Extended identifier

### **frame\_type**

Frame type

CAN\_FRAME\_DATA: data frame

CAN\_FRAME\_REMOTE: Remote frame

**fd\_format\_type**

Format type

CAN\_FORMAT\_CLASSIC: Classic CAN2.0A/B

CAN\_FORMAT\_FD: CAN-FD

**fd\_rate\_switch**

Baud rate switch type

CAN\_BRS\_OFF: baud rate switch OFF

CAN\_BRS\_ON: baud rate switch ON

**data\_length**

Data field length

CAN\_DLC\_BYTES\_0: 0 bytes

.....

CAN\_DLC\_BYTES\_8: 8 bytes

CAN\_DLC\_BYTES\_12: 12 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_16: 16 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_20: 20 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_24: 24 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_32: 32 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_48: 48 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_64: 64 bytes (for CAN-FD only)

**fd\_error\_state**

Error state

CAN\_ESI\_ACTIVE: Active error

CAN\_ESI\_PASSIVE: Passive error

**kind\_error**

error type

CAN\_KOER\_NOERR: no error

CAN\_KOER\_BIT: bit error

CAN\_KOER\_FORM: format error

CAN\_KOER\_STUFF: bit stuffing error

CAN\_KOER\_ACK: Acknowledge error

CAN\_KOER\_CRC: CRC error

CAN\_KOER\_OTHER: other errors

**recv\_frame**

receive frame type

CAN\_RECV\_NORMAL normal receive frame

CAN\_RECV\_LOOPBACK loopback receive frame

**data[64]**

Data to write transmit buffer (for CAN-FD only)

Value range: 0x00~0xFF

**data[8]**

Data to write transmit buffer

Value range: 0x00~0xFF

**rx\_timestamp**

Receive frame timestamp

Value range: depends on the counter of TMR

**cycle\_time**

Receive frame cycle time (for TTCAN)

Value range: 0x0000~0xFFFF

**Example:**

```
can_rdbuf_type can_rdbuf_struct;
while(ERROR != can_rdbuf_read(CAN1, &can_rdbuf_struct))
{
    if(can_rdbuf_struct.id_type == CAN_ID_STANDARD)
        at32_led_toggle(LED2);
    else
        at32_led_toggle(LED3);
    printf("receive timestamp = %u\r\n", can_rdbuf_struct.rx_timestamp);
}
```

## 5.2.24 can\_rdbuf\_release function

The table below describes the function can\_rdbuf\_release.

**Table 80. can\_rdbuf\_release function**

Name	Description
Function name	can_rdbuf_release
Function prototype	error_status can_rdbuf_release(can_type* can_x);
Function description	Release one frame dta of receive buffer
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	error_status: operation is successful or not
Required preconditions	NA
Called functions	NA

**Example:**

```
can_rdbuf_release (CAN1);
```

## 5.2.25 can\_rdbuf\_status\_get function

The table below describes the function can\_rdbuf\_status\_get.

**Table 81. can\_rdbuf\_status\_get function**

Name	Description
Function name	can_rdbuf_status_get
Function prototype	can_rdbuf_status_type can_rdbuf_status_get(can_type* can_x);
Function description	Get receive buffer status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	<a href="#">can_rdbuf_status</a> : receive buffer status
Required preconditions	NA
Called functions	NA

**can\_rdbuf\_status**

Receive buffer status

CAN_RXBUF_STATUS_EMPTY:	receive buffer is empty
CAN_RXBUF_STATUS_LESS:	receive buffer is less than almost full
CAN_RXBUF_STATUS_ALMOST:	receive buffer is more than or equal to almost full
CAN_RXBUF_STATUS_FULL:	receive buffer is full
CAN_RXBUF_STATUS_OVERFLOW:	receive buffer is overflow

**Example:**

```
can_rxbuf_status_type rdbuf_status;
rdbuf_status = can_rxbuf_status_get(CAN1);
```

## 5.2.26 can\_filter\_default\_para\_init function

The table below describes the function can\_filter\_default\_para\_init.

**Table 82. can\_filter\_default\_para\_init function**

Name	Description
Function name	can_filter_default_para_init
Function prototype	void can_filter_default_para_init(can_filter_config_type* filter_config_struct);
Function description	Set an initial default value for the filter_config_struct
Input parameter 1	filter_config_struct: pointer of the <a href="#">can_filter_config_type</a>
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define the can_filter_config_type, can_filter_code_type and can_filter_mask_type first before starting.
Called functions	NA

**can\_filter\_config\_type** is defined in the AT32M412\_416\_can.h:

```
typedef struct
{
    can_filter_code_type code_para;
    can_filter_mask_type mask_para;
} can_filter_config_type;
```

**can\_filter\_code\_type** is defined in the AT32M412\_416\_can.h:

```
typedef struct
{
    uint32_t id;
    can_identifier_type id_type;
    can_frame_type frame_type;
    uint8_t data_length;
#define SUPPORT_CAN_FD
    can_format_type fd_format;
    can_rate_switch_type fd_rate_switch;
    can_error_state_type fd_error_state;
#endif
    can_recv_frame_type recv_frame;
} can_filter_code_type;
```

**id**

Standard identifier (11bits) or extended identifier (29bits)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFFF

**id\_type**

Filter identifier type

CAN\_ID\_STANDARD: Standard identifier

CAN\_ID\_EXTENDED: Extended identifier

**frame\_type**

Frame type

CAN\_FRAME\_DATA: data frame

CAN\_FRAME\_REMOTE: remote frame

**fd\_format**

Filter format type

CAN\_FORMAT\_CLASSIC: Classic CAN2.0A/B

CAN\_FORMAT\_FD: CAN-FD

**fd\_rate\_switch**

Baud rate switch on/off

CAN\_BRS\_OFF: baud rate switch OFF

CAN\_BRS\_ON: baud rate switch ON

**data\_length**

Filter data length

Value range: 0x00~0xFF

**fd\_error\_state**

Filter error state

CAN\_ESI\_ACTIVE: Active error

CAN\_ESI\_PASSIVE: Passive error

**recv\_frame**

Filter receive type

CAN\_RECV\_NORMAL: normal receive frame

CAN\_RECV\_LOOPBACK: loopback receive frame

**can\_filter\_mask\_type** is defined in the AT32M412\_416\_can.h:

typedef struct

{

    uint32\_t id;

    confirm\_state id\_type;

    confirm\_state frame\_type;

    uint8\_t data\_length;

#ifdef SUPPORT\_CAN\_FD

    confirm\_state fd\_format\_type;

    confirm\_state fd\_rate\_switch;

    confirm\_state fd\_error\_state;

#endif

    confirm\_state recv\_frame;

} can\_filter\_mask\_type;

**id**

Filter standard identifier (11bits) or extended identifier (29bits)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFF (0: filter, 1: ignore)

**id\_type**

Filter identifier mask

FALSE: filter

TRUE: ignore

#### **frame\_type**

Filter frame type mask

FALSE: filter

TRUE: ignore

#### **fd\_format**

Filter format mask

FALSE: filter

TRUE: ignore

#### **fd\_rate\_switch**

Baud rate switch type mask

FALSE: filter

TRUE: ignore

#### **data\_length**

Filter data length mask

Value range 0x00~0xFF (0: filter, 1: ignore)

#### **fd\_error\_state**

Filter error state mask

FALSE: filter

TRUE: ignore

#### **recv\_frame**

Filter receive frame type mask

FALSE: filter

TRUE: ignore

#### **Example:**

```
can_filter_config_type can_filter_struct;
can_filter_default_para_init(&can_filter_struct);
```

### 5.2.27 can\_filter\_set function

The table below describes the function can\_filter\_set

**Table 83. can\_filter\_set function**

Name	Description
Function name	can_filter_set
Function prototype	void can_filter_set(can_type* can_x, can_filter_type filter_number, can_filter_config_type* filter_config_struct);
Function description	Set filter
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>filter_number</i> : filter number
Input parameter 3	filter_config_struct: pointer to the <i>can_filter_config_type</i>
Output parameter	NA
Return value	NA
Required preconditions	1. It is necessary to first define the can_filter_config_type, can_filter_code_type, can_filter_mask_type

Name	Description
	2. This function can be configured only when software resets
Called functions	NA

**filter\_number**

CAN\_FILTER\_NUM\_0: filter 0

CAN\_FILTER\_NUM\_1: filter 1

.....

CAN\_FILTER\_NUM\_15: filter 15

**can\_filter\_config\_type** is defined in the AT32M412\_416\_can.h:

typedef struct

```
{
    can_filter_code_type    code_para;
    can_filter_mask_type   mask_para;
} can_filter_config_type;
```

**can\_filter\_code\_type** is defined in the AT32M412\_416\_can.h:

typedef struct

```
{
    uint32_t id;
    can_identifier_type id_type;
    can_frame_type frame_type;
    uint8_t data_length;
#endif SUPPORT_CAN_FD
    can_format_type fd_format_type;
    can_rate_switch_type fd_rate_switch
    can_error_state_type fd_error_state;
#endif
    can_recv_frame_type recv_frame;
} can_filter_code_type;
```

**id**

Standard identifier (11bits) or extended identifier (29bits)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFF

**id\_type**

Filter identifier type

CAN\_ID\_STANDARD: Standard identifier

CAN\_ID\_EXTENDED: Extended identifier

**frame\_type**

Frame type

CAN\_FRAME\_DATA: data frame

CAN\_FRAME\_REMOTE: remote frame

**fd\_format**

Filter format type

CAN\_FORMAT\_CLASSIC: Classic CAN2.0A/B

CAN\_FORMAT\_FD: CAN-FD

**fd\_rate\_switch**

Baud rate switch on/off

**CAN\_BRS\_OFF:** baud rate switch OFF

**CAN\_BRS\_ON:** baud rate switch ON

### **data\_length**

Filter data length

Value range: 0x00~0xFF

### **fd\_error\_state**

Filter error state

**CAN\_ESI\_ACTIVE:** Active error

**CAN\_ESI\_PASSIVE:** Passive error

### **recv\_frame**

Filter receive type

**CAN\_RECV\_NORMAL** normal receive frame

**CAN\_RECV\_LOOPBACK** loopback receive frame

**can\_filter\_mask\_type** is defined in the AT32M412\_416\_can.h:

typedef struct

{

    uint32\_t id;

    confirm\_state id\_type;

    confirm\_state frame\_type;

    uint8\_t data\_length;

#ifdef SUPPORT\_CAN\_FD

    confirm\_state fd\_format\_type;

    confirm\_state fd\_rate\_switch;

    confirm\_state fd\_error\_state;

#endif

    confirm\_state recv\_frame;

} can\_filter\_mask\_type;

### **id**

Filter standard identifier (11bits) or extended identifier (29bits)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFF (0: filter, 1: ignore)

### **id\_type**

Filter identifier mask

FALSE: filter

TRUE: ignore

### **frame\_type**

Filter frame type mask

FALSE: filter

TRUE: ignore

### **fd\_format\_type**

Filter format type mask

FALSE: filter

TRUE: ignore

### **fd\_rate\_switch**

Baud rate switch type mask

FALSE: filter

TRUE: ignore  
**data\_length**  
 Filter data length mask  
 Value range 0x00~0xFF (0: filter, 1: ignore)

**fd\_error\_state**  
 Filter error state mask  
 FALSE: filter  
 TRUE: ignore  
**recv\_frame**  
 Filter receive frame type mask  
 FALSE: filter  
 TRUE: ignore

#### Example:

```
can_software_reset(CAN1, TRUE);
/* can filter 0 config */
can_filter_struct.code_para.id = FILTER_CODE_EXT_ID;
can_filter_struct.code_para.id_type = CAN_ID_EXTENDED;
can_filter_struct.mask_para.id = FILTER_MASK_EXT_ID;
can_filter_struct.mask_para.id_type = FALSE;           /* not mask, filter id_type. */
can_filter_struct.mask_para.data_length = 0xF;         /* mask data_length, not filter. */
can_filter_struct.mask_para.frame_type = TRUE;        /* mask frame_type, not filter. */
can_filter_struct.mask_para.fd_error_state = TRUE;     /* mask error_state, not filter. */
can_filter_struct.mask_para.fd_format = TRUE;          /* mask format_type, not filter. */
can_filter_struct.mask_para.fd_rate_switch = TRUE;     /* mask switch_type, not filter. */
can_filter_struct.mask_para.recv_frame = TRUE;         /* mask recv_type, not filter. */
can_filter_set(CAN1, CAN_FILTER_NUM_0, &can_filter_struct);
can_software_reset(CAN1, FALSE);
```

## 5.2.28 can\_filter\_enable function

The table below describes the function can\_filter\_enable

Table 84. can\_filter\_enable function

Name	Description
Function name	can_filter_enable
Function prototype	void can_filter_enable(can_type* can_x, can_filter_type filter_number, confirm_state new_state);
Function description	Enable receive filter
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>filter_number</i> : filter number
Input parameter 3	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### filter\_number

CAN\_FILTER\_NUM\_0: filter 0  
CAN\_FILTER\_NUM\_1: filter 1  
.....  
CAN\_FILTER\_NUM\_15: filter 15

**Example:**

```
can_filter_enable(CAN1, CAN_FILTER_NUM_0, TRUE);
```

## 5.2.29 can\_arbitration\_lost\_position\_get function

The table below describes the function can\_arbitration\_lost\_position\_get

Table 85. can\_arbitration\_lost\_position\_get function

Name	Description
Function name	can_arbitration_lost_position_get
Function prototype	uint8_t can_arbitration_lost_position_get(can_type* can_x);
Function description	Get arbitration lost position
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>filter_number</i> : filter number
Input parameter 3	filter_config_struct: pointer to the <i>can_filter_config_type</i>
Output parameter	NA
Return value	Arbitration lost position (the position in the arbitration field) Parameter range: 0~31
Required preconditions	NA
Called functions	NA

**Example:**

```
uint8_t arbitration_lost_position;  
transmit_timestamp = can_arbitration_lost_position_get (CAN1);
```

## 5.2.30 can\_rxbuf\_warning\_set function

The table below describes the function can\_rxbuf\_warning\_set

**Table 86. can\_rxbuf\_warning\_set function**

Name	Description
Function name	can_rxbuf_warning_set
Function prototype	void can_rxbuf_warning_set(can_type* can_x, uint8_t warning_value);
Function description	Set a warning value indicating the receive buffer is almost full
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	warning_value: warning value to indicate that the receive buffer is almost full Value range: 1~6
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
can_rxbuf_warning_set(CAN1, 3);
```

## 5.2.31 can\_error\_warning\_set function

The table below describes the function can\_error\_warning\_set

**Table 87. can\_error\_warning\_set function**

Name	Description
Function name	can_error_warning_set
Function prototype	void can_error_warning_set(can_type* can_x, uint8_t warning_value);
Function description	Set a warning value indicating an error
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	warning_value: error warning value Value range: 0~15 programmable error warning value = (warning_value + 1)*8.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* programmable error warning limit = (10+1)*8 = 88. */  
can_error_warning_set(CAN1, 10);
```

## 5.2.32 can\_kind\_error\_get function

The table below describes the function can\_kind\_error\_get

**Table 88. can\_kind\_error\_get function**

Name	Description
Function name	can_kind_error_get
Function prototype	can_error_type can_kind_error_get(can_type* can_x);
Function description	Get CAN error type
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	<a href="#">error_type</a> : error type
Required preconditions	NA
Called functions	NA

### error\_type

Error type.

CAN_KOER_NOERR:	No error
CAN_KOER_BIT:	Bit error
CAN_KOER_FORM:	Format error
CAN_KOER_STUFF:	Bit stuffing error
CAN_KOER_ACK:	Acknowledge error
CAN_KOER_CRC:	CRC error
CAN_KOER_OTHER:	Other error

### Example:

```
/* programmable error warning limit = (10+1)*8 = 88. */
can_error_warning_set(CAN1, 10);
```

## 5.2.33 can\_receive\_error\_counter\_get function

The table below describes the function can\_receive\_error\_counter\_get.

**Table 89. can\_receive\_error\_counter\_get function**

Name	Description
Function name	can_receive_error_counter_get
Function prototype	uint8_t can_receive_error_counter_get(can_type* can_x);
Function description	Read CAN receive error counter
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	receive_error_counter: Receive error counter Value range: 0x00~0xFF
Required preconditions	NA
Called functions	NA

### Example:

```
/* get the receive error counter (rec) */
uint8_t receive_error_counter;
receive_error_counter = can_receive_error_counter_get (CAN1);
```

## 5.2.34 can\_transmit\_error\_counter\_get function

The table below describes the function can\_transmit\_error\_counter\_get.

**Table 90. can\_transmit\_error\_counter\_get function**

Name	Description
Function name	can_transmit_error_counter_get
Function prototype	uint8_t can_transmit_error_counter_get(can_type* can_x);
Function description	Read CAN transmit error counter
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Output parameter	NA
Return value	transmit_error_counter: Transmit error counter Value range: 0x00~0xFF
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get the transmit error counter (tec) */
uint8_t transmit_error_counter;
transmit_error_counter = can_transmit_error_counter_get (CAN1);
```

## 5.2.35 can\_busoff\_get function

The table below describes the function can\_busoff\_get.

**Table 91. can\_busoff\_get function**

Name	Description
Function name	can_busoff_get
Function prototype	flag_status can_busoff_get(can_type* can_x);
Function description	Get bus off status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	NA
Output parameter	NA
Return value	flag_status: bus state This parameter can be SET or RESET
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get bus-off status */
flag_status bit_status = RESET;
bit_status = can_busoff_get (CAN1);
```

## 5.2.36 can\_busoff\_reset function

The table below describes the function can\_busoff\_reset.

Table 92. can\_busoff\_reset function

Name	Description
Function name	can_busoff_reset
Function prototype	void can_busoff_reset(can_type* can_x);
Function description	Bus-off reset
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* resets the error counters and therefore forces the node to leave the bus off state. */  
can_busoff_reset (CAN1);
```

## 5.2.37 can\_ttcan\_ref\_message\_set function

The table below describes the function can\_ttcan\_ref\_message\_set.

Table 93. can\_ttcan\_ref\_message\_set function

Name	Description
Function name	can_ttcan_ref_message_set
Function prototype	void can_ttcan_ref_message_set(can_type* can_x, can_identifier_type id_type, uint32_t id);
Function description	Set TTCAN reference message
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>id_type</i> : identifier type
Input parameter 3	id: standard identifier (11bit) or extended identifier (29bit) Parameter range: 0x000~0x7FF or 0x000~0x1FFFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **id\_type**

Identifier type.

CAN\_ID\_STANDARD: Standard identifier

CAN\_ID\_EXTENDED: Extended identifier

### **Example:**

```
/* set the reference message identifier for ttcan */  
can_ttcan_ref_message_set(CAN1, CAN_ID_EXTENDED, 0x1F543210);
```

## 5.2.38 can\_ttcancan\_timer\_div\_set function

The table below describes the function can\_ttcancan\_timer\_div\_set.

Table 94. can\_ttcancan\_timer\_div\_set function

Name	Description
Function name	can_ttcancan_timer_div_set
Function prototype	void can_ttcancan_timer_div_set(can_type* can_x, can_ttcancan_timer_div_type div_value);
Function description	Set TTCAN clock division
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>div_value</i> : TTCAN clock division value
Output parameter	NA
Return value	NA
Required preconditions	This function can be called only when the TTCAN is not enabled.
Called functions	NA

### div\_value

CAN_TTCAN_TIMER_DIV_1:	TTCAN/1
CAN_TTCAN_TIMER_DIV_2:	TTCAN/2
CAN_TTCAN_TIMER_DIV_4:	TTCAN/4
CAN_TTCAN_TIMER_DIV_8:	TTCAN/8

### Example:

```
/* 1 tick of the cycle time = 8/ac_baudrate = 8/1M = 8us */
can_ttcancan_timer_div_set(CAN1, CAN_TTCAN_TIMER_DIV_8);
```

## 5.2.39 can\_ttcan\_enable function

The table below describes the function can\_ttcan\_enable.

Table 95. can\_ttcan\_enable function

Name	Description
Function name	can_ttcan_enable
Function prototype	void can_ttcan_enable(can_type* can_x, confirm_state new_state);
Function description	Enable TTCAN
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* ttcan enabled, timer is running */  
can_ttcan_enable(CAN1, TRUE);
```

## 5.2.40 can\_ttcancan\_trigger\_type\_set function

The table below describes the function can\_ttcancan\_trigger\_type\_set.

Table 96. can\_ttcancan\_trigger\_type\_set function

Name	Description
Function name	can_ttcancan_trigger_type_set
Function prototype	void can_ttcancan_trigger_type_set(can_type* can_x, can_ttcancan_trigger_type trigger_type);
Function description	Set TTCAM trigger type
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>trigger_type</i> : TTCAN trigger type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### trigger\_type

TTCAN trigger type.

CAN_TTCAN_TRIGGER_IMMEDIATE:	trigger immediately
CAN_TTCAN_TRIGGER_TIME:	time trigger
CAN_TTCAN_TRIGGER_SINGLE_TRANSMIT:	trigger single transmit
CAN_TTCAN_TRIGGER_TRANSMIT_START:	trigger transmit start
CAN_TTCAN_TRIGGER_TRANSMIT_STOP:	trigger transmit stop

### Example:

```
/* set the time trigger type be single shot transmit trigger */  
can_ttcancan_trigger_type_set(CAN1, CAN_TTCAN_TRIGGER_SINGLE_TRANSMIT);
```

## 5.2.41 can\_ttcancan\_trigger\_set function

The table below describes the function can\_ttcancan\_trigger\_set.

**Table 97. can\_ttcancan\_trigger\_set function**

Name	Description
Function name	can_ttcancan_trigger_set
Function prototype	void can_ttcancan_trigger_set(can_type* can_x, uint16_t trigger_time);
Function description	Set TTCAN trigger time
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	trigger_time: TTCAN trigger time Parameter range: 0x0000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* trigger transmit time = 40000*1 tick = 40000*8us = 320ms */  
can_ttcancan_trigger_set(CAN1, 40000);
```

## 5.2.42 can\_ttcancan\_watch\_trigger\_set function

The table below describes the function can\_ttcancan\_watch\_trigger\_set.

**Table 98. can\_ttcancan\_watch\_trigger\_set function**

Name	Description
Function name	can_ttcancan_watch_trigger_set
Function prototype	void can_ttcancan_watch_trigger_set(can_type* can_x, uint16_t watch_trigger_time);
Function description	Set TTCAN watch trigger time
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	watch_trigger_time: TTCAN watch trigger time Parameter range: 0x0000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* the cycle time for a watch trigger = 8us * 10000 = 80ms */
can_ttcancan_watch_trigger_set(CAN1, 10000);
```

## 5.2.43 can\_ttcancan\_transmit\_window\_set function

The table below describes the function can\_ttcancan\_transmit\_window\_set

**Table 99. can\_ttcancan\_transmit\_window\_set function**

Name	Description
Function name	can_ttcancan_transmit_window_set
Function prototype	void can_ttcancan_transmit_window_set(can_type* can_x, uint8_t window_ticks);
Function description	Set TTCAN transmit enable window (for single transmit trigger type)
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	window_ticks: TTCAN transmit enable window Value range: 0~15
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* transmit enable window = (15+1)*1 tick = (15+1)*8us = 128us */
can_ttcancan_transmit_window_set(CAN1, 15);
```

## 5.2.44 can\_ttcanc\_txbuf\_enable function

The table below describes the function can\_ttcanc\_txbuf\_enable

**Table 100. can\_ttcanc\_txbuf\_enable function**

Name	Description
Function name	can_ttcanc_txbuf_enable
Function prototype	void can_ttcanc_txbuf_enable(can_type* can_x, confirm_state new_state);
Function description	Enable TTCAN transmit buffer slot mode
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable transmit buffer support for ttcanc mode */  
can_ttcanc_txbuf_enable(CAN1, TRUE);
```

## 5.2.45 can\_ttcancan\_txbuff\_status\_set function

The table below describes the function can\_ttcancan\_txbuff\_status\_set

Table 101. can\_ttcancan\_txbuff\_status\_set function

Name	Description
Function name	can_ttcancan_txbuff_status_set
Function prototype	void can_ttcancan_txbuff_status_set(can_type* can_x, can_ttcancan_txbuff_type txbuff_number, can_ttcancan_txbuff_status_type status_type);
Function description	Set TTCAN transmit buffer status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>txbuff_number</i> : TTCAN transmit buffer number
Input parameter 3	<i>status_type</i> : TTCAN transmit buffer status
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **txbuff\_number**

CAN\_TTCAN\_TXBUF\_NUM\_0: TTCAN transmit buffer 0

CAN\_TTCAN\_TXBUF\_NUM\_1: TTCAN transmit buffer 1

CAN\_TTCAN\_TXBUF\_NUM\_2: TTCAN transmit buffer 2

CAN\_TTCAN\_TXBUF\_NUM\_3: TTCAN transmit buffer 3

### **status\_type**

CAN\_TTCAN\_TXBUF\_EMPTY: TTCAN transmit buffer is empty

CAN\_TTCAN\_TXBUF\_FILLED: TTCAN transmit buffer is full

### **Example:**

```
can_ttcancan_txbuff_status_set(CAN1, CAN_TTCAN_TXBUF_NUM_1, CAN_TTCAN_TXBUF_EMPTY);
```

## 5.2.46 can\_ttcancan\_txbuf\_status\_get function

The table below describes the function can\_ttcancan\_txbuf\_status\_get

Table 102. can\_ttcancan\_txbuf\_status\_get function

Name	Description
Function name	can_ttcancan_txbuf_status_get
Function prototype	can_ttcancan_txbuf_status_type can_ttcancan_txbuf_status_get(can_type* can_x, can_ttcancan_txbuf_type txbuf_number);
Function description	Get TTCAN transmit buffer status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>txbuf_number</i> : TTCAN transmit buffer number
Output parameter	NA
Return value	<i>status_type</i> : TTCAN transmit buffer status
Required preconditions	NA
Called functions	NA

### **txbuf\_number**

CAN\_TTCAN\_TXBUF\_NUM\_0: TTCAN transmit buffer 0  
CAN\_TTCAN\_TXBUF\_NUM\_1: TTCAN transmit buffer 1  
CAN\_TTCAN\_TXBUF\_NUM\_2: TTCAN transmit buffer 2  
CAN\_TTCAN\_TXBUF\_NUM\_3: TTCAN transmit buffer 3

### **status\_type**

CAN\_TTCAN\_TXBUF\_EMPTY TTCAN transmit buffer is empty  
CAN\_TTCAN\_TXBUF\_FILLED TTCAN transmit buffer is full

### **Example:**

```
if(can_ttcancan_txbuf_status_get(CAN1, CAN_TTCAN_TXBUF_NUM_1) != CAN_TTCAN_TXBUF_FILLED)
{
    /* write the transmission buffer 0 for ttcancan*/
    can_ttcancan_txbuf_write(CAN1, CAN_TTCAN_TXBUF_NUM_1, &can_txbuf_struct);
}
```

## 5.2.47 can\_ttcancan\_txbuff\_transmit\_set function

The table below describes the function can\_ttcancan\_txbuff\_transmit\_set

**Table 103. can\_ttcancan\_txbuff\_transmit\_set function**

Name	Description
Function name	can_ttcancan_txbuff_transmit_set
Function prototype	void can_ttcancan_txbuff_transmit_set(can_type* can_x, can_ttcancan_txbuff_type txbuff_number);
Function description	Get TTCAN transmit buffer status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>txbuff_number</i> : TTCAN transmit buffer number
Output parameter	NA
Return value	<i>status_type</i> : TTCAN transmit buffer status
Required preconditions	NA
Called functions	NA

### **txbuff\_number**

- CAN\_TTCAN\_TXBUF\_NUM\_0: TTCAN transmit buffer 0
- CAN\_TTCAN\_TXBUF\_NUM\_1: TTCAN transmit buffer 1
- CAN\_TTCAN\_TXBUF\_NUM\_2: TTCAN transmit buffer 2
- CAN\_TTCAN\_TXBUF\_NUM\_3: TTCAN transmit buffer 3

### **status\_type**

- CAN\_TTCAN\_TXBUF\_EMPTY TTCAN transmit buffer is empty
- CAN\_TTCAN\_TXBUF\_FILLED TTCAN transmit buffer is full

### **Example:**

```
if(can_ttcancan_txbuff_status_get(CAN1, CAN_TTCAN_TXBUF_NUM_1) != CAN_TTCAN_TXBUF_FILLED)
{
    /* write the transmission buffer 0 for ttcan*/
    can_ttcancan_txbuff_write(CAN1, CAN_TTCAN_TXBUF_NUM_1, &can_txbuff_struct);
}
```

## 5.2.48 can\_ttcan\_txbuf\_write function

The table below describes the function can\_ttcan\_txbuf\_write

**Table 104. can\_ttcan\_txbuf\_write function**

Name	Description
Function name	can_ttcan_txbuf_write
Function prototype	error_status can_ttcan_txbuf_write(can_type* can_x, can_ttcan_txbuf_type txbuf_number, can_txbuf_type* can_txbuf_struct);
Function description	Write TTCAN transmit buffer
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>txbuf_number</i> : TTCAN transmit buffer number
Input parameter 3	can_txbuf_struct: data to write, referto the pointer of the <i>can_txbuf_type</i>
Output parameter	NA
Return value	error_status: write operation is successful or not
Required preconditions	NA
Called functions	NA

### **txbuf\_number**

CAN\_TTCAN\_TXBUF\_NUM\_0:      TTCAN transmit buffer 0  
 CAN\_TTCAN\_TXBUF\_NUM\_1:      TTCAN transmit buffer 1  
 CAN\_TTCAN\_TXBUF\_NUM\_2:      TTCAN transmit buffer 2  
 CAN\_TTCAN\_TXBUF\_NUM\_3:      TTCAN transmit buffer 3

**can\_txbuf\_type** is defined in the AT32M412\_416\_can.h:

```
typedef struct
{
    uint32_t id;
    can_identifier_type id_type;
    can_frame_type frame_type;
#define SUPPORT_CAN_FD
    can_format_type fd_format;
    can_rate_switch_type fd_rate_switch;
    uint8_t data[64];
}#else
    uint8_t data[8];
#endif
} can_txbuf_type;
```

### **id**

Standard identifier (11bit) or extended identifier (29bit)

Value range: 0x000~0x7FF or 0x000~0x1FFFFFFF

### **id\_type**

Identifier type.

CAN\_ID\_STANDARD: Standard identifier

CAN\_ID\_EXTENDED: Extended identifier

### **frame\_type**

Frame type.

CAN\_FRAME\_DATA: Data frame

CAN\_FRAME\_REMOTE: Remote frame

#### **fd\_format**

Format type.

CAN\_FORMAT\_CLASSIC: Classic CAN2.0A/B

CAN\_FORMAT\_FD: CAN-FD

#### **fd\_rate\_switch**

baud rate switch type.

CAN\_BRS\_OFF: baud rate switch OFF

CAN\_BRS\_ON: baud rate switch ON

#### **tx\_timestamp**

Enable or disable transmit timestamp

FALSE: Disable transmit timestamp

TRUE: Enable transmit timestamp

#### **data\_length**

data field length

CAN\_DLC\_BYTES\_0: 0 bytes

.....

CAN\_DLC\_BYTES\_8: 8 bytes

CAN\_DLC\_BYTES\_12: 12 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_16: 16 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_20: 20 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_24: 24 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_32: 32 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_48: 48 bytes (for CAN-FD only)

CAN\_DLC\_BYTES\_64: 64 bytes (for CAN-FD only)

#### **data[64]**

Data to write transmit buffer (for CAN-FD only)

Value range: 0x00~0xFF

#### **data[8]**

Data to write transmit buffer

Value range: 0x00~0xFF

#### **handle**

Handle that is used to identify frames.

Value range: 0x00~0xFF

#### **Example:**

```
can_txbuf_type can_txbuf_struct;
can_txbuf_struct.id = 0x400;
can_txbuf_struct.id_type = CAN_ID_STANDARD;
can_txbuf_struct.frame_type = CAN_FRAME_DATA;
can_txbuf_struct.format_type = CAN_FORMAT_FD;
can_txbuf_struct.switch_type = CAN_BRS_ON;
can_txbuf_struct.data_length = CAN_DLC_BYTES_8;
can_txbuf_struct.data[0] = 0x00;
can_txbuf_struct.data[1] = 0x11;
```

```

can_txbuf_struct.data[2] = 0x22;
can_txbuf_struct.data[3] = 0x33;
can_txbuf_struct.data[4] = 0x44;
can_txbuf_struct.data[5] = 0x55;
can_txbuf_struct.data[6] = 0x66;
can_txbuf_struct.data[7] = 0x77;
if(can_ttcan_txbuf_status_get(CAN1, CAN_TTCAN_TXBUF_NUM_1) != CAN_TTCAN_TXBUF_FILLED)
{
    /* write the transmission buffer 0 for ttcan*/
    can_ttcan_txbuf_write(CAN1, CAN_TTCAN_TXBUF_NUM_1, &can_txbuf_struct);
}

```

## 5.2.49 can\_interrupt\_enable function

The table below describes the function can\_interrupt\_enable.

**Table 105. can\_interrupt\_enable function**

Name	Description
Function name	can_interrupt_enable
Function prototype	void can_interrupt_enable(can_type* can_x, uint32_t can_int, confirm_state new_state);
Function description	Enable the selected CAN interrupt
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1 or CAN2.
Input parameter 2	<i>can_int</i> : the selected CAN interrupt
Input parameter3	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### can\_int

CAN interrupt selection includes:

- CAN\_AIE\_INT: Abort transmit interrupt enable
- CAN\_EIE\_INT: Error interrupt enable (including error warning and disconnection)
- CAN\_TSIE\_INT: Secondary transmit buffer transmit complete interrupt enable
- CAN\_TPIE\_INT: Primary transmit buffer transmit complete interrupt enable
- CAN\_RAFIE\_INT: Receive buffer almost full interrupt enable
- CAN\_RFIE\_INT: Receive buffer full interrupt enable
- CAN\_ROIE\_INT: Receive buffer overflow interrupt enable
- CAN\_RIE\_INT: Receive interrupt enable
- CAN\_BEIE\_INT: Bus error interrupt enable
- CAN\_ALIE\_INT: Arbitration lost interrupt enable
- CAN\_EPIE\_INT: Error passtive interrupt enable
- CAN\_TTIE\_INT: Time-triggered interrupt enable
- CAN\_TEIE\_INT: Trigger error interrupt enable
- CAN\_WTIE\_INT: Window trigger interrupt enable

### Example:

```

/* can interrupt config */
nvic_irq_enable(CAN1_TX_IRQn, 0x00, 0x00);
nvic_irq_enable(CAN1_RX_IRQn, 0x00, 0x00);
nvic_irq_enable(CAN1_ERR_IRQn, 0x00, 0x00);
nvic_irq_enable(CAN1_STAT_IRQn, 0x00, 0x00);
can_interrupt_enable(CAN1, CAN_TSIE_INT, TRUE);
can_interrupt_enable(CAN1, CAN_RIE_INT, TRUE);
can_interrupt_enable(CAN1, CAN_TEIE_INT|CAN_TTIE_INT|CAN_WTIE_INT, TRUE);
can_interrupt_enable(CAN1, CAN_BEIE_INT, TRUE);

```

## 5.2.50 can\_flag\_get function

The table below describes the function can\_flag\_get.

**Table 106. can\_flag\_get function**

Name	Description
Function name	can_flag_get
Function prototype	flag_status can_flag_get(can_type* can_x, uint32_t can_flag);
Function description	Get the status of the selected CAN flag
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<a href="#">can_flag</a> : indicates the selected flag Refer to the “can_flag” description below for details
Output parameter	NA
Return value	flag_status: the status of the selected flag Return value can be SET or RESET.
Required preconditions	NA
Called functions	NA

### can\_flag

This is used to select a flag and get its status, including:

CAN_AIF_FLAG:	Aborted transmit interrupt flag
CAN{EIF}_FLAG:	Error interrupt flag
CAN_TSIF_FLAG:	Secondary transmit buffer transmit complete interrupt flag
CAN_TPIF_FLAG:	Primary transmit buffer transmit complete interrupt flag
CAN_RAFIF_FLAG:	Receive buffer almost full interrupt flag
CAN_RFIF_FLAG:	Receive buffer full interrupt flag
CAN_ROIF_FLAG:	Receive buffer overflow interrupt flag
CAN_RIF_FLAG:	Receive interrupt flag
CAN_BEIF_FLAG:	Bus error interrupt flag
CAN_ALIF_FLAG:	Arbitration lost interrupt flag
CAN_EPIF_FLAG:	Error passive interrupt flag
CAN_TTIF_FLAG:	Time-triggered interrupt flag
CAN_TEIF_FLAG:	Trigger error interrupt flag
CAN_WTIF_FLAG:	Window trigger interrupt flag
CAN_EPASS_FLAG:	Error passive status flag
CAN_EWARN_FLAG:	Error warning flag

### Example:

```

/* transmit the primary transmit buffer */
can_txbuf_transmit(CAN1, CAN_TRANSMIT_PTB);
/* wait transmit be completed */
while(can_flag_get(CAN1, CAN_TPIF_FLAG) != SET);
can_flag_clear(CAN1, CAN_TPIF_FLAG);

```

### 5.2.51 can\_interrupt\_flag\_get function

The table below describes the function can\_interrupt\_flag\_get.

**Table 107. can\_interrupt\_flag\_get function**

Name	Description
Function name	can_interrupt_flag_get
Function prototype	flag_status can_interrupt_flag_get(can_type* can_x, uint32_t can_flag);
Function description	Get CAN interrupt flag status
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>can_flag</i> : indicates the selected flag. Refer to “can_flag” below for details.
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

#### can\_flag:

This is used to clear the selected flag, including:

CAN_AIF_FLAG:	Aborted transmit interrupt flag
CAN_EIF_FLAG:	Error interrupt flag
CAN_TSIF_FLAG:	Secondary transmit buffer transmit complete interrupt flag
CAN_TPIF_FLAG:	Primary transmit buffer transmit complete interrupt flag
CAN_RAFIF_FLAG:	Receive buffer almost full interrupt flag
CAN_RFIF_FLAG:	Receive buffer full interrupt flag
CAN_ROIF_FLAG:	Receive buffer overflow interrupt flag
CAN_RIF_FLAG:	Receive interrupt flag
CAN_BEIF_FLAG:	Bus error interrupt flag
CAN_ALIF_FLAG:	Arbitration lost interrupt flag
CAN_EPIF_FLAG:	Error passtive interrupt flag
CAN_TTIF_FLAG:	Time-triggered interrupt flag
CAN_TEIF_FLAG:	Trigger error interrupt flag
CAN_WTIF_FLAG:	Window trigger interrupt flag

#### Example:

```

can_rxbuf_type can_rxbuf_struct;
/* rx_buffer had data be received */
if(can_interrupt_flag_get(CAN1, CAN_RIF_FLAG) != RESET)
{
    can_flag_clear(CAN1, CAN_RIF_FLAG);
    while(ERROR != can_rxbuf_read(CAN1, &can_rxbuf_struct))
    {

```

```
    }  
}
```

## 5.2.52 can\_flag\_clear function

The table below describes the function can\_flag\_clear.

Table 108. can\_flag\_clear function

Name	Description
Function name	can_flag_clear
Function prototype	void can_flag_clear(can_type* can_x, uint32_t can_flag);
Function description	Clear the selected CAN flag
Input parameter 1	can_x: indicates the selected CAN This parameter can be CAN1
Input parameter 2	<i>can_flag</i> : indicates the selected flag. Refer to “can_flag” below for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### can\_flag:

This is used to clear the selected flag, including:

CAN_AIF_FLAG:	Aborted transmit interrupt flag
CAN{EIF}_FLAG:	Error interrupt flag
CAN_TSIF_FLAG:	Secondary transmit buffer transmit complete interrupt flag
CAN_TPIF_FLAG:	Primary transmit buffer transmit complete interrupt flag
CAN_RAFIF_FLAG:	Receive buffer almost full interrupt flag
CAN_RFIF_FLAG:	Receive buffer full interrupt flag
CAN_ROIF_FLAG:	Receive buffer overflow interrupt flag
CAN_RIF_FLAG:	Receive interrupt flag
CAN_BEIF_FLAG:	Bus error interrupt flag
CAN_ALIF_FLAG:	Arbitration lost interrupt flag
CAN_EPIF_FLAG:	Error passive interrupt flag
CAN_TTIF_FLAG:	Time-triggered interrupt flag
CAN_TEIF_FLAG:	Trigger error interrupt flag
CAN_WTIF_FLAG:	Window trigger interrupt flag

### Example:

```
/* clear receive flag */  
can_flag_clear(CAN1, CAN_RIF_FLAG);
```

## 5.3 CRC calculation unit (CRC)

The CRC register structure `crc_type` is defined in the “`AT32M412_416_crc.h`”.

```
/*
 * @brief type define crc register all
 */
typedef struct
{
    ...
} crc_type;
```

The table below gives a list of the CRC registers.

**Table 109. Summary of CRC registers**

Register	Description
dt	Data register
cdt	General-purpose data register
ctrl	Control register
idt	Control register
poly	Polynomial generator

The table below gives a list of CRC library functions.

**Table 110. Summary of CRC library functions**

Function name	Description
<code>crc_data_reset</code>	Data register reset
<code>crc_one_word_calculate</code>	Calulate the CRC value using combination of a new 32-bit data and the previous CRC value
<code>crc_block_calculate</code>	Write a data block in order into CRC check and return the calculated result
<code>crc_data_get</code>	Get the currently calculated CRC result
<code>crc_common_data_set</code>	Configure common registers
<code>crc_common_data_get</code>	Get the value of common registers
<code>crc_init_data_set</code>	Set the CRC initialization register
<code>crc_reverse_input_data_set</code>	Set CRC input data bit reverse type
<code>crc_reverse_output_data_set</code>	Set CRC output data reverse type
<code>crc_poly_value_set</code>	Set polynomial value
<code>crc_poly_value_get</code>	Get polynomial value
<code>crc_poly_size_set</code>	Set polynomial valid width
<code>crc_poly_size_get</code>	Get polynomial valid width

### 5.3.1 crc\_data\_reset function

The table below describes the function crc\_data\_reset.

Table 111. crc\_data\_reset function

Name	Description
Function name	crc_data_reset
Function prototype	void crc_data_reset(void);
Function description	After data register reset, the value of the initialization register is added into the data register as an initial value. The default reset value is 0xFFFFFFFF.
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* reset crc data register */  
crc_data_reset();
```

### 5.3.2 crc\_one\_word\_calculate function

The table below describes the function crc\_one\_word\_calculate.

Table 112. crc\_one\_word\_calculate function

Name	Description
Function name	crc_one_word_calculate
Function prototype	uint32_t crc_one_word_calculate(uint32_t data);
Function description	Calculate the CRC value by using a combination of a new 32-bit data and the previous CRC value, and return the result
Input parameter 1	data: 32-bit data input
Input parameter 2	NA
Output parameter	NA
Return value	uint32_t: return CRC calculation result
Required preconditions	NA
Called functions	NA

**Example:**

```
/* calculate and return result */  
uint32_t data = 0x12345678, result = 0;  
result = crc_one_word_calculate (data);
```

### 5.3.3 crc\_block\_calculate function

The table below describes the function crc\_block\_calculate

Table 113. crc\_block\_calculate function

Name	Description
Function name	crc_block_calculate
Function prototype	uint32_t crc_block_calculate(uint32_t *pbuffer, uint32_t length);
Function description	Input a data block in sequence to go through CRC calculation and return a result
Input parameter 1	pbuffer: point to the data block pending for CRC check
Input parameter 2	length: data block length pending for CRC check, in terms of 32-bit
Output parameter	NA
Return value	uint32_t: return CRC calculation result
Required preconditions	NA
Called functions	NA

**Example:**

```
/* calculate and return result */  
uint32_t pbuffer[2] = {0x12345678, 0x87654321};  
uint32_t result = 0;  
result = crc_block_calculate (pbuffer, 2);
```

### 5.3.4 crc\_data\_get function

The table below describes the function crc\_data\_get.

Table 114. crc\_data\_get function

Name	Description
Function name	crc_data_get
Function prototype	uint32_t crc_data_get(void);
Function description	Return the current CRC calculation result
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	uint32_t: return CRC calculation result
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get result */  
uint32_t result = 0;  
result = crc_data_get();
```

### 5.3.5 crc\_common\_data\_set function

The table below describes the function crc\_common\_data\_set.

Table 115. crc\_common\_data\_set function

Name	Description
Function name	crc_common_data_set
Function prototype	void crc_common_data_set(uint8_t cdt_value);
Function description	Configure common data register
Input parameter 1	cdt_value: 8-bit common data that can be used as temporary storage data
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set common data */  
crc_common_data_set (0x88);
```

### 5.3.6 crc\_common\_data\_get function

The table below describes the function crc\_common\_data\_get.

Table 116. crc\_common\_data\_get function

Name	Description
Function name	crc_common_data_get
Function prototype	uint8_t crc_common_data_get(void);
Function description	Return the value of the command data register
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	uint8_t: return the value of the previously programmed common data register
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get common data */  
uint8_t cdt_value = 0;  
cdt_value = crc_common_data_get();
```

### 5.3.7 crc\_init\_data\_set function

The table below describes the function `crc_init_data_set`.

**Table 117. `crc_init_data_set` function**

Name	Description
Function name	<code>crc_init_data_set</code>
Function prototype	<code>void crc_init_data_set(uint32_t value);</code>
Function description	Set the value of the CRC initialization register
Input parameter 1	value: the value of the CRC initialization register
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

After the value of the CRC initialization register is programmed, the CRC data register is updated with this value whenever the `crc_data_reset` function is called.

**Example:**

```
/* set initial data */
uint32_t init_value = 0x11223344;
crc_init_data_set (init_value);
```

### 5.3.8 crc\_reverse\_input\_data\_set function

The table below describes the function `crc_reverse_input_data_set`.

**Table 118. `crc_reverse_input_data_set` function**

Name	Description
Function name	<code>crc_reverse_input_data_set</code>
Function prototype	<code>void crc_reverse_input_data_set(crc_reverse_input_type value);</code>
Function description	Define CRC input data bit reverse type
Input parameter 1	value: input data bit reverse type. Refer to “value” below for details.
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

Define the reverse type of input data bit.

`CRC_REVERSE_INPUT_NO_AFFECTE`: No effect

`CRC_REVERSE_INPUT_BY_BYTE`: Byte reverse

`CRC_REVERSE_INPUT_BY_HALFWORD`: Half-word reverse

`CRC_REVERSE_INPUT_BY_WORD`: Word reverse

**Example:**

```
/* set input data reversing type */
crc_reverse_input_data_set(CRC_REVERSE_INPUT_BY_WORD);
```

### 5.3.9 crc\_reverse\_output\_data\_set function

The table below describes the function crc\_reverse\_output\_data\_set.

**Table 119. crc\_reverse\_output\_data\_set function**

Name	Description
Function name	crc_reverse_output_data_set
Function prototype	void crc_reverse_output_data_set(crc_reverse_output_type value);
Function description	Define CRC output data reverse type
Input parameter 1	value: output data bit reverse type. Refer to “value” below for details.
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### value

Define the reverse type of output data bit.

CRC\_REVERSE\_OUTPUT\_NO\_AFFECTE: No effect

CRC\_REVERSE\_OUTPUT\_DATA: Word reverse

#### Example:

```
/* set output data reversing type */
crc_reverse_output_data_set(CRC_REVERSE_OUTPUT_DATA);
```

### 5.3.10 crc\_poly\_value\_set function

The table below describes the function crc\_poly\_value\_set.

**Table 120. crc\_poly\_value\_set function**

Name	Description
Function name	crc_poly_value_set
Function prototype	void crc_poly_value_set(uint32_t value);
Function description	Set CRC polynomial value
Input parameter 1	value: polynomial value
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### Example:

```
/* set poly value */
crc_poly_value_set(0x12345671);
```

### 5.3.11 crc\_poly\_value\_get function

The table below describes the function crc\_poly\_value\_get.

**Table 121. crc\_poly\_value\_get function**

Name	Description
Function name	crc_poly_value_get
Function prototype	uint32_t crc_poly_value_get(void);
Function description	Get CRC polynomial value
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	uint32_t: return polynomial value
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get poly value */
uint32_t poly = 0;
poly = crc_poly_value_get();
```

### 5.3.12 crc\_poly\_size\_set function

The table below describes the function crc\_poly\_size\_set.

**Table 122. crc\_poly\_size\_set function**

Name	Description
Function name	crc_poly_size_set
Function prototype	void crc_poly_size_set(crc_poly_size_type size);
Function description	Set CRC polynomial valid width
Input parameter 1	size: polynomial valid width
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**size**

Define the valid width of polynomial.

- CRC\_POLY\_SIZE\_32B: 32-bit
- CRC\_POLY\_SIZE\_16B: 16-bit
- CRC\_POLY\_SIZE\_8B: 8-bit
- CRC\_POLY\_SIZE\_7B: 7-bit

**Example:**

```
/* set poly size 32-bit */
crc_poly_size_set(CRC_POLY_SIZE_32B);
```

### 5.3.13 crc\_poly\_size\_get function

The table below describes the function crc\_poly\_size\_get.

Table 123. crc\_poly\_size\_get function

Name	Description
Function name	crc_poly_size_get
Function prototype	crc_poly_size_type crc_poly_size_get(void);
Function description	Get CRC polynomial valid width
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	crc_poly_size_type: polynomial valid width
Required preconditions	NA
Called functions	NA

#### crc\_poly\_size\_type

Define the valid width of polynomial.

- CRC\_POLY\_SIZE\_32B: 32-bit
- CRC\_POLY\_SIZE\_16B: 16-bit
- CRC\_POLY\_SIZE\_8B: 8-bit
- CRC\_POLY\_SIZE\_7B: 7-bit

#### Example:

```
/* get poly size */  
crc_poly_size_type size;  
size = crc_poly_size_get();
```

## 5.4 Clock and reset management (CRM)

The CRM register structure `crm_type` is defined in the “`AT32M412_416_crm.h`”:

```
/**  
 * @brief type define crm register all  
 */  
  
typedef struct  
{  
    ...  
  
} crm_type;
```

The table below gives a list of the CRM registers.

**Table 124. Summary of CRM registers**

Register	Description
ctrl	Clock control register
pllcfg	PLL clock configuration register
cfg	Clock configuration register
clkint	Clock interrupt register
ahbrst1	AHB peripheral reset register 1
apb1rst	APB1 peripheral reset register
apb2rst	APB2 peripheral reset register
ahben1	AHB peripheral clock enable register 1
apb1en	APB1 peripheral clock enable register
apb2en	APB2 peripheral clock enable register
ahblpen1	AHB peripheral clock enable in low power mode register 1
apb1lpen	APB1 peripheral clock enable in low power mode register
apb2lpen	APB2 peripheral clock enable in low power mode register
piclks	Peripheral independent clock select register
bpdc	Battery powered domain control register
ctrlsts	Control/status register
misc1	Extra register 1
misc2	Extra register 2

The table below gives a list of CRM library functions.

**Table 125. Summary of CRM library functions**

Function name	Description
crm_reset	Reset clock reset management register and control status
crm_lext_bypass	Configure low-speed external clock bypass
crm_hext_bypass	Configure higded external clock bypass
crm_flag_get	Check if the selected flag is set or not
crm_hext_stable_wait	Wait HEXT to get stable
crm_hick_clock_trimming_set	High speed internal clock trimming
crm_hick_clock_calibration_set	High speed internal clock calibration
crm_periph_clock_enable	Peripheral clock enable
crm_periph_reset	Peripheral set
crm_periph_lowpower_mode_enable	Enable peripheral clock in low-power mode
crm_clock_source_enable	Clock source enable
crm_flag_clear	Clear flag
crm_erc_clock_select	ERTC clock source selection
crm_erc_clock_enable	ERTC clock enable
crm_ahb_div_set	AHB clock division
crm_apb1_div_set	APB1 clock division
crm_apb2_div_set	APB2 clock division
crm_hext_sclk_div_set	HEXT clock division
crm_hick_sclk_div_set	HICK clock division
crm_usb_clock_div_set	USB clock division
crm_clock_failure_detection_enable	Clock failure detection enable
crm_batteryPowered_domain_reset	Battery powered domain reset
crm_auto_step_mode_enable	Auto step mode enable
crm_hick_sclk_frequency_select	When HICK as a system clock, system frequency is 8M or 48M
crm_can_clock_select	CAN clock source select
crm_can_clock_get	Get CAN clock source
crm_pll_config	PLL clock source and frequency multiplication factor
crm_sysclk_switch	System clock source switch
crm_sysclk_switch_status_get	Get the status of system clock source
crm_clocks_freq_get	Get clock frequency
crm_clock_out_set	Clock output clock source
crm_clkout_div_set	Clock frequency division on clock out pins
crm_interrupt_enable	Interrupt enable
crm_auto_step_mode_enable	Auto step-by-step mode enable
crm_hick_sclk_frequency_select	Set system clock frequency as 8M or 48M when HICK is used as system clock
crm_usb_clock_source_select	Select PLL or interal high-speed clock (48M) as USB clock source
crm_usart_clock_select	Select USART clock source
crm_usart_clock_get	Get USART clock source status
crm_i2c1_clock_select	Select I2C1 clock source
crm_i2c1_clock_get	Get I2C1 clock source status

crm_adc_clock_select	Select ADC clock source
crm_pll_parameter_calculate	Calculate PLL parameters automatically
crm_apb3_div_set	Set clock division from AHB to APB3
crm_vbath_div_set	Set clock division from AHB to vbat
crm_lextdrv_set	Set LEXT drive capability
crm_hextdrv_set	Set HEXT drive capability

### 5.4.1 crm\_reset function

The table below describes the function crm\_reset.

**Table 126. crm\_reset function**

Name	Description
Function name	crm_reset
Function prototype	void crm_reset(void);
Function description	Reset the clock reset management register and control status
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

1. This function does not change the HICKTRIM[5:0] in the CRM\_CTRL register;
2. Modifying the function does not reset the CRM\_BPDC and CRM\_CTRLSTS registers.

**Example:**

```
/* reset crm */
crm_reset();
```

### 5.4.2 crm\_lext\_bypass function

The table below describes the function crm\_lext\_bypass.

**Table 127. crm\_lext\_bypass function**

Name	Description
Function name	crm_lext_bypass
Function prototype	void crm_lext_bypass(confirm_state new_state);
Function description	Configure low-speed external clock bypass
Input parameter 1	new_state: Enable bypass (TRUE), disable bypass (FALSE)
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	The LEXT configuration must be done before being enabled.
Called functions	NA

**Example:**

```
/* enable lext bypass mode */
crm_lext_bypass(TRUE);
```

### 5.4.3 crm\_hext\_bypass function

The table below describes the function crm\_hext\_bypass.

**Table 128. crm\_hext\_bypass function**

Name	Description
Function name	crm_hext_bypass
Function prototype	void crm_hext_bypass(confirm_state new_state);
Function description	Configure high-speed external clock bypass
Input parameter 1	new_state: Enable bypass (TRUE), disable bypass (FALSE)
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	The HEXT configuration must be done before being enabled.
Called functions	NA

**Example:**

```
/* enable hext bypass mode */
crm_hext_bypass(TRUE);
```

### 5.4.4 crm\_flag\_get function

The table below describes the function crm\_flag\_get.

**Table 129. crm\_flag\_get function**

Name	Description
Function name	crm_flag_get
Function prototype	flag_status crm_flag_get(uint32_t flag);
Function description	Check if the selected flag has been set.
Input parameter 1	flag: flag selection
Input parameter 2	NA
Output parameter	NA
Return value	flag_status: check the status of the selected flag. (SET or RESET)
Required preconditions	NA
Called functions	NA

**flag**

Select a flag to read, including:

CRM_HICK_STABLE_FLAG:	HICK clock stable flag
CRM_HEXT_STABLE_FLAG:	HEXT clock stable flag
CRM_PLL_STABLE_FLAG:	PLL clock stable flag
CRM_PLLU_STABLE_FLAG:	PLLU clock stable flag
CRM_LEXT_STABLE_FLAG:	LEXT clock stable flag
CRM_LICK_STABLE_FLAG:	LICK clock stable flag
CRM_NRST_RESET_FLAG:	NRST pin reset flag
CRM_POR_RESET_FLAG:	Power-on/low voltage reset flag
CRM_SW_RESET_FLAG:	Software reset flag
CRM_WDT_RESET_FLAG:	Watchdog reset flag
CRM_WWDT_RESET_FLAG:	Window watchdog reset flag

CRM_LOWPOWER_RESET_FLAG:	Low-power consumption reset flag
CRM_LICK_READY_INT_FLAG:	LICK clock ready interrupt flag
CRM_LEXT_READY_INT_FLAG:	LEXT clock ready interrupt flag
CRM_HICK_READY_INT_FLAG:	HICK clock ready interrupt flag
CRM_HEXT_READY_INT_FLAG:	HEXT clock ready interrupt flag
CRM_PLL_READY_INT_FLAG:	PLL clock ready interrupt flag
CRM_CLOCK_FAILURE_INT_FLAG:	Clock failure interrupt flag

**Example:**

```
/* wait till pll is ready */
while(crm_flag_get(CRM_PLL_STABLE_FLAG) != SET)
{
}
```

## 5.4.5 crm\_interrupt\_flag\_get function

The table below describes the function crm\_interrupt\_flag\_get

**Table 130. crm\_interrupt\_flag\_get function**

Name	Description
Function name	crm_interrupt_flag_get
Function prototype	flag_status crm_interrupt_flag_get(uint32_t flag);
Function description	Get CRM interrupt flag status
Input parameter 1	flag: select a flag Refer to the "flag" below for details
Input parameter 2	NA
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

**flag**

Select a flag to read, including:

CRM_LICK_READY_INT_FLAG:	LICK clock ready interrupt flag
CRM_LEXT_READY_INT_FLAG:	LEXT clock ready interrupt flag
CRM_HICK_READY_INT_FLAG:	HICK clock ready interrupt flag
CRM_HEXT_READY_INT_FLAG:	HEXT clock ready interrupt flag
CRM_PLL_READY_INT_FLAG:	PLL clock ready interrupt flag
CRM_CLOCK_FAILURE_INT_FLAG:	Clock failure interrupt flag

**Example:**

```
/* check pll ready interrupt flag */
if(crm_interrupt_flag_get(CRM_PLL_READY_INT_FLAG) != RESET)
{
}
```

## 5.4.6 crm\_hext\_stable\_wait function

The table below describes the function crm\_hext\_stable\_wait

**Table 131. crm\_hext\_stable\_wait function**

Name	Description
Function name	crm_hext_stable_wait
Function prototype	error_status crm_hext_stable_wait(void);
Function description	Wait for HEXT to activate and become stable
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	error_status: Return the status of HEXT (SUCCESS or ERROR).
Required preconditions	NA
Called functions	NA

**Example:**

```
/* wait till hext is ready */
while(crm_hext_stable_wait() == ERROR)
{
}
```

## 5.4.7 crm\_hick\_clock\_trimming\_set function

The table below describes the function crm\_hick\_clock\_trimming\_set.

**Table 132. crm\_hick\_clock\_trimming\_set function**

Name	Description
Function name	crm_hick_clock_trimming_set
Function prototype	void crm_hick_clock_trimming_set(uint8_t trim_value);
Function description	Trim HICK clock
Input parameter 1	trim_value: trimming value. Default value is 0x20, configurable range is from 0 to 0x3F.
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set trimming value */
crm_hick_clock_trimming_set(0x1F);
```

## 5.4.8 crm\_hick\_clock\_calibration\_set function

The table below describes the function crm\_hick\_clock\_calibration\_set.

**Table 133. crm\_hick\_clock\_calibration\_set function**

Name	Description
Function name	crm_hick_clock_calibration_set
Function prototype	void crm_hick_clock_calibration_set(uint8_t cali_value);
Function description	Set HICK clock calibration value
Input parameter 1	cali_value: calibration compensation value. The factory gate value is the default value, Its configurable range is from 0 to 0xFF.
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set trimming value */
crm_hick_clock_trimming_set(0x80);
```

## 5.4.9 crm\_periph\_clock\_enable

The table below describes the function crm\_periph\_clock\_enable.

**Table 134. crm\_periph\_clock\_enable function**

Name	Description
Function name	crm_periph_clock_enable
Function prototype	void crm_periph_clock_enable(crm_periph_clock_type value, confirm_state new_state);
Function description	Enable peripheral clock
Input parameter 1	value: defines peripheral clock type
Input parameter 2	new_state: TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

The crm\_periph\_clock\_type is defined in the AT32M412\_416\_crm.h.

The naming rule of this parameter is: CRM\_peripheral\_PERIPH\_CLOCK.

CRM\_DMA1\_PERIPH\_CLOCK: DMA1 peripheral clock enable

CRM\_DMA1\_PERIPH\_CLOCK: DMA1 peripheral clock enable

...

CRM\_PWC\_PERIPH\_CLOCK: PWC peripheral clock enable

**Example:**

```
/* enable gpioa periph clock */
crm_periph_clock_enable(CRM_GPIOA_PERIPH_CLOCK, TRUE);
```

## 5.4.10 crm\_periph\_reset function

The table below describes the function crm\_periph\_reset.

**Table 135. crm\_periph\_reset function**

Name	Description
Function name	crm_periph_reset
Function prototype	void crm_periph_reset(crm_periph_reset_type value, confirm_state new_state);
Function description	Reset peripherals
Input parameter 1	value: Peripheral reset type
Input parameter 2	new_state: TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### value

This indicates the selected peripheral. The crm\_periph\_reset\_type is defined in the AT32M412\_416\_crm.h.

The naming rule of this parameter is: CRM\_peripheral\_PERIPH\_RESET.

CRM\_DMA1\_PERIPH\_RESET: DMA1 peripheral reset

CRM\_DMA1\_PERIPH\_RESET: DMA1 peripheral reset

...

CRM\_PWC\_PERIPH\_RESET: PWC peripheral reset

### Example:

```
/* reset gpioa periph */
crm_periph_reset(CRM_GPIOA_PERIPH_RESET, TRUE);
```

## 5.4.11 crm\_periph\_lowpower\_mode\_enable function

The table below describes the function crm\_periph\_lowpower\_mode\_enable.

**Table 136. crm\_periph\_lowpower\_mode\_enable function**

Name	Description
Function name	crm_periph_lowpower_mode_enable
Function prototype	void crm_periph_lowpower_mode_enable(crm_periph_clock_lowpower_type value, confirm_state new_state);
Function description	Enable peripheral clock in low-power mode
Input parameter 1	value: indicates peripheral clock type in low-power mode
Input parameter 2	new_state: TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### value

It indicates the selected peripheral. The crm\_periph\_lowpower\_type is defined in AT32M412\_416\_crm.h.

The naming rule of this parameter is: CRM\_peripheral\_PERIPH\_LOWPOWER.

CRM\_DMA1\_PERIPH\_LOWPOWER: DMA1 peripheral low-power clock definition  
 CRM\_DMA1\_PERIPH\_LOWPOWER: DMA1 peripheral low-power clock definition  
 ...  
 CRM\_PWC\_PERIPH\_LOWPOWER: PWC peripheral low-power clock definition

**Example:**

```
/* disable gpioa periph clock at sleep mode */
crm_periph_reset(CRM_GPIOA_PERIPH_LOWPOWER, FALSE);
```

## 5.4.12 crm\_clock\_source\_enable function

The table below describes the function crm\_clock\_source\_enable function.

**Table 137. crm\_clock\_source\_enable function**

Name	Description
Function name	crm_clock_source_enable
Function prototype	void crm_clock_source_enable(crm_clock_source_type source, confirm_state new_state);
Function description	Enable clock source
Input parameter 1	source: Clock type
Input parameter 2	new_state: TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**source**

Clock source selection.

CRM\_CLOCK\_SOURCE\_HICK: HICK  
 CRM\_CLOCK\_SOURCE\_HEXT: HEXT  
 CRM\_CLOCK\_SOURCE\_PLL: PLL  
 CRM\_CLOCK\_SOURCE\_LEXT: LEXT  
 CRM\_CLOCK\_SOURCE\_LICK: LICK

**Example:**

```
/* enable hext */
crm_clock_source_enable (CRM_CLOCK_SOURCE_HEXT, FALSE);
```

## 5.4.13 crm\_flag\_clear function

The table below describes the function crm\_flag\_clear function.

Table 138. crm\_flag\_clear function

Name	Description
Function name	crm_flag_clear
Function prototype	void crm_flag_clear(uint32_t flag);
Function description	Clear the selected flags
Input parameter 1	Flag: indicates the flag to clear
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### flag

Select a flag to clear.

CRM_NRST_RESET_FLAG:	NRST pin reset flag
CRM_POR_RESET_FLAG:	Power-on/low voltage reset flag
CRM_SW_RESET_FLAG:	Software reset flag
CRM_WDT_RESET_FLAG:	Watchdog reset flag
CRM_WWDT_RESET_FLAG:	Window watchdog reset flag
CRM_LOWPOWER_RESET_FLAG:	Low-power reset flag
CRM_ALL_RESET_FLAG:	All reset flags
CRM_LICK_READY_INT_FLAG:	LICK clock ready interrupt flag
CRM_LEXT_READY_INT_FLAG:	LEXT clock ready interrupt flag
CRM_HICK_READY_INT_FLAG:	HICK clock ready interrupt flag
CRM_HEXT_READY_INT_FLAG:	HEXT clock ready interrupt flag
CRM_PLL_READY_INT_FLAG:	PLL clock ready interrupt flag
CRM_CLOCK_FAILURE_INT_FLAG:	Clock failure interrupt flag

### Example:

```
/* clear clock failure detection flag */  
crm_flag_clear(CRM_CLOCK_FAILURE_INT_FLAG);
```

## 5.4.14 crm\_ertc\_clock\_select function

The table below describes the function crm\_ertc\_clock\_select function.

**Table 139. crm\_ertc\_clock\_select function**

Name	Description
Function name	crm_ertc_clock_select
Function prototype	void crm_ertc_clock_select(crm_ertc_clock_type value);
Function description	Select ERTC clock source
Input parameter 1	value: indicates ertc clock source type
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### value

ERTC clock source selection.

CRM_ERTC_CLOCK_NOCLK:	No clock source for ERTC
CRM_ERTC_CLOCK_LEXT:	LEXT selected as ERTC clock
CRM_ERTC_CLOCK_LICK:	LICK selected as ERTC clock
CRM_ERTC_CLOCK_HEXT_DIV2:	HEXT/2 selected as ERTC clock
...	
CRM_ERTC_CLOCK_HEXT_DIV31:	HEXT/31 selected as ERTC clock

### Example:

```
/* config lext as ertc clock */
crm_ertc_clock_select(CRM_ERTC_CLOCK_LEXT);
```

## 5.4.15 crm\_ertc\_clock\_enable function

The table below describes the function crm\_ertc\_clock\_enable.

**Table 140. crm\_ertc\_clock\_enable function**

Name	Description
Function name	crm_ertc_clock_enable
Function prototype	void crm_ertc_clock_enable(confirm_state new_state);
Function description	Enable ERTC clock
Input parameter 1	new_state: TRUE or FALSE
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### Example:

```
/* enable ertc clock */
crm_ertc_clock_enable (TRUE);
```

## 5.4.16 crm\_ahb\_div\_set function

The table below describes the function crm\_ahb\_div\_set.

**Table 141. crm\_ahb\_div\_set function**

Name	Description
Function name	crm_ahb_div_set
Function prototype	void crm_ahb_div_set(crm_ahb_div_type value);
Function description	Configure AHB clock division
Input parameter 1	value: the division factor
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### value

- CRM\_AHB\_DIV\_1: SCLK/1 used as AHB clock
- CRM\_AHB\_DIV\_2: SCLK/2 used as AHB clock
- CRM\_AHB\_DIV\_4: SCLK/4 used as AHB clock
- CRM\_AHB\_DIV\_8: SCLK/8 used as AHB clock
- CRM\_AHB\_DIV\_16: SCLK/16 used as AHB clock
- CRM\_AHB\_DIV\_64: SCLK/64 used as AHB clock
- CRM\_AHB\_DIV\_128: SCLK/128 used as AHB clock
- CRM\_AHB\_DIV\_256: SCLK/256 used as AHB clock
- CRM\_AHB\_DIV\_512: SCLK/512 used as AHB clock

### Example:

```
/* config ahbclk */
crm_ahb_div_set(CRM_AHB_DIV_1);
```

## 5.4.17 crm\_apb1\_div\_set function

The table below describes the function crm\_apb1\_div\_set.

**Table 142. crm\_apb1\_div\_set function**

Name	Description
Function name	crm_apb1_div_set
Function prototype	void crm_apb1_div_set(crm_apb1_div_type value);
Function description	Configure APB1 clock division
Input parameter 1	value: the division factor
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### value

- CRM\_APB1\_DIV\_1: APB1/1 used as APB1 clock
- CRM\_APB1\_DIV\_2: APB1/2 used as APB1 clock
- CRM\_APB1\_DIV\_4: APB1/4 used as APB1 clock

- CRM\_APB1\_DIV\_8: AHB/8 used as APB1 clock  
 CRM\_APB1\_DIV\_16: AHB/16 used as APB1 clock

**Example:**

```
/* config apb1clk */
crm_apb1_div_set(CRM_APB1_DIV_2);
```

### 5.4.18 crm\_apb2\_div\_set function

The table below describes the function crm\_apb2\_div\_set.

**Table 143. crm\_apb2\_div\_set function**

Name	Description
Function name	crm_apb2_div_set
Function prototype	void crm_apb2_div_set(crm_apb2_div_type value);
Function description	Configure APB2 clock division
Input parameter 1	value: the division factor
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

- CRM\_APB2\_DIV\_1: AHB/1 used as APB2 clock  
 CRM\_APB2\_DIV\_2: AHB/2 used as APB2 clock  
 CRM\_APB2\_DIV\_4: AHB/4 used as APB2 clock  
 CRM\_APB2\_DIV\_8: AHB/8 used as APB2 clock  
 CRM\_APB2\_DIV\_16: AHB/16 used as APB2 clock

**Example:**

```
/* config apb2clk */
crm_apb2_div_set(CRM_APB2_DIV_2);
```

### 5.4.19 crm\_hext\_sclk\_div\_set function

The table below describes the function crm\_hext\_sclk\_div\_set.

**Table 144. crm\_hext\_sclk\_div\_set function**

Name	Description
Function name	crm_hext_sclk_div_set
Function prototype	void crm_hext_sclk_div_set(crm_hext_sclk_div_type value);
Function description	Configure HEXT clock division
Input parameter 1	value: the division factor
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

- CRM\_HEXT\_SCLK\_DIV\_1: HEXT/1 used as system clock  
 CRM\_HEXT\_SCLK\_DIV\_2: HEXT/2 used as system clock  
 CRM\_HEXT\_SCLK\_DIV\_4: HEXT/4 used as system clock

CRM\_HEXT\_SCLK\_DIV\_8: HEXT/8 used as system clock  
CRM\_HEXT\_SCLK\_DIV\_16: HEXT/16 used as system clock  
CRM\_HEXT\_SCLK\_DIV\_32: HEXT/32 used as system clock

**Example:**

```
/* config hext to sysclk div */  
crm_hext_sclk_div_set(CRM_HEXT_SCLK_DIV_1);
```

### 5.4.20 crm\_hick\_sclk\_div\_set function

The table below describes the function crm\_hick\_sclk\_div\_set.

**Table 145. crm\_hick\_sclk\_div\_set function**

Name	Description
Function name	crm_hick_sclk_div_set
Function prototype	void crm_hick_sclk_div_set(crm_hick_sclk_div_type value);
Function description	Configure HICK clock division
Input parameter 1	value: the division factor
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

CRM\_HICK\_SCLK\_DIV\_1: HICK/1 used as system clock  
CRM\_HICK\_SCLK\_DIV\_2: HICK/2 used as system clock  
CRM\_HICK\_SCLK\_DIV\_4: HICK/4 used as system clock  
CRM\_HICK\_SCLK\_DIV\_8: HICK/8 used as system clock  
CRM\_HICK\_SCLK\_DIV\_16: HICK/16 used as system clock

**Example:**

```
/* config hick to sysclk div */  
crm_hick_sclk_div_set(CRM_HICK_SCLK_DIV_1);
```

## 5.4.21 crm\_clock\_failure\_detection\_enable function

The table below describes the function crm\_clock\_failure\_detection\_enable.

**Table 146. crm\_clock\_failure\_detection\_enable function**

Name	Description
Function name	crm_clock_failure_detection_enable
Function prototype	void crm_clock_failure_detection_enable(confirm_state new_state);
Function description	Enable clock failure detection
Input parameter 1	new_state: TRUE or FALSE
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable clock failure detection */
crm_clock_failure_detection_enable(TRUE);
```

## 5.4.22 crm\_batteryPowered\_domain\_reset function

The table below describes the function crm\_batteryPowered\_domain\_reset.

**Table 147. crm\_batteryPowered\_domain\_reset**

Name	Description
Function name	crm_batteryPowered_domain_reset
Function prototype	void crm_batteryPowered_domain_reset(confirm_state new_state);
Function description	Reset battery powered domain
Input parameter 1	new_state: Reset (TRUE), Not reset (FALSE)
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

When it comes to resetting battery powered domain, it is usually necessary to reset battery powered domain through TRUE operation and then disable battery powered domain reset through FALSE operation after the completion of reset.

**Example:**

```
/* reset battery powered domain */
crm_batteryPowered_domain_reset (TRUE);
```

## 5.4.23 crm\_auto\_step\_mode\_enable function

The table below describes the function crm\_auto\_step\_mode\_enable.

**Table 148. crm\_auto\_step\_mode\_enable function**

Name	Description
Function name	crm_auto_step_mode_enable
Function prototype	void crm_auto_step_mode_enable(confirm_state new_state);
Function description	Enable CRM auto step-by-step mode
Input parameter 1	new_state: Enable (TRUE), disable (FALSE)
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable auto step mode */
crm_auto_step_mode_enable(TRUE);
```

## 5.4.24 crm\_hick\_sclk\_frequency\_select function

The table below describes the function crm\_hick\_sclk\_frequency\_select.

**Table 149. crm\_hick\_sclk\_frequency\_select function**

Name	Description
Function name	crm_hick_sclk_frequency_select
Function prototype	void crm_hick_sclk_frequency_select(crm_hick_sclk_frequency_type value);
Function description	Select 8M or 48M system clock frequency when HICK is used as system clock
Input parameter 1	value: 8M or 48M HICK
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

CRM\_HICK\_SCLK\_8MHZ: 8MHz HICK used as system clock

CRM\_HICK\_SCLK\_48MHZ: 48MHz HICK used as system clock

**Example:**

```
/* config sysclk with hick 48mhz */
crm_hick_sclk_frequency_select(CRM_HICK_SCLK_48MHZ);
```

## 5.4.25 crm\_can\_clock\_select function

The table below describes the function crm\_can\_clock\_select

**Table 150. crm\_can\_clock\_select function**

Name	Description
Function name	crm_can_clock_select
Function prototype	void crm_can_clock_select(crm_can_type can_index, crm_can_clock_source_type value);
Function description	CAN clock source select
Input parameter 1	can_index: a can peripheral
Input parameter 2	value: clock source type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**can\_index**

CRM\_CAN11: CAN1 clock

**value**

CRM\_CAN\_CLOCK\_SOURCE\_HEXT: HEXT as CAN clock source

CRM\_CAN\_CLOCK\_SOURCE\_PLL: PLL as CAN clock source

CRM\_CAN\_CLOCK\_SOURCE\_PCLK: PCLK as CAN clock source

**Example:**

```
/* select hext as can clock */
crm_can_clock_select ( CRM_CAN1, CRM_CAN_CLOCK_SOURCE_HEXT);
```

## 5.4.26 crm\_can\_clock\_get function

The table below describes the function crm\_can\_clock\_get

**Table 151. crm\_can\_clock\_get function**

Name	Description
Function name	crm_can_clock_get
Function prototype	crm_can_clock_source_type crm_can_clock_get(crm_can_type can_index);
Function description	Get CAN clock
Input parameter 1	can_index: a can peripheral
Input parameter 2	value: clock source type
Output parameter	NA
Return value	crm_can_clock_source_type: return the current CAN peripheral clock
Required preconditions	NA
Called functions	NA

**can\_index**

CRM\_CAN11: CAN1 clock

**Example:**

```
/* get can1 clock source */
crm_can_clock_source_type can_clock;
can_clock = crm_can_clock_get ( CRM_CAN1);
```

## 5.4.27 crm\_pll\_config function

The table below describes the function crm\_pll\_config.

**Table 152. crm\_pll\_config function**

Name	Description
Function name	crm_pll_config
Function prototype	void crm_pll_config(crm_pll_clock_source_type clock_source, uint16_t pll_ns, uint16_t pll_ms, crm_pll_fr_type pll_fr);
Function description	Configure PLL clock source and frequency multiplication and division factor
Input parameter 1	clock_source: the clock source for PLL frequency multiplication
Input parameter 2	pll_ns: frequency multiplication factor from 31 to 500
Input parameter3	pll_ms: pre-division frequency factor from 1 to 15
Input parameter4	pll_fr: the post-division frequency factor
Output parameter	NA
Return value	NA
Required preconditions	PLL clock source must be enabled and stabilized before configuring and enabling PLL
Called functions	NA

Frequency multiplication formula:  $\text{PLLCLK} = \text{PLL input clock} / \text{PLL_MS} * \text{PLL_NS} / \text{PLL_FR}$

Requirements:

$2\text{MHz} \leq \text{PLL input clock} / \text{PLL_MS} \leq 16\text{MHz}$

$500\text{MHz} \leq \text{PLL input clock} / \text{PLL_MS} * \text{PLL_NS} \leq 1000\text{MHz}$

**clock\_source**

CRM\_PLL\_SOURCE\_HICK: HICK is selected as PLL clock source

CRM\_PLL\_SOURCE\_HEXT: HEXT is selected as PLL clock source

**pll\_fr**

CRM\_PLL\_FR\_1: PLL/1

CRM\_PLL\_FR\_2: PLL/2

CRM\_PLL\_FR\_4: PLL/4

CRM\_PLL\_FR\_8: PLL/8

CRM\_PLL\_FR\_16: PLL/16

CRM\_PLL\_FR\_32: PLL/32

**Example:**

```
/* config pll clock resource */
crm_pll_config(CRM_PLL_SOURCE_HEXT, 120, 1, CRM_PLL_FR_8);
```

## 5.4.28 crm\_sysclk\_switch function

The table below describes the function crm\_sysclk\_switch.

**Table 153. crm\_sysclk\_switch function**

Name	Description
Function name	crm_sysclk_switch
Function prototype	void crm_sysclk_switch(crm_sclk_type value);
Function description	Switch system clock source
Input parameter 1	value: indicates the clock source for system clock
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### value

CRM\_SCLK\_HICK: HICK as system clock

CRM\_SCLK\_HEXT: HEXT as system clock

CRM\_SCLK\_PLL: PLL as system clock

### Example:

```
/* select pll as system clock source */
crm_sysclk_switch(CRM_SCLK_PLL);
```

## 5.4.29 crm\_sysclk\_switch\_status\_get function

The table below describes the function crm\_sysclk\_switch\_status\_get.

**Table 154. crm\_sysclk\_switch\_status\_get function**

Name	Description
Function name	crm_sysclk_switch_status_get
Function prototype	crm_sclk_type crm_sysclk_switch_status_get(void);
Function description	Get the clock source of system clock
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	crm_sclk_type: return value is the clock source of system clock
Required preconditions	NA
Called functions	NA

### Example:

```
/* wait till pll is used as system clock source */
while(crm_sysclk_switch_status_get() != CRM_SCLK_PLL)
{
}
```

## 5.4.30 crm\_clocks\_freq\_get function

The table below describes the function crm\_clocks\_freq\_get.

**Table 155. crm\_clocks\_freq\_get function**

Name	Description
Function name	crm_clocks_freq_get
Function prototype	void crm_clocks_freq_get(crm_clocks_freq_type *clocks_struct);
Function description	Get clock frequency
Input parameter 1	clocks_struct: crm_clocks_freq_type pointer, including clock frequency
Input parameter 2	NA
Output parameter	NA
Return value	crm_sclk_type: return the clock source for system clock
Required preconditions	NA
Called functions	NA

### crm\_clocks\_freq\_type

The crm\_clocks\_freq\_type is defined in the AT32M412\_416\_crm.h:

typedef struct

```
{
    uint32_t    sclk_freq;
    uint32_t    ahb_freq;
    uint32_t    apb2_freq;
    uint32_t    apb1_freq;
} crm_clocks_freq_type;
```

### sclk\_freq

Get the system clock frequency, in Hz

### ahb\_freq

Get the clock frequency of AHB, in Hz

### apb2\_freq

Get the clock frequency of APB2, in Hz

### apb1\_freq

Get the clock frequency of APB1, in Hz

### Example:

```
/* get frequency */
crm_clocks_freq_type clocks_struct;
crm_clocks_freq_get(&clocks_struct);
```

### 5.4.31 crm\_clock\_out\_set function

The table below describes the function crm\_clock\_out\_set.

**Table 156. crm\_clock\_out\_set function**

Name	Description
Function name	crm_clock_out_set
Function prototype	void crm_clock_out_set(crm_clkout_select_type clkout);
Function description	Select clock source output on clkout pin
Input parameter 1	clkout: clock source output on clkout pin
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### clkout

Select clock source output on the clkout1 pin.

CRM\_CLKOUT\_SCLK: SCLK output on clkout pin

CRM\_CLKOUT\_HEXT: HEXT output on clkout pin

CRM\_CLKOUT\_PLL: PLL output on clkout pin

CRM\_CLKOUT\_USB: USB output on clkout pin

CRM\_CLKOUT\_ADC: ADC output on clkout pin

CRM\_CLKOUT\_HICK: HICK output on clkout pin

CRM\_CLKOUT\_LICK: LICK output on clkout pin

CRM\_CLKOUT\_LEXT: LEXT output on clkout pin

#### Example:

```
/* config clkout output hick */
crm_clock_out_set(CRM_CLKOUT_HICK);
```

### 5.4.32 crm\_clkout\_div\_set function

The table below describes the function crm\_clkout\_div\_set.

**Table 157. crm\_clkout\_div\_set function**

Name	Description
Function name	crm_clkout_div_set
Function prototype	void crm_clkout_div_set(crm_clkout_div1_type div1, crm_clkout_div2_type div2)
Function description	Clock frequency division on clockout pin
Input parameter 1	div1: divider 1 clock frequency division
Input parameter 2	div2: divider 2 clock frequency division
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### div1

Divider 1 clock frequency division

CRM\_CLKOUT\_DIV1\_1: divided by 1

CRM\_CLKOUT\_DIV1\_2: Divided by 2  
 CRM\_CLKOUT\_DIV1\_3: Divided by 3  
 CRM\_CLKOUT\_DIV1\_4: Divided by 4  
 CRM\_CLKOUT\_DIV1\_5: Divided by 5

**div2**

Divider 2 clock frequency division

CRM\_CLKOUT\_DIV2\_1: divided by 1  
 CRM\_CLKOUT\_DIV2\_2: divided by 2  
 CRM\_CLKOUT\_DIV2\_4: divided by 4  
 CRM\_CLKOUT\_DIV2\_8: divided by 8  
 CRM\_CLKOUT\_DIV2\_16: divided by 16  
 CRM\_CLKOUT\_DIV2\_64: divided by 64  
 CRM\_CLKOUT\_DIV2\_128: divided by 128  
 CRM\_CLKOUT\_DIV2\_256: divided by 256  
 CRM\_CLKOUT\_DIV2\_512: divided by 512

**Example:**

```
/* config clkout div */
crm_clkout_div_set(CRM_CLKOUT_DIV1_1, CRM_CLKOUT_DIV2_8);
```

### 5.4.33 cmm\_interrupt\_enable function

The table below describes the function cmm\_interrupt\_enable.

**Table 158. cmm\_interrupt\_enable function**

Name	Description
Function name	cmm_interrupt_enable
Function prototype	void cmm_interrupt_enable(uint32_t cmm_int, confirm_state new_state);
Function description	Enable interrupts
Input parameter 1	cmm_int: the selected interrupt
Input parameter 2	new_state: Enable (TRUE), disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**cmm\_int**

CRM\_LICK\_STABLE\_INT: LICK stable interrupt  
 CRM\_LEXT\_STABLE\_INT: LEXT stable interrupt  
 CRM\_HICK\_STABLE\_INT: HICK stable interrupt  
 CRM\_HEXT\_STABLE\_INT: HEXT stable interrupt  
 CRM\_PLL\_STABLE\_INT: PLL stable interrupt  
 CRM\_CLOCK\_FAILURE\_INT: Clock failure interrupt

**Example:**

```
/* enable pll stable interrupt */
cmm_interrupt_enable(CRM_PLL_STABLE_INT);
```

### 5.4.34 crm\_pll\_parameter\_calculate function

The table below describes the function crm\_pll\_parameter\_calculate

**Table 159. crm\_pll\_parameter\_calculate function**

Name	Description
Function name	crm_pll_parameter_calculate
Function prototype	error_status crm_pll_parameter_calculate(crm_pll_clock_source_type pll_rcs, uint32_t target_sclk_freq, uint16_t *ret_ms, uint16_t *ret_ns, uint16_t *ret_fr);
Function description	PLL parameters auto calculation
Input parameter 1	pll_rcs: pll input clock source
Input parameter 2	target_sclk_freq: target SCLK frequency, for example, for 200MHz, target_sclk_freq=200000000
Output parameter 1	ret_ms: return pll_ms parameter
Output parameter 2	ret_ns: return pll_ns parameter
Output parameter 3	ret_fr: return pll_fr parameter
Return value	error_status: calculation result. SUCCESS: the calculated result matches the target clock PLL parameter ERROR: the calculated result is close to the target clock PLL parameter
Required preconditions	NA
Called functions	NA

**Example:**

```
/* pll parameter calculate automatic */
uint16_t pll_ms = 0, pll_ns = 0, pll_fr = 0;
crm_pll_parameter_calculate(CRM_PLL_SOURCE_HEXT, 200000000, &pll_ms, &pll_ns, &pll_fr);
```

### 5.4.35 crm\_apb3\_div\_set function

The table below describes the function crm\_apb3\_div\_set.

**Table 160. crm\_apb3\_div\_set function**

Name	Description
Function name	crm_apb3_div_set
Function prototype	void crm_apb3_div_set(crm_apb3_div_type value);
Function description	Set clock division from AHB to APB3
Input parameter 1	Value: division value
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

- CRM\_APB3\_DIV\_1: AHB/1 as APB3 clock
- CRM\_APB3\_DIV\_2: AHB/2 as APB3 clock
- CRM\_APB3\_DIV\_4: AHB/4 as APB3 clock
- CRM\_APB3\_DIV\_8: AHB/8 as APB3 clock
- CRM\_APB3\_DIV\_16: AHB/16 as APB3 clock

**Example:**

```
/* config apb3clk */
crm_apb3_div_set(CRM_APB3_DIV_2);
```

### 5.4.36 crm\_vbath\_div\_set function

The table below describes the function crm\_vbath\_div\_set

**Table 161. crm\_vbath\_div\_set function**

Name	Description
Function name	crm_vbath_div_set
Function prototype	void crm_vbath_div_set(crm_vbath_div_type value);
Function description	Set clock division from AHB to vbat
Input parameter 1	Value: division value
Input parameter 2	无
Output parameter	NA
Return value	crm_usart_clock_source_type: USART clock source type
Required preconditions	NA
Called functions	NA

**value**

- CRM\_VBATH\_DIV\_1: AHB/1 as VBAT clock
- CRM\_VBATH\_DIV\_2: AHB/2 as VBAT clock
- CRM\_VBATH\_DIV\_4: AHB/4 as VBAT clock

**Example:**

```
/* config vbathclk */
crm_vbath_div_set(CRM_VBATH_DIV_2);
```

### 5.4.37 crm\_lextdrv\_set function

The table below describes the function crm\_lextdrv\_set.

**Table 162. crm\_lextdrv\_set function**

Name	Description
Function name	crm_lextdrv_set
Function prototype	void crm_lextdrv_set(crm_drv_strength_type value);
Function description	Set LEXT drive strength
Input parameter 1	Value: LEXT drive strength
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

- CRM\_DRV\_STRENGTH\_LOW: Low drive strength
- CRM\_DRV\_STRENGTH\_MEDIUM\_LOW: Medium low drive strength
- CRM\_DRV\_STRENGTH\_MEDIUM\_HIGH: Medium high drive strength
- CRM\_DRV\_STRENGTH\_HIGH: High drive strength

**Example:**

```
/* config lext high driving strength */  
crm_lextdrv_set ( CRM_DRV_STRENGTH_HIGH);
```

### 5.4.38 crm\_hextdrv\_set function

The table below describes the function crm\_lextdrv\_set.

**Table 163. crm\_lextdrv\_set function**

Name	Description
Function name	crm_hextdrv_set
Function prototype	void crm_hextdrv_set(crm_drv_strength_type value);
Function description	Set HEXT drive strength
Input parameter 1	value: HEXT drive strength
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**value**

- |                               |                            |
|-------------------------------|----------------------------|
| CRM_DRV_STRENGTH_LOW:         | Low drive strength         |
| CRM_DRV_STRENGTH_MEDIUM_LOW:  | Medium low drive strength  |
| CRM_DRV_STRENGTH_MEDIUM_HIGH: | Medium high drive strength |
| CRM_DRV_STRENGTH_HIGH:        | High drive strength        |

**Example:**

```
/* config hext high driving strength */  
crm_hextdrv_set ( CRM_DRV_STRENGTH_HIGH);
```

## 5.5 Digital-to-analog converter (DAC)

The DAC register structure `dac_type` is defined in the “`at32m412_416_dac.h`”.

```
/*
 * @brief type define dac register all
 */
typedef struct
{
    ...
} dac_type;
```

The table below gives a list of the DAC registers.

**Table 164. Summary of DAC registers**

Register	Description
ctrl	DAC control register
swtrg	DAC software trigger register
d1dth	DAC1 12-bit right-aligned data holding register
d1dth	DAC1 12-bit left-aligned data holding register
d1dth	DAC1 8-bit right-aligned data holding register
d1odt	DAC1 data output register
sts	DAC status register
outen	DAC output select register

The table below gives a list of DAC library functions.

**Table 165. Summary of DAC library functions**

Function name	Description
<code>dac_reset</code>	Reset all DAC registers to their reset values
<code>dac_enable</code>	Enable DAC
<code>dac_trigger_enable</code>	Enable DAC trigger
<code>dac_trigger_select</code>	Select DAC trigger source
<code>dac_software_trigger_generate</code>	Trigger DAC by software
<code>dac_dual_software_trigger_generate</code>	Simultaneous trigger DAC1 and DAC2 by software
<code>dac_dma_enable</code>	DAC DMA enable
<code>dac_data_output_get</code>	Get DAC output value
<code>dac_1_data_set</code>	Set DAC1 output value
<code>dac_2_data_set</code>	Set DAC2 output value
<code>dac_dual_data_set</code>	Set DAC1 and DAC2 output values
<code>dac_udr_enable</code>	Enable overflow interrupt
<code>dac_udr_flag_get</code>	Get overflow interrupt flag
<code>dac_reference_voltage_select</code>	Select reference voltage
<code>dac_output_enable</code>	DAC output enable

## 5.5.1 dac\_reset function

The table below describes the function dac\_reset.

**Table 166. dac\_reset function**

Name	Description
Function name	dac_reset
Function prototype	void dac_reset(void);
Function description	Reset all DAC registers to their reset values
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset();

**Example:**

```
dac_reset();
```

## 5.5.2 dac\_enable function

The table below describes the function dac\_enable.

**Table 167. dac\_enable function**

Name	Description
Function name	dac_enable
Function prototype	void dac_enable(dac_select_type dac_select, confirm_state new_state);
Function description	Enable DAC
Input parameter 1	dac_select: Select a DAC This parameter can be DAC1_SELECT or DAC2_SELECT.
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_enable(DAC1_SELECT, TRUE);
```

### 5.5.3 dac\_trigger\_enable function

The table below describes the function dac\_trigger\_enable.

**Table 168. dac\_trigger\_enable function**

Name	Description
Function name	dac_trigger_enable
Function prototype	void dac_trigger_enable(dac_select_type dac_select, confirm_state new_state);
Function description	Enable DAC trigger
Input parameter 1	dac_select: Select a DAC This parameter can be DAC1_SELECT or DAC2_SELECT.
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_trigger_enable (DAC1_SELECT, TRUE);
```

### 5.5.4 dac\_trigger\_select function

The table below describes the function dac\_trigger\_select.

**Table 169. dac\_trigger\_select function**

Name	Description
Function name	dac_trigger_select
Function prototype	void dac_trigger_select(dac_select_type dac_select, dac_trigger_type dac_trigger_source);
Function description	Select DAC trigger source
Input parameter 1	dac_select: Select a DAC This parameter can be DAC1_SELECT or DAC2_SELECT.
Input parameter 2	<i>dac_trigger_source</i> : trigger source selected
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**dac\_trigger\_source**

Trigger source selection

DAC_TMR6_TRGOUT_EVENT:	TMR6 TRGOUT event triggers DAC
DAC_TMR3_TRGOUT_EVENT:	TMR3 TRGOUT event triggers DAC
DAC_TMR7_TRGOUT_EVENT:	TMR7 TRGOUT event triggers DAC
DAC_TMR9_TRGOUT_EVENT:	TMR9 TRGOUT event triggers DAC
DAC_TMR4_TRGOUT_EVENT:	TMR4 TRGOUT event triggers DAC
DAC_EXTERNAL_INTERRUPT_LINE_9:	EXINT LINE 9 event triggers DAC
DAC_SOFTWARE_TRIGGER:	Software triggers DAC

**Example:**

```
dac_trigger_select(DAC1_SELECT, DAC_TMR3_TRGOUT_EVENT);
dac_trigger_select(DAC2_SELECT, DAC_TMR3_TRGOUT_EVENT);
```

### 5.5.5 dac\_software\_trigger\_generate function

The table below describes the function dac\_software\_trigger\_generate.

**Table 170. dac\_software\_trigger\_generate function**

Name	Description
Function name	dac_software_trigger_generate
Function prototype	void dac_software_trigger_generate(dac_select_type dac_select);
Function description	Trigger DAC by software
Input parameter 1	dac_select: the selected DAC This parameter can be DAC1_SELECT or DAC2_SELECT.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_software_trigger_generate (DAC1_SELECT);
```

### 5.5.6 dac\_dual\_software\_trigger\_generate function

The table below describes the function dac\_dual\_software\_trigger\_generate.

**Table 171. dac\_dual\_software\_trigger\_generate function**

Name	Description
Function name	dac_dual_software_trigger_generate
Function prototype	void dac_dual_software_trigger_generate(void);
Function description	Trigger DAC1 and DAC2 by software simultaneously
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_dual_software_trigger_generate ();
```

### 5.5.7 dac\_dma\_enable function

The table below describes the function dac\_dma\_enable.

**Table 172. dac\_dma\_enable function**

Name	Description
Function name	dac_dma_enable
Function prototype	void dac_dma_enable(dac_select_type dac_select, confirm_state new_state);
Function description	DAC DMA enable
Input parameter 1	dac_select: the selected DAC This parameter can be DAC1_SELECT or DAC2_SELECT.
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_dma_enable (DAC1_SELECT, TRUE);
```

### 5.5.8 dac\_data\_output\_get function

The table below describes the function dac\_data\_output\_get.

**Table 173. dac\_data\_output\_get function**

Name	Description
Function name	dac_data_output_get
Function prototype	uint16_t dac_data_output_get(dac_select_type dac_select);
Function description	Get DAC output value
Input parameter 1	dac_select: the selected DAC This parameter can be DAC1_SELECT or DAC2_SELECT.
Output parameter	NA
Return value	dacx_data: dac1/dac2 output value
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t dac1_data;  
dac1_data = dac_data_output_get (DAC1_SELECT);
```

### 5.5.9 dac\_1\_data\_set function

The table below describes the function dac\_1\_data\_set.

Table 174. dac\_1\_data\_set function

Name	Description
Function name	dac_1_data_set
Function prototype	void dac_1_data_set(uint8_t dac1_data);
Function description	Set DAC1 output data
Input parameter 1	dac1_data : DAC output value
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_1_data_set (0x16);
```

### 5.5.10 dac\_2\_data\_set function

The table below describes the function dac\_2\_data\_set.

Table 175. dac\_2\_data\_set function

Name	Description
Function name	dac_2_data_set
Function prototype	void dac_2_data_set(uint8_t dac2_data);
Function description	Set DAC2 output data
Input parameter 2	DAC output value
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_2_data_set (0x16);
```

## 5.5.11 dac\_dual\_data\_set function

The table below describes the function dac\_dual\_data\_set.

**Table 176. dac\_dual\_data\_set function**

Name	Description
Function name	dac_dual_data_set
Function prototype	void dac_dual_data_set(uint8_t data1, uint8_t data2);
Function description	Set DAC1/DAC2 output data
Input parameter 2	<i>Data1</i> : DAC1 output value
Input parameter3	DAC2 output value
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_dual_data_set (0x16, 0x17);
```

## 5.5.12 dac\_udr\_enable function

The table below describes the function dac\_udr\_enable.

**Table 177. dac\_udr\_enable function**

Name	Description
Function name	dac_udr_enable
Function prototype	void dac_udr_enable(dac_select_type dac_select, confirm_state new_state);
Function description	Set DAC1/DAC2 output data
Input parameter 1	dac_select: Select DAC1/2
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_udr_enable (DAC1_SELECT, TRUE);
```

### 5.5.13 dac\_udr\_flag\_get function

The table below describes the function dac\_udr\_flag\_get.

Table 178. dac\_udr\_flag\_get function

Name	Description
Function name	dac_udr_flag_get
Function prototype	flag_status dac_udr_flag_get(dac_select_type dac_select);
Function description	Get DAC1/DAC2 underflow flag status
Input parameter 1	dac_select: Select DAC1/2
Output parameter	NA
Return value	Status flag
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_udr_flag_get (DAC1_SELECT);
```

### 5.5.14 dac\_udr\_interrupt\_flag\_get function

The table below describes the function dac\_udr\_interrupt\_flag\_get.

Table 179. dac\_udr\_interrupt\_flag\_get function

Name	Description
Function name	dac_udr_interrupt_flag_get
Function prototype	flag_status dac_udr_interrupt_flag_get (dac_select_type dac_select);
Function description	Get DAC1 and DAC2 overflow interrupt flag status
Input parameter 1	dac_select: Select DAC1/2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_udr_interrupt_flag_get (DAC1_SELECT);
```

## 5.5.15 dac\_udr\_flag\_clear function

The table below describes the function dac\_udr\_flag\_clear.

**Table 180. dac\_udr\_flag\_clear function**

Name	Description
Function name	dac_udr_flag_clear
Function prototype	void dac_udr_flag_clear(dac_select_type dac_select);
Function description	Get DAC1/DAC2 underflow flag
Input parameter 1	dac_select: Select DAC1/2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_udr_flag_clear (DAC1_SELECT);
```

## 5.5.16 dac\_reference\_voltage\_select function

The table below describes the function dac\_reference\_voltage\_select.

**Table 181. dac\_reference\_voltage\_select function**

Name	Description
Function name	dac_reference_voltage_select
Function prototype	void dac_reference_voltage_select(dac_select_type dac_select, dac_reference_voltage_type dac_reference_voltage)
Function description	Set DAC1 and DAC2 reference voltage
Input parameter 1	dac_select: DAC1/2 select
Input parameter 2	dac_reference_voltage: reference voltage select DAC_VDDA DAC_VREF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_reference_voltage_select (DAC1_SELECT, DAC_VDDA);
```

## 5.5.17 dac\_output\_enable function

The table below describes the function dac\_output\_enable.

**Table 182. dac\_output\_enable function**

Name	Description
Function name	dac_output_enable
Function prototype	void dac_output_enable(dac_select_type dac_select, confirm_state new_state)
Function description	Enable DAC output to gpio
Input parameter 1	dac_select: DAC select This parameter can be DAC1_SELECT or DAC2_SELECT.
Input parameter 2	new_state: enable or disable This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
dac_output_enable (DAC1_SELECT, TRUE);
```

## 5.6 Debug

The DEBUG register structure debug\_type is defined in the ““AT32M412\_416\_debug.h””:

```
/*
 * @brief type define debug register all
 */
typedef struct
{
    ...
} debug_type;
```

The table below gives a list of the DEBUG registers.

**Table 183. Summary of DEBUG registers**

Register	Description
idcode	Device ID
ctrl	Control register
apb1_pause	APB1 pause control register
apb2_pause	APB2 pause control register
Apb3_pause	APB3 pause control register

The table below gives a list of DEBUG library functions.

**Table 184. Summary of DEBUG library functions**

Function name	Description
debug_device_id_get	Read device idcode
debug_low_power_mode_set	Low-power debug mode configuration
debug_apb1_periph_mode_set	apb1 debug mode configuration
debug_apb2_periph_mode_set	apb2 debug mode configuration
debug_apb3_periph_mode_set	Apb3 debug mode configuration

### 5.6.1 debug\_device\_id\_get function

The table below describes the function debug\_device\_id\_get.

**Table 185. debug\_device\_id\_get function**

Name	Description
Function name	debug_device_id_get
Function prototype	uint32_t debug_device_id_get(void);
Function description	Read device idcode
Input parameter 1	NA
Input parameter 2	NA
Output parameter	NA
Return value	Return 32-bit idcode
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get idcode */
```

```
uint32_t idcode = 0;
idcode = debug_device_id_get();
```

## 5.6.2 debug\_low\_power\_mode\_set function

The table below describes the function debug\_low\_power\_mode\_set.

**Table 186. debug\_low\_power\_mode\_set function**

Name	Description
Function name	debug_low_power_mode_set
Function prototype	void debug_low_power_mode_set(uint32_t low_power_mode, confirm_state new_state)
Function description	Debug in low-power mode
Input parameter 1	periph_debug_mode: the selected peripheral or mode
Input parameter 2	new_state: enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### low\_power\_mode

Select a low-power mode to debug

DEBUG_SLEEP:	DEBUG in SLEEP mode
DEBUG_DEEPSLEEP:	DEBUG in DEEPSLEEP mode
DEBUG_STANDBY:	DEBUG in STANDBY mode

### Example:

```
/* enable sleep debug mode */
debug_low_power_mode_set(DEBUG_SLEEP, TRUE);
```

## 5.6.3 debug\_apb1\_periph\_mode\_set function

The table below describes the function debug\_apb1\_periph\_mode\_set.

**Table 187. debug\_apb1\_periph\_mode\_set function**

Name	Description
Function name	debug_apb1_periph_mode_set
Function prototype	void debug_apb1_periph_mode_set(uint32_t apb1_periph, confirm_state new_state)
Function description	Select a peripheral to debug
Input parameter 1	apb1_periph: Select a peripheral
Input parameter 2	new_state: enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### apb1\_periph

Select a peripheral or mode to debug

DEBUG_WDT_PAUSE:	Watchdog pause control bit
DEBUG_WWDT_PAUSE:	Window watchdog pause control bit
DEBUG_TMR3_PAUSE:	TMR3 pause control bit

DEBUG_TMR4_PAUSE:	TMR4 pause control bit
DEBUG_TMR6_PAUSE:	TMR6 pause control bit
DEBUG_TMR7_PAUSE:	TMR7 pause control bit
DEBUG_I2C1_SMBUS_TIMEOUT:	I2C1 SMBUS TIMEOUT pause control bit
DEBUG_I2C2_SMBUS_TIMEOUT:	I2C2 SMBUS TIMEOUT pause control bit
DEBUG_I2C3_SMBUS_TIMEOUT:	I2C3 SMBUS TIMEOUT pause control bit
DEBUG_CAN1_PAUSE:	CAN1 receive register pause control bit

**Example:**

```
/* enable tmr2 debug mode */
debug_apb1_periph_mode_set(DEBUG_TMR3_PAUSE, TRUE);
```

## 5.6.4 debug\_apb2\_periph\_mode\_set function

The table below describes the function debug\_apb2\_periph\_mode\_set.

**Table 188. debug\_apb2\_periph\_mode\_set function**

Name	Description
Function name	debug_apb2_periph_mode_set
Function prototype	void debug_apb2_periph_mode_set(uint32_t apb2_periph, confirm_state new_state)
Function description	Select a peripheral to debug
Input parameter 1	apb2_periph: the selected peripheral or mode
Input parameter 2	new_state: enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**apb2\_periph**

Select a peripheral or mode to debug

DEBUG_TMR9_PAUSE:	TMR9 pause control bit
DEBUG_TMR10_PAUSE:	TMR10 pause control bit
DEBUG_TMR11_PAUSE:	TMR11 pause control bit
DEBUG_TMR1_PAUSE:	TMR1 pause control bit

**Example:**

```
/* enable tmr1 debug mode */
debug_apb2_periph_mode_set(DEBUG_TMR1_PAUSE, TRUE);
```

## 5.6.5 debug\_apb3\_periph\_mode\_set function

The table below describes the function debug\_apb3\_periph\_mode\_set.

**Table 189. debug\_apb3\_periph\_mode\_set function**

Name	Description
Function name	debug_apb3_periph_mode_set
Function prototype	void debug_apb3_periph_mode_set(uint32_t apb3_periph, confirm_state new_state)
Function description	Select a peripheral to debug
Input parameter 1	Apb3_periph: the selected peripheral or mode
Input parameter 2	new_state: enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### apb3\_periph

Select a peripheral or mode to debug

DEBUG\_ERTC\_PAUSE: ERTC pause control bit

### Example:

```
/* enable etrc debug mode */
debug_apb3_periph_mode_set (DEBUG_ERTC_PAUSE, TRUE);
```

## 5.7 DMA controller

The DMA register structure `dma_type` is defined in the “AT32M412\_416\_dma.h”:

```
/*
 * @brief type define dma register
 */
typedef struct
{
    ...
}
```

`} dma_type;`

DMA channel register structure `dma_channel_type` is defined in the “AT32M412\_416\_dma.h”:

```
/*
 * @brief type define dma channel register all
 */
typedef struct
{
    ...
}
```

`} dma_channel_type;`

The table below gives a list of the DMA registers.

**Table 190. Summary of DMA registers**

Register	Description
<code>dma_sts</code>	DMA status register
<code>dma_clr</code>	DMA status clear register
<code>dma_c1ctrl</code>	DMA channel 1 configuration register
<code>dma_c1dtcnt</code>	DMA channel 1 number of data register
<code>dma_c1paddr</code>	DMA channel 1 peripheral address register
<code>dma_c1maddr</code>	DMA channel 1 memory address register
<code>dma_c2ctrl</code>	DMA channel 2 configuration register
<code>dma_c2dtcnt</code>	DMA channel 2 number of data register
<code>dma_c2paddr</code>	DMA channel 2 peripheral address register
<code>dma_c2maddr</code>	DMA channel 2 memory address register
<code>dma_c3ctrl</code>	DMA channel 3 configuration register
<code>dma_c3dtcnt</code>	DMA channel 3 number of data register
<code>dma_c3paddr</code>	DMA channel 3 peripheral address register
<code>dma_c3maddr</code>	DMA channel 3 memory address register
<code>dma_c4ctrl</code>	DMA channel 4 configuration register
<code>dma_c4dtcnt</code>	DMA channel 4 number of data register
<code>dma_c4paddr</code>	DMA channel 4 peripheral address register
<code>dma_c4maddr</code>	DMA channel 4 memory address register
<code>dma_c5ctrl</code>	DMA channel 5 configuration register
<code>dma_c5dtcnt</code>	DMA channel 5 number of data register

Register	Description
dma_c5paddr	DMA channel 5 peripheral address register
dma_c5maddr	DMA channel 5 memory address register
dma_c6ctrl	DMA channel 6 configuration register
dma_c6dtcnt	DMA channel 6 number of data register
dma_c6paddr	DMA channel 6 peripheral address register
dma_c6maddr	DMA channel 6 memory address register
dma_c7ctrl	DMA channel 7 configuration register
dma_c7dtcnt	DMA channel 7 number of data register
dma_c7paddr	DMA channel 7 peripheral address register
dma_c7maddr	DMA channel 7 memory address register
dma_muxsel	DMAMUX enable register
dma_muxc1ctrl	DMAMUX channel 1 control register
dma_muxc2ctrl	DMAMUX channel 2 control register
dma_muxc3ctrl	DMAMUX channel 3 control register
dma_muxc4ctrl	DMAMUX channel 4 control register
dma_muxc5ctrl	DMAMUX channel 5 control register
dma_muxc6ctrl	DMAMUX channel 6 control register
dma_muxc7ctrl	DMAMUX channel 7 control register
dma_muxg1ctrl	DMAMUX request generator 1 control register
dma_muxg2ctrl	DMAMUX request generator 2 control register
dma_muxg3ctrl	DMAMUX request generator 3 control register
dma_muxg4ctrl	DMAMUX request generator 4 control register
dma_muxsyncsts	DMAMUX synchronous status register
dma_muxsyncclr	DMAMUX synchronous status clear register
dma_muxgsts	DMAMUX request generator status register
dma_muxgclr	DMAMUX request generator status clear register

The table below gives a list of DMA library functions.

**Table 191. Summary of DMA library functions**

Function name	Description
dma_default_para_init	Initialize the parameters of the <code>dma_init_struct</code>
dma_init	Initialize the selected DMA channel
dma_reset	Reset the selected DMA channel
dma_data_number_set	Set the number of data transfer of a given channel
dma_data_number_get	Get the number of data transfer of a given channel
dma_interrupt_enable	Enable DMA channel interrupt
dma_channel_enable	Enable DMA channel
dma_flexible_config	Configure flexible DMA request mapping
dma_flag_get	Get the flag of DMA channels
dma_flag_clear	Clear the flag of DMA channels
dmamux_enable	Enable DMAMUX
dmamux_init	Initialize DMAMUX
dmamux_sync_default_para_init	Initialize DMAMUX synchronous module

dmamux_sync_config	Configure DMAMUX synchronous module
dmamux_generator_default_para_init	Initialize DMAMUX request generator
dmamux_generator_config	Configure DMAMUX request generator
dmamux_sync_interrupt_enable	Enable DMAMUX synchronous module interrupt
dmamux_generator_interrupt_enable	Enable DMAMUX request generator interrupt
dmamux_sync_flag_get	Get the flag of DMAMUX synchronous module
dmamux_sync_flag_clear	Clear the flag of DMAMUX synchronous module
dmamux_generator_flag_get	Get the flag of DMAMUX request generator
dmamux_generator_flag_clear	Clear the flag of DMAMUX request generator

### 5.7.1 dma\_default\_para\_init function

The table below describes the function `dma_default_para_init`.

**Table 192. `dma_default_para_init` function**

Name	Description
Function name	<code>dma_default_para_init</code>
Function prototype	<code>void dma_default_para_init(dma_init_type* dma_init_struct);</code>
Function description	Initialize the parameters of the <code>dma_init_struct</code>
Input parameter 1	<code>dma_init_struct</code> : <code>dma_init_type</code> pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of the `dma_init_struct` members.

**Table 193. `dma_init_struct` default values**

Member	Default values
<code>peripheral_base_addr</code>	0x0
<code>memory_base_addr</code>	0x0
<code>direction</code>	<code>DMA_DIR_PERIPHERAL_TO_MEMORY</code>
<code>buffer_size</code>	0x0
<code>peripheral_inc_enable</code>	FALSE
<code>memory_inc_enable</code>	FALSE
<code>peripheral_data_width</code>	<code>DMA_PERIPHERAL_DATA_WIDTH_BYTE</code>
<code>memory_data_width</code>	<code>DMA_MEMORY_DATA_WIDTH_BYTE</code>
<code>loop_mode_enable</code>	FALSE
<code>priority</code>	<code>DMA_PRIORITY_LOW</code>

Example:

```
/* dma init config with its default value */
dma_init_type dma_init_struct = {0};
dma_default_para_init(&dma_init_struct);
```

## 5.7.2 dma\_init function

The table below describes the function `dma_init`.

**Table 194. `dma_init` function**

Name	Description
Function name	<code>dma_init</code>
Function prototype	<code>void dma_init(dma_channel_type* dmax_channely, dma_init_type* dma_init_struct)</code>
Function description	Initialize the selected DMA channel
Input parameter 1	<code>dmax_channely</code> : DMAx_CHANNELy defines a DMA channel number, x=1 or 2, y=1...7
Input parameter 2	<code>dma_init_struct</code> : <code>dma_init_type</code> pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **dma\_init\_type structure**

The `dma_init_type` is defined in the `AT32M412_416_dma.h`:

`typedef struct`

```
{
    uint32_t          peripheral_base_addr;
    uint32_t          memory_base_addr;
    dma_dir_type      direction;
    uint16_t          buffer_size;
    confirm_state     peripheral_inc_enable;
    confirm_state     memory_inc_enable;
    dma_peripheral_data_size_type peripheral_data_width;
    dma_memory_data_size_type   memory_data_width;
    confirm_state     loop_mode_enable;
    dma_priority_level_type priority;
}
```

`} dma_init_type;`

#### **peripheral\_base\_addr**

Set the peripheral address of a DMA channel

#### **memory\_base\_addr**

Set the memory address of a DMA channel

#### **direction**

Set the transfer direction of a DMA channel

`DMA_DIR_PERIPHERAL_TO_MEMORY`: Peripheral to memory

`DMA_DIR_MEMORY_TO_PERIPHERAL`: Memory to peripheral

`DMA_DIR_MEMORY_TO_MEMORY`: Memory to memory

#### **buffer\_size**

Set the number of data transfer of a DMA channel

#### **peripheral\_inc\_enable**

Enable/disable DMA channel peripheral address auto increment

`FALSE`: Peripheral address is not incremented

`TRUE`: Peripheral address is incremented

**memory\_inc\_enable**

Enable/disable DMA channel memory address auto increment

FALSE: Memory address is not incremented

TRUE: Memory address is incremented

**peripheral\_data\_width**

Set DMA peripheral data width

DMA_PERIPHERAL_DATA_WIDTH_BYTE:	Byte
DMA_PERIPHERAL_DATA_WIDTH_HALFWORD:	Half-word
DMA_PERIPHERAL_DATA_WIDTH_WORD:	Word

**memory\_data\_width**

Set DMA memory data width

DMA_MEMORY_DATA_WIDTH_BYTE:	Byte
DMA_MEMORY_DATA_WIDTH_HALFWORD:	Half-word
DMA_MEMORY_DATA_WIDTH_WORD:	Word

**loop\_mode\_enable**

Set DMA loop mode

FALSE: DMA single mode

TRUE: DMA loop mode

**priority**

Set DMA channel priority

DMA_PRIORITY_LOW:	Low
DMA_PRIORITY_MEDIUM:	Medium
DMA_PRIORITY_HIGH:	High
DMA_PRIORITY VERY HIGH:	Very high

**Example:**

```
dma_init_type dma_init_struct = {0};  
/* DMA1 channel1 configuration */  
dma_init_struct.buffer_size = BUFFER_SIZE;  
dma_init_struct.direction = DMA_DIR_MEMORY_TO_PERIPHERAL;  
dma_init_struct.memory_base_addr = (uint32_t)src_buffer;  
dma_init_struct.memory_data_width = DMA_MEMORY_DATA_WIDTH_HALFWORD;  
dma_init_struct.memory_inc_enable = TRUE;  
dma_init_struct.peripheral_base_addr = (uint32_t)0x4001100C;  
dma_init_struct.peripheral_data_width = DMA_PERIPHERAL_DATA_WIDTH_HALFWORD;  
dma_init_struct.peripheral_inc_enable = FALSE;  
dma_init_struct.priority = DMA_PRIORITY_MEDIUM;  
dma_init_struct.loop_mode_enable = FALSE;  
dma_init(DMA1_CHANNEL1, &dma_init_struct);
```

### 5.7.3 dma\_reset function

The table below describes the function dma\_reset.

**Table 195. dma\_reset function**

Name	Description
Function name	dma_reset
Function prototype	void dma_reset(dma_channel_type* dmax_channely);
Function description	Reset the selected DMA channel
Input parameter 1	dmax_channely: DMAx_CHANNELy defines a DMA channel number, x=1 or 2, y=1...7
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* reset DMA1 channel1 */
dma_reset(DMA1_CHANNEL1);
```

### 5.7.4 dma\_data\_number\_set function

The table below describes the function dma\_data\_number\_set.

**Table 196. dma\_data\_number\_set function**

Name	Description
Function name	dma_data_number_set
Function prototype	void dma_data_number_set(dma_channel_type* dmax_channely, uint16_t data_number);
Function description	Set the number of data transfer of the selected DMA channel
Input parameter 1	dmax_channely: DMAx_CHANNELy defines a DMA channel number, x=1 or 2, y=1...7
Input parameter 2	data_number: the number of data transfer, the maximum value is 65535
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* set DMA1 channel1 data count is 0x100*/
dma_data_number_set(DMA1_CHANNEL1, 0x100);
```

## 5.7.5 dma\_data\_number\_get function

The table below describes the function dma\_data\_number\_get.

**Table 197. dma\_data\_number\_get function**

Name	Description
Function name	dma_data_number_get
Function prototype	uint16_t dma_data_number_get(dma_channel_type* dmax_channely);
Function description	Get the number of data transfer of the selected DMA channel
Input parameter 1	dmax_channely: DMAx_CHANNELy defines a DMA channel number, x=1 or 2, y=1...7
Output parameter	NA
Return value	Get the number of data transfer of a DMA channel
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get DMA1 channel1 data count/
uint16_t data_counter;
data_counter = dma_data_number_get(DMA1_CHANNEL1);
```

## 5.7.6 dma\_interrupt\_enable function

The table below describes the function dma\_interrupt\_enable.

**Table 198. dma\_interrupt\_enable function**

Name	Description
Function name	dma_interrupt_enable
Function prototype	void dma_interrupt_enable(dma_channel_type* dmax_channely, uint32_t dma_int, confirm_state new_state);
Function description	Enable DMA channels interrupt
Input parameter 1	dmax_channely: DMAx_CHANNELy defines a DMA channel number, x=1 or 2, y=1...7
Input parameter 2	dma_int: the selected interrupt source
Input parameter3	new_state: interrupt enable/disable
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**dma\_int**

Select DMA interrupt source

DMA\_FDT\_INT: Transfer complete interrupt

DMA\_HDT\_INT: Half transfer complete interrupt

DMA\_DTERR\_INT: Transfer error interrupt

**new\_state**

Enable or disable DMA channel interrupt

FALSE: Disabled

TRUE: Enabled

**Example:**

```
/* enable DMA1 channel1 transfer full data interrupt */
dma_interrupt_enable(DMA1_CHANNEL1, DMA_FDT_INT, TRUE);
```

### 5.7.7 dma\_channel\_enable function

The table below describes the function `dma_channel_enable`.

**Table 199. `dma_channel_enable` function**

Name	Description
Function name	<code>dma_channel_enable</code>
Function prototype	<code>void dma_channel_enable(dma_channel_type* dmax_channely, confirm_state new_state);</code>
Function description	Enable the selected DMA channel
Input parameter 1	<code>dmax_channely</code> : DMAx_CHANNELy defines a DMA channel number, x=1 or 2, y=1...7
Input parameter 2	<code>new_state</code> : Enable or disable the selected DMA channel
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**new\_state**

Enable or disable DMA channels

FALSE: Disabled

TRUE: Enabled

**Example:**

```
/* enable dma channel */
dma_channel_enable(DMA1_CHANNEL1, TRUE);
```

### 5.7.8 dma\_flag\_get function

The table below describes the function `dma_flag_get`.

**Table 200. `dma_flag_get` function**

Name	Description
Function name	<code>dma_flag_get</code>
Function prototype	<code>flag_status dma_flag_get(uint32_t dmax_flag);</code>
Function description	Get the flag of the selected DMA channel
Input parameter 1	<code>dmax_flag</code> : select the desired flag
Output parameter	NA
Return value	<code>flag_status</code> : indicates whether the desired flag is set or not
Required preconditions	NA
Called functions	NA

**dmax\_flag**

The `dmax_flag` is used for flag section, including:

DMA1\_GL1\_FLAG: DMA1 channel 1 global flag

DMA1\_FDT1\_FLAG: DMA1 channel 1 transfer complete flag

DMA1_HDT1_FLAG:	DMA1 channel 1 half transfer complete flag
DMA1_DTERR1_FLAG:	DMA1 channel 1 transfer error flag
DMA1_GL2_FLAG:	DMA1 channel 2 global flag
DMA1_FDT2_FLAG:	DMA1 channel 2 transfer complete flag
DMA1_HDT2_FLAG:	DMA1 channel 2 half transfer complete flag
DMA1_DTERR2_FLAG:	DMA1 channel 2 transfer error flag
DMA1_GL3_FLAG:	DMA1 channel 3 global flag
DMA1_FDT3_FLAG:	DMA1 channel 3 transfer complete flag
DMA1_HDT3_FLAG:	DMA1 channel 3 half transfer complete flag
DMA1_DTERR3_FLAG:	DMA1 channel 3 transfer error flag
DMA1_GL4_FLAG:	DMA1 channel 4 global flag
DMA1_FDT4_FLAG:	DMA1 channel 4 transfer complete flag
DMA1_HDT4_FLAG:	DMA1 channel 4 half transfer complete flag
DMA1_DTERR4_FLAG:	DMA1 channel 4 transfer error flag
DMA1_GL5_FLAG:	DMA1 channel 5 global flag
DMA1_FDT5_FLAG:	DMA1 channel 5 transfer complete flag
DMA1_HDT5_FLAG:	DMA1 channel 5 half transfer complete flag
DMA1_DTERR5_FLAG:	DMA1 channel 5 transfer error flag
DMA1_GL6_FLAG:	DMA1 channel 6 global flag
DMA1_FDT6_FLAG:	DMA1 channel 6 transfer complete flag
DMA1_HDT6_FLAG:	DMA1 channel 6 half transfer complete flag
DMA1_DTERR6_FLAG:	DMA1 channel 6 transfer error flag
DMA1_GL7_FLAG:	DMA1 channel 7 global flag
DMA1_FDT7_FLAG:	DMA1 channel 7 transfer complete flag
DMA1_HDT7_FLAG:	DMA1 channel 7 half transfer complete flag
DMA1_DTERR7_FLAG:	DMA1 channel 7 transfer error flag

**flag\_status**

RESET: Flag is reset

SET: Flag is set

**Example:**

```
if(dma_flag_get(DMA1_FDT1_FLAG) != RESET)
{
    /* turn led2/led3/led4 on */
    at32_led_on(LED2);
    at32_led_on(LED3);
    at32_led_on(LED4);
}
```

## 5.7.9 dma\_flag\_clear function

The table below describes the function `dma_flag_clear`.

**Table 201. `dma_flag_clear` function**

Name	Description
Function name	<code>dma_flag_clear</code>
Function prototype	<code>void dma_flag_clear(uint32_t dmax_flag);</code>
Function description	Clear the selected flag
Input parameter 1	<code>dmax_flag</code> : a flag to clear
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### `dmax_flag`

`dmax_flag` is used to select the desired flag, including:

<code>DMA1_GL1_FLAG</code> :	DMA1 channel 1 global flag
<code>DMA1_FDT1_FLAG</code> :	DMA1 channel 1 transfer complete flag
<code>DMA1_HDT1_FLAG</code> :	DMA1 channel 1 half transfer complete flag
<code>DMA1_DTERR1_FLAG</code> :	DMA1 channel 1 transfer error flag
<code>DMA1_GL2_FLAG</code> :	DMA1 channel 2 global flag
<code>DMA1_FDT2_FLAG</code> :	DMA1 channel 2 transfer complete flag
<code>DMA1_HDT2_FLAG</code> :	DMA1 channel 2 half transfer complete flag
<code>DMA1_DTERR2_FLAG</code> :	DMA1 channel 2 transfer error flag
<code>DMA1_GL3_FLAG</code> :	DMA1 channel 3 global flag
<code>DMA1_FDT3_FLAG</code> :	DMA1 channel 3 transfer complete flag
<code>DMA1_HDT3_FLAG</code> :	DMA1 channel 3 half transfer complete flag
<code>DMA1_DTERR3_FLAG</code> :	DMA1 channel 3 transfer error flag
<code>DMA1_GL4_FLAG</code> :	DMA1 channel 4 global flag
<code>DMA1_FDT4_FLAG</code> :	DMA1 channel 4 transfer complete flag
<code>DMA1_HDT4_FLAG</code> :	DMA1 channel 4 half transfer complete flag
<code>DMA1_DTERR4_FLAG</code> :	DMA1 channel 4 transfer error flag
<code>DMA1_GL5_FLAG</code> :	DMA1 channel 5 global flag
<code>DMA1_FDT5_FLAG</code> :	DMA1 channel 5 transfer complete flag
<code>DMA1_HDT5_FLAG</code> :	DMA1 channel 5 half transfer complete flag
<code>DMA1_DTERR5_FLAG</code> :	DMA1 channel 5 transfer error flag
<code>DMA1_GL6_FLAG</code> :	DMA1 channel 6 global flag
<code>DMA1_FDT6_FLAG</code> :	DMA1 channel 6 transfer complete flag
<code>DMA1_HDT6_FLAG</code> :	DMA1 channel 6 half transfer complete flag
<code>DMA1_DTERR6_FLAG</code> :	DMA1 channel 6 transfer error flag
<code>DMA1_GL7_FLAG</code> :	DMA1 channel 7 global flag
<code>DMA1_FDT7_FLAG</code> :	DMA1 channel 7 transfer complete flag
<code>DMA1_HDT7_FLAG</code> :	DMA1 channel 7 half transfer complete flag
<code>DMA1_DTERR7_FLAG</code> :	DMA1 channel 7 transfer error flag

### **Example:**

```
if(dma_flag_get(DMA1_FDT1_FLAG) != RESET)
{
```

```

/* turn led2/led3/led4 on */
at32_led_on(LED2);
at32_led_on(LED3);
at32_led_on(LED4);
dma_flag_clear(DMA1_FDT1_FLAG);
}

```

### 5.7.10 dma\_flexible\_config function

The table below describes the function `dma_flexible_enable`.

**Table 202. `dma_flexible_config` function**

Name	Description
Function name	<code>dma_flexible_config</code>
Function prototype	<code>void dma_flexible_config(dma_type* dma_x, dmamux_channel_type *dmamux_channelx, dmamux_reqst_id_sel_type dmamux_req_sel);</code>
Function description	Configure DMAMUX
Input parameter 1	<code>dma_x</code> : DMAx, x=1 or 2
Input parameter 2	<i>dmamux_channelx</i> :DMAMUX channel selection, x=1...7
Input parameter3	<i>dmamux_req_sel</i> :DMAMUX channel request ID
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### **dmamux\_channelx**

DMAMUX channel selection, including:

DMA1MUX\_CHANNEL1  
DMA1MUX\_CHANNEL2  
DMA1MUX\_CHANNEL3  
DMA1MUX\_CHANNEL4  
DMA1MUX\_CHANNEL5  
DMA1MUX\_CHANNEL6  
DMA1MUX\_CHANNEL7

#### **dmamux\_req\_sel**

The table below shows the DMAMUX channel request ID:

**Table 203. DMAMUX channel request source ID**

Request source ID	Description	Request source ID	Description
0x01	DMAMUX_DMAREQ_ID_REQ_G1	0x02	DMAMUX_DMAREQ_ID_REQ_G2
0x03	DMAMUX_DMAREQ_ID_REQ_G3	0x04	DMAMUX_DMAREQ_ID_REQ_G4
0x05	DMAMUX_DMAREQ_ID_ADC1	0x24	DMAMUX_DMAREQ_ID_ADC2
0x4E	DMAMUX_DMAREQ_ID_TMR9_CH1	0x06	DMAMUX_DMAREQ_ID_DAC1
0x29	DMAMUX_DMAREQ_ID_DAC2	0x08	DMAMUX_DMAREQ_ID_TMR6_OVERFLOW

0x09	DMAMUX_DMAREQ_ID_TMR7_OVERFLOW	0x0A	DMAMUX_DMAREQ_ID_SPI1_RX
0x0B	DMAMUX_DMAREQ_ID_SPI1_TX	0x0C	DMAMUX_DMAREQ_ID_SPI2_RX
0x0D	DMAMUX_DMAREQ_ID_SPI2_TX	0x7C	DMAMUX_DMAREQ_ID_TMR9_CH2
0x4F	DMAMUX_DMAREQ_ID_TMR9_OVERFLOW	0x10	DMAMUX_DMAREQ_ID_I2C1_RX
0x11	DMAMUX_DMAREQ_ID_I2C1_TX	0x12	DMAMUX_DMAREQ_ID_I2C2_RX
0x13	DMAMUX_DMAREQ_ID_I2C2_TX	0x50	DMAMUX_DMAREQ_ID_TMR9_TRIG
0x51	DMAMUX_DMAREQ_ID_TMR9_HALL	0x18	DMAMUX_DMAREQ_ID_USART1_RX
0x19	DMAMUX_DMAREQ_ID_USART1_TX	0x1A	DMAMUX_DMAREQ_ID_USART2_RX
0x1B	DMAMUX_DMAREQ_ID_USART2_TX	0x52	DMAMUX_DMAREQ_ID_TMR10_CH1
0x2B	DMAMUX_DMAREQ_ID_TMR1_CH2	0x2A	DMAMUX_DMAREQ_ID_TMR1_CH1
0x2D	DMAMUX_DMAREQ_ID_TMR1_CH4	0x2C	DMAMUX_DMAREQ_ID_TMR1_CH3
0x2F	DMAMUX_DMAREQ_ID_TMR1_TRIG	0x2E	DMAMUX_DMAREQ_ID_TMR1_OVERFLOW
0x53	DMAMUX_DMAREQ_ID_TMR10_OVERFLOW	0x30	DMAMUX_DMAREQ_ID_TMR1_HALL
0x3E	DMAMUX_DMAREQ_ID_TMR3_CH2	0x3D	DMAMUX_DMAREQ_ID_TMR3_CH1
0x40	DMAMUX_DMAREQ_ID_TMR3_CH4	0x3F	DMAMUX_DMAREQ_ID_TMR3_CH3
0x42	DMAMUX_DMAREQ_ID_TMR3_TRIG	0x41	DMAMUX_DMAREQ_ID_TMR3_OVERFLOW
0x44	DMAMUX_DMAREQ_ID_TMR4_CH2	0x43	DMAMUX_DMAREQ_ID_TMR4_CH1
0x46	DMAMUX_DMAREQ_ID_TMR4_CH4	0x45	DMAMUX_DMAREQ_ID_TMR4_CH3
0x7F	DMAMUX_DMAREQ_ID_TMR4_TRIG	0x47	DMAMUX_DMAREQ_ID_TMR4_OVERFLOW
0x54	DMAMUX_DMAREQ_ID_TMR11_CH1	0x55	DMAMUX_DMAREQ_ID_TMR11_OVERFLOW

**Example:**

```
/* tmr20 hall dmamux function enable */
dma_flexible_config(DMA1, DMA1MUX_CHANNEL1, DMAMUX_DMAREQ_ID_TMR20_HALL);
```

### 5.7.11 dmamux\_enable function

The table below describes the function dmamux\_enable.

Table 204. dmamux\_enable function

Name	Description
Function name	dmamux_enable
Function prototype	void dmamux_enable(dma_type *dma_x, confirm_state new_state);
Function description	Enable DMAMUX feature
Input parameter 1	dma_x: DMAx, x=1
Input parameter 2	new_state: enable or disable a channel
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**new\_state**

Enable or disable a DMA channel

FALSE: Channel disabled

TRUE: Channel enabled

**Example:**

```
/* dmamux function enable */
dmamux_enable(DMA1, TRUE);
```

## 5.7.12 dmamux\_init

The table below describes the function dmamux\_init.

**Table 205. dmamux\_init function**

Name	Description
Function name	dmamux_init
Function prototype	void dmamux_init(dmamux_channel_type *dmamux_channelx, dmamux_request_id_sel_type dmamux_req_sel);
Function description	Configure DMAMUX
Input parameter 1	<i>dmamux_channelx</i> :DMAMUX channel selection, x=1...7
Input parameter 2	<i>dmamux_req_sel</i> :DMAMUX channel request ID
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* generator1 for dmamux channel4 as dma request */
dmamux_init(DMA1MUX_CHANNEL4, DMAMUX_DMAREQ_ID_REQ_G1);
```

## 5.7.13 dmamux\_sync\_default\_para\_init function

The table below describes the function dmamux\_sync\_default\_para\_init.

**Table 206. dmamux\_sync\_default\_para\_init function**

Name	Description
Function name	dmamux_sync_default_para_init
Function prototype	void dmamux_sync_default_para_init(dmamux_sync_init_type *dmamux_sync_init_struct);
Function description	Initialize the parameters in the dmamux_sync_init_struct
Input parameter 1	dmamux_sync_init_struct: dmamux_sync_init_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below shows the default values of members in the dmamux\_sync\_init\_struct.

**Table 207. dmamux\_sync\_init\_struct default values**

Member	Default value
sync_enable	FALSE
sync_event_enable	FALSE
sync_polarity	DMAMUX_SYNC_POLARITY_DISABLE
sync_request_number	0x0
sync_signal_sel	(dmamux_sync_id_sel_type)0

**Example:**

```
/* dmamux sync init config with its default value */
dmamux_sync_init_type dmamux_sync_init_struct = {0};
dmamux_sync_default_para_init (&dmamux_sync_init_struct);
```

## 5.7.14 dmamux\_sync\_config function

The table below describes the function dmamux\_sync\_config.

**Table 208. dmamux\_sync\_config function**

Name	Description
Function name	dmamux_sync_config
Function prototype	void dmamux_sync_config(dmamux_channel_type *dmamux_channelx, dmamux_sync_init_type *dmamux_sync_init_struct);
Function description	Configure DMAMUX synchronous feature
Input parameter 1	<i>dmamux_channelx</i> :DMAMUX channel selection, x=1...7
Input parameter 2	dmamux_sync_init_struct: dmamux_sync_init_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### dmamux\_sync\_init\_struct

The dmamux\_sync\_init\_type is defined in the “AT32M412\_416\_dma.h”:

typedef struct

```
{
    dmamux_sync_id_sel_type      sync_signal_sel;
    uint32_t                      sync_polarity;
    uint32_t                      sync_request_number;
    confirm_state                  sync_event_enable;
    confirm_state                  sync_enable;
}
```

### sync\_signal\_sel

Select signal source for synchronous module.

DMAMUX_SYNC_ID_EXINT0:	External extint0 signal
DMAMUX_SYNC_ID_EXINT1:	External extint1 signal
DMAMUX_SYNC_ID_EXINT2:	External extint2 signal
DMAMUX_SYNC_ID_EXINT3:	External extint3 signal
DMAMUX_SYNC_ID_EXINT4:	External extint4 signal
DMAMUX_SYNC_ID_EXINT5:	External extint5 signal
DMAMUX_SYNC_ID_EXINT6:	External extint6 signal
DMAMUX_SYNC_ID_EXINT7:	External extint7 signal
DMAMUX_SYNC_ID_EXINT8:	External extint8 signal
DMAMUX_SYNC_ID_EXINT9:	External extint9 signal
DMAMUX_SYNC_ID_EXINT10:	External extint10 signal
DMAMUX_SYNC_ID_EXINT11:	External extint11 signal
DMAMUX_SYNC_ID_EXINT12:	External extint12 signal
DMAMUX_SYNC_ID_EXINT13:	External extint13 signal

DMAMUX\_SYNC\_ID\_EXINT14: External extint14 signal  
DMAMUX\_SYNC\_ID\_EXINT15: External extint15 signal  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH1\_EVT: dmamux channel 1 event  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH2\_EVT: dmamux channel 2 event  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH3\_EVT: dmamux channel 3 event  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH4\_EVT: dmamux channel 4 event  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH5\_EVT: dmamux channel 5 event  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH6\_EVT: dmamux channel 6 event  
DMAMUX\_SYNC\_ID\_DMAMUX\_CH7\_EVT: dmamux channel 7 event

**sync\_polarity**

Polarity selection for synchronous signal

DMAMUX_SYNC_POLARITY_RISING:	Rising edge
DMAMUX_SYNC_POLARITY_FALLING:	Falling edge
DMAMUX_SYNC_POLARITY_RISING_FALLING:	Rising edge and falling edge

**sync\_request\_number**

The number of DMA requests that can be synchronized

Range: 1~32

**sync\_event\_enable**

Enable or disable synchronous event generation

TRUE: Synchronous event generated

FALSE: No synchronous event generated

**sync\_enable**

Enable or disable synchronous module

FALSE: Disabled

TRUE: Enabled

**Example:**

```
dmamux_sync_default_para_init(&dmamux_sync_init_struct);
dmamux_sync_init_struct.sync_request_number = 4;
dmamux_sync_init_struct.sync_signal_sel = DMAMUX_SYNC_ID_EXINT1;
dmamux_sync_init_struct.sync_polarity = DMAMUX_SYNC_POLARITY_RISING;
dmamux_sync_init_struct.sync_event_enable = TRUE;
dmamux_sync_init_struct.sync_enable = TRUE;
dmamux_sync_config(DMA1MUX_CHANNEL4, &dmamux_sync_init_struct);
```

## 5.7.15 dmamux\_generator\_default\_para\_init function

The table below describes the function dmamux\_generator\_default\_para\_init.

**Table 209. dmamux\_generator\_default\_para\_init function**

Name	Description
Function name	dmamux_generator_default_para_init
Function prototype	void dmamux_generator_default_para_init(dmamux_gen_init_type *dmamux_gen_init_struct);
Function description	Initialize the parameters of the dmamux_gen_init_struct
Input parameter 1	dmamux_gen_init_struct: dmamux_gen_init_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below shows the default values of members in the dmamux\_gen\_init\_struct:

**Table 210. dmamux\_gen\_init\_struct default values**

Member	Default value
gen_signal_sel	(dmamux_gen_id_sel_type)0x0
gen_polarity	DMAMUX_GEN_POLARITY_DISABLE
gen_request_number	0x0
gen_enable	FALSE

Example:

```
/* dmamux gen init config with its default value */
dmamux_gen_init_type dmamux_gen_init_struct = {0};
dmamux_gen_default_para_init (&dmamux_gen_init_struct);
```

## 5.7.16 dmamux\_generator\_config function

The table below describes the function dmamux\_generator\_config.

**Table 211. dmamux\_generator\_config function**

Name	Description
Function name	dmamux_generator_config
Function prototype	void dmamux_generator_config(dmamux_generator_type * dmamux_gen_x, dmamux_gen_init_type *dmamux_gen_init_struct);
Function description	Configure DMAMUX request generator
Input parameter 1	<a href="#">dmamux_gen_x</a> request generator channel
Input parameter 2	dmamux_sync_init_struct: dmamux_sync_init_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**dmamux\_gen\_x**

dma request generator channel selection

DMA1MUX\_GENERATOR1

DMA1MUX\_GENERATOR2

DMA1MUX\_GENERATOR3

DMA1MUX\_GENERATOR4

#### **dmamux\_sync\_init\_struct**

The dmamux\_gen\_init\_type is defined in the “AT32M412\_416\_dma.h”:

typedef struct

{

dmamux_gen_id_sel_type	gen_signal_sel;
uint32_t	gen_polarity;
uint32_t	gen_request_number;
confirm_state	gen_enable;

} dmamux\_gen\_init\_type;

#### **gen\_signal\_sel**

Select signal source for synchronous module

DMAMUX_GEN_ID_EXINT0:	External extint0 singal
DMAMUX_GEN_ID_EXINT1:	External extint1 singal
DMAMUX_GEN_ID_EXINT2:	External extint2 singal
DMAMUX_GEN_ID_EXINT3:	External extint3 singal
DMAMUX_GEN_ID_EXINT4:	External extint4 singal
DMAMUX_GEN_ID_EXINT5:	External extint5 singal
DMAMUX_GEN_ID_EXINT6:	External extint6 singal
DMAMUX_GEN_ID_EXINT7:	External extint7 singal
DMAMUX_GEN_ID_EXINT8:	External extint8 singal
DMAMUX_GEN_ID_EXINT9:	External extint9 singal
DMAMUX_GEN_ID_EXINT10:	External extint10 singal
DMAMUX_GEN_ID_EXINT11:	External extint11 singal
DMAMUX_GEN_ID_EXINT12:	External extint12 singal
DMAMUX_GEN_ID_EXINT13:	External extint13 singal
DMAMUX_GEN_ID_EXINT14:	External extint14 singal
DMAMUX_GEN_ID_EXINT15:	External extint15 singal
DMAMUX_GEN_ID_DMAMUX_CH1_EVT:	dmamux channel 1 event
DMAMUX_GEN_ID_DMAMUX_CH2_EVT:	dmamux channel 2 event
DMAMUX_GEN_ID_DMAMUX_CH3_EVT:	dmamux channel 3 event
DMAMUX_GEN_ID_DMAMUX_CH4_EVT:	dmamux channel 4 event
DMAMUX_GEN_ID_DMAMUX_CH5_EVT:	dmamux channel 5 event
DMAMUX_GEN_ID_DMAMUX_CH6_EVT:	dmamux channel 6 event
DMAMUX_GEN_ID_DMAMUX_CH7_EVT:	dmamux channel 7 event

#### **gen\_polarity**

Polarity selection for request generator signal

DMAMUX\_GEN\_POLARITY\_RISING: Rising edge

DMAMUX\_GEN\_POLARITY\_FALLING: Falling edge

DMAMUX\_GEN\_POLARITY\_RISING\_FALLING: Rising edge and falling edge

#### **gen\_request\_number**

The number of DMA requests that are generated by request generator

Range: 1~32

**gen\_enable**

Enable or disable request generator

FALSE: Disabled

TRUE: Enabled

**Example:**

```
/* generotor1 configuration */
dmamux_generator_default_para_init(&dmamux_gen_init_struct);
dmamux_gen_init_struct.gen_polarity = DMAMUX_GEN_POLARITY_RISING;
dmamux_gen_init_struct.gen_request_number = 4;
dmamux_gen_init_struct.gen_signal_sel = DMAMUX_GEN_ID_EXINT1;
dmamux_gen_init_struct.gen_enable = TRUE;
dmamux_generator_config(DMA1MUX_GENERATOR1, &dmamux_gen_init_struct);
```

## 5.7.17 dmamux\_sync\_interrupt\_enable function

The table below describes the function dmamux\_sync\_interrupt\_enable.

**Table 212. dmamux\_sync\_interrupt\_enable function**

Name	Description
Function name	dmamux_sync_interrupt_enable
Function prototype	void dmamux_sync_interrupt_enable(dmamux_channel_type *dmamux_channelx, confirm_state new_state);
Function description	Enable synchronous module overflow interrupt
Input parameter 1	<i>dmamux_channelx</i> DMAMUX channel selection, x=1...7
Input parameter 2	new_state: enable or disable interrupts
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**new\_state**

Enable or disable DMA channel interrupts

FALSE: Interrupt disabled

TRUE: Interrupt enabled

**Example:**

```
/* enable sync overrun intterrupt */
dmamux_sync_interrupt_enable (DMA1MUX_CHANNEL1, TRUE);
```

## 5.7.18 dmamux\_generator\_interrupt\_enable function

The table below describes the function dmamux\_generator\_interrupt\_enable.

**Table 213. dmamux\_generator\_interrupt\_enable function**

Name	Description
Function name	dmamux_generator_interrupt_enable
Function prototype	void dmamux_generator_interrupt_enable(dmamux_generator_type *dmamux_gen_x, confirm_state new_state);
Function description	Enable request generator overflow interrupt
Input parameter 1	<i>dmamux_gen_x</i> DMAMUX request generator channel selection, x=1...4
Input parameter 2	new_state: enable or disable interrupts
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **new\_state**

Enable or disable request generator channel interrupts

FALSE: Interrupt disabled

TRUE: Interrupt enabled

### **Example:**

```
/* enable gen overrun interrupt */
dmamux_generator_interrupt_enable(DMA1MUX_GENERATOR3, TRUE);
```

## 5.7.19 dmamux\_sync\_flag\_get function

The table below describes the function dmamux\_sync\_flag\_get.

**Table 214. dmamux\_sync\_flag\_get function**

Name	Description
Function name	dmamux_sync_flag_get
Function prototype	flag_status dmamux_sync_flag_get(dma_type *dma_x, uint32_t flag);
Function description	Get dmamux synchronous flag
Input parameter 1	dma_x: DMAx, x=1
Input parameter 2	Flag: flag selection
Output parameter	NA
Return value	flag_status: indicates whether or not the selected flag is set
Required preconditions	NA
Called functions	NA

### **flag**

This is used for flag selection, including:

DMAMUX\_SYNC\_OV1\_FLAG

DMAMUX\_SYNC\_OV2\_FLAG

DMAMUX\_SYNC\_OV3\_FLAG

DMAMUX\_SYNC\_OV4\_FLAG

DMAMUX\_SYNC\_OV5\_FLAG

DMAMUX\_SYNC\_OV6\_FLAG

DMAMUX\_SYNC\_OV7\_FLAG

#### flag\_status

RESET: Corresponding flag is not set

SET: Corresponding flag is set

#### Example:

```
if(dmamux_sync_flag_get(DMA1, DMAMUX_SYNC_OV1_FLAG) != RESET)
{
    /* turn led2/led3/led4 on */
    at32_led_on(LED2);
    at32_led_on(LED3);
    at32_led_on(LED4);
}
```

## 5.7.20 dmamux\_sync\_flag\_clear function

The table below describes the function dmamux\_sync\_flag\_clear.

**Table 215. dmamux\_sync\_flag\_clear function**

Name	Description
Function name	dmamux_sync_flag_clear
Function prototype	void dmamux_sync_flag_clear(dma_type *dma_x, uint32_t flag);
Function description	Clear synchronous module flag
Input parameter 1	dma_x: DMAx, x=1
Input parameter 2	Flag: the selected flag to clear
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### flag

This is used for flag selection, including:

DMAMUX\_SYNC\_OV1\_FLAG

DMAMUX\_SYNC\_OV2\_FLAG

DMAMUX\_SYNC\_OV3\_FLAG

DMAMUX\_SYNC\_OV4\_FLAG

DMAMUX\_SYNC\_OV5\_FLAG

DMAMUX\_SYNC\_OV6\_FLAG

DMAMUX\_SYNC\_OV7\_FLAG

#### Example:

```
if(dmamux_sync_flag_get(DMA1, DMAMUX_SYNC_OV1_FLAG) != RESET)
{
    /* turn led2/led3/led4 on */
    at32_led_on(LED2);
    at32_led_on(LED3);
    at32_led_on(LED4);
    dmamux_sync_flag_clear(DMA1, DMAMUX_SYNC_OV1_FLAG);
}
```

## 5.7.21 dmamux\_generator\_flag\_get function

The table below describes the function dmamux\_generator\_flag\_get.

**Table 216. dmamux\_generator\_flag\_get function**

Name	Description
Function name	dmamux_generator_flag_get
Function prototype	flag_status dmamux_generator_flag_get(dma_type *dma_x, uint32_t flag);
Function description	Get dmamux request generator flag
Input parameter 1	dma_x: DMAx, x=1
Input parameter 2	Flag: the selected flag
Output parameter	NA
Return value	flag_status: indicates whether or not the selected flag is set
Required preconditions	NA
Called functions	NA

### flag

This is used for flag selection, including:

DMAMUX\_GEN\_TRIG\_OV1\_FLAG  
DMAMUX\_GEN\_TRIG\_OV2\_FLAG  
DMAMUX\_GEN\_TRIG\_OV3\_FLAG  
DMAMUX\_GEN\_TRIG\_OV4\_FLAG

### flag\_status

RESET: Corresponding flag is not set

SET: Corresponding flag is set

### Example:

```
if(dmamux_generator_flag_get (DMA1, DMAMUX_GEN_TRIG_OV1_FLAG) != RESET)
{
    /* turn led2/led3/led4 on */
    at32_led_on(LED2);
    at32_led_on(LED3);
    at32_led_on(LED4);
}
```

## 5.7.22 dmamux\_generator\_flag\_clear function

The table below describes the function dmamux\_generator\_flag\_clear.

**Table 217. dmamux\_generator\_flag\_clear function**

Name	Description
Function name	dmamux_generator_flag_clear
Function prototype	void dmamux_generator_flag_clear(dma_type *dma_x, uint32_t flag);
Function description	Clear request generator flag
Input parameter 1	dma_x: DMAx, x=1
Input parameter 2	Flag: the selected flag
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### flag

This is used for flag selection, including:

DMAMUX\_GEN\_TRIG\_OV1\_FLAG  
DMAMUX\_GEN\_TRIG\_OV2\_FLAG  
DMAMUX\_GEN\_TRIG\_OV3\_FLAG  
DMAMUX\_GEN\_TRIG\_OV4\_FLAG

### Example:

```
if(dmamux_generator_flag_get (DMA1, DMAMUX_GEN_TRIG_OV1_FLAG) != RESET)
{
    /* turn led2/led3/led4 on */
    at32_led_on(LED2);
    at32_led_on(LED3);
    at32_led_on(LED4);
    dmamux_generator_flag_clear(DMA1, DMAMUX_GEN_TRIG_OV1_FLAG);
}
```

## 5.8 Real-time clock (ERTC)

The ERTC register structure ertc\_type is defined in the “AT32M412\_416\_ertc.h”:

```
/*
 * @brief type define ertc register all
 */
typedef struct
{

} ertc_type;
```

The table below gives a list of the ERTC registers:

**Table 218. Summary of ERTC registers**

Register	Description
time	ERTC time register
date	ERTC date register
ctrl	ERTC control register
sts	ERTC initialization and status register
div	ERTC divider register
wat	ERTC wakeup timer register
ccal	ERTC coarse calibration register
ala	ERTC alarm clock A register
alb	ERTC alarm clock B register
wp	ERTC write protection register
sbs	ERTC subsecond register
tadj	ERTC time adjustment register
tstm	ERTC time stamp time register
tsdt	ERTC time stamp date register
tssbs	ERTC time stamp subsecond register
scal	ERTC smooth calibration register
tamp	ERTC tamper configuration register
alasbs	ERTC alarm clock A subsecond register
albsbs	ERTC alarm clock B subsecond register
bprx	ERTC battery powered domain data register

The table below gives a list of ERTC library functions.

**Table 219. Summary of ERTC library functions**

Function name	Description
ertc_num_to_bcd	Convert number to BCD code
ertc_bcd_to_num	Convert BCD code to number
ertc_write_protect_enable	Enable write protection
ertc_write_protect_disable	Disable write protection
ertc_wait_update	Wait for register update complete
ertc_wait_flag	Wait flag

ertc_init_mode_enter	Enter initialization mode
ertc_init_mode_exit	Exit initialization mode
ertc_reset	Reset ERTC registers
ertc_divider_set	Divider setting
ertc_hour_mode_set	Hour mode setting
ertc_date_set	Date setting
ertc_time_set	Time setting
ertc_calendar_get	Get calendar
ertc_sub_second_get	Get the current subsecond
ertc_alarm_mask_set	Set alarm mask
ertc_alarm_week_date_select	Alarm time format selection (week/date)
ertc_alarm_set	Set alarm
ertc_alarm_sub_second_set	Set alarm subsecond
ertc_alarm_enable	Enable alarm
ertc_alarm_get	Get alarm value
ertc_alarm_sub_second_get	Get alarm subsecond
ertc_wakeup_clock_set	Select wakeup clock source
ertc_wakeup_counter_set	Set wakeup counter value
ertc_wakeup_counter_get	Get wakeup counter value
ertc_wakeup_enable	Enable wakeup timer
ertc_smooth_calibration_config	Configure smooth calibration
ertc_coarse_calibration_set	Configure coarse calibration
ertc_coarse_calibration_enable	Enable coarse calibration
ertc_cal_output_select	Calibration output source selection
ertc_cal_output_enable	Enable calibration output
ertc_time_adjust	Time adjustment
ertc_daylight_set	Set daylight saving time
ertc_daylight_bpr_get	Get daylight saving time battery powered domain data register value (BPR)
ertc_refer_clock_detect_enable	Enable reference clock detection
ertc_direct_read_enable	Enable direct read mode
ertc_output_set	Set event output
ertc_timestamp_pin_select	Time stamp detection pin selection
ertc_timestamp_valid_edge_set	Set time stamp detection valid edge
ertc_timestamp_enable	Enable time stamp
ertc_timestamp_get	Get time stamp
ertc_timestamp_sub_second_get	Get time stamp subsecond
ertc_tamper_1_pin_select	Tamper detection 1 pin selection
ertc_tamper_pull_up_enable	Enable tamper pin pull-up resistor
ertc_tamper_precharge_set	Set tamper pin precharge time
ertc_tamper_filter_set	Set tamper filter time
ertc_tamper_detect_freq_set	Set tamper detection frequency
ertc_tamper_valid_edge_set	Set tamper detection valid edge
ertc_tamper_timestamp_enable	Enable time stamp upon a tamper event
ertc_tamper_enable	Enable tamper detection
ertc_interrupt_enable	Enable interrupts

ertc_interrupt_get	Get the status of interrupt enable
ertc_flag_get	Get flag status
ertc_flag_clear	Clear flag
ertc_bpr_data_write	Write data to battery powered data register (BPR)
ertc_bpr_data_read	Read from battery powered data register (BPR)

### 5.8.1 ertc\_num\_to\_bcd function

The table below describes the function ertc\_num\_to\_bcd.

Table 220. ertc\_num\_to\_bcd function

Name	Description
Function name	ertc_num_to_bcd
Function prototype	uint8_t ertc_num_to_bcd(uint8_t num);
Function description	Convert number into BCD format
Input parameter 1	num: the number to be converted
Output parameter	NA
Return value	BCD code
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_num_to_bcd(12);
```

### 5.8.2 ertc\_bcd\_to\_num function

The table below describes the function ertc\_bcd\_to\_num.

Table 221. ertc\_bcd\_to\_num function

Name	Description
Function name	ertc_bcd_to_num
Function prototype	uint8_t ertc_bcd_to_num(uint8_t bcd);
Function description	Convert BCD code into number
Input parameter 1	bcd: the BCD code to be converted
Output parameter	NA
Return value	Return the number corresponding to BCD code
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_bcd_to_num(0x12);
```

### 5.8.3 ertc\_write\_protect\_enable function

The table below describes the function ertc\_write\_protect\_enable.

**Table 222. ertc\_write\_protect\_enable function**

Name	Description
Function name	ertc_write_protect_enable
Function prototype	void ertc_write_protect_enable(void);
Function description	Enable write protection
Input parameter 1	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_write_protect_enable();
```

### 5.8.4 ertc\_write\_protect\_disable function

The table below describes the function ertc\_write\_protect\_disable.

**Table 223. ertc\_write\_protect\_disable function**

Name	Description
Function name	ertc_write_protect_disable
Function prototype	void ertc_write_protect_disable(void);
Function description	Disable write protection
Input parameter 1	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_write_protect_disable();
```

## 5.8.5 ertc\_wait\_update function

The table below describes the function ertc\_wait\_update.

**Table 224. ertc\_wait\_update function**

Name	Description
Function name	ertc_wait_update
Function prototype	error_status ertc_wait_update(void);
Function description	Wait for register to finish update
Input parameter 1	NA
Output parameter	NA
Return value	SUCCESS: register update complete ERROR: flag wait timeout
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_wait_update();
```

## 5.8.6 ertc\_wait\_flag function

The table below describes the function ertc\_wait\_flag.

**Table 225. ertc\_wait\_flag function**

Name	Description
Function name	ertc_wait_flag
Function prototype	error_status ertc_wait_flag(uint32_t flag, flag_status status);
Function description	Wait flag
Input parameter 1	flag: the selected flag Refer to the "flag" description below for details.
Input parameter 1	status: flag status. After the flag status is set, the function remains stuck here until flag status changes. This parameter can be SET or RESET.
Output parameter	NA
Return value	SUCCESS: flag state changed ERROR: flag wait timeout
Required preconditions	NA
Called functions	NA

### flag

Flag selection

- ERTC\_ALAWF\_FLAG: Alarm A write enable flag
- ERTC\_ALBWF\_FLAG: Alarm B write enable flag
- ERTC\_WATWF\_FLAG: Wakeup timer register write enable flag
- ERTC\_TADJF\_FLAG: Time adjustment flag
- ERTC\_CALUPDF\_FLAG: Calibration value update complete flag

**Example:**

```
ertc_wait_flag(ERTC_ALAWF_FLAG, RESET);
```

### 5.8.7 ertc\_init\_mode\_enter function

The table below describes the function ertc\_init\_mode\_enter.

**Table 226. ertc\_init\_mode\_enter function**

Name	Description
Function name	ertc_init_mode_enter
Function prototype	error_status ertc_init_mode_enter(void);
Function description	Enter initialization mode
Input parameter 1	NA
Output parameter	NA
Return value	SUCCESS: Initialization mode is entered successfully ERROR: Timeout
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_init_mode_enter();
```

### 5.8.8 ertc\_init\_mode\_exit function

The table below describes the function ertc\_init\_mode\_exit.

**Table 227. ertc\_init\_mode\_exit function**

Name	Description
Function name	ertc_init_mode_exit
Function prototype	void ertc_init_mode_exit(void);
Function description	Exit initialization mode
Input parameter 1	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_init_mode_exit();
```

## 5.8.9 ertc\_reset function

The table below describes the function ertc\_reset.

**Table 228. ertc\_reset function**

Name	Description
Function name	ertc_reset
Function prototype	error_status ertc_reset(void);
Function description	Reset all ERTC registers
Input parameter 1	NA
Output parameter	NA
Return value	SUCCESS: Reset successful ERROR: Reset failed
Required preconditions	NA
Called functions	NA

**Example:**

ertc_reset();
---------------

## 5.8.10 ertc\_divider\_set function

The table below describes the function ertc\_divider\_set.

**Table 229. ertc\_divider\_set function**

Name	Description
Function name	ertc_divider_set
Function prototype	error_status ertc_divider_set(uint16_t div_a, uint16_t div_b);
Function description	Divider settings, frequency division value $(div\_a + 1) * (div\_b + 1) = ERTC\_CLK$ frequency For example, if 32768Hz is used, the frequency division should be div_a = 127, div_b = 255
Input parameter 1	div_a: divider A, range: 0~0x7F
Input parameter 2	div_b: divider B, range: 0~0x7FFF
Output parameter	NA
Return value	SUCCESS: Reset successful ERROR: Reset failed
Required preconditions	NA
Called functions	NA

**Example:**

ertc_divider_set(127, 255);
-----------------------------

## 5.8.11 ertc\_hour\_mode\_set function

The table below describes the function ertc\_hour\_mode\_set.

**Table 230. ertc\_hour\_mode\_set function**

Name	Description
Function name	ertc_hour_mode_set
Function prototype	error_status ertc_hour_mode_set(ertc_hour_mode_set_type mode);
Function description	Hour mode settings
Input parameter 1	mode: hour mode Refer to the following description "Mode" for details.
Output parameter	NA
Return value	SUCCESS: Setting success ERROR: Setting error
Required preconditions	NA
Called functions	NA

### mode

ERTC\_HOUR\_MODE\_24: 24-hour format

ERTC\_HOUR\_MODE\_12: 12-hour format

### Example:

```
ertc_hour_mode_set(ERTC_HOUR_MODE_24);
```

## 5.8.12 ertc\_date\_set function

The table below describes the function ertc\_date\_set.

**Table 231. ertc\_date\_set function**

Name	Description
Function name	ertc_date_set
Function prototype	error_status ertc_date_set(uint8_t year, uint8_t month, uint8_t date, uint8_t week);
Function description	Set date: year, month, date, weekday
Input parameter 1	year: range 0~99
Input parameter 2	month: range 1~12
Input parameter3	date: range 1~31
Input parameter4	week: range 1~7
Output parameter	NA
Return value	SUCCESS: Setting success ERROR: Setting error
Required preconditions	NA
Called functions	NA

### Example:

```
ertc_date_set(22, 5, 26, 4);
```

## 5.8.13 ertc\_time\_set function

The table below describes the function ertc\_time\_set.

**Table 232. ertc\_time\_set function**

Name	Description
Function name	ertc_time_set
Function prototype	error_status ertc_time_set(uint8_t hour, uint8_t min, uint8_t sec, ertc_am_pm_type ampm);
Function description	Set time: hour, minute, second, AM/PM (for 12-hour format only)
Input parameter 1	hour: range 0~23
Input parameter 2	min: range 0~59
Input parameter3	sec: range 0~59
Input parameter4	ampm: AM/PM in 12-hour format (for 12-hour format only, don't care in 24-hour format) Refer to the following description "ampm" for details.
Output parameter	NA
Return value	SUCCESS: Setting success ERROR: Setting error
Required preconditions	NA
Called functions	NA

### ampm

AM/PM in 12-hour format (for 12-hour format only, don't care in 24-hour format)

ERTC\_24H: 24-hour format (for 24-hour format)

ERTC\_AM: AM in 12-hour format

ERTC\_PM: PM in 12-hour format

### Example:

```
ertc_time_set(12, 1, 20, ERTC_24H);
```

## 5.8.14 ertc\_calendar\_get function

The table below describes the function ertc\_calendar\_get.

**Table 233. ertc\_calendar\_get function**

Name	Description
Function name	ertc_calendar_get
Function prototype	void ertc_calendar_get(ertc_time_type* time);
Function description	Get calendar, including year, month, date, weekday, hour, minute, second, AM/PM
Input parameter 1	time: ertc_time_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

ertc\_time\_type\* time

The ertc\_time\_type is defined in the "AT32M412\_416\_ertc.h":

typedef struct

{

```

    uint8_t          year;
    uint8_t          month;
    uint8_t          day;
    uint8_t          hour;
    uint8_t          min;
    uint8_t          sec;
    uint8_t          week;
    ertc_am_pm_type ampm;
} ertc_time_type;

year
Range 0~99
month
Range 1~12
day
Range 1~31
week
Range 1~7
hour
Range 0~23
min
Range 0~59
sec
Range 0~59
ampm
AM/PM in 12-hour format (for 12-hour format only, doesn't care in 24 hour), including:  

ERTC_AM: AM in 12 hour format  

ERTC_PM: PM in 12 hour format

```

**Example:**

```
ertc_calendar_get(&time);
```

### 5.8.15 ertc\_sub\_second\_get function

The table below describes the function ertc\_sub\_second\_get.

**Table 234. ertc\_sub\_second\_get function**

Name	Description
Function name	ertc_sub_second_get
Function prototype	uint32_t ertc_sub_second_get(void);
Function description	Get current subsecond (the current value of divider B)
Input parameter 1	NA
Output parameter	NA
Return value	Current subsecond
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_sub_second_get();
```

## 5.8.16 ertc\_alarm\_mask\_set function

The table below describes the function ertc\_alarm\_mask\_set.

**Table 235. ertc\_alarm\_mask\_set function**

Name	Description
Function name	ertc_alarm_mask_set
Function prototype	void ertc_alarm_mask_set(ertc_alarm_type alarm_x, uint32_t mask);
Function description	Set alarm mask
	alarm_x: alarm selection Refer to the following description "alarm_x" for details.
Input parameter 1	mask: Set alarm mask Refer to the following description "mask" for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **alarm\_x**

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

### **mask**

Set alarm mask

ERTC\_ALARM\_MASK\_NONE: No mask, alarm is relevant to all fields

ERTC\_ALARM\_MASK\_SEC: Mask second, alarm is not relevant to second

ERTC\_ALARM\_MASK\_MIN: Mask minute, alarm is not relevant to minute

ERTC\_ALARM\_MASK\_HOUR: Mask hour, alarm is not relevant to hour

ERTC\_ALARM\_MASK\_DATE\_WEEK: Mask date, alarm is not relevant to date

ERTC\_ALARM\_MASK\_ALL: Mask all. Generate an alarm per one second

### **Example:**

```
ertc_alarm_mask_set(ERTC_ALA, ERTC_ALARM_MASK_NONE);
```

## 5.8.17 ertc\_alarm\_week\_date\_select function

The table below describes the function ertc\_alarm\_week\_date\_select.

Table 236. ertc\_alarm\_week\_date\_select function

Name	Description
Function name	ertc_alarm_week_date_select
Function prototype	void ertc_alarm_week_date_select(ertc_alarm_type alarm_x, ertc_week_date_select_type wk);
Function description	Alarm time format selection: week/date
Input parameter 1	alarm_x: alarm selection Refer to the following description “alarm_x” for details.
Input parameter 2	wk: alarm week/date format selection Refer to the following description “wk” for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### alarm\_x

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

### wk

Alarm week/date format selection

ERTC\_SELECT\_DATE: Date mode

ERTC\_SELECT\_WEEK: Week mode

### Example:

```
ertc_alarm_week_date_select(ERTC_ALA, ERTC_SELECT_DATE);
```

## 5.8.18 ertc\_alarm\_set function

The table below describes the function ertc\_alarm\_set.

**Table 237. ertc\_alarm\_set function**

Name	Description
Function name	ertc_alarm_set
Function prototype	void ertc_alarm_set(ertc_alarm_type alarm_x, uint8_t week_date, uint8_t hour, uint8_t min, uint8_t sec, ertc_am_pm_type ampm);
Function description	Set alarm
Input parameter 1	alarm_x: alarm selection Refer to the following description “alarm_x” for details.
Input parameter 2	week_date: date or week, depending on the ertc_alarm_week_date_select() Date: range 1~31 Week: range 1~7
Input parameter3	hour: range 0~23
Input parameter4	min: range 0~59
Input parameter5	sec: range 0~59
Input parameter6	ampm: AM/PM in 12-hour format (12 hour format only, doesn't care in 24-hour format) Refer to the following description “ampm” for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### alarm\_x

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

### ampm

AM/PM in 12-hour format (for 12 hour format only, doesn't care in 24 hour)

ERTC\_24H: 24-hour format (for 24 hour format)

ERTC\_AM: AM in 12-hour format

ERTC\_PM: PM in 12-hour format

### Example:

```
ertc_alarm_set(ERTC_ALA, 15, 8, 0, 0, ERTC_24H);
```

## 5.8.19 ertc\_alarm\_sub\_second\_set function

The table below describes the function ertc\_alarm\_sub\_second\_set.

**Table 238. ertc\_alarm\_sub\_second\_set function**

Name	Description
Function name	ertc_alarm_sub_second_set
Function prototype	void ertc_alarm_sub_second_set(ertc_alarm_type alarm_x, uint32_t value, ertc_alarm_sbs_mask_type mask);
Function description	Set alarm subsecond
Input parameter 1	alarm_x: alarm selection Refer to the following description “alarm_x” for details.
Input parameter 2	value: subsecond value, range 0~0x7FFF
Input parameter3	mask: alarm mask settings Refer to the following description “mask” for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### alarm\_x

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

### mask

Subsecond mask

ERTC_ALARM_SBS_MASK_ALL:	Mask all
ERTC_ALARM_SBS_MASK_14_1:	Only match SBS bit [0]
ERTC_ALARM_SBS_MASK_14_2:	Only match SBS bit [1:0]
ERTC_ALARM_SBS_MASK_14_3:	Only match SBS bit [2:0]
ERTC_ALARM_SBS_MASK_14_4:	Only match SBS bit [3:0]
ERTC_ALARM_SBS_MASK_14_5:	Only match SBS bit [4:0]
ERTC_ALARM_SBS_MASK_14_6:	Only match SBS bit [5:0]
ERTC_ALARM_SBS_MASK_14_7:	Only match SBS bit [6:0]
ERTC_ALARM_SBS_MASK_14_8:	Only match SBS bit [7:0]
ERTC_ALARM_SBS_MASK_14_9:	Only match SBS bit [8:0]
ERTC_ALARM_SBS_MASK_14_10:	Only match SBS bit [9:0]
ERTC_ALARM_SBS_MASK_14_11:	Only match SBS bit [10:0]
ERTC_ALARM_SBS_MASK_14_12:	Only match SBS bit [11:0]
ERTC_ALARM_SBS_MASK_14_13:	Only match SBS bit [12:0]
ERTC_ALARM_SBS_MASK_14:	Only match SBS bit [13:0]
ERTC_ALARM_SBS_MASK_NONE:	Only match SBS bit [14:0]

### Example:

```
ertc_alarm_sub_second_set(ERTC_ALA, 200, ERTC_ALARM_SBS_MASK_NONE);
```

## 5.8.20 ertc\_alarm\_enable function

The table below describes the function ertc\_alarm\_enable.

**Table 239. ertc\_alarm\_enable function**

Name	Description
Function name	ertc_alarm_enable
Function prototype	error_status ertc_alarm_enable(ertc_alarm_type alarm_x, confirm_state new_state);
Function description	Alarm enable
Input parameter 1	alarm_x: alarm selection Refer to the following description “alarm_x” for details.
Input parameter 2	new_state: alarm enable status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	SUCCESS: Setting success ERROR: Setting error
Required preconditions	NA
Called functions	NA

### alarm\_x

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

### Example:

```
ertc_alarm_enable(ERTC_ALA, TRUE);
```

## 5.8.21 ertc\_alarm\_get function

The table below describes the function ertc\_alarm\_get.

**Table 240. ertc\_alarm\_get function**

Name	Description
Function name	ertc_alarm_get
Function prototype	void ertc_alarm_get(ertc_alarm_type alarm_x, ertc_alarm_value_type* alarm);
Function description	Get alarm value
Input parameter 1	alarm_x: alarm selection Refer to the following description “alarm_x” for details.
Input parameter 2	alarm: ertc_alarm_value_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### alarm\_x

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

ertc\_alarm\_value\_type\* alarm

ertc\_alarm\_value\_type is defined in the “AT32M412\_416\_ertc.h”:

typedef struct

```
{  
    uint8_t          day;  
    uint8_t          hour;  
    uint8_t          min;  
    uint8_t          sec;  
    ertc_am_pm_type ampm;  
    uint32_t         mask;  
    uint8_t          week_date_sel;  
    uint8_t          week;
```

} ertc\_alarm\_value\_type;

**day**

Range 1~31

**hour**

Range 0~23

**min**

Range 0~59

**sec**

Range 0~59

**ampm**

AM/PM in 12-hour format (for 12-hour format only, doesn't care in 24 hour), including:

ERTC\_AM: AM in 12 hour format

ERTC\_PM: PM in 12 hour format

**mask**

Alarm mask value, including:

ERTC_ALARM_MASK_NONE:	No mask
ERTC_ALARM_MASK_SEC:	Mask second
ERTC_ALARM_MASK_MIN:	Mask minute
ERTC_ALARM_MASK_HOUR:	Mask hour
ERTC_ALARM_MASK_DATE_WEEK:	Mask date
ERTC_ALARM_MASK_ALL:	Mask all

**week\_date\_sel**

Alarm week/date format, including:

ERTC\_SELECT\_DATE: date mode

ERTC\_SELECT\_WEEK: week mode

**week**

Range 1~7

**Example:**

```
ertc_alarm_get(ERTC_ALA, &alarm);
```

## 5.8.22 ertc\_alarm\_sub\_second\_get function

The table below describes the function ertc\_alarm\_sub\_second\_get.

**Table 241. ertc\_alarm\_sub\_second\_get function**

Name	Description
Function name	ertc_alarm_sub_second_get
Function prototype	uint32_t ertc_alarm_sub_second_get(ertc_alarm_type alarm_x);
Function description	Get alarm subsecond value
Input parameter 1	alarm_x: alarm selection Refer to the following description "alarm_x" for details.
Output parameter	NA
Return value	Alarm subsecond value
Required preconditions	NA
Called functions	NA

### alarm\_x

Alarm selection

ERTC\_ALA: Alarm A

ERTC\_ALB: Alarm B

### Example:

```
ertc_alarm_sub_second_get(ERTC_ALA);
```

## 5.8.23 ertc\_wakeup\_clock\_set function

The table below describes the function ertc\_wakeup\_clock\_set.

**Table 242. ertc\_wakeup\_clock\_set function**

Name	Description
Function name	ertc_wakeup_clock_set
Function prototype	void ertc_wakeup_clock_set(ertc_wakeup_clock_type clock);
Function description	Select wakeup timer clock source
Input parameter 1	clock: clock source for wakeup timer Refer to the following description "clock" for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### clock

Wakeup timer clock source

ERTC\_WAT\_CLK\_ERTCCLK\_DIV16: ERTC\_CLK / 16

ERTC\_WAT\_CLK\_ERTCCLK\_DIV8: ERTC\_CLK / 8

ERTC\_WAT\_CLK\_ERTCCLK\_DIV4: ERTC\_CLK / 4

ERTC\_WAT\_CLK\_ERTCCLK\_DIV2: ERTC\_CLK / 2

ERTC\_WAT\_CLK\_CK\_B\_16BITS: CK\_B (1Hz calendar clock), wakeup counter value =

ERTC\_WAT

ERTC\_WAT\_CLK\_CK\_B\_17BITS: CK\_B (1Hz calendar clock), wakeup counter value =

ERTC\_WAT + 65535

**Example:**

```
ertc_wakeup_clock_set(ERTC_WAT_CLK_CK_B_16BITS);
```

### 5.8.24 ertc\_wakeup\_counter\_set function

The table below describes the function ertc\_wakeup\_counter\_set.

**Table 243. ertc\_wakeup\_counter\_set function**

Name	Description
Function name	ertc_wakeup_counter_set
Function prototype	void ertc_wakeup_counter_set(uint32_t counter);
Function description	Set wakeup counter value
Input parameter 1	counter: counter value, range 0~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_wakeup_counter_set(0x7FFF);
```

### 5.8.25 ertc\_wakeup\_counter\_get function

The table below describes the function ertc\_wakeup\_counter\_get.

**Table 244. ertc\_wakeup\_counter\_get function**

Name	Description
Function name	ertc_wakeup_counter_get
Function prototype	uint16_t ertc_wakeup_counter_get(void);
Function description	Get the current wakeup counter value
Input parameter 1	NA
Output parameter	NA
Return value	Return the current wakeup counter value
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_wakeup_counter_get();
```

## 5.8.26 ertc\_wakeup\_enable function

The table below describes the function ertc\_wakeup\_enable.

**Table 245. ertc\_wakeup\_enable function**

Name	Description
Function name	ertc_wakeup_enable
Function prototype	error_status ertc_wakeup_enable(confirm_state new_state);
Function description	Enable wakeup timer
Input parameter 1	new_state: wakeup timer enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	SUCCESS: Set success ERROR: Set error
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_wakeup_enable(TRUE);
```

## 5.8.27 ertc\_smooth\_calibration\_config function

The table below describes the function ertc\_smooth\_calibration\_config.

**Table 246. ertc\_smooth\_calibration\_config function**

Name	Description
Function name	ertc_smooth_calibration_config
Function prototype	error_status ertc_smooth_calibration_config(ertc_smooth_cal_period_type period, ertc_smooth_cal_clk_add_type clk_add, uint32_t clk_dec);
Function description	et smooth digital calibration
Input parameter 1	period: calibration period Refer to the following "period" descriptions for details.
Input parameter 2	clk_add: add ERTC CLK cycles Refer to the following "clk_add" descriptions for details.
Input parameter3	clk_dec: reduce ERTC CLK cycles, range 0~511
Output parameter	NA
Return value	SUCCESS: Set success ERROR: Set error
Required preconditions	NA
Called functions	NA

### period

Calibration periods

ERTC\_SMOOTH\_CAL\_PERIOD\_32: 32 seconds

ERTC\_SMOOTH\_CAL\_PERIOD\_16: 16 seconds

ERTC\_SMOOTH\_CAL\_PERIOD\_8: 8 seconds

### clk\_add

Add ERTC CLK

ERTC\_SMOOTH\_CAL\_CLK\_ADD\_0: No effect

ERTC\_SMOOTH\_CAL\_CLK\_ADD\_512: Add 512 ERTC\_CLK cycles

**Example:**

```
ertc_smooth_calibration_config(ERTC_SMOOTH_CAL_PERIOD_32, ERTC_SMOOTH_CAL_CLK_ADD_0, 511);
```

## 5.8.28 ertc\_cal\_output\_select function

The table below describes the function ertc\_cal\_output\_select.

**Table 247. ertc\_cal\_output\_select function**

Name	Description
Function name	ertc_cal_output_select
Function prototype	void ertc_cal_output_select(ertc_cal_output_select_type output);
Function description	Calibration output source selection
Input parameter 1	output: Calibration output source Refer to the following “output” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**output**

Calibration output source

ERTC\_CAL\_OUTPUT\_512HZ: 512 Hz output

ERTC\_CAL\_OUTPUT\_1HZ: 1 Hz output

**Example:**

```
ertc_cal_output_select(ERTC_CAL_OUTPUT_1HZ);
```

## 5.8.29 ertc\_cal\_output\_enable function

The table below describes the function ertc\_cal\_output\_enable.

**Table 248. ertc\_cal\_output\_enable function**

Name	Description
Function name	ertc_cal_output_enable
Function prototype	void ertc_cal_output_enable(confirm_state new_state);
Function description	Calibration output enable
Input parameter 1	new_state: calibration output enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_cal_output_enable(TRUE);
```

## 5.8.30 ertc\_time\_adjust function

The table below describes the function ertc\_time\_adjust.

**Table 249. ertc\_time\_adjust function**

Name	Description
Function name	ertc_time_adjust
Function prototype	error_status ertc_time_adjust(ertc_time_adjust_type add1s, uint32_t decsbs);
Function description	Adjust time
Input parameter 1	add1s: add seconds Refer to the following “add1s” descriptions for details.
Input parameter 2	decsbs: reduce subseconds, range 0~0x7FFF
Output parameter	NA
Return value	SUCCESS: Setting success ERROR: Setting error
Required preconditions	NA
Called functions	NA

### add1s

This bit is used to add seconds.

ERTC\_TIME\_ADD\_NONE: No effect

ERTC\_TIME\_ADD\_1S: Add 1 second

### Example:

```
ertc_time_adjust(ERTC_TIME_ADD_1S, 254);
```

## 5.8.31 ertc\_daylight\_set function

The table below describes the function ertc\_daylight\_set.

**Table 250. ertc\_daylight\_set function**

Name	Description
Function name	ertc_daylight_set
Function prototype	void ertc_daylight_set(ertc_dst_operation_type operation, ertc_dst_save_type save);
Function description	Set daylight-saving time
Input parameter 1	operation: daylight-saving time settings Refer to the following “operation” descriptions for details.
Input parameter 2	save: save daylight time Refer to the following “save” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### operation

Daylight-saving time settings

ERTC\_DST\_ADD\_1H: Add 1 hour

ERTC\_DST\_DEC\_1H: Reduce 1 hour

### save

Save daylight time

ERTC\_DST\_SAVE\_0: set BPR bit to 0 in the CTRL register

ERTC\_DST\_SAVE\_1: set BPR bit to 1 in the CTRL register

**Example:**

<code>ertc_daylight_set(ERTC_DST_ADD_1H, ERTC_DST_SAVE_1);</code>
---

### 5.8.32 ertc\_daylight\_bpr\_get function

The table below describes the function ertc\_daylight\_bpr\_get.

**Table 251. ertc\_daylight\_bpr\_get function**

Name	Description
Function name	ertc_daylight_bpr_get
Function prototype	<code>uint8_t ertc_daylight_bpr_get(void);</code>
Function description	Get the value of daylight-saving time battery powered register (BPR bit in the CTRL register)
Input parameter 1	NA
Output parameter	NA
Return value	Return the value of daylight-saving time battery powered register (BPR bit in the CTRL register)
Required preconditions	NA
Called functions	NA

**Example:**

<code>ertc_daylight_bpr_get();</code>
---------------------------------------

### 5.8.33 ertc\_refer\_clock\_detect\_enable function

The table below describes the function ertc\_refer\_clock\_detect\_enable.

**Table 252. ertc\_refer\_clock\_detect\_enable function**

Name	Description
Function name	ertc_refer_clock_detect_enable
Function prototype	<code>error_status ertc_refer_clock_detect_enable(confirm_state new_state);</code>
Function description	Enable reference clock detection
Input parameter 1	<code>new_state</code> : reference clock detection enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	SUCCESS: Set success ERROR: Set error
Required preconditions	NA
Called functions	NA

**Example:**

<code>ertc_refer_clock_detect_enable(TRUE);</code>
--

## 5.8.34 ertc\_direct\_read\_enable function

The table below describes the function ertc\_direct\_read\_enable.

**Table 253. ertc\_direct\_read\_enable function**

Name	Description
Function name	ertc_direct_read_enable
Function prototype	void ertc_direct_read_enable(confirm_state new_state);
Function description	Enable direct read mode
Input parameter 1	new_state: direct read mode enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_direct_read_enable(TRUE);
```

## 5.8.35 ertc\_output\_set function

The table below describes the function ertc\_output\_set.

**Table 254. ertc\_output\_set function**

Name	Description
Function name	ertc_output_set
Function prototype	void ertc_output_set(ertc_output_source_type source, ertc_output_polarity_type polarity, ertc_output_type type);
Function description	Set event output, event output on PC13
Input parameter 1	source: output source Refer to the following “source” descriptions for details.
Input parameter 2	polarity: output polarity Refer to the following “polarity” descriptions for details.
Input parameter3	type: output type Refer to the following “type” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### source

Output source selection

- |                      |                      |
|----------------------|----------------------|
| ERTC_OUTPUT_DISABLE: | Output disabled      |
| ERTC_OUTPUT_ALARM_A: | Output alarm A event |
| ERTC_OUTPUT_ALARM_B: | Output alarm B event |
| ERTC_OUTPUT_WAKEUP:  | Output wakeup event  |

### polarity

Output polarity

- |                            |                                    |
|----------------------------|------------------------------------|
| ERTC_OUTPUT_POLARITY_HIGH: | Output high when an event occurred |
|----------------------------|------------------------------------|

ERTC\_OUTPUT\_POLARITY\_LOW: Output low when an event occurred  
**type**  
 Output type

ERTC\_OUTPUT\_TYPE\_OPEN\_DRAIN: Open-drain output  
 ERTC\_OUTPUT\_TYPE\_PUSH\_PULL: Push-pull output

**Example:**

```
ertc_output_set(ERTC_OUTPUT_ALARM_A, ERTC_OUTPUT_POLARITY_HIGH,
ERTC_OUTPUT_TYPE_PUSH_PULL);
```

### 5.8.36 ertc\_timestamp\_pin\_select function

The table below describes the function ertc\_timestamp\_pin\_select.

**Table 255. ertc\_timestamp\_pin\_select function**

Name	Description
Function name	ertc_timestamp_pin_select
Function prototype	void ertc_timestamp_pin_select(ertc_pin_select_type pin);
Function description	Timestamp detection pin selection
Input parameter 1	pin: Timestamp detection pin Refer to the following “pin” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**pin**

Timestampe detection pin

ERTC\_PIN\_PC13: PC13 is selected as timestampe detection pin

ERTC\_PIN\_PA0: PA0 is selected as timestampe detection pin

**Example:**

```
ertc_timestamp_pin_select(ERTC_PIN_PC13);
```

### 5.8.37 ertc\_timestamp\_valid\_edge\_set function

The table below describes the function ertc\_timestamp\_valid\_edge\_set.

**Table 256. ertc\_timestamp\_valid\_edge\_set function**

Name	Description
Function name	ertc_timestamp_valid_edge_set
Function prototype	void ertc_timestamp_valid_edge_set(ertc_timestamp_valid_edge_type edge);
Function description	Set timestampe detection valid edge
Input parameter 1	edge: timestampe detection valid edge Refer to the following “edge” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**edge**

Timestamp detection valid edge

ERTC\_TIMESTAMP\_EDGE\_RISING: Rising edge

ERTC\_TIMESTAMP\_EDGE\_FALLING: Falling edge

**Example:**

```
ertc_timestamp_valid_edge_set(ERTC_TIMESTAMP_EDGE_RISING);
```

### 5.8.38 ertc\_timestamp\_enable function

The table below describes the function ertc\_timestamp\_enable.

**Table 257. ertc\_timestamp\_enable function**

Name	Description
Function name	ertc_timestamp_enable
Function prototype	void ertc_timestamp_enable(confirm_state new_state);
Function description	Enable timestamp
Input parameter 1	new_state: timestamp enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_timestamp_enable(TRUE);
```

### 5.8.39 ertc\_timestamp\_get function

The table below describes the function ertc\_timestamp\_get.

**Table 258. ertc\_timestamp\_get function**

Name	Description
Function name	ertc_timestamp_get
Function prototype	void ertc_timestamp_get(ertc_time_type* time);
Function description	Get timestamp
Input parameter 1	time: ertc_time_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

ertc\_time\_type\* time

The ertc\_time\_type is defined in the "AT32M412\_416\_ertc.h":

typedef struct

```
{
    uint8_t          year;
    uint8_t          month;
    uint8_t          day;
    uint8_t          hour;
```

```

    uint8_t          min;
    uint8_t          sec;
    uint8_t          week;
    ertc_am_pm_type ampm;
} ertc_time_type;

year
Range 0~99

month
Range 1~12

day
Range 1~31

week
Range 1~7

hour
Range 0~23

min
Range 0~59

sec
Range 0~59

ampm
AM/PM in 12-hour format (only for 12-hour format, doesn't care in 24-hour format), including:  

ERTC_AM: AM in 12-hour format  

ERTC_PM: PM in 12-hour format

```

**Example:**

```
ertc_timestamp_get(&time);
```

### 5.8.40 ertc\_timestamp\_sub\_second\_get function

The table below describes the function ertc\_timestamp\_sub\_second\_get.

**Table 259. ertc\_timestamp\_sub\_second\_get function**

Name	Description
Function name	ertc_timestamp_sub_second_get
Function prototype	uint32_t ertc_timestamp_sub_second_get(void);
Function description	Get timestamp subsecond
Input parameter 1	NA
Output parameter	NA
Return value	Return timestamp subsecond
Required preconditions	NA
Called functions	NA

**Example:**

```
ertc_timestamp_sub_second_get();
```

## 5.8.41 ertc\_tamper\_1\_pin\_select function

The table below describes the function ertc\_tamper\_1\_pin\_select.

**Table 260. ertc\_tamper\_1\_pin\_select function**

Name	Description
Function name	ertc_tamper_1_pin_select
Function prototype	void ertc_tamper_1_pin_select(ertc_pin_select_type pin);
Function description	Select tamper detection 1 pin
Input parameter 1	pin: Tamper detection pin Refer to the following "pin" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### pin

Tamper detection pin

ERTC\_PIN\_PC13: PC13 is selected as a tamper detection pin

ERTC\_PIN\_PA0: PA0 is selected as a tamper detection pin

### Example:

```
ertc_tamper_1_pin_select(ERTC_PIN_PC13);
```

## 5.8.42 ertc\_tamper\_pull\_up\_enable function

The table below describes the function ertc\_tamper\_pull\_up\_enable.

**Table 261. ertc\_tamper\_pull\_up\_enable function**

Name	Description
Function name	ertc_tamper_pull_up_enable
Function prototype	void ertc_tamper_pull_up_enable(confirm_state new_state);
Function description	Enable tamper pin pull-up resistor
Input parameter 1	new_state: tamper pin pull-up resistor enable status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### Example:

```
ertc_tamper_pull_up_enable(TRUE);
```

## 5.8.43 ertc\_tamper\_purge\_set function

The table below describes the function ertc\_tamper\_purge\_set.

**Table 262. ertc\_tamper\_purge\_set function**

Name	Description
Function name	ertc_tamper_purge_set
Function prototype	void ertc_tamper_purge_set(ertc_tamper_purge_type purge);
Function description	Set tamper pin purge time. This setting is needed only when the tamper pull-up resistor is enabled through the function ertc_tamper_pull_up_enable.
Input parameter 1	purge: tamper pin purge time Refer to the following “purge” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### purge

Tamper pin purge time

- ERTC\_TAMPER\_PR\_1\_ERTCCLK: One ERTC\_CLK cycle
- ERTC\_TAMPER\_PR\_2\_ERTCCLK: Two ERTC\_CLK cycles
- ERTC\_TAMPER\_PR\_4\_ERTCCLK: Four ERTC\_CLK cycles
- ERTC\_TAMPER\_PR\_8\_ERTCCLK: Eight ERTC\_CLK cycles

### Example:

```
ertc_tamper_purge_set(ERTC_TAMPER_PR_2_ERTCCLK);
```

## 5.8.44 ertc\_tamper\_filter\_set function

The table below describes the function ertc\_tamper\_filter\_set.

**Table 263. ertc\_tamper\_filter\_set function**

Name	Description
Function name	ertc_tamper_filter_set
Function prototype	void ertc_tamper_filter_set(ertc_tamper_filter_type filter);
Function description	Set tamper filtering time
Input parameter 1	filter: tamper filtering time Refer to the following “filter” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### filter

Set tamper filtering time

ERTC\_TAMPER\_FILTER\_DISABLE:

No filtering

ERTC\_TAMPER\_FILTER\_2:

Tamper event is considered to have occur after two valid consecutive sampling

ERTC\_TAMPER\_FILTER\_4:

Tamper event is considered to have occur after four valid consecutive sampling

ERTC\_TAMPER\_FILTER\_8:

Tamper event is considered to have occur after eight valid consecutive sampling

**Example:**

```
ertc_tamper_filter_set(ERTC_TAMPER_FILTER_2);
```

## 5.8.45 ertc\_tamper\_detect\_freq\_set function

The table below describes the function ertc\_tamper\_detect\_freq\_set.

**Table 264. ertc\_tamper\_detect\_freq\_set function**

Name	Description
Function name	ertc_tamper_detect_freq_set
Function prototype	void ertc_tamper_detect_freq_set(ertc_tamper_detect_freq_type freq);
Function description	Set tamper detection frequency
Input parameter 1	freq: tamper detection frequency Refer to the following "freq" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**freq**

Select tamper detection frequency

ERTC\_TAMPER\_FREQ\_DIV\_32768: ERTC\_CLK / 32768  
ERTC\_TAMPER\_FREQ\_DIV\_16384: ERTC\_CLK / 16384  
ERTC\_TAMPER\_FREQ\_DIV\_8192: ERTC\_CLK / 8192  
ERTC\_TAMPER\_FREQ\_DIV\_4096: ERTC\_CLK / 4096  
ERTC\_TAMPER\_FREQ\_DIV\_2048: ERTC\_CLK / 2048  
ERTC\_TAMPER\_FREQ\_DIV\_1024: ERTC\_CLK / 1024  
ERTC\_TAMPER\_FREQ\_DIV\_512: ERTC\_CLK / 512  
ERTC\_TAMPER\_FREQ\_DIV\_256: ERTC\_CLK / 256

**Example:**

```
ertc_tamper_detect_freq_set(ERTC_TAMPER_FREQ_DIV_512);
```

## 5.8.46 ertc\_tamper\_valid\_edge\_set function

The table below describes the function ertc\_tamper\_valid\_edge\_set.

**Table 265. ertc\_tamper\_valid\_edge\_set function**

Name	Description
Function name	ertc_tamper_valid_edge_set
Function prototype	void ertc_tamper_valid_edge_set(ertc_tamper_select_type tamper_x, ertc_tamper_valid_edge_type trigger);
Function description	Set tamper detection valid edge
Input parameter 1	tamper_x: tamper selection Refer to the following “tamper_x” descriptions for details.
Input parameter 2	trigger: tamper detection valid edge Refer to the following “trigger” descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tamper\_x

Tamper selection

ERTC\_TAMPER\_1: Tamper detection 1

ERTC\_TAMPER\_2: Tamper detection 2

### trigger

Tamper detection valid edge selection

ERTC\_TAMPER\_EDGE\_RISING: Rising edge

ERTC\_TAMPER\_EDGE\_FALLING: Falling edge

ERTC\_TAMPER\_EDGE\_LOW: Low level

ERTC\_TAMPER\_EDGE\_HIGH: High level

### Example:

```
ertc_tamper_valid_edge_set(ERTC_TAMPER_1, ERTC_TAMPER_EDGE_RISING);
```

## 5.8.47 ertc\_tamper\_timestamp\_enable function

The table below describes the function ertc\_tamper\_timestamp\_enable.

**Table 266. ertc\_tamper\_timestamp\_enable function**

Name	Description
Function name	ertc_tamper_timestamp_enable
Function prototype	void ertc_tamper_timestamp_enable(confirm_state new_state);
Function description	Enable timestamp when a tamper event occurred
Input parameter 1	new_state: timestamp feature enable state when a tamper event occurred This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### Example:

```
ertc_tamper_timestamp_enable(TRUE);
```

## 5.8.48 ertc\_tamper\_enable function

The table below describes the function ertc\_tamper\_enable.

**Table 267. ertc\_tamper\_enable function**

Name	Description
Function name	ertc_tamper_enable
Function prototype	void ertc_tamper_enable(ertc_tamper_select_type tamper_x, confirm_state new_state);
Function description	Enable tamper detection
Input parameter 1	tamper_x: the selected tamper Refer to the following “tamper_x” descriptions for details.
Input parameter 2	new_state: tamper detection enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tamper\_x

Tamper selection

ERTC\_TAMPER\_1: Tamper detection 1

ERTC\_TAMPER\_2: Tamper detection 2

### Example:

```
ertc_tamper_enable(ERTC_TAMPER_1, TRUE);
```

## 5.8.49 ertc\_interrupt\_enable function

The table below describes the function ertc\_interrupt\_enable.

**Table 268. ertc\_interrupt\_enable function**

Name	Description
Function name	ertc_interrupt_enable
Function prototype	void ertc_interrupt_enable(uint32_t source, confirm_state new_state);
Function description	Interrupt enable
	source: interrupt source to be enabled Refer to the following “source” descriptions for details.
Input parameter 1	new_state: interrupt enable state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### source

Interrupt source to be enabled

ERTC\_TP\_INT: Tamper detection interrupt

ERTC\_ALA\_INT: Alarm A interrupt

ERTC\_ALB\_INT: Alarm B interrupt

ERTC\_WAT\_INT: Wakeup timer interrupt

ERTC\_TS\_INT: Time stamp interrupt

**Example:**

ertc_interrupt_enable(ERTC_TP_INT, TRUE);
---

### 5.8.50 ertc\_interrupt\_get function

The table below describes the function ertc\_interrupt\_get.

**Table 269. ertc\_interrupt\_get function**

Name	Description
Function name	ertc_interrupt_get
Function prototype	flag_status ertc_interrupt_get(uint32_t source);
Function description	Get interrupt enable state
Input parameter 1	source: interrupt source Refer to the following "source" descriptions for details.
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**source**

Interrupt source

ERTC\_TP\_INT: Tamper detection interrupt

ERTC\_ALA\_INT: Alarm A interrupt

ERTC\_ALB\_INT: Alarm B interrupt

ERTC\_WAT\_INT: Wakeup timer interrupt

ERTC\_TS\_INT: Time stamp interrupt

**Example:**

ertc_interrupt_get(ERTC_TP_INT);
----------------------------------

### 5.8.51 ertc\_flag\_get function

The table below describes the function ertc\_flag\_get.

**Table 270. ertc\_flag\_get function**

Name	Description
Function name	ertc_flag_get
Function prototype	flag_status ertc_flag_get(uint32_t flag);
Function description	Get flag status
Input parameter 1	flag: the selected flag Refer to the following "flag" descriptions for details.
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**flag**

This bit is used to select a flag. Optional parameters are as follows:

ERTC_ALAWF_FLAG:	Alarm A write enable flag
ERTC_ALBWF_FLAG:	Alarm B write enable flag
ERTC_WATWF_FLAG:	Wakeup timer register write enable flag
ERTC_TADJF_FLAG:	Time adjust flag
ERTC_INITF_FLAG:	Calendar initialization flag
ERTC_UPDF_FLAG:	Calendar update flag
ERTC_IMF_FLAG:	Initialization mode entry flag
ERTC_ALAF_FLAG:	Alarm A flag
ERTC_ALBF_FLAG:	Alarm B flag
ERTC_WATF_FLAG:	Wakeup timer flag
ERTC_TSF_FLAG:	Time stamp flag
ERTC_TSOF_FLAG:	Time stamp overflow flag
ERTC_TP1F_FLAG:	Tamper detection 1 flag
ERTC_TP2F_FLAG:	Tamper detection 2 flag
ERTC_CALUPDF_FLAG:	Calibration value update complete flag

**Example:**

```
ertc_flag_get(ERTC_TP1F_FLAG);
```

### 5.8.52 ertc\_interrupt\_flag\_get function

The table below describes the function ertc\_interrupt\_flag\_get.

**Table 271. ertc\_interrupt\_flag\_get function**

Name	Description
Function name	ertc_interrupt_flag_get
Function prototype	flag_status ertc_interrupt_flag_get(uint32_t flag);
Function description	Get ERTC interrupt flag bit status, and check corresponding interrupt enable bit
Input parameter 1	flag: flag selection Refer to the "flag" below for details.
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

**flag**

This bit is used to select a flag. Optional parameters are as follows:

ERTC_ALAF_FLAG:	Alarm A flag
ERTC_ALBF_FLAG:	Alarm B flag
ERTC_WATF_FLAG:	Wakeup timer flag
ERTC_TSF_FLAG:	Time stamp flag
ERTC_TSOF_FLAG:	Time stamp overflow flag
ERTC_TP1F_FLAG:	Tamper detection 1 flag
ERTC_TP2F_FLAG:	Tamper detection 2 flag

**Example:**

```
ertc_interrupt_flag_get(ERTC_TP1F_FLAG);
```

## 5.8.53 ertc\_flag\_clear function

The table below describes the function ertc\_flag\_clear.

**Table 272. ertc\_flag\_clear function**

Name	Description
Function name	ertc_flag_clear
Function prototype	void ertc_flag_clear(uint32_t flag);
Function description	Clear flag
Input parameter 1	flag: the selected flag Refer to the following "flag" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### flag

This bit is used to select a flag. Optional parameters are as follows:

ERTC_ALAWF_FLAG:	Alarm A write enable flag
ERTC_ALBWF_FLAG:	Alarm B write enable flag
ERTC_WATWF_FLAG:	Wakeup timer register write enable flag
ERTC_TADJF_FLAG:	Time adjust flag
ERTC_INITF_FLAG:	Calendar initialization flag
ERTC_UPDF_FLAG:	Calendar update flag
ERTC_IMF_FLAG:	Initialization mode entry flag
ERTC_ALAF_FLAG:	Alarm A flag
ERTC_ALBF_FLAG:	Alarm B flag
ERTC_WATF_FLAG:	Wakeup timer flag
ERTC_TSOF_FLAG:	Time stamp flag
ERTC_TSOF_FLAG:	Time stamp overflow flag
ERTC_TP1F_FLAG:	Tamper detection 1 flag
ERTC_TP2F_FLAG:	Tamper detection 2 flag
ERTC_CALUPDF_FLAG:	Calibration value update complete flag

### Example:

```
ertc_flag_clear(ERTC_TP1F_FLAG);
```

## 5.8.54 ertc\_bpr\_data\_write function

The table below describes the function ertc\_bpr\_data\_write.

**Table 273. ertc\_bpr\_data\_write function**

Name	Description
Function name	ertc_bpr_data_write
Function prototype	void ertc_bpr_data_write(ertc_dt_type dt, uint32_t data);
Function description	Write data to BPR register (battery powered data register)
Input parameter 1	dt: data register Refer to the following "dt" descriptions for details.
Input parameter 1	data: 32-bit data

Name	Description
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**dt**

Data register

ERTC\_DT1: Data register 1

ERTC\_DT2: Data register 2

ERTC\_DT19: Data register 19

ERTC\_DT20: Data register 20

**Example:**

```
ertc_bpr_data_write(ERTC_DT1, 0x12345678);
```

### 5.8.55 ertc\_bpr\_data\_read function

The table below describes the function ertc\_bpr\_data\_read.

**Table 274. ertc\_bpr\_data\_read function**

Name	Description
Function name	ertc_bpr_data_read
Function prototype	uint32_t ertc_bpr_data_read(ertc_dt_type dt);
Function description	Read data from BPR register (battery powered data register)
Input parameter 1	dt: data register Refer to the following “dt” descriptions for details.
Output parameter	NA
Return value	Data from BPR register
Required preconditions	NA
Called functions	NA

**dt**

Data register

ERTC\_DT1: Data register 1

ERTC\_DT2: Data register 2

...

ERTC\_DT19: Data register19

ERTC\_DT20: Data register 20

**Example:**

```
ertc_bpr_data_read(ERTC_DT1);
```

## 5.9 External interrupt/event controller (EXINT)

The EXINT register structure exint\_type is defined in the “AT32M412\_416\_exint.h”:

```
/*
 * @brief type define exint register all
 */
typedef struct
{
    ...
} exint_type;
```

The table below gives a list of the EXINT registers:

**Table 275. Summary of EXINT registers**

Register	Description
inten	Interrupt enable register
evten	Event enable register
polcfg1	Polarity configuration register 1
polcfg2	Polarity configuration register 2
swtrg	Software trigger register
intsts	Interrupt status register

The table below gives a list of EXINT library functions.

**Table 276. Summary of EXINT library functions**

Function name	Description
exint_reset	Reset all EXINT registers to their reset values
exint_default_para_init	Configure the EXINT initial structure with the initial value
exint_init	Initialize EXINT
exint_flag_clear	Clear the selected EXINT interrupt flag
exint_flag_get	Read the selected EXINT flag
exint_interrupt_flag_get	Get the selected EXINT interrupt flag status
exint_software_interrupt_event_generate	Software interrupt event generation
exint_interrupt_enable	Enable the selected EXINT interrupt
exint_event_enable	Enable the selected EXINT event

## 5.9.1 exint\_reset function

The table below describes the function exint\_reset.

**Table 277. exint\_reset function**

Name	Description
Function name	exint_reset
Function prototype	void exint_reset(void);
Function description	Reset all EXINT registers to their reset values.
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset();

**Example:**

```
exint_reset();
```

## 5.9.2 exint\_default\_para\_init function

The table below describes the function exint\_default\_para\_init.

**Table 278. exint\_default\_para\_init function**

Name	Description
Function name	exint_default_para_init
Function prototype	void exint_default_para_init(exint_init_type *exint_struct);
Function description	Configure the EXINT initial structure with the initiali value
Input parameter 1	exint_struct: <a href="#">exint_init_type</a> pointer
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of exint_init_type before starting.
Called functions	NA

**Example:**

```
exint_init_type exint_init_struct;  
exint_default_para_init(&exint_init_struct);
```

### 5.9.3 exint\_init function

The table below describes the function exint\_init.

**Table 279. exint\_init function**

Name	Description
Function name	exint_init
Function prototype	void exint_init(exint_init_type *exint_struct);
Function description	Initialize EXINT
Input parameter 1	<a href="#">exint_init_type</a> : exint_init_struct pointer
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of exint_init_type before starting.
Called functions	NA

The exint\_init\_type is defined in the “AT32M412\_416\_exint.h”:

typedef struct

```
{
    exint_line_mode_type          line_mode;
    uint32_t                      line_select;
    exint_polarity_config_type   line_polarity;
    confirm_state                 line_enable;
} exint_init_type;
```

#### line\_mode

Select event mode or interrupt mode

EXINT\_LINE\_INTERRUPT: Interrupt mode

EXINT\_LINE\_EVENT: Event mode

#### line\_select

Line selection

EXINT\_LINE\_NONE: No e

EXINT\_LINE\_0: line0

EXINT\_LINE\_1: line1

...

EXINT\_LINE\_18: line18

EXINT\_LINE\_20: line20

EXINT\_LINE\_21: line21

EXINT\_LINE\_22: line22

#### line\_polarity

Trigger edge selection

EXINT\_TRIGGER\_RISING\_EDGE: Rising edge

EXINT\_TRIGGER\_FALLING\_EDGE: Falling edge

EXINT\_TRIGGER\_BOTH\_EDGE: Rising/Falling edge

#### line\_enable

Enable/disable line

FALSE: Disable line

TRUE: Enable line

**Example:**

```
exint_init_type exint_init_struct;
exint_default_para_init(&exint_init_struct);
exint_init_struct.line_enable = TRUE;
exint_init_struct.line_mode = EXINT_LINE_INTERRUPT;
exint_init_struct.line_select = EXINT_LINE_0;
exint_init_struct.line_polarity = EXINT_TRIGGER_RISING_EDGE;
exint_init(&exint_init_struct);
```

## 5.9.4 exint\_flag\_clear function

The table below describes the function exint\_flag\_clear.

**Table 280. exint\_flag\_clear function**

Name	Description
Function name	exint_flag_clear
Function prototype	void exint_flag_clear(uint32_t exint_line);
Function description	Clear the selected EXINT interrupt flag
Input parameter	exint_line: line selection Refer to the <a href="#">line_select</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
exint_flag_clear(EXINT_LINE_0);
```

## 5.9.5 exint\_flag\_get function

The table below describes the function exint\_flag\_get.

**Table 281. exint\_flag\_get function**

Name	Description
Function name	exint_flag_get
Function prototype	flag_status exint_flag_get(uint32_t exint_line);
Function description	Get the selected EXINT interrupt flag
Input parameter	exint_line: line selection Refer to <a href="#">line_select</a> for details.
Output parameter	NA
Return value	flag_status: indicates the status of the selected flag This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flag_status status = RESET;
status = exint_flag_get(EXINT_LINE_0);
```

## 5.9.6 exint\_interrupt\_flag\_get function

The table below describes the function exint\_interrupt\_flag\_get.

**Table 282. exint\_interrupt\_flag\_get function**

Name	Description
Function name	exint_interrupt_flag_get
Function prototype	flag_status exint_interrupt_flag_get(uint32_t extint_line)
Function description	Get EXINT interrupt flag status
Input parameter	extint_line: the selected extint line Refer to <a href="#">line_select</a> for details.
Output parameter	NA
Return value	flag_status: SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flag_status status = RESET;  
status = exint_interrupt_flag_get (EXINT_LINE_0);
```

## 5.9.7 exint\_software\_interrupt\_event\_generate function

The table below describes the function exint\_software\_interrupt\_event\_generate.

**Table 283. exint\_software\_interrupt\_event\_generate function**

Name	Description
Function name	exint_software_interrupt_event_generate
Function prototype	void exint_software_interrupt_event_generate(uint32_t extint_line);
Function description	Generate software interrupt event
Input parameter	extint_line: the selected extint line Refer to <a href="#">line_select</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
exint_software_interrupt_event_generate (EXINT_LINE_0);
```

## 5.9.8 exint\_interrupt\_enable function

The table below describes the function exint\_interrupt\_enable.

**Table 284. exint\_interrupt\_enable function**

Name	Description
Function name	exint_interrupt_enable
Function prototype	void exint_interrupt_enable(uint32_t exint_line, confirm_state new_state);
Function description	Enable the selected EXINT interrupt
Input parameter 1	exint_line: the selected exint line Refer to <a href="#">line_select</a> for details.
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
exint_interrupt_enable (EXINT_LINE_0);
```

## 5.9.9 exint\_event\_enable function

The table below describes the function exint\_event\_enable.

**Table 285. exint\_event\_enable function**

Name	Description
Function name	exint_event_enable
Function prototype	void exint_event_enable(uint32_t exint_line, confirm_state new_state);
Function description	Enable the selected EXINT event
Input parameter 1	exint_line: the selected exint_line Refer to <a href="#">line_select</a> for details.
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
exint_event_enable (EXINT_LINE_0);
```

## 5.10 Flash memory controller (FLASH)

The FLASH register structure flash\_type is defined in the “AT32M412\_416\_flash.h”:

```
/*
 * @brief type define flash register all
 */
typedef struct
{
    ...
} flash_type;
```

The table below gives a list of the FLASH registers

Table 286. Summary of FLASH registers

Register	Description
flash_psr	Flash performance select register
flash_unlock	Flash unlock register
flash_usd_unlock	Flash user system data unlock register
flash_sts	Flash status register
flash_ctrl	Flash control register
flash_addr	Flash address register
flash_usd	User system data register
flash_epps	Erase/program protection status register
slib_sts0	Flash security library status register 0
slib_sts1	Flash security library status register 1
slib_pwd_clr	Flash security library password clear register
slib_misc_sts	Flash security library extra status register
Flash_crc_addr	Flash CRC address register
flash_crc_ctrl	Flash CRC check control register
flash_crc_chkr	Flash CRC check result register
slib_set_pwd	Flash security library password setting register
slib_set_range	Flash security library address setting register
em_slib_set	Extended memory security library setting register
btm_mode_set	Boot memory mode setting register
slib_unlock	Flash security library unlock register

The table below gives a list of FLASH library functions.

**Table 287. Summary of FLASH library functions**

Function name	Description
flash_flag_get	Get flag status
flash_flag_clear	Clear flag
flash_operation_wait_for	Wait for operation complete (Flash memory bank 1)
flash_operation_status_get	Get Flash operation status
flash_operation_wait_for	Wait for Flash operation complete
flash_unlock	Unlock Flash (Flash memory bank 1 and 2)
flash_lock	Lock Flash (Flash memory bank 1 and 2)
flash_sector_erase	Erase Flash sector
flash_internal_all_erase	Erase internal Flash
flash_user_system_data_erase	Erase user system data
flash_word_program	Flash word programming
flash_halfword_program	Flash half-word programming
flash_byte_program	Flash byte programming
flash_user_system_data_program	User system data programming
flash_epp_set	Erase/programming protection configuration
flash_epp_status_get	Get erase/programming protection status
flash_fap_enable	Flash low level access protection enable
flash_fap_status_get	Get Flash low level access protection status
flash_fap_high_level_enable	Flash high level access protection enable
flash_fap_high_level_status_get	Get Flash high level access protection status
flash(ssb)_set	System configuration byte configuration
flash(ssb)_status_get	Get system configuration byte configuration status
flash_interrupt_enable	Flash interrupt configuration
flash_slib_enable	sLib enable
flash_slib_disable	sLib disable
flash_slib_state_get	Get sLib states
flash_slib_start_sector_get	Get sLib start sector
flash_slib_datastart_sector_get	Get sLib data area start sector
flash_slib_end_sector_get	Get sLib end sector
flash_crc_calibrate	Flash CRC verify
flash_boot_memory_extension_mode_enable	Boot memory is used as an extended Flash memory
flash_extension_memory_slib_enable	Extended Flash memory is used as a security library
flash_extension_memory_slib_state_get	Get the status of extended Flash memory which is used as a security library
flash_em_slib_inststart_sector_get	Get the start page of instruction area of security library in the extended memory

## 5.10.1 flash\_flag\_get function

The table below describes the function flash\_flag\_get.

**Table 288. flash\_flag\_get function**

Name	Description
Function name	flash_flag_get
Function prototype	flag_status flash_flag_get(uint32_t flash_flag);
Function description	Get flag status
Input parameter	flash_flag: the selected flag
Output parameter	NA
Return value	flag_status: indicates the flag status Return RESET or SET
Required preconditions	NA
Called functions	NA

### flash\_flag

Flag selection.

FLASH_OBF_FLAG:	Flash operation busy (bank 1)
FLASH_ODF_FLAG:	Flash operation complete (bank 1)
FLASH_PGMERR_FLAG:	Flash programming error (bank 1)
FLASH_EPPERR_FLAG:	Flash erase error (bank 1)
FLASH_USDERR_FLAG:	User system data area error

### Example:

```
flag_status status;  
status = flash_flag_get (FLASH_ODF_FLAG);
```

## 5.10.2 flash\_flag\_clear function

The table below describes the function flash\_flag\_clear.

**Table 289. flash\_flag\_clear function**

Name	Description
Function name	flash_flag_clear
Function prototype	void flash_flag_clear(uint32_t flash_flag);
Function description	Clear flag
Input parameter	flash_flag: the selected flag
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### flash\_flag

Flag selection

FLASH\_ODF\_FLAG: Flash operation complete

FLASH\_PRGMERR\_FLAG: Flash programming error

FLASH\_EPPERR\_FLAG: Flash erase error

### Example:

```
flash_flag_clear(FLASH_ODF_FLAG);
```

## 5.10.3 flash\_operation\_status\_get function

The table below describes the function flash\_operation\_status\_get.

**Table 290. flash\_operation\_status\_get function**

Name	Description
Function name	flash_operation_status_get
Function prototype	flash_status_type flash_operation_status_get(void);
Function description	Get operation status
Input parameter	NA
Output parameter	NA
Return value	Refer to the <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

### flash\_status\_type

FLASH\_OPERATE\_BUSY Operate busy

FLASH\_PROGRAM\_ERROR Programming error

FLASH\_EPP\_ERROR Erase/program protection error

FLASH\_OPERATE\_DONE Operation complete

### Example:

```
flash_status_type status = FLASH_OPERATE_DONE;
/* check for the flash status */
status = flash_operation_status_get();
```

## 5.10.4 flash\_operation\_wait\_for function

The table below describes the function `flash_operation_wait_for`.

**Table 291. `flash_operation_wait_for` function**

Name	Description
Function name	<code>flash_operation_wait_for</code>
Function prototype	<code>flash_status_type flash_operation_wait_for(uint32_t time_out);</code>
Function description	Wait for Flash operation
Input parameter	<code>time_out</code> : wait timeout The timeout value is defined in the <code>flash.h</code> file, refer to <a href="#"><code>flash_time_out</code></a> for details.
Output parameter	NA
Return value	Refer to <a href="#"><code>flash_status_type</code></a> for details.
Required preconditions	NA
Called functions	NA

**`flash_time_out`**

`OPERATION_TIMEOUT` General operation timeout

**Example:**

```
/* wait for operation to be completed */
status = flash_operation_wait_for(PROGRAMMING_TIMEOUT);
```

## 5.10.5 flash\_unlock function

The table below describes the function `flash_unlock`.

**Table 292. `flash_unlock` function**

Name	Description
Function name	<code>flash_unlock</code>
Function prototype	<code>void flash_unlock(void);</code>
Function description	Unlock Flash memory controller
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_unlock();
```

## 5.10.6 flash\_lock function

The table below describes the function flash\_lock.

**Table 293. flash\_lock function**

Name	Description
Function name	flash_lock
Function prototype	void flash_lock(void);
Function description	Lock Flash memory controller
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_lock();
```

## 5.10.7 flash\_sector\_erase function

The table below describes the function flash\_sector\_erase.

**Table 294. flash\_sector\_erase function**

Name	Description
Function name	flash_sector_erase
Function prototype	flash_status_type flash_sector_erase(uint32_t sector_address);
Function description	Erase data in the selected Flash sector address
Input parameter	sector_address: select the Flash sector address to be erased, usually Flash sector start address
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;  
flash_unlock();  
status = flash_sector_erase(0x08001000);
```

## 5.10.8 flash\_internal\_all\_erase function

The table below describes the function flash\_internal\_all\_erase.

**Table 295. flash\_internal\_all\_erase function**

Name	Description
Function name	flash_internal_all_erase
Function prototype	flash_status_type flash_internal_all_erase(void);
Function description	Erase internal Flash data
Input parameter	NA
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
flash_unlock();
status = flash_internal_all_erase();
```

## 5.10.9 flash\_user\_system\_data\_erase function

The table below describes the function flash\_user\_system\_data\_erase.

**Table 296. flash\_user\_system\_data\_erase function**

Name	Description
Function name	flash_user_system_data_erase
Function prototype	flash_status_type flash_user_system_data_erase(void);
Function description	Erase user system data
Input parameter	NA
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

*Note: As this function remains in FAP state, it only erases data except FAP in the user system data area.*

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
flash_unlock();
status = flash_user_system_data_erase();
```

## 5.10.10 flash\_word\_program function

The table below describes the function flash\_word\_program.

**Table 297. flash\_word\_program function**

Name	Description
Function name	flash_word_program
Function prototype	flash_status_type flash_word_program(uint32_t address, uint32_t data);
Function description	Write one word data to a given address
Input parameter 1	Address: programming address in word-aligned format
Input parameter 2	Data: programming data
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	The programming operation can be allowed only when data in the address are all 0xFF
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
uint32_t i;
flash_unlock();
status = flash_sector_erase(0x08001000);
if(status = FLASH_OPERATE_DONE)
{
    /* program 256 words */
    for(I = 0; I < 256; i++)
    {
        status = flash_word_program(0x08001000 + i*4, i);
    }
}
```

## 5.10.11 flash\_halfword\_program function

The table below describes the function flash\_halfword\_program.

**Table 298. flash\_halfword\_program function**

Name	Description
Function name	flash_halfword_program
Function prototype	flash_status_type flash_halfword_program(uint32_t address, uint16_t data);
Function description	Write a half-word data to a given address
Input parameter 1	Address: programming address in half-word-aligned format
Input parameter 2	Data: programming data
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	The programming operation can be allowed only when data in the address are all 0xFF
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
```

```

uint32_t i;
flash_unlock();
status = flash_sector_erase(0x08001000);
if(status == FLASH_OPERATE_DONE)
{
    /* program 256 halfwords */
    for(i = 0; i < 256; i++)
    {
        status = flash_halfword_program(0x08001000 + i*2, (uint16_t)i);
    }
}

```

### 5.10.12 **flash\_byte\_program** function

The table below describes the function `flash_byte_program`.

**Table 299. `flash_byte_program` function**

Name	Description
Function name	<code>flash_byte_program</code>
Function prototype	<code>flash_status_type flash_byte_program(uint32_t address, uint8_t data);</code>
Function description	Program a byte data to a given address
Input parameter 1	Address: programming address
Input parameter 2	Data: programming data
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	The programming operation can be allowed only when data in the address are all 0xFF
Called functions	NA

**Example:**

```

flash_status_type status = FLASH_OPERATE_DONE;
uint32_t i;
flash_unlock();
status = flash_sector_erase(0x08001000);
if(status == FLASH_OPERATE_DONE)
{
    /* program 256 bytes */
    for(i = 0; i < 256; i++)
    {
        status = flash_byte_program(0x08001000 + i*2, (uint8_t)i);
    }
}

```

### 5.10.13 flash\_user\_system\_data\_program function

The table below describes the function flash\_user\_system\_data\_program.

**Table 300. flash\_user\_system\_data\_program function**

Name	Description
Function name	flash_user_system_data_program
Function prototype	flash_status_type flash_user_system_data_program (uint32_t address, uint8_t data);
Function description	Program a byte data to a given address in the user system data area
Input parameter 1	Address: programming address
Input parameter 2	Data: programming data
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	The programming operation can be allowed only when data and its inverse data in the user system data area are all 0xFF
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
flash_unlock();
status = flash_user_system_data_erase();
if(status = FLASH_OPERATE_DONE)
{
    /* program user system data */
    status = flash_user_system_data_program(0x1FFFF804, 0x55);
}
```

### 5.10.14 flash\_epp\_set function

The table below describes the function flash\_epp\_set.

**Table 301. flash\_epp\_set function**

Name	Description
Function name	flash_epp_set
Function prototype	flash_status_type flash_epp_set(uint32_t *sector_bits);
Function description	Enable erase programming protection
Input parameter	*sector_bits: Erase programming protection sector address pointer. Each bit in bits 30~0 protects 4KB sectors, bit 31 protects 256KB of Flash memory from sector 62 to sector 63, as well as 128KB of Flash memory from sector 124 to sector 127, the extended Flash memory. Setting this bit to 1 enables sector protection.
Output parameter	NA
Return value	Return operation status. Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
uint32_t epp_val[1];
```

```

flash_unlock();
status = flash_user_system_data_erase();
if(status == FLASH_OPERATE_DONE)
{
    epp_val[0] = 0x00000001;
    /* program epp */
    status = flash_epp_set(epp_val);
}

```

## 5.10.15 flash\_epp\_status\_get function

The table below describes the function flash\_epp\_status\_get.

**Table 302. flash\_epp\_status\_get function**

Name	Description
Function name	flash_epp_status_get
Function prototype	void flash_epp_status_get(uint32_t *sector_bits);
Function description	Get the status of erase programming protection
Input parameter	NA
Output parameter	*sector_bits: Erase programming protection sector address pointer. Each bit in bits 30~0 protects 4KB sectors, bit 31 protects 256KB of Flash memory from sector 62 to sector 63, as well as 128KB of Flash memory from sector 124 to sector 127, the extended Flash memory. Setting this bit to 1 enables sector protection.
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```

uint32_t epp_val[1];
/* get epp status */
flash_epp_status_get(epp_val);

```

## 5.10.16 flash\_fap\_enable function

The table below describes the function flash\_fap\_enable.

**Table 303. flash\_fap\_enable function**

Name	Description
Function name	flash_fap_enable
Function prototype	flash_status_type flash_fap_enable(confirm_state new_state);
Function description	Enable Flash low level access protection
Input parameter	new_state: Flash access protection status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

*Note: This function will erase the whole user system data area. If there were data programmed in the user system data area before calling this function, they have to be re-programmed after calling this*

*function.*

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
flash_unlock();
status = flash_fap_enable(TRUE);
```

### 5.10.17 flash\_fap\_status\_get function

The table below describes the function flash\_fap\_status\_get.

**Table 304. flash\_fap\_status\_get function**

Name	Description
Function name	flash_fap_status_get
Function prototype	flag_status flash_fap_status_get(void);
Function description	Get the status of Flash low level access protection
Input parameter	NA
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flag_status status;
status = flash_fap_status_get();
```

### 5.10.18 flash\_fap\_high\_level\_enable

The table below describes the function flash\_fap\_high\_level\_enable.

**Table 305. flash\_fap\_high\_level\_enable function**

Name	Description
Function name	flash_fap_high_level_enable
Function prototype	flash_status_type flash_fap_high_level_enable (void);
Function description	Enable Flash high level access protection
Input parameter	NA
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;
flash_unlock();
status = flash_fap_high_level_enable (void);
```

## 5.10.19 flash\_fap\_high\_level\_status\_get

The table below describes the function `flash_fap_high_level_status_get`.

**Table 306. `flash_fap_high_level_status_get` function**

Name	Description
Function name	<code>flash_fap_high_level_status_get</code>
Function prototype	<code>flash_status_flash_fap_high_level_status_get (void);</code>
Function description	Get Flash high level access protection status
Input parameter	NA
Output parameter	NA
Return value	<code>flag_status</code> : flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flag_status status;
status = flash_fap_high_level_status_get();
```

## 5.10.20 flash(ssb) set function

The table below describes the function `flash(ssb) set`.

**Table 307. `flash(ssb) set` function**

Name	Description
Function name	<code>flash_ssbs_set</code>
Function prototype	<code>flash_status_type flash_ssbs_set(uint8_t usd_ssbs);</code>
Function description	Configure system setting bytes
Input parameter	<code>usd_ssbs</code> : system setting byte value is a combination of the selected data from all data group, refer to <a href="#">ssb_data_define</a> for details.
Output parameter	NA
Return value	Return operation status, refer to the <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

**ssb\_data\_define**

type 1:

`USD_WDT_ATO_DISABLE`: Watchdog auto-start disabled

`USD_WDT_ATO_ENABLE`: Watchdog auto-start enabled

type 2:

`USD_DEPSLP_NO_RST`: No reset occurred when entering Deepsleep mode

`USD_DEPSLP_RST`: Reset occurred when entering Deepsleep mode

type 3:

`USD_STDBY_NO_RST`: No reset occurred when entering Standby mode

`USD_STDBY_RST`: Reset occurred when entering Standby mode

type 4:

`USD_BOOT1_LOW` BOOT1 LOW

`USD_BOOT1_HIGH` BOOT1 HIGH

type 5:

USD\_DEPSLP\_WDT\_CONTINUE WDT continues counting in Deepsleep mode

USD\_DEPSLP\_WDT\_STOP WDT stops counting in Deepsleep mode

type 6:

USD\_STDBY\_WDT\_CONTINUE WDT continues counting in Standby mode

USD\_STDBY\_WDT\_STOP WDT stops counting in Standby mode

**Example:**

```
flash_status_type status = FLASH_OPERATE_DONE;  
flash_unlock();  
status = flash_user_system_data_erase();  
if(status == FLASH_OPERATE_DONE)  
{  
    status = flash(ssb_set(USD_WDT_ATO_DISABLE | USD_DEPSLP_NO_RST | USD_STDBY_RST |  
    USD_BOOT1_LOW);  
}
```

### 5.10.21 flash\_ssbb\_status\_get function

The table below describes the function flash\_ssbb\_status\_get.

**Table 308. flash\_ssbb\_status\_get function**

Name	Description
Function name	flash_ssbb_status_get
Function prototype	uint8_t flash_ssbb_status_get(void);
Function description	Get the status of system setting bytes
Input parameter	NA
Output parameter	NA
Return value	Return system setting byte value, refer to <a href="#">ssbb_data_define</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
uint8_t ssb_val;  
ssb_val = flash_ssbb_status_get();
```

## 5.10.22 flash\_interrupt\_enable function

The table below describes the function flash\_interrupt\_enable.

**Table 309. flash\_interrupt\_enable function**

Name	Description
Function name	flash_interrupt_enable
Function prototype	void flash_interrupt_enable(uint32_t flash_int, confirm_state new_state);
Function description	Enable Flash interrupts
Input parameter 1	flash_int: Flash interrupt type. Refer to <a href="#">flash_interrupt_type</a> for details.
Input parameter 2	new_state: interrupt status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### flash\_interrupt\_type

FLASH\_ERR\_INT: Flash error interrupt

FLASH\_ODF\_INT: Flash operation complete interrupt

#### Example:

```
flash_interrupt_enable(FLASH_ERR_INT | FLASH_ODF_INT, TRUE);
```

## 5.10.23 flash\_slib\_enable function

The table below describes the function flash\_slib\_enable.

**Table 310. flash\_slib\_enable function**

Name	Description
Function name	flash_slib_enable
Function prototype	flash_status_type flash_slib_enable(uint32_t pwd, uint16_t start_sector, uint16_t inst_start_sector, uint16_t end_sector);
Function description	Enable security library (sLib) and its address range
Input parameter 1	Pwd: sLib password. The sLib data are saved as ciphertext for encryption computing. A correct password is required to unlock encryption.
Input parameter 2	start_sector: sLib start sector number
Input parameter 3	inst_start_sector: sLib data area instruction start sector number
Input parameter 4	end_sector: sLib end sector number
Output parameter	NA
Return value	Refer to <a href="#">flash_status_type</a> for details.
Required preconditions	NA
Called functions	NA

#### Example:

```
flash_status_type status = FLASH_OPERATE_DONE;
status = flash_slib_enable(0x12345678, 0x04, 0x05, 0x06);
```

## 5.10.24 flash\_slib\_disable function

The table below describes the function flash\_slib\_disable.

**Table 311. flash\_slib\_disable function**

Name	Description
Function name	flash_slib_disable
Function prototype	error_status flash_slib_disable(uint32_t pwd);
Function description	Disable security library (sLib)
Input parameter	Pwd: sLib password. it must be entered correctly, otherwise it is not allowed to enter until after reset.
Output parameter	NA
Return value	Return error status This parameter can be ERROE or SUCCESS.
Required preconditions	NA
Called functions	NA

*Note: Successful calling of this function will erase the whole internal Flash memory.*

**Example:**

```
error_status status;
status = flash_slib_disable(0x12345678);
```

## 5.10.25 flash\_slib\_state\_get function

The table below describes the function flash\_slib\_state\_get.

**Table 312. flash\_slib\_state\_get function**

Name	Description
Function name	flash_slib_state_get
Function prototype	flag_status flash_slib_state_get(void);
Function description	Get the status of sLib
Input parameter	NA
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flag_status status;
status = flash_slib_state_get();
```

### 5.10.26 flash\_slib\_start\_sector\_get function

The table below describes the function flash\_slib\_start\_sector\_get.

**Table 313. flash\_slib\_start\_sector\_get function**

Name	Description
Function name	flash_slib_start_sector_get
Function prototype	uint16_t flash_slib_start_sector_get(void);
Function description	Get the start sector number of sLib
Input parameter	NA
Output parameter	NA
Return value	Return the start sector number of sLib
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t num;  
num = flash_slib_start_sector_get();
```

### 5.10.27 flash\_slib\_inststart\_sector\_get function

The table below describes the function flash\_slib\_inststart\_sector\_get.

**Table 314. flash\_slib\_inststart\_sector\_get function**

Name	Description
Function name	flash_slib_inststart_sector_get
Function prototype	uint16_t flash_slib_inststart_sector_get(void);
Function description	Get the start sector number of sLib instruction area
Input parameter	NA
Output parameter	NA
Return value	Return the start sector number of sLib instruction area
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t num;  
num = flash_slib_inststart_sector_get();
```

## 5.10.28 flash\_slib\_end\_sector\_get function

The table below describes the function flash\_slib\_end\_sector\_get.

**Table 315. flash\_slib\_end\_sector\_get function**

Name	Description
Function name	flash_slib_end_sector_get
Function prototype	uint16_t flash_slib_end_sector_get(void);
Function description	Get the end sector number of sLib
Input parameter	NA
Output parameter	NA
Return value	Return the end sector number of sLib
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t num;
num = flash_slib_end_sector_get();
```

## 5.10.29 flash\_crc\_calibrate function

The table below describes the function flash\_crc\_calibrate.

**Table 316. flash\_crc\_calibrate function**

Name	Description
Function name	flash_crc_calibrate
Function prototype	uint32_t flash_crc_calibrate(uint32_t start_sector, uint32_t sector_cnt);
Function description	Enable Flash CRC check
Input parameter 1	start_addr: CRC check start address
Input parameter 2	sector_cnt: CRC check sector count
Output parameter	NA
Return value	Return CRC calculation result
Required preconditions	NA
Called functions	NA

*Note: The sector set to go through CRC check is only allowed to be on a single area, rather than on both security library and common area.*

**Example:**

```
uint32_t crc_val;
crc_val = flash_crc_calibrate(0, 10);
```

### 5.10.30 flash\_boot\_memory\_extension\_mode\_enable

The table describes the flash\_boot\_memory\_extension\_mode\_enable

**Table 317. flash\_boot\_memory\_extension\_mode\_enable**

Name	Description
Function name	flash_boot_memory_extension_mode_enable
Function prototype	void flash_boot_memory_extension_mode_enable (void);
Function description	Boot memory is used as extended Flash memory
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_boot_memory_extension_mode_enable();
```

### 5.10.31 flash\_extension\_memory\_slib\_enable

The table describes the flash\_extension\_memory\_slib\_enable

**Table 318. flash\_extension\_memory\_slib\_enable**

Name	Description
Function name	flash_extension_memory_slib_enable
Function prototype	void flash_extension_memory_slib_enable (uint32_t pwd, uint16_t inst_start_sector);
Function description	Extended Flash memory is used as security library
Input parameter	Pwd: sLib password inst_start_sector: the start sector of security library instruction area when extended Flash memory is used as security library
Output parameter	NA
Return value	Operature status, see <a href="#">flash_status_type</a>
Required preconditions	NA
Called functions	NA

**Example:**

```
flash_extension_memory_slib_enable(0x12345678, 0x04);
```

### 5.10.32 flash\_extension\_memory\_slib\_state\_get

The table describes the flash\_extension\_memory\_slib\_state\_get

**Table 319. flash\_extension\_memory\_slib\_state\_get**

Name	Description
Function name	flash_extension_memory_slib_state_get
Function prototype	flag_status flash_extension_memory_slib_state_get (void);
Function description	Get the status of extended Flash memory which is used to store security library code
Input parameter	NA
Output parameter	NA
Return value	flag_status: flag status This value can be SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
flag_status status;
status = flash_extension_memory_slib_state_get();
```

### 5.10.33 flash\_em\_slib\_inststart\_sector\_get

The table describes the flash\_em\_slib\_inststart\_sector\_get

**Table 320. flash\_em\_slib\_inststart\_sector\_get**

Name	Description
Function name	flash_em_slib_inststart_sector_get
Function prototype	uint16_t flash_em_slib_inststart_sector_get (void);
Function description	Get the start sector of security library instruction area when an extended Flash memory is used as security library
Input parameter	NA
Output parameter	NA
Return value	Return the start sector of security library instruction area when the extended Flash memory is used as a security library
Required preconditions	NA
Called functions	NA

**Example:**

```
uint16_t num;
num = flash_em_slib_inststart_sector_get();
```

## 5.11 General-purpose I/Os and multiplexed I/Os (GPIO/IOMUX)

The GPIO register structure gpio\_type is defined in the “AT32M412\_416\_gpio.h”:

```
/*
 * @brief type define gpio register all
 */
typedef struct
{
} gpio_type;
```

Table 299 gives a list of the GPIO registers

**Table 321. Summary of GPIO registers**

Register	Description
cfg	GPIO configuration register
omode	GPIO output mode register
odrvr	GPIO drive capability switch control register
pull	GPIO pull-up/pull-down register
idt	GPIO input register
odt	GPIO output register
scr	GPIO set/clear register
wpr	GPIO write protection register
muxl	GPIO multiplexed function low register
muxh	GPIO multiplexed function high register
clr	GPIO port bit clear register
hdrv	GPIO huge current control register

The table below gives a list of GPIO and IOMUX library functions.

**Table 322. GPIO and IOMUX library functions**

Function name	Description
gpio_reset	GPIO is reset by CRM reset register
gpio_init	Initialize GPIO peripherals
gpio_default_para_init	Initialize GPIO default parameters
gpio_input_data_bit_read	Read GPIO input data bit
gpio_input_data_read	Read GPIO input data
gpio_output_data_bit_read	Read GPIO output data bit
gpio_output_data_read	Read GPIO output data
gpio_bits_set	Set GPIO bits
gpio_bits_reset	Reset GPIO bits
gpio_bits_toggle	Toggle GPIO bits
gpio_bits_write	Write GPIO bits
gpio_port_write	Write GPIO ports
gpio_pin_wp_config	Configure GPIO pin write protection
gpio_pins_huge_driven_config	Configure GPIO huge drive capability

gpio_pin_mux_config	Configure GPIO pin multiplexed function
---------------------	---

### 5.11.1 gpio\_reset function

The table below describes the function gpio\_reset.

**Table 323. gpio\_reset function**

Name	Description
Function name	gpio_reset
Function prototype	void gpio_reset(gpio_type *gpio_x);
Function description	GPIO is reset by CRM reset register
Input parameter	gpio_x: Select a GPIO peripheral. GPIOA, GPIOB, GPIOC, GPIOF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset();

**Example:**

```
gpio_reset(GPIOA);
```

### 5.11.2 gpio\_init function

The table below describes the function gpio\_init.

**Table 324. gpio\_init function**

Name	Description
Function name	gpio_init
Function prototype	void gpio_init(gpio_type *gpio_x, gpio_init_type *gpio_init_struct);
Function description	Initialize GPIO peripherals
Input parameter 1	gpio_x: the selected GPIO peripheral GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	gpio_init_struct: gpio_init_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**gpio\_init\_type structure**

The gpio\_init\_type is defined in the AT32M412\_416\_gpio.h:

```
typedef struct
{
    uint32_t          gpio_pins;
    gpio_output_type gpio_out_type;
    gpio_pull_type   gpio_pull;
    gpio_mode_type   gpio_mode;
    gpio_drive_type  gpio_drive_strength;
} gpio_init_type;

gpio_pins
Select a GPIO pin.
```

GPIO_PINS_0:	GPIO pin 0
GPIO_PINS_1:	GPIO pin 1
GPIO_PINS_2:	GPIO pin 2
GPIO_PINS_3:	GPIO pin 3
GPIO_PINS_4:	GPIO pin 4
GPIO_PINS_5:	GPIO pin 5
GPIO_PINS_6:	GPIO pin 6
GPIO_PINS_7:	GPIO pin 7
GPIO_PINS_8:	GPIO pin 8
GPIO_PINS_9:	GPIO pin 9
GPIO_PINS_10:	GPIO pin 10
GPIO_PINS_11:	GPIO pin 11
GPIO_PINS_12:	GPIO pin 12
GPIO_PINS_13:	GPIO pin 13
GPIO_PINS_14:	GPIO pin 14
GPIO_PINS_15:	GPIO pin 15

**gpio\_out\_type**

Set GPIO output type.

GPIO_OUTPUT_PUSH_PULL:	GPIO push-pull
GPIO_OUTPUT_OPEN_DRAIN:	GPIO open drain

**gpio\_pull**

Set GPIO pull-up or pull-down.

GPIO_PULL_NONE:	No GPIO pull-up/pull-down
GPIO_PULL_UP:	GPIO pull-up
GPIO_PULL_DOWN:	GPIO pull-down

**gpio\_mode**

Set GPIO mode

GPIO_MODE_INPUT:	GPIO input mode
GPIO_MODE_OUTPUT:	GPIO output mode
GPIO_MODE_MUX:	GPIO multiplexed mode
GPIO_MODE_ANALOG:	GPIO analog mode

**gpio\_drive\_strength**

Set GPIO driver capability.

GPIO_DRIVE_STRENGTH_STRONGER:	Strong drive strength
GPIO_DRIVE_STRENGTH_MODERATE:	Moderate drive strength

**Example:**

```
gpio_init_type gpio_init_struct;
gpio_init_struct gpio_pins = GPIO_PINS_0;
gpio_init_struct gpio_mode = GPIO_MODE_MUX;
gpio_init_struct gpio_out_type = GPIO_OUTPUT_PUSH_PULL;
gpio_init_struct gpio_pull = GPIO_PULL_NONE;
gpio_init_struct gpio_drive_strength = GPIO_DRIVE_STRENGTH_STRONGER;
gpio_init(GPIOA, &gpio_init_struct);
```

### 5.11.3 gpio\_default\_para\_init function

The table below describes the function gpio\_default\_para\_init.

**Table 325. gpio\_default\_para\_init function**

Name	Description
Function name	gpio_default_para_init
Function prototype	void gpio_default_para_init(gpio_init_type *gpio_init_struct);
Function description	Initialize GPIO default parameters
Input parameter	gpio_init_struct: gpio_init_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of members of the gpio\_init\_struct.

**Table 326. gpio\_init\_struct default values**

Member	Default value
gpio_pins	GPIO_PINS_ALL
gpio_mode	GPIO_MODE_INPUT
gpio_out_type	GPIO_OUTPUT_PUSH_PULL
gpio_pull	GPIO_PULL_NONE
gpio_drive_strength	GPIO_DRIVE_STRENGTH_STRONGER

**Example:**

```
gpio_init_type gpio_init_struct;
gpio_default_para_init(&gpio_init_struct);
```

### 5.11.4 gpio\_input\_data\_bit\_read function

The table below describes the function gpio\_input\_data\_bit\_read.

**Table 327. gpio\_input\_data\_bit\_read function**

Name	Description
Function name	gpio_input_data_bit_read
Function prototype	flag_status gpio_input_data_bit_read(gpio_type *gpio_x, uint16_t pins);
Function description	Read GPIO input port pins
Input parameter 1	gpio_x: the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to <a href="#">gpio_pins</a> for details. for details.
Output parameter	NA
Return value	Return GPIO input pin status
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_input_data_bit_read(GPIOA, GPIO_PINS_0);
```

## 5.11.5 gpio\_input\_data\_read function

The table below describes the function gpio\_input\_data\_read.

**Table 328. gpio\_input\_data\_read function**

Name	Description
Function name	gpio_input_data_read
Function prototype	uint16_t gpio_input_data_read(gpio_type *gpio_x);
Function description	Read GPIO input ports
Input parameter	gpio_x: indicates the selected GPIO peripheral. This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Output parameter	NA
Return value	Return GPIO input port status
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_input_data_read(GPIOA);
```

## 5.11.6 gpio\_output\_data\_bit\_read function

The table below describes the function gpio\_output\_data\_bit\_read.

**Table 329. gpio\_output\_data\_bit\_read function**

Name	Description
Function name	gpio_output_data_bit_read
Function prototype	uint16_t gpio_output_data_bit_read(gpio_type *gpio_x);
Function description	Read GPIO output port pin
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to, refer to <a href="#">gpio_pins</a> for details.
Output parameter	NA
Return value	Return GPIO output pin status
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_output_data_bit_read(GPIOA, GPIO_PINS_0);
```

## 5.11.7 gpio\_output\_data\_read function

The table below describes the function gpio\_output\_data\_read.

**Table 330. gpio\_output\_data\_read function**

Name	Description
Function name	gpio_output_data_read
Function prototype	uint16_t gpio_output_data_read(gpio_type *gpio_x);
Function description	Read GPIO output port
Input parameter	gpio_x: the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Output parameter	NA
Return value	Read GPIO output port status
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_output_data_read(GPIOA);
```

## 5.11.8 gpio\_bits\_set function

The table below describes the function gpio\_bits\_set.

**Table 331. gpio\_bits\_set function**

Name	Description
Function name	gpio_bits_set
Function prototype	void gpio_bits_set(gpio_type *gpio_x, uint16_t pins);
Function description	Set GPIO pins
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to <a href="#">gpio_pins</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_bits_set(GPIOA, GPIO_PINS_0);
```

## 5.11.9 gpio\_bits\_reset function

The table below describes the function gpio\_bits\_reset.

**Table 332. gpio\_bits\_reset function**

Name	Description
Function name	gpio_bits_reset
Function prototype	void gpio_bits_reset(gpio_type *gpio_x, uint16_t pins);
Function description	Reset GPIO pins
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to <a href="#">gpio_pins</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_bits_reset(GPIOA, GPIO_PINS_0);
```

## 5.11.10 gpio\_bits\_write function

The table below describes the function gpio\_bits\_write.

**Table 333. gpio\_bits\_write function**

Name	Description
Function name	gpio_bits_toggle
Function prototype	void gpio_bits_toggle (gpio_type *gpio_x, uint16_t pins);
Function description	Write GPIO pins
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to <a href="#">gpio_pins</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_bits_toggle(GPIOA, GPIO_PINS_0);
```

### 5.11.11 gpio\_bits\_write function

The table below describes the function gpio\_bits\_write.

**Table 334. gpio\_bits\_write function**

Name	Description
Function name	gpio_bits_write
Function prototype	void gpio_bits_write(gpio_type *gpio_x, uint16_t pins, confirm_state bit_state);
Function description	Write GPIO pins
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to <a href="#">gpio_pins</a> for details.
Input parameter 3	bit_state: GPIO pin value to be written, it can be 1 (TRUE) or 0 (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_bits_write(GPIOA, GPIO_PINS_0, TRUE);
```

### 5.11.12 gpio\_port\_write function

The table below describes the function gpio\_port\_write.

**Table 335. gpio\_port\_write function**

Name	Description
Function name	gpio_port_write
Function prototype	void gpio_port_write(gpio_type *gpio_x, uint16_t port_value);
Function description	Write GPIO ports
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF,
Input parameter 2	port_value: indicates the port value to write This parameter can be 0x0000~0xFFFF.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_port_write(GPIOA, 0xFFFF);
```

### 5.11.13 gpio\_pin\_wp\_config function

The table below describes the function gpio\_pin\_wp\_config.

**Table 336. gpio\_pin\_wp\_config function**

Name	Description
Function name	gpio_pin_wp_config
Function prototype	void gpio_pin_wp_config(gpio_type *gpio_x, uint16_t pins);
Function description	Configure GPIO pin write protection
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: indicates the GPIO pins, refer to <a href="#">gpio_pins</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_pin_wp_config(GPIOA, GPIO_PINS_0);
```

### 5.11.14 gpio\_pins\_huge\_driven\_config function

The table below describes the function gpio\_pins\_huge\_driven\_config.

**Table 337. gpio\_pins\_huge\_driven\_config function**

Name	Description
Function name	gpio_pins_huge_driven_config
Function prototype	void gpio_pins_huge_driven_config(gpio_type *gpio_x, uint16_t pins, confirm_state new_state);
Function description	Configure huge drive capability of GPIO pins
Input parameter 1	gpio_x: indicates the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	Pins: refer to <a href="#">gpio_pins</a> for details.
Input parameter 3	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
gpio_pins_huge_driven_config(GPIOA, GPIO_PINS_0, TRUE);
```

## 5.11.15 gpio\_pin\_mux\_config function

The table below describes the function gpio\_pin\_mux\_config.

**Table 338. gpio\_pin\_mux\_config function**

Name	Description
Function name	gpio_pin_mux_config
Function prototype	void gpio_pin_mux_config(gpio_type *gpio_x, gpio_pins_source_type gpio_pin_source, gpio_mux_sel_type gpio_mux);
Function description	Configure GPIO pin multiplexed function
Input parameter 1	gpio_x: the selected GPIO peripheral This parameter can be GPIOA, GPIOB, GPIOC, GPIOF
Input parameter 2	gpio_pin_source: GPIO pin to be configured
Input parameter 3	gpio_mux: IOMUX index to be configured
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### gpio\_pin\_source

Set GPIO pins

GPIO_PINS_SOURCE0:	GPIO pin 0
GPIO_PINS_SOURCE1:	GPIO pin 1
GPIO_PINS_SOURCE2:	GPIO pin 2
GPIO_PINS_SOURCE3:	GPIO pin 3
GPIO_PINS_SOURCE4:	GPIO pin 4
GPIO_PINS_SOURCE5:	GPIO pin 5
GPIO_PINS_SOURCE6:	GPIO pin 6
GPIO_PINS_SOURCE7:	GPIO pin 7
GPIO_PINS_SOURCE8:	GPIO pin 8
GPIO_PINS_SOURCE9:	GPIO pin 9
GPIO_PINS_SOURCE10:	GPIO pin 10
GPIO_PINS_SOURCE11:	GPIO pin 11
GPIO_PINS_SOURCE12:	GPIO pin 12
GPIO_PINS_SOURCE13:	GPIO pin 13
GPIO_PINS_SOURCE14:	GPIO pin 14
GPIO_PINS_SOURCE15:	GPIO pin 15

### gpio\_mux

Select IOMUX index

GPIO_MUX_0
GPIO_MUX_1
GPIO_MUX_2
GPIO_MUX_3
GPIO_MUX_4
GPIO_MUX_5
GPIO_MUX_6
GPIO_MUX_7
GPIO_MUX_8

GPIO\_MUX\_9  
GPIO\_MUX\_10  
GPIO\_MUX\_11  
GPIO\_MUX\_12  
GPIO\_MUX\_13  
GPIO\_MUX\_14  
GPIO\_MUX\_15

**Example:**

```
gpio_pin_mux_config(GPIOA, GPIO_PINS_SOURCE0, GPIO_MUX_0);
```

## 5.12 I2C interfaces

The I2C register structure i2c\_type is defined in the “AT32M412\_416\_i2c.h”:

```
/*
 * @brief type define i2c register all
 */
typedef struct
{
    } i2c_type;
```

The table below gives a list of the I2C registers

**Table 339. Summary of I2C register**

Register	Description
ctrl1	I2C Control register 1
ctrl2	I2C Control register 2
oaddr1	I2C Own address register 1
oaddr2	I2C Own address register 2
clkctrl	Timing register
timeout	Timeout register
sts	Status register
clr	Status clear register
pec	PEC register
rxdt	Receive data register
txdt	Transmit data register

The table below gives a list of I2C library functions.

**Table 340. Summary of I2C library functions**

Function name	Description
i2c_reset	I2C peripheral reset
i2c_init	Set I2C bus speed
i2c_own_address1_set	Set I2C own address 1
i2c_own_address2_set	Set I2C own address 2
i2c_own_address2_enable	Enable I2C own address 2
i2c_smbus_enable	Enable Smbus mode
i2c_enable	Enable I2C
i2c_clock_stretch_enable	Enable clock stretching capability
i2c_ack_enable	Enable ACK response
i2c_addr10_mode_enable	Enable master transmit 10-bit address mode
i2c_transfer_addr_set	Set master transfer address (slave address)
i2c_transfer_addr_get	Get slave address from master
i2c_transfer_dir_set	Set master data transfer direction
i2c_transfer_dir_get	Slave gets data transfer direction
i2c_matched_addr_get	Slave gets address match value

i2c_auto_stop_enable	Enable auto transmission stop conditions
i2c_reload_enable	Enable transmitted data reload mode
i2c_cnt_set	Set number of data to send/receive
i2c_addr10_header_enable	Enable 10-bit address header read timing
i2c_general_call_enable	Enable general call (broadcast address enable)
i2c_smbus_alert_set	Set SMBus alert pin level
i2c_slave_data_ctrl_enable	Enable slave single-byte receive control
i2c_pec_calculate_enable	Enable PEC calculation
i2c_pec_transmit_enable	Enable PEC transmit
i2c_pec_value_get	Get current PEC value
i2c_timeout_set	Set clock level timeout detection
i2c_timeout_detct_set	Set clock level timeout detect mode
i2c_timeout_enable	Enable clock level timeout detect
i2c_ext_timeout_set	Set accumulated clock stretching timeout
i2c_ext_timeout_enable	Enable accumulated clock stretching timeout
i2c_interrupt_enable	I2C interrupt enable
i2c_interrupt_get	Get interrupt status
i2c_dma_enable	DMA transfer enable
i2c_transmit_set	Set master-initiated transfer
i2c_start_generate	Generate start conditions
i2c_stop_generate	Generate stop conditions
i2c_data_send	Send data
i2c_data_receive	Receive data
i2c_flag_get	Get flag
i2c_flag_clear	Clear flag

**Table 341. I2C application-layer library functions**

Function name	Description
i2c_config	I2C application initialization
i2c_lowlevel_init	I2C low-layer initialization
i2c_wait_end	I2C wait data transmit complete
i2c_wait_flag	I2C wait flag
i2c_master_transmit	I2C master transmits data (polling mode)
i2c_master_receive	I2C master receives data (polling mode)
i2c_slave_transmit	I2C slave transmits data (polling mode)
i2c_slave_receive	I2C slave receives data (polling mode)
i2c_master_transmit_int	I2C master transmits data (interrupt mode)
i2c_master_receive_int	I2C master receives data (interrupt mode)
i2c_slave_transmit_int	I2C slave transmits data (interrupt mode)
i2c_slave_receive_int	I2C slave receives data (interrupt mode)
i2c_master_transmit_dma	I2C master transmits data (DMA mode)
i2c_master_receive_dma	I2C master receives data (DMA mode)
i2c_slave_transmit_dma	I2C slave transmits data (DMA mode)
i2c_slave_receive_dma	I2C slave receives data (DMA mode)
i2c_smbus_master_transmit	SMBus master sends data (polling mode)

Function name	Description
i2c_smbus_master_receive	SMBus master receives data (polling mode)
i2c_smbus_slave_transmit	SMBus slave sends data (polling mode)
i2c_smbus_slave_receive	SMBus slave receives data (polling mode)
i2c_memory_write	I2C writes data to EEPROM (polling mode)
i2c_memory_write_int	I2C writes data to EEPROM (interrupt mode)
i2c_memory_write_dma	I2C writes data to EEPROM (DMA mode)
i2c_memory_read	I2C reads from EEPROM (polling mode)
i2c_memory_read_int	I2C reads from EEPROM (interrupt mode)
i2c_memory_read_dma	I2C reads from EEPROM (DMA mode)
i2c_evt_irq_handler	I2C event interrupt function
i2c_err_irq_handler	I2C error interrupt function
i2c_dma_tx_irq_handler	I2C DMA Tx interrupt function
i2c_dma_rx_irq_handler	I2C DMA Rx interrupt function

### 5.12.1 i2c\_reset function

The table below describes the function i2c\_reset.

Table 342. i2c\_reset function

Name	Description
Function name	i2c_reset
Function prototype	void i2c_reset(i2c_type *i2c_x);
Function description	Reset all I2C registers to their initial values through CRM (Clock and reset management)
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2, I2C3
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	void crm_periph_reset(crm_periph_reset_type value, confirm_state new_state)

**Example:**

```
i2c_reset(I2C1);
```

## 5.12.2 i2c\_init function

The table below describes the function i2c\_init.

**Table 343. i2c\_init function**

Name	Description
Function name	i2c_init
Function prototype	void i2c_init(i2c_type *i2c_x, uint8_t dfilters, uint32_t clk);
Function description	Set I2C bus speed and digital filter
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2, I2C3
Input parameter 2	Dfilters: digital filter, ranging from 0x00 to 0x0F When in use, it is recommended to program the digital filter with a maximum value to effectively filter disturbance
Input parameter 3	Clk: timing register (I2C_CLKCTRL) value used to control I2C communication speed. This value can be calculated through “Artery_I2C_Timing_Configuration” defined in the AN0091_AT32M412_416_I2C_Application_Note
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_init(I2C1, 0x0F, 0x80504C4E);
```

## 5.12.3 i2c\_own\_address1\_set function

The table below describes the function i2c\_own\_address1\_set.

**Table 344. i2c\_own\_address1\_set function**

Name	Description
Function name	i2c_own_address1_set
Function prototype	void i2c_own_address1_set(i2c_type *i2c_x, i2c_address_mode_type mode, uint16_t address);
Function description	Set own address 1
Input parameter 1	Mode: Own address 1 address mode Refer to the “mode” description below for details.
Input parameter 2	Address: own address 1
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**mode**

Own address 1 address mode

I2C\_ADDRESS\_MODE\_7BIT: 7-bit address

I2C\_ADDRESS\_MODE\_10BIT: 10-bit address

**Example:**

```
i2c_own_address1_set(I2C1, I2C_ADDRESS_MODE_7BIT, 0xA0);
```

## 5.12.4 i2c\_own\_address2\_set function

The table below describes the function i2c\_own\_address2\_set.

**Table 345. i2c\_own\_address2\_set function**

Name	Description
Function name	i2c_own_address2_set
Function prototype	void i2c_own_address2_set(i2c_type *i2c_x, uint8_t address, i2c_addr2_mask_type mask);
Function description	Set own address 2. The address 2 becomes active only after it is enabled. Note: only 7-bit address is supported, not 10-bit address mode
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Address: own address 2
Input parameter 3	Mask: own address 2 bit mask Refer to the following "mask" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### mask

Own address 2 bit mask.

I2C_ADDR2_NOMASK:	match address bit [7:1]
I2C_ADDR2_MASK01:	match address bit [7:2] only
I2C_ADDR2_MASK02:	match address bit [7:3] only
I2C_ADDR2_MASK03:	match address bit [7:4] only
I2C_ADDR2_MASK04:	match address bit [7:5] only
I2C_ADDR2_MASK05:	match address bit [7:6] only
I2C_ADDR2_MASK06:	match address bit [7] only
I2C_ADDR2_MASK07:	All non-I2C reserved addresses would respond

### Example:

```
i2c_own_address2_set(I2C1, 0xB0, I2C_ADDR2_NOMASK);
```

## 5.12.5 i2c\_own\_address2\_enable function

The table below describes the function i2c\_own\_address2\_enable.

**Table 346. i2c\_own\_address2\_enable function**

Name	Description
Function name	i2c_own_address2_enable
Function prototype	void i2c_own_address2_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable own address 2. The address becomes active only after it is enabled. Note that this function should be used in conjunction with the i2c_own_address2_set.
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: indicates address 2 status This parameter can be TRUE or FALSE.

Name	Description
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_own_address2_enable(I2C1, TRUE);
```

### 5.12.6 i2c\_smbus\_enable function

The table below describes the function i2c\_smbus\_enable.

**Table 347. i2c\_smbus\_enable function**

Name	Description
Function name	i2c_smbus_enable
Function prototype	void i2c_smbus_enable(i2c_type *i2c_x, i2c_smbus_mode_type mode, confirm_state new_state);
Function description	Enable SMBus mode. After power-on reset, the default mode is I2C mode.
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Mode: SMBus mode selection Refer to the following “mode” descriptions for details.
Input parameter 3	new_state: indicates SMBus mode status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**mode**

SMBus mode

I2C\_SMBUS\_MODE\_DEVICE: SMBus device

I2C\_SMBUS\_MODE\_HOST: SMBus host

**Example:**

```
i2c_smbus_enable(I2C1, I2C_SMBUS_MODE_DEVICE, TRUE);
```

## 5.12.7 i2c\_enable function

The table below describes the function i2c\_enable.

**Table 348. i2c\_enable function**

Name	Description
Function name	i2c_enable
Function prototype	void i2c_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable I2C peripheral
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: indicates I2C status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

i2c_enable(I2C1, TRUE);
-------------------------

## 5.12.8 i2c\_clock\_stretch\_enable function

The table below describes the function i2c\_clock\_stretch\_enable.

**Table 349. i2c\_clock\_stretch\_enable function**

Name	Description
Function name	i2c_clock_stretch_enable
Function prototype	void i2c_clock_stretch_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable clock stretching capability. This function is applicable to slave mode only. In most cases, enabling the clock stretching mode is recommended in order to prevent slave from having no sufficient time to receive or send data due to slow process speed, which causes a loss of data.  It should be noted that the host must be able to support clock stretching function before using this mode by slave. For example, some hosts based on IO analog are not equipped with the clock stretching capability.
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: clock stretching status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

i2c_clock_stretch_enable(I2C1, TRUE);
---------------------------------------

## 5.12.9 i2c\_ack\_enable function

The table below describes the function i2c\_ack\_enable.

**Table 350. i2c\_ack\_enable function**

Name	Description
Function name	i2c_ack_enable
Function prototype	void i2c_ack_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	<p>Enable ACK and NACK.</p> <p>This function is used to enable ACK or NACK of each byte in master and slave mode. For ACK information on I2C communication protocol, refer to I2C protocol or AT32 reference manual.</p>
Input parameter 1	<p>i2c_x: the selected I2C peripheral</p> <p>This parameter can be I2C1, I2C2</p>
Input parameter 2	<p>new_state: ACK response status</p> <p>This parameter can be TRUE or FALSE.</p>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_ack_enable(I2C1, TRUE);
```

## 5.12.10 i2c\_addr10\_mode\_enable function

The table below describes the function i2c\_addr10\_mode\_enable.

**Table 351. i2c\_addr10\_mode\_enable function**

Name	Description
Function name	i2c_addr10_mode_enable
Function prototype	void i2c_addr10_mode_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable master transmit 10-bit address mode
Input parameter 1	<p>i2c_x: the selected I2C peripheral</p> <p>This parameter can be I2C1, I2C2</p>
Input parameter 2	<p>new_state: 10-bit address mode enable state</p> <p>This parameter can be TRUE or FALSE.</p>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_addr10_mode_enable(I2C1, TRUE);
```

### 5.12.11 i2c\_transfer\_addr\_set function

The table below describes the function i2c\_transfer\_addr\_set.

**Table 352. i2c\_transfer\_addr\_set function**

Name	Description
Function name	i2c_transfer_addr_set
Function prototype	void i2c_transfer_addr_set(i2c_type *i2c_x, uint16_t address);
Function description	Set master transfer address (slave address)
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Address: slave address
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_transfer_addr_set(I2C1, 0xA0);
```

### 5.12.12 i2c\_transfer\_addr\_get function

The table below describes the function i2c\_transfer\_addr\_get.

**Table 353. i2c\_transfer\_addr\_get function**

Name	Description
Function name	i2c_transfer_addr_get
Function prototype	uint16_t i2c_transfer_addr_get(i2c_type *i2c_x);
Function description	Get slave address sent from master
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Output parameter	NA
Return value	uint16_t: slave address sent from master
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_transfer_addr_get(I2C1);
```

### 5.12.13 i2c\_transfer\_dir\_set function

The table below describes the function i2c\_transfer\_dir\_set.

**Table 354. i2c\_transfer\_dir\_set function**

Name	Description
Function name	i2c_transfer_dir_set
Function prototype	void i2c_transfer_dir_set(i2c_type *i2c_x, i2c_transfer_dir_type i2c_direction);
Function description	Set master data transfer direction
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Direction: data transfer direction Refer to the following "direction" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### direction

Data transfer direction

I2C\_DIR\_TRANSMIT: Master sends data

I2C\_DIR\_RECEIVE: Master receives data

#### Example:

```
i2c_transfer_dir_set(I2C1, I2C_DIR_TRANSMIT);
```

### 5.12.14 i2c\_transfer\_dir\_get function

The table below describes the function i2c\_transfer\_dir\_get.

**Table 355. i2c\_transfer\_dir\_get function**

Name	Description
Function name	i2c_transfer_dir_get
Function prototype	i2c_transfer_dir_type i2c_transfer_dir_get(i2c_type *i2c_x);
Function description	Get slave data transfer direction
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Output parameter	NA
Return value	i2c_transfer_dir_type: slave data transfer direction Refer to the following "i2c_transfer_dir_type" descriptions for details.
Required preconditions	NA
Called functions	NA

#### i2c\_transfer\_dir\_type

Data transfer direction.

I2C\_DIR\_TRANSMIT: master sends data, and slave receives data

I2C\_DIR\_RECEIVE: master receives data and slave sends data

#### Example:

```
i2c_transfer_dir_get(I2C1);
```

### 5.12.15 i2c\_matched\_addr\_get function

The table below describes the function i2c\_matched\_addr\_get.

**Table 356. i2c\_matched\_addr\_get function**

Name	Description
Function name	i2c_matched_addr_get
Function prototype	uint8_t i2c_matched_addr_get(i2c_type *i2c_x);
Function description	Get slave address match value
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Output parameter	NA
Return value	uint8_t: slave matched address
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_matched_addr_get(I2C1);
```

### 5.12.16 i2c\_auto\_stop\_enable function

The table below describes the function i2c\_auto\_stop\_enable.

**Table 357. i2c\_auto\_stop\_enable function**

Name	Description
Function name	i2c_auto_stop_enable
Function prototype	void i2c_auto_stop_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable auto transmit stop conditions
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: auto transmit stop condition enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_auto_stop_enable(I2C1, TRUE);
```

### 5.12.17 i2c\_reload\_enable function

The table below describes the function i2c\_reload\_enable.

**Table 358. i2c\_reload\_enable function**

Name	Description
Function name	i2c_reload_enable
Function prototype	void i2c_reload_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable transmitted data reload mode
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: reload mode enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_reload_enable(I2C1, TRUE);
```

### 5.12.18 i2c\_cnt\_set function

The table below describes the function i2c\_cnt\_set.

**Table 359. i2c\_cnt\_set function**

Name	Description
Function name	i2c_cnt_set
Function prototype	void i2c_cnt_set(i2c_type *i2c_x, uint8_t cnt);
Function description	Set the number of data to send or receive, ranging from 1 to 255
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Cnt: number of data to send/receive
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_cnt_set(I2C1, 200);
```

## 5.12.19 i2c\_addr10\_header\_enable function

The table below describes the function i2c\_addr10\_header\_enable.

**Table 360. i2c\_addr10\_header\_enable function**

Name	Description
Function name	i2c_addr10_header_enable
Function prototype	void i2c_addr10_header_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable 10-bit address header read timing
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: enable state of auto transmit stop conditions This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_addr10_header_enable(I2C1, TRUE);
```

## 5.12.20 i2c\_general\_call\_enable function

The table below describes the function i2c\_dma\_enable.

**Table 361. i2c\_general\_call\_enable function**

Name	Description
Function name	i2c_general_call_enable
Function prototype	void i2c_general_call_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable broadcast address. After enabled, broadcast address 0x00 is responded
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: Broadcast address enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_general_call_enable(I2C1, TRUE);
```

### 5.12.21 i2c\_smbus\_alert\_set function

The table below describes the function i2c\_smbus\_alert\_set.

**Table 362. i2c\_smbus\_alert\_set function**

Name	Description
Function name	i2c_smbus_alert_set
Function prototype	void i2c_smbus_alert_set(i2c_type *i2c_x, i2c_smbus_alert_set_type level);
Function description	Set SMBus alert pin level (high or low)
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	level: SMBus alert pin level Refer to the following "level" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**source**

SMBus alert pin level

I2C\_SMBUS\_ALERT\_LOW: SMBus alert pin output low

I2C\_SMBUS\_ALERT\_HIGH: SMBus alert pin output high

**Example:**

```
i2c_smbus_alert_set(I2C1, I2C_SMBUS_ALERT_LOW);
```

### 5.12.22 i2c\_slave\_data\_ctrl\_enable function

The table below describes the function i2c\_start\_generate.

**Table 363. i2c\_start\_generate function**

Name	Description
Function name	i2c_slave_data_ctrl_enable
Function prototype	void i2c_slave_data_ctrl_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable slave data receive control. This function is used to control ACK or NACK response to each received byte when in slave receive mode. It is usually used for SMBus.
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_data_ctrl_enable(I2C1, FALSE);
```

### 5.12.23 i2c\_pec\_calculate\_enable function

The table below describes the function i2c\_pec\_calculate\_enable

**Table 364. i2c\_pec\_calculate\_enable**

Name	Description
Function name	i2c_pec_calculate_enable
Function prototype	void i2c_pec_calculate_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable PEC calculation
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: PEC calculation state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_pec_calculate_enable(I2C1, TRUE);
```

### 5.12.24 i2c\_pec\_transmit\_enable function

The table below describes the function i2c\_pec\_transmit\_enable.

**Table 365. i2c\_pec\_transmit\_enable function**

Name	Description
Function name	i2c_pec_transmit_enable
Function prototype	void i2c_pec_transmit_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	PEC transmit enable (send/receive PEC)
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: PEC transmit enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_pec_transmit_enable(I2C1, TRUE);
```

### 5.12.25 i2c\_pec\_value\_get function

The table below describes the function i2c\_pec\_value\_get

Table 366. i2c\_pec\_value\_get function

Name	Description
Function name	i2c_pec_value_get
Function prototype	uint8_t i2c_pec_value_get(i2c_type *i2c_x);
Function description	Get current PEC value
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Output parameter	uint8_t: current PEC value
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
pec_value = i2c_pec_value_get(I2C1);
```

### 5.12.26 i2c\_timeout\_set function

The table below describes the function i2c\_timeout\_set.

Table 367. i2c\_timeout\_set function

Name	Description
Function name	i2c_timeout_set
Function prototype	void i2c_timeout_set(i2c_type *i2c_x, uint16_t timeout);
Function description	Set SCL line level timeout detect time
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Timeout: timeout value, ranging from 0x0000 to 0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_timeout_set(I2C1, 0xFFFF);
```

### 5.12.27 i2c\_timeout\_detcet\_set function

The table below describes the function i2c\_timeout\_detcet\_set.

**Table 368. i2c\_timeout\_detcet\_set function**

Name	Description
Function name	i2c_timeout_detcet_set
Function prototype	void i2c_timeout_detcet_set(i2c_type *i2c_x, i2c_timeout_detcet_type mode);
Function description	Set SCL line level timeout detect mode
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Mode: level detect mode Refer to the following "mode" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### mode

Level detection mode.

I2C\_TIMEOUT\_DETCET\_HIGH: High level timeout detect

I2C\_TIMEOUT\_DETCET\_LOW: Low level timeout detect

#### Example:

```
i2c_timeout_detcet_set(I2C1, I2C_TIMEOUT_DETCET_HIGH);
```

### 5.12.28 i2c\_timeout\_enable function

The table below describes the function i2c\_timeout\_enable.

**Table 369. i2c\_timeout\_enable function**

Name	Description
Function name	i2c_timeout_enable
Function prototype	void i2c_timeout_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable SCL line level timeout detect
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: level timeout detect enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### Example:

```
i2c_timeout_enable(I2C1, TRUE);
```

## 5.12.29 i2c\_ext\_timeout\_set function

The table below describes the function i2c\_ext\_timeout\_set.

**Table 370. i2c\_ext\_timeout\_set function**

Name	Description
Function name	i2c_ext_timeout_set
Function prototype	void i2c_ext_timeout_set(i2c_type *i2c_x, uint16_t timeout);
Function description	Set SCL line cumulative clock stretching timeout value, usually used in SMBus mode
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Timeout: range from 0x0000 to 0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_ext_timeout_set(I2C1, 0xFFFF);
```

## 5.12.30 i2c\_ext\_timeout\_enable function

The table below describes the function i2c\_ext\_timeout\_enable.

**Table 371. i2c\_ext\_timeout\_enable function**

Name	Description
Function name	i2c_ext_timeout_enable
Function prototype	void i2c_ext_timeout_enable(i2c_type *i2c_x, confirm_state new_state);
Function description	Enable SCL line cumulative clock stretching timeout
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	new_state: cumulative clock stretching timeout enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_ext_timeout_enable(I2C1, TRUE);
```

### 5.12.31 i2c\_interrupt\_enable function

The table below describes the function i2c\_interrupt\_enable.

Table 372. i2c\_interrupt\_enable function

Name	Description
Function name	i2c_interrupt_enable
Function prototype	void i2c_interrupt_enable(i2c_type *i2c_x, uint32_t source, confirm_state new_state);
Function description	I2C interrupt enable
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Source: interrupt sources Refer to the following "source" descriptions for details.
Input parameter 3	new_state: interrupt enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### source

Interrupt source.

I2C_TD_INT:	Data transmit interrupt
I2C_RD_INT:	Data receive interrupt
I2C_ADDR_INT:	Address match interrupt
I2C_ACKFIAL_INT:	Acknowledge failure interrupt
I2C_STOP_INT:	Stop condition generation complete interrupt
I2C_TDC_INT:	Data transfer complete interrupt
I2C_ERR_INT:	Error interrupt

#### Example:

```
i2c_interrupt_enable(I2C1, I2C_TD_INT, TRUE);
```

### 5.12.32 i2c\_interrupt\_get function

The table below describes the function i2c\_interrupt\_get.

**Table 373. i2c\_interrupt\_get function**

Name	Description
Function name	i2c_interrupt_get
Function prototype	flag_status i2c_interrupt_get(i2c_type *i2c_x, uint16_t source);
Function description	Get interrupt enable state
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Source: interrupt source Refer to the following "source" descriptions for details.
Output parameter	flag_status: flag status This parameter can be SET or RESET
Return value	NA
Required preconditions	NA
Called functions	NA

#### source

Interrupt source.

I2C_TD_INT:	Data transmit interrupt
I2C_RD_INT:	Data receive interrupt
I2C_ADDR_INT:	Address match interrupt
I2C_ACKFIAL_INT:	Acknowledge failure interrupt
I2C_STOP_INT:	Stop condition generation complete interrupt
I2C_TDC_INT:	Data transfer complete interrupt
I2C_ERR_INT:	Error interrupt

#### Example:

```
i2c_interrupt_get(I2C1, I2C_TD_INT, TRUE);
```

### 5.12.33 i2c\_dma\_enable function

The table below describes the function i2c\_dma\_enable.

**Table 374. i2c\_dma\_enable function**

Name	Description
Function name	i2c_dma_enable
Function prototype	void i2c_dma_enable(i2c_type *i2c_x, i2c_dma_request_type dma_req, confirm_state new_state);
Function description	DMA transfer enable
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	dma_req: DMA request Refer to the following "dma_req" descriptions for details.
Input parameter 3	new_state: DMA enable state This parameter can be TRUE or FALSE
Output parameter	NA
Return value	NA

Name	Description
Required preconditions	NA
Called functions	NA

**dma\_req**

I2C\_DMA\_REQUEST\_TX: DMA data transmit enable

I2C\_DMA\_REQUEST\_RX: DMA data receive enable

**Example:**

```
i2c_dma_enable(I2C1, I2C_DMA_REQUEST_TX, TRUE);
```

### 5.12.34 i2c\_transmit\_set function

The table below describes the function i2c\_transmit\_set.

**Table 375. i2c\_transmit\_set function**

Name	Description
Function name	i2c_transmit_set
Function prototype	void i2c_transmit_set(i2c_type *i2c_x, uint16_t address, uint8_t cnt, i2c_reload_stop_mode_type rld_stop, i2c_start_mode_type start);
Function description	Set master transmit. This function is used to start data transfer on bus.
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Address: slave address
Input parameter 3	Cnt: count of data to send/receive
Input parameter 4	rld_stop: reload mode and STOP condition generation mode Refer to the following "rld_stop" descriptions for details.
Input parameter 5	Start: set START condition generation mode Refer to the following "start" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**rld\_stop**

Reload mode and STOP condition generation mode.

I2C\_AUTO\_STOP\_MODE: Auto stop mode (automatically sends STOP condition)

I2C\_SOFT\_STOP\_MODE: Software stop mode (software sends STOP condition, usually RESTART condition)

I2C\_RELOAD\_MODE: Reload mode (when a single transfer &gt;255)

**start**

START condition generation mode.

I2C\_WITHOUT\_START: Start sending data, without START, used in reload mode

I2C\_GEN\_START\_READ: Start sending data, with START condition (for master receive data)

I2C\_GEN\_START\_WRITE: Start sending data with START condition (for master transmit data)

**Example:**

```
i2c_transmit_set(I2C1, I2C_AUTO_STOP_MODE, I2C_GEN_START_WRITE);
```

### 5.12.35 i2c\_start\_generate function

The table below describes the function i2c\_start\_generate.

**Table 376. i2c\_slave\_transmit function**

Name	Description
Function name	i2c_start_generate
Function prototype	void i2c_start_generate(i2c_type *i2c_X);
Function description	Generate a START condition (for master)
Input parameter 1	i2c_X: the selected I2C peripheral This parameter can be I2C1, I2C2.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_start_generate(I2C1);
```

### 5.12.36 i2c\_stop\_generate function

The table below describes the function i2c\_stop\_generate.

**Table 377. i2c\_stop\_generate function**

Name	Description
Function name	i2c_stop_generate
Function prototype	void i2c_stop_generate(i2c_type *i2c_X);
Function description	Generate a STOP condition
Input parameter 1	i2c_X: the selected I2C peripheral This parameter can be I2C1, I2C2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_stop_generate(I2C1);
```

### 5.12.37 i2c\_data\_send function

The table below describes the function i2c\_data\_send.

Table 378. i2c\_data\_send function

Name	Description
Function name	i2c_data_send
Function prototype	void i2c_data_send(i2c_type *i2c_x, uint8_t data);
Function description	Send data
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Data: data to be sent
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_data_send(I2C1, 0x55);
```

### 5.12.38 i2c\_data\_receive function

The table below describes the function i2c\_data\_receive

Table 379. i2c\_data\_receive function

Name	Description
Function name	i2c_data_receive
Function prototype	uint8_t i2c_data_receive(i2c_type *i2c_x);
Function description	Receive data
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Output parameter	uint8_t: data to be received
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
data_value = i2c_data_receive(I2C1);
```

### 5.12.39 i2c\_flag\_get function

The table below describes the function i2c\_flag\_get

**Table 380. i2c\_flag\_get function**

Name	Description
Function name	i2c_flag_get
Function prototype	flag_status i2c_flag_get(i2c_type *i2c_x, uint32_t flag);
Function description	Get flag status
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Flag: the selected flag Refer to the following "flag" descriptions for details.
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET
Required preconditions	NA
Called functions	NA

#### flag

This bit is used to select a flag to get its status. Optional parameters are below:

I2C_TDBE_FLAG:	Transmit data register empty flag
I2C_TDIS_FLAG:	Transmit interrupt status flag
I2C_RDBF_FLAG:	Receive data buffer full flag
I2C_ADDRF_FLAG:	Address match flag
I2C_ACKFAIL_FLAG:	Acknowledge failure flag
I2C_STOPF_FLAG:	STOP condition generation complete flag
I2C_TDC_FLAG:	Data transfer complete flag
I2C_TCRLD_FLAG:	Transfer complete to wait for loading data
I2C_BUSERR_FLAG:	Bus error flag
I2C_ARLOST_FLAG:	Arbitration lost flag
I2C_OUF_FLAG:	Overflow or underflow flag
I2C_PECERR_FLAG:	PEC receive error flag
I2C_TMOUT_FLAG:	SMBus timeout flag
I2C_ALERTF_FLAG:	SMBus alert flag
I2C_BUSYF_FLAG:	Bus busy flag
I2C_SDIR_FLAG:	Slave data transfer direction

#### Example:

```
i2c_flag_get(I2C1, I2C_TDIS_FLAG);
```

### 5.12.40 i2c\_interrupt\_flag\_get function

The table below describes the function i2c\_interrupt\_flag\_get.

Table 381. i2c\_interrupt\_flag\_get function

Name	Description
Function name	i2c_interrupt_flag_get
Function prototype	flag_status i2c_interrupt_flag_get(i2c_type *i2c_x, uint32_t flag);
Function description	Get I2C interrupt flag status, ancheck the corresponding interrupt enable bit
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Flag: the selected flag Refer to the “flag” below for details.
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

#### flag

This bit is used to select a flag, including:

- I2C\_TDBE\_FLAG: Transmit data register empty flag
- I2C\_TDIS\_FLAG: Transmit interrupt status flag
- I2C\_RDBF\_FLAG: Receive data buffer full flag
- I2C\_ADDRF\_FLAG: Address match flag
- I2C\_ACKFAIL\_FLAG: Acknowledge failure flag
- I2C\_STOPF\_FLAG: STOP condition generation complete flag
- I2C\_TDC\_FLAG: Data transfer complete flag
- I2C\_TCRLD\_FLAG: Transfer complete to wait for loading data
- I2C\_BUSERR\_FLAG: Bus error flag
- I2C\_ARLOST\_FLAG: Arbitration lost flag
- I2C\_OUF\_FLAG: Overflow or underflow flag
- I2C\_PECERR\_FLAG: PEC receive error flag
- I2C\_TMOUT\_FLAG: SMBus timeout flag
- I2C\_ALERTF\_FLAG: SMBus alert flag

#### Example:

```
i2c_interrupt_flag_get(I2C1, I2C_TDIS_FLAG);
```

### 5.12.41 i2c\_flag\_clear function

The table below describes the function i2c\_flag\_clear.

**Table 382. i2c\_flag\_clear function**

Name	Description
Function name	i2c_flag_clear
Function prototype	void i2c_flag_clear(i2c_type *i2c_x, uint32_t flag);
Function description	Clear flag
Input parameter 1	i2c_x: the selected I2C peripheral This parameter can be I2C1, I2C2
Input parameter 2	Flag: the selected flag Refer to the following "flag" descriptions for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### flag

This bit is used to select a flag, including:

- I2C\_ADDRF\_FLAG: Address match flag
- I2C\_ACKFAIL\_FLAG: Acknowledge failure flag
- I2C\_STOPF\_FLAG: STOP condition generation complete flag
- I2C\_BUSERR\_FLAG: Bus error flag
- I2C\_ARLOST\_FLAG: Arbitration lost flag
- I2C\_OUF\_FLAG: Overflow or underflow flag
- I2C\_PECERR\_FLAG: PEC receive error flag
- I2C\_TMOUT\_FLAG: SMBus timeout flag
- I2C\_ALERTF\_FLAG: SMBus alert flag

#### Example:

```
i2c_flag_clear(I2C1, I2C_ACKFAIL_FLAG);
```

## 5.12.42 i2c\_config function

The table below describes the function i2c\_config.

**Table 383. i2c\_config function**

Name	Description
Function name	i2c_config
Function prototype	void i2c_config(i2c_handle_type* hi2c);
Function description	I2C initialization function used to initialize I2C. Call the function i2c_lowlevel_init() to initialize I2C peripherals, GPIO, DMA, interrupts and others.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### i2c\_handle\_type\* hi2c

i2c\_handle\_type is defined in the i2c\_application.h.

typedef struct

```
{
    i2c_type          *i2cx;
    uint8_t            *pbuff;
    __IO uint16_t      psize;
    __IO uint16_t      pcount;
    __IO uint32_t      mode;
    __IO uint32_t      timeout;
    __IO uint32_t      status;
    __IO i2c_status_type error_code;
    dma_channel_type   *dma_tx_channel;
    dma_channel_type   *dma_rx_channel;
    dma_init_type      dma_init_struct;
}i2c_handle_type;
```

### i2cx

Select an I2C peripheral from I2C1, I2C2

### pbuff

An array of data to be sent or received.

### psize

This bit is used to count the size of bytes in a single transfer when the transfer size is over 255. It is used in internal state machine. Users don't care.

### pcount

The number of data to be sent or received.

### mode

I2C communication mode. It is used in internal state machine. Users don't care.

### timeout

Communications timeout

### status

Transfer status. It is used in internal state machine. Users don't care.

#### **error\_code**

This bit is used to enumerate error code in the i2c\_status\_type. When a communication error occurred, it logs the corresponding error code.

I2C_OK:	Communication OK
I2C_ERR_STEP_1:	Step 1 error
I2C_ERR_STEP_2:	Step 2 error
I2C_ERR_STEP_3:	Step 3 error
I2C_ERR_STEP_4:	Step 4 error
I2C_ERR_STEP_5:	Step 5 error
I2C_ERR_STEP_6:	Step 6 error
I2C_ERR_STEP_7:	Step 7 error
I2C_ERR_STEP_8:	Step 8 error
I2C_ERR_STEP_9:	Step 9 error
I2C_ERR_STEP_10:	Step 10 error
I2C_ERR_STEP_11:	Step 11 error
I2C_ERR_STEP_12:	Step 12 error
I2C_ERR_TCRLD:	Wait for TCRLD timeout
I2C_ERR_TDC:	Wait for TDC timeout
I2C_ERR_ADDR:	Address send error
I2C_ERR_STOP:	STOP condition send error
I2C_ERR_ACKFAIL:	Acknowledge error
I2C_ERR_TIMEOUT:	Timeout error
I2C_ERR_INTERRUPT:	Enter an interrupt when an error event occurred

#### **dma\_tx\_channel**

I2C transmit DMA channel

#### **dma\_rx\_channel**

I2C receive DMA channel

#### **dma\_init\_struct**

DMA initialization structure

#### **Example:**

```
i2c_handle_type hi2c;  
hi2c.i2cx = I2C1;  
i2c_config(&hi2c);
```

### 5.12.43 i2c\_lowlevel\_init function

The table below describes the function i2c\_lowlevel\_init.

**Table 384. i2c\_lowlevel\_init function**

Name	Description
Function name	i2c_lowlevel_init
Function prototype	void i2c_lowlevel_init(i2c_handle_type* hi2c);
Function description	I2C lower-level initialization callback function. It is called in the i2c_config to initialize I2C peripherals, GPIO, DMA, interrupts, etc. It requires users to implement I2C initialization inside the function.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
void i2c_lowlevel_init(i2c_handle_type* hi2c)
{
    if(hi2c->i2cx == I2C1)
    {
        Implement I2C1 initialization
    }
    else if(hi2c->i2cx == I2C2)
    {
        Implement I2C2 initialization
    }
}
```

### 5.12.44 i2c\_wait\_end function

The table below describes the function i2c\_wait\_end.

**Table 385. i2c\_wait\_end function**

Name	Description
Function name	i2c_wait_end
Function prototype	i2c_status_type i2c_wait_end(i2c_handle_type* hi2c, uint32_t timeout);
Function description	Wait for the end of communications. This function is used in DMA and interrupt transfer modes as they are non-blocking functions and can thus be used to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA

Name	Description
Called functions	NA

**Example:**

```

if (i2c_master_transmit_dma(&hi2c, 0xB0, tx_buf, 8, 0xFFFFFFFF) != I2C_OK)
{
    error_handler(i2c_status);
}

/* wait for the end of transfer*/
if(i2c_wait_end(&hi2c, 0xFFFFFFFF) != I2C_OK)
{
    error_handler(i2c_status);
}

```

## 5.12.45 i2c\_wait\_flag function

The table below describes the function i2c\_wait\_flag.

**Table 386. i2c\_wait\_flag function**

Name	Description
Function name	i2c_wait_flag
Function prototype	i2c_status_type i2c_wait_flag(i2c_handle_type* hi2c, uint32_t flag, uint32_t event_check, uint32_t timeout)
Function description	Wait for a flag to be set or reset Only BUSFY flag is “wait for a flag to reset”, and others are “wait for a flag to set”
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Flag: the selected flag Refer to the following “flag” descriptions for details.
Input parameter 3	event_check: check if the event has occurred or not while waiting for a flag Refer to the “event_check” descriptions below for details.
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

### flag

Select a flag to wait for.

- I2C\_TDBE\_FLAG: Transmit data register empty flag
- I2C\_TDIS\_FLAG: Transmit interrupt status flag
- I2C\_RDBF\_FLAG: Receive data buffer full flag
- I2C\_ADDRF\_FLAG: Address match flag
- I2C\_ACKFAIL\_FLAG: Acknowledge failure flag
- I2C\_STOPF\_FLAG: STOP condition generation complete flag
- I2C\_TDC\_FLAG: Data transfer complete flag
- I2C\_TCRLD\_FLAG: Transfer complete to wait for loading data

I2C_BUSERR_FLAG:	Bus error flag
I2C_ARLOST_FLAG:	Arbitration lost flag
I2C_OUF_FLAG:	Overflow or underflow flag
I2C_PECERR_FLAG:	PEC receive error flag
I2C_TMOUT_FLAG:	SMBus timeout flag
I2C_ALERTF_FLAG:	SMBus alert flag
I2C_BUSYF_FLAG:	Bus busy flag
I2C_SDIR_FLAG:	Slave data transfer direction

**event\_check**

Check if the event has occurred or not while waiting for a flag.

I2C\_EVENT\_CHECK\_NONE: None

I2C\_EVENT\_CHECK\_ACKFAIL: Check ACKFAIL event

I2C\_EVENT\_CHECK\_STOP: Check STOP event

**Example:**

```
i2c_wait_flag(&hi2c, I2C_BUSYF_FLAG, I2C_EVENT_CHECK_NONE, 0xFFFFFFFF);
```

## 5.12.46 i2c\_master\_transmit function

The table below describes the function i2c\_master\_transmit.

**Table 387. i2c\_master\_transmit function**

Name	Description
Function name	i2c_master_transmit
Function prototype	i2c_status_type i2c_master_transmit(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Master sends data (polling mode). This is a blocking function, and so I2C transfer ends after the function is executed
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address of to-be-sent data
Input parameter 4	Size: the size of data to be sent
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_master_transmit(&hi2c, 0xB0, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.47 i2c\_master\_receive function

The table below describes the function i2c\_master\_receive.

**Table 388. i2c\_master\_receivefunction**

Name	Description
Function name	i2c_master_receive
Function prototype	i2c_status_type i2c_master_receive(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Master receives data (polling mode). This function is a blocking type. After the execution is done, so does I2C transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address to receive data
Input parameter 4	Size: number of data to receive
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_master_receive(&hi2c, 0xB0, rx_buf, 8, 0xFFFFFFFF);
```

### 5.12.48 i2c\_slave\_transmit function

The table below describes the function i2c\_slave\_transmit.

**Table 389. i2c\_slave\_transmit function**

Name	Description
Function name	i2c_slave_transmit
Function prototype	i2c_status_type i2c_slave_transmit(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Slave sends data (polling mode). This function is a blocking type. In other words, after the function execution is done, so is I2C transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address of data to be sent
Input parameter 3	Size: number of data to be sent
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_transmit(&hi2c, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.49 i2c\_slave\_receive function

The table below describes the function i2c\_slave\_receive.

**Table 390. i2c\_slave\_receive function**

Name	Description
Function name	i2c_slave_receive
Function prototype	i2c_status_type i2c_slave_receive(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Slave receives data (polling mode). This function is a blocking type. In other words, after the function execution is done, so is I2C transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address to receive data
Input parameter 3	Size: number of data to be received
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_receive(&hi2c, rx_buf, 8, 0xFFFFFFFF);
```

## 5.12.50 i2c\_master\_transmit\_int function

The table below describes the function i2c\_master\_transmit\_int.

**Table 391. i2c\_master\_transmit\_int function**

Name	Description
Function name	i2c_master_transmit_int
Function prototype	i2c_status_type i2c_master_transmit_int(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Master sends data (interrupt mode). This function is a non-blocking type. In other words, after the function execution is done, I2C transfer has not completed yet. In this case, it is possible to call the i2c_wait_end() to wait for the completion of communication.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address of data to be sent
Input parameter 4	Size: number of data to be sent
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_master_transmit_int(&hi2c, 0xB0, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.51 i2c\_master\_receive\_int function

The table below describes the function i2c\_master\_receive\_int.

**Table 392. i2c\_master\_receive\_int function**

Name	Description
Function name	i2c_master_receive_int
Function prototype	i2c_status_type i2c_master_receive_int(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Master receives data (through interrupt mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address to receive data
Input parameter 4	Size: number of data to be received
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_master_receive_int(&hi2c, 0xB0, rx_buf, 8, 0xFFFFFFFF);
```

### 5.12.52 i2c\_slave\_transmit\_int function

The table below describes the function i2c\_master\_receive\_int.

**Table 393. i2c\_master\_receive\_int function**

Name	Description
Function name	i2c_slave_transmit_int
Function prototype	i2c_status_type i2c_slave_transmit_int(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Slave sends data (through interrupt mode). This function operates in non-blocking mode. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address of data to be sent
Input parameter 3	Size: number of data to be sent
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.

Name	Description
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_transmit_int(&hi2c, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.53 i2c\_slave\_receive\_int function

The table below describes the function i2c\_slave\_receive\_int

**Table 394. i2c\_master\_receive\_int function**

Name	Description
Function name	i2c_slave_receive_int
Function prototype	i2c_status_type i2c_slave_receive_int(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Slave receives data (through interrupt mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address to receive data
Input parameter 3	Size: number of data to be received
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_receive_int(&hi2c, rx_buf, 8, 0xFFFFFFFF);
```

### 5.12.54 i2c\_master\_transmit\_dma function

The table below describes the function i2c\_master\_transmit\_dma.

Table 395. i2c\_master\_transmit\_dma function

Name	Description
Function name	i2c_master_transmit_dma
Function prototype	i2c_status_type i2c_master_transmit_dma(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Master sends data (through DMA mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address of data to be sent
Input parameter 4	Size: number of data to send
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_master_transmit_dma(&hi2c, 0xB0, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.55 i2c\_master\_receive\_dma function

The table below describes the function i2c\_master\_receive\_dma.

**Table 396. i2c\_master\_receive\_dma function**

Name	Description
Function name	i2c_master_receive_dma
Function prototype	i2c_status_type i2c_master_receive_dma(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Master receives data (through DMA mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address to receive data
Input parameter 4	Size: number of data to be received
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_master_receive_dma(&hi2c, 0xB0, rx_buf, 8, 0xFFFFFFFF);
```

### 5.12.56 i2c\_slave\_transmit\_dma function

The table below describes the function i2c\_slave\_transmit\_dma.

**Table 397. i2c\_slave\_transmit\_dma function**

Name	Description
Function name	i2c_slave_transmit_dma
Function prototype	i2c_status_type i2c_slave_transmit_dma(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Slave sends data (through DMA mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address of data to be sent
Input parameter 3	Size: number of data to be sent
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.

Name	Description
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_transmit_dma(&hi2c, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.57 i2c\_slave\_receive\_dma function

The table below describes the function i2c\_slave\_transmit\_dma.

**Table 398. i2c\_slave\_transmit\_dma function**

Name	Description
Function name	i2c_slave_receive_dma
Function prototype	i2c_status_type i2c_slave_receive_dma(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Slave receives data (through DMA mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address to receive data
Input parameter 3	Size: number of data to be received
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_slave_receive_dma(&hi2c, rx_buf, 8, 0xFFFFFFFF);
```

### 5.12.58 i2c\_smbus\_master\_transmit function

The table below describes the function i2c\_smbus\_master\_transmit

**Table 399. i2c\_smbus\_master\_transmit function**

Name	Description
Function name	i2c_smbus_master_transmit
Function prototype	i2c_status_type i2c_smbus_master_transmit(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	SMBus master sends data (through polling mode). This function is a blocking type. In other words, after the function execution is done, so is data transfer. It is mainly used for PEC transmission and reception.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address of data to be sent
Input parameter 4	Size: number of data to be sent

Name	Description
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_smbus_master_transmit(&hi2c, 0xB0, tx_buf, 8, 0xFFFFFFFF);
```

### 5.12.59 i2c\_smbus\_master\_receive function

The table below describes the function i2c\_smbus\_master\_receive

**Table 400. i2c\_smbus\_master\_receive function**

Name	Description
Function name	i2c_smbus_master_receive
Function prototype	i2c_status_type i2c_smbus_master_receive(i2c_handle_type* hi2c, uint16_t address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	SMBus master receives data (through polling mode). This function is a blocking type. In other words, after the function execution is done, so is data transfer. It is mainly used for PEC transmission and reception.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Address: slave address
Input parameter 3	Pdata: array address to receive data
Input parameter 4	Size: number of data to be received
Input parameter 5	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_smbus_master_receive(&hi2c, 0xB0, rx_buf, 8, 0xFFFFFFFF);
```

## 5.12.60 i2c\_smbus\_slave\_transmit function

The table below describes the function i2c\_smbus\_slave\_transmit

**Table 401. i2c\_smbus\_slave\_transmit function**

Name	Description
Function name	i2c_smbus_slave_transmit
Function prototype	i2c_status_type i2c_smbus_slave_transmit(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	SMBus slave sends data (through polling mode). This function is a blocking type. In other words, after the function execution is done, so is data transfer. It is mainly used for PEC transmission and reception.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address of data to be sent
Input parameter 3	Size: number of data to be sent
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_smbus_slave_transmit(&hi2c, tx_buf, 8, 0xFFFFFFFF);
```

## 5.12.61 i2c\_smbus\_slave\_receive function

The table below describes the function i2c\_smbus\_slave\_receive

**Table 402. i2c\_smbus\_slave\_receive function**

Name	Description
Function name	i2c_smbus_slave_receive
Function prototype	i2c_status_type i2c_smbus_slave_receive(i2c_handle_type* hi2c, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	SMBus slave receives data (through polling mode). This function is a blocking type. In other words, after the function execution is done, so is data transfer. It is mainly used for PEC transmission and reception.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	Pdata: array address to receive data
Input parameter 3	Size: number of data to be received
Input parameter 4	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**Example:**

```
i2c_smbus_slave_receive(&hi2c, rx_buf, 8, 0xFFFFFFFF);
```

## 5.12.62 i2c\_memory\_write function

The table below describes the function i2c\_memory\_write

**Table 403. i2c\_memory\_write function**

Name	Description
Function name	i2c_memory_write
Function prototype	i2c_status_type i2c_memory_write(i2c_handle_type* hi2c, i2c_mem_address_width_type mem_address_width, uint16_t address, uint16_t mem_address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Write data to EEPROM (through polling mode). This function is a blocking type. In other words, after the function execution is done, so is I2C transfer.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	mem_address_width: EEPROM memory address width Refer to the "mem_address_width" below for details.
Input parameter 3	address: EEPROM address
Input parameter 4	mem_address: EEPROM data memory address
Input parameter 5	Pdata: array address of data to be sent
Input parameter 6	Size: number of data to be sent
Input parameter 7	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code

Name	Description
	Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**mem\_address\_width**

EEPROM memory address width

I2C\_MEM\_ADDR\_WIDIH\_8: 8-bit address width

I2C\_MEM\_ADDR\_WIDIH\_16: 16-bit address width

**Example:**`i2c_memory_write(&hi2c, 0xA0, 0x05, tx_buf, 8, 0xFFFFFFFF);`

### 5.12.63 i2c\_memory\_write\_int function

The table below describes the function i2c\_memory\_write\_int

**Table 404. i2c\_memory\_write\_int function**

Name	Description
Function name	i2c_memory_write_int
Function prototype	i2c_status_type i2c_memory_write_int(i2c_handle_type* hi2c, i2c_mem_address_width_type mem_address_width, uint16_t address, uint16_t mem_address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Write EEPROM (through interrupt mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	mem_address_width: EEPROM memory address width Refer to the "mem_address_width" below for details.
Input parameter 3	address: EEPROM address
Input parameter 4	mem_address: EEPROM data memory address
Input parameter 5	pdata: array address of data to be sent
Input parameter 6	size: number of data to be sent
Input parameter 7	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

**mem\_address\_width**

EEPROM memory address width

I2C\_MEM\_ADDR\_WIDIH\_8: 8-bit address width

I2C\_MEM\_ADDR\_WIDIH\_16: 16-bit address width

**Example:**`i2c_memory_write_int(&hi2c, 0xA0, 0x05, tx_buf, 8, 0xFFFFFFFF);`

## 5.12.64 i2c\_memory\_write\_dma function

The table below describes the function i2c\_memory\_write\_dma

**Table 405. i2c\_memory\_write\_dma function**

Name	Description
Function name	i2c_memory_write_dma
Function prototype	i2c_status_type i2c_memory_write_dma(i2c_handle_type* hi2c, i2c_mem_address_width_type mem_address_width, uint16_t address, uint16_t mem_address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Write EEPROM (through DMA mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	mem_address_width: EEPROM memory address width Refer to the “mem_address_width” below for details.
Input parameter 3	address: EEPROM address
Input parameter 4	mem_address: EEPROM data memory address
Input parameter 5	pdata: array address of data to be sent
Input parameter 6	size: number of data to be sent
Input parameter 7	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

### mem\_address\_width

EEPROM memory address width

I2C\_MEM\_ADDR\_WIDIH\_8: 8-bit address width

I2C\_MEM\_ADDR\_WIDIH\_16: 16-bit address width

### Example:

```
i2c_memory_write_dma(&hi2c, 0xA0, 0x05, tx_buf, 8, 0xFFFFFFFF);
```

## 5.12.65 i2c\_memory\_read function

The table below describes the function i2c\_memory\_write\_dma

**Table 406. i2c\_memory\_write\_dma function**

Name	Description
Function name	i2c_memory_read
Function prototype	i2c_status_type i2c_memory_read(i2c_handle_type* hi2c, i2c_mem_address_width_type mem_address_width, uint16_t address, uint16_t mem_address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Read EEPROM (through DMA mode). This function is a blocking type. In other words, after the function execution is done, so is data transfer. It is mainly used for PEC transmission and reception.
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	mem_address_width: EEPROM memory address width Refer to the “mem_address_width” below for details.
Input parameter 3	address: EEPROM address
Input parameter 4	mem_address: EEPROM data memory address
Input parameter 5	pdata: array address of data to be read
Input parameter 6	size: number of data to be read
Input parameter 7	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

### mem\_address\_width

EEPROM memory address width

I2C\_MEM\_ADDR\_WIDIH\_8: 8-bit address width

I2C\_MEM\_ADDR\_WIDIH\_16: 16-bit address width

### Example:

```
i2c_memory_read(&hi2c, 0xA0, 0x05, rx_buf, 8, 0xFFFFFFFF);
```

## 5.12.66 i2c\_memory\_read\_int function

The table below describes the function i2c\_memory\_read\_int

**Table 407. i2c\_memory\_write\_dma function**

Name	Description
Function name	i2c_memory_read_int
Function prototype	i2c_status_type i2c_memory_read_int(i2c_handle_type* hi2c, i2c_mem_address_width_type mem_address_width, uint16_t address, uint16_t mem_address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Read EEPROM (through interrupt mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	mem_address_width: EEPROM memory address width Refer to the “mem_address_width” below for details.
Input parameter 3	address: EEPROM address
Input parameter 4	mem_address: EEPROM data memory address
Input parameter 5	pdata: array address of data to be read
Input parameter 6	size: number of data to be read
Input parameter 7	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

### mem\_address\_width

EEPROM memory address width

I2C\_MEM\_ADDR\_WIDIH\_8: 8-bit address width

I2C\_MEM\_ADDR\_WIDIH\_16: 16-bit address width

### Example:

```
i2c_memory_read_int(&hi2c, 0xA0, 0x05, rx_buf, 8, 0xFFFFFFFF);
```

## 5.12.67 i2c\_memory\_read\_dma function

The table below describes the function i2c\_memory\_read\_dma

**Table 408. i2c\_memory\_write\_dma function**

Name	Description
Function name	i2c_memory_read_dma
Function prototype	i2c_status_type i2c_memory_read_dma(i2c_handle_type* hi2c, i2c_mem_address_width_type mem_address_width, uint16_t address, uint16_t mem_address, uint8_t* pdata, uint16_t size, uint32_t timeout);
Function description	Read EEPROM (through DMA mode). This function is a non-blocking type. In other words, after the function is executed, the I2C transfer has not completed yet. So in this case, it is possible to call the i2c_wait_end() to wait for the end of transfer
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Input parameter 2	mem_address_width: EEPROM memory address width Refer to the "mem_address_width" below for details.
Input parameter 3	address: EEPROM address
Input parameter 4	mem_address: EEPROM data memory address
Input parameter 5	pdata: array address of data to be read
Input parameter 6	size: number of data to be read
Input parameter 7	Timeout: wait timeout
Output parameter	NA
Return value	i2c_status_type: error code Refer to <a href="#">error_code</a> for details.
Required preconditions	NA
Called functions	NA

### mem\_address\_width

EEPROM memory address width

I2C\_MEM\_ADDR\_WIDIH\_8: 8-bit address width

I2C\_MEM\_ADDR\_WIDIH\_16: 16-bit address width

### Example:

```
i2c_memory_read_dma(&hi2c, 0xA0, 0x05, rx_buf, 8, 0xFFFFFFFF);
```

## 5.12.68 i2c\_evt\_irq\_handler function

The table below describes the function i2c\_evt\_irq\_handler

**Table 409. i2c\_evt\_irq\_handler function**

Name	Description
Function name	i2c_evt_irq_handler
Function prototype	void i2c_evt_irq_handler(i2c_handle_type* hi2c);
Function description	Event interrupt function. It is used to handle I2C event interrupt
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
void I2C1_EVT_IRQHandler(void)
{
    i2c_evt_irq_handler(&hi2c);
}
```

## 5.12.69 i2c\_err\_irq\_handler function

The table below describes the function i2c\_err\_irq\_handler

**Table 410. i2c\_err\_irq\_handler function**

Name	Description
Function name	i2c_err_irq_handler
Function prototype	void i2c_err_irq_handler(i2c_handle_type* hi2c);
Function description	Error interrupt function. It is used to handle I2C error interrupt
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
void I2C1_ERR_IRQHandler(void)
{
    i2c_err_irq_handler(&hi2c);
}
```

## 5.12.70 i2c\_dma\_tx\_irq\_handler function

The table below describes the function i2c\_dma\_tx\_irq\_handler

**Table 411. i2c\_dma\_tx\_irq\_handler function**

Name	Description
Function name	i2c_dma_tx_irq_handler
Function prototype	void i2c_dma_tx_irq_handler(i2c_handle_type* hi2c);
Function description	DMA transmit interrupt function. It is used to handle DMA transmit interrupt
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
void DMA1_Channel6_IRQHandler(void)
{
    i2c_dma_rx_irq_handler(&hi2c);
}
```

## 5.12.71 i2c\_dma\_rx\_irq\_handler function

The table below describes the function i2c\_dma\_rx\_irq\_handler

**Table 412. i2c\_dma\_rx\_irq\_handler function**

Name	Description
Function name	i2c_dma_rx_irq_handler
Function prototype	void i2c_dma_rx_irq_handler(i2c_handle_type* hi2c);
Function description	DMA receive interrupt function. It is used to handle DMA receive interrupt
Input parameter 1	hi2c: i2c_handle_type pointer Refer to <a href="#">i2c_handle_type</a>
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
void DMA1_Channel7_IRQHandler(void)
{
    i2c_dma_tx_irq_handler(&hi2c);
}
```

## 5.13 Nested vectored interrupt controller (NVIC)

The NVIC register structure NVIC\_Type is defined in the “core\_cm4.h”:

```
/*
 * @brief Structure type to access the Nested Vectored Interrupt Controller (NVIC).
 */
typedef struct
{
    .....
} NVIC_Type;
```

The table below gives a list of the NVIC registers

**Table 413. Summary of PWC registers**

Register	Description
iser	Interrupt enable set register
icer	Interrupt enable clear register
ispr	Interrupt suspend set register
icpr	Interrupt suspend clear register
iabr	Interrupt activate bit register
ip	Interrupt priority register
stir	Software trigger interrupt register

The table below gives a list of NVIC library functions.

**Table 414. Summary of PWC library functions**

Function name	Description
nvic_system_reset	System software reset
nvic_irq_enable	NVIC interrupt enable and priority enable
nvic_irq_disable	NVIC interrupt disable
nvic_priority_group_config	NVIC interrupt priority grouping configuration
nvic_vector_table_set	NVIC interrupt vector table base address and offset address configuration
nvic_lowpower_mode_config	NVIC low-power mode configuration

### 5.13.1 nvic\_system\_reset function

The table below describes the function nvic\_system\_reset.

**Table 415. nvic\_system\_reset function**

Name	Description
Function name	nvic_system_reset
Function prototype	void nvic_system_reset(void)
Function description	System software reset
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NVIC_SystemReset()

**Example:**

```
/* system reset */
nvic_system_reset();
```

### 5.13.2 nvic\_irq\_enable function

The table below describes the function nvic\_irq\_enable.

**Table 416. nvic\_irq\_enable function**

Name	Description
Function name	nvic_irq_enable
Function prototype	void nvic_irq_enable(IRQn_Type irqn, uint32_t preempt_priority, uint32_t sub_priority)
Function description	NVIC interrupt enable and priority configuration
Input parameter 1	Irqn: interrupt vector selection Refer to the "irqn" descriptions below for details.
Input parameter 2	preempt_priority: set preemption priority This parameter cannot be greater than the highest preemption priority defined in the NVIC_PRIORITY_GROUP_x
Input parameter 3	sub_priority: set response priority This parameter cannot be greater than the highest response priority defined in the NVIC_PRIORITY_GROUP_x
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NVIC_SetPriority() NVIC_EnableIRQ()

#### irqn

irqn is used to select interrupt vectors, including:

WWDT IRQn:	Window timer interrupt
PVM IRQn:	PVM interrupt linked to EXINT
.....	
DMA1_Channel6 IRQn:	DMA1 channel 6 global interrupt
DMA1_Channel7 IRQn:	DMA1 channel 7 global interrupt

**Example:**

```
/* enable nvic irq */
nvic_irq_enable(ADC1_2_3 IRQn, 0, 0);
```

### 5.13.3 nvic\_irq\_disable function

The table below describes the function nvic\_irq\_disable.

**Table 417. nvic\_irq\_disable function**

Name	Description
Function name	nvic_irq_disable
Function prototype	void nvic_irq_disable(IRQn_Type irqn)
Function description	NVIC interrupt enable
Input parameter	Irqn: select interrupt vector. Refer to <a href="#">irqn</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NVIC_DisableIRQ()

**Example:**

```
/* disable nvic irq */
nvic_irq_disable(ADC1_2_3 IRQn);
```

### 5.13.4 nvic\_priority\_group\_config function

The table below describes the function nvic\_priority\_group\_config.

**Table 418. nvic\_priority\_group\_config function**

Name	Description
Function name	nvic_priority_group_config
Function prototype	void nvic_priority_group_config(nvic_priority_group_type priority_group)
Function description	NVIC interrupt priority grouping configuration
Input parameter	priority_group: select interrupt priority group This parameter can be any enumerated value in the nvic_priority_group_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NVIC_SetPriorityGrouping()

**priority\_group**

priority\_group is used to select priority group from the parameters below

NVIC\_PRIORITY\_GROUP\_0:

Priority group 0 (0 bit for preemption priority, and 4 bits for response priority)

NVIC\_PRIORITY\_GROUP\_1:

Priority group 1 (1 bit for preemption priority, and 3 bits for response priority)

NVIC\_PRIORITY\_GROUP\_2:

Priority group 2 (2 bits for preemption priority, and 2 bits for response priority)

NVIC\_PRIORITY\_GROUP\_3:

Priority group 3 (3 bits for preemption priority, and 1 bit for response priority)

NVIC\_PRIORITY\_GROUP\_4:

Priority group 4 (4 bits for preemption priority, and 0 bit for response priority)

**Example:**

```
/* config nvic priority group */  
nvic_priority_group_config(NVIC_PRIORITY_GROUP_4);
```

### 5.13.5 nvic\_vector\_table\_set function

The table below describes the function nvic\_vector\_table\_set.

**Table 419. nvic\_vector\_table\_set function**

Name	Description
Function name	nvic_vector_table_set
Function prototype	void nvic_vector_table_set(uint32_t base, uint32_t offset)
Function description	Set NVIC interrupt vector table base address and offset address
Input parameter 1	Base: base address of interrupt vector table The base address can be set in RAM or FLASH
Input parameter 2	Offset: offset address of interrupt vector table This parameter defines the start address of interrupt vector table, so it must be set to a multiple of 0x200.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**base**

base is used to select the base address of interrupt vector table, including:

NVIC\_VECTTAB\_RAM:      Interrupt vector table base address is located in RAM  
NVIC\_VECTTAB\_FLASH:     Interrupt vector table base address is located in FLASH

**Example:**

```
/* config vector table offset */  
nvic_vector_table_set(NVIC_VECTTAB_FLASH, 0x4000);
```

## 5.13.6 nvic\_lowpower\_mode\_config function

The table below describes the function nvic\_lowpower\_mode\_config.

Table 420. nvic\_lowpower\_mode\_config function

Name	Description
Function name	nvic_lowpower_mode_config
Function prototype	void nvic_lowpower_mode_config(nvic_lowpower_mode_type lp_mode, confirm_state new_state)
Function description	Configure NVIC low-power mode
Input parameter 1	lp_mode: select low-power modes This parameter can be any enumerated value in the nvic_lowpower_mode_type.
Input parameter 2	new_state: indicates the pre-configured status of battery powered domain This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### lp\_mode

lp\_mode is used to select low-power modes, including:

NVIC\_LP\_SEVONPEND:

Send wakeup event upon interrupt suspend (this option is usually used in conjunction with WFE)

NVIC\_LP\_SLEEPDEEP:

Deepsleep mode control bit (enable or disable core clock)

NVIC\_LP\_SLEEPONEXIT: Sleep mode entry when system leaves the lowest-priority interrupt

### Example:

```
/* enable sleep-on-exit feature */  
nvic_lowpower_mode_config(NVIC_LP_SLEEPONEXIT, TRUE);
```

## 5.14 Operational amplifier (OP)

The op register structure op\_type is defined in the “at32m412\_416\_op.h”:

```
typedef struct
```

```
{
```

```
.....
```

```
} op_type;
```

The table below gives a list of the OP registers

**Table 421. Summary of OP registers**

Register	Description
op1_ctrl	Operational amplifier 1 control register
op2_ctrl	Operational amplifier 2 control register
op3_ctrl	Operational amplifier 3 control register
op4_ctrl	Operational amplifier 4 control register
op1_tc	Operational amplifier 1 timer control register
op2_tc	Operational amplifier 2 timer control register
op3_tc	Operational amplifier 3 timer control register
op4_tc	Operational amplifier 4 timer control register

The table below gives a list of OP library functions.

**Table 422. Summary of OP library functions**

Function name	Description
op_enable	Enable operational amplifier
op_set_mode	Set operational amplifier mode
op_set_functional_mode	Set functional mode of operational amplifier
op_set_gain	Set operational amplifier gain
op_highspeed_mode_enable	Enable operational amplifier high-speed mode
op_set_input_non_inverting	Select operational amplifier non-inverting input
op_set_input_inverting	Select operational amplifier inverting input
op_input_non_inverting_switch	Set operational amplifier non-inverting input switch mode
op_input_inverting_switch	Set operational amplifier inverting input switch mode
op_input_mux_enable	Enable operational amplifier input switch
op_internal_output_select	Select operational amplifier output
op_set_trimming_mode	Set operational amplifier trimming mode
op_calibration_select	Select operational amplifier calibration
op_calout_status_get	Get operational amplifier calibration status
op_set_trimming_value	Set operational amplifier trimming value
op_write_protected_enable	Enable operational amplifier write protection

## 5.14.1 op\_enable function

The table below describes the function op\_enable.

**Table 423. op\_enable function**

Name	Description
Function name	op_enable
Function prototype	void op_enable(op_type *op_x, confirm_state new_state)
Function description	Enable OP
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	new_state: op pre-set state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* op1 enable */
op_enable (OP1, TRUE);
```

## 5.14.2 op\_set\_mode function

The table below describes the function op\_set\_mode.

**Table 424. op\_set\_mode function**

Name	Description
Function name	op_set_mode
Function prototype	void op_set_mode(op_type *op_x, op_mode_type mode)
Function description	Set OP functional mode
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	mode: op mode This parameter can be from OP_FUNCTIONAL_MODE: functional mode OP_CALIBRATION_MODE: calibration mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* op1 function mode enable*/
op_set_mode(OP1, OP_FUNCTIONAL_MODE);
```

### 5.14.3 op\_set\_functional\_mode function

The table below describes the function op\_set\_functional\_mode.

**Table 425. op\_set\_functional\_mode function**

Name	Description
Function name	op_set_functional_mode
Function prototype	void op_set_functional_mode(op_type *op_x, op_functional_mode_type functional_mode)
Function description	Select OP functional mode
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	functional_mode: op mode select
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### functional\_mode

op 模式选择

OP\_STANDALONE\_MODE: standalone mode

OP\_FOLLOWER\_MODE: follower mode

OP\_PGA\_MODE: programmable gain mode

OP\_PGA\_INM0\_MODE: programmable bias positive or negative gain mode

OP\_PGA\_INM0\_BIAS\_MODE: programmable gain mode with external filter

OP\_PGA\_INM0\_INM1\_BIAS\_MODE: bias positive or negative gain mode with filter

#### Example:

```
/* op1 follower mode*/
op_set_functional_mode(OP1, OP_FOLLOWER_MODE);
```

### 5.14.4 op\_set\_gain function

The table below describes the function op\_set\_gain.

**Table 426. op\_set\_gain function**

Name	Description
Function name	op_set_gain
Function prototype	void op_set_gain(op_type *op_x, op_gain_type gain)
Function description	Set OP gain mode
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	Gain: op gain select
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### gain

op gain select.

OP\_PGA\_GAIN\_2\_OR\_MINUS\_1: gain 2 or minus 1

OP\_PGA\_GAIN\_4\_OR\_MINUS\_3: gain 4 or minus 3  
 OP\_PGA\_GAIN\_8\_OR\_MINUS\_7: gain 8 or minus -7  
 OP\_PGA\_GAIN\_16\_OR\_MINUS\_15: gain 16 or minus -15  
 OP\_PGA\_GAIN\_32\_OR\_MINUS\_31: gain 32 or minus -31  
 OP\_PGA\_GAIN\_64\_OR\_MINUS\_63: gain 64 or minus -63

**Example:**

```
/* op1 pga set */
op_set_gain (OP1, OP_PGA_GAIN_2_OR_MINUS_1);
```

### 5.14.5 op\_set\_highspeed\_mode function

The table below describes the function op\_set\_highspeed\_mode.

**Table 427. op\_set\_highspeed\_mode function**

Name	Description
Function name	op_set_highspeed_mode
Function prototype	void op_set_highspeed_mode(op_type *op_x, confirm_state new_state)
Function description	Enable OP high-speed mode
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	new_state: op pre-set status This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* op1 highspeed enable */
op_set_highspeed_mode (OP1, TRUE);
```

### 5.14.6 op\_set\_input\_non\_inverting function

The table below describes the function op\_set\_input\_non\_inverting.

**Table 428. op\_set\_input\_non\_inverting function**

Name	Description
Function name	op_set_input_non_inverting
Function prototype	void op_set_input_non_inverting(op_type *op_x, op_non_inverting_input_type non_inverting_input)
Function description	Set OP non-inverting input
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	non_inverting_input: op non-inverting input
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**non\_inverting\_input**

op non-inverting input select.

OP\_NON\_INVERTING\_INPUT\_INP0: non-inverting inp0  
 OP\_NON\_INVERTING\_INPUT\_INP1: non-inverting inp1  
 OP\_NON\_INVERTING\_INPUT\_INP2: non-inverting inp2  
 OP\_NON\_INVERTING\_INPUT\_INP3: non-inverting inp3

**Example:**

```
/* op1 vinp select dac1 output */
op_set_input_non_inverting(OP1, OP_NON_INVERTING_INPUT_INP3);
```

### 5.14.7 op\_set\_input\_inverting function

The table below describes the function op\_set\_input\_inverting.

**Table 429. op\_set\_input\_inverting function**

Name	Description
Function name	op_set_input_inverting
Function prototype	void op_set_input_inverting(op_type *op_x, op_inverting_input_type inverting_input)
Function description	Set OP inverting input
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	inverting_input: op inverting input
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**inverting\_input**

op inverting input select.

OP\_INVERTING\_INPUT\_INM0: inverting input inm0

OP\_INVERTING\_INPUT\_INM1: inverting input inm1

OP\_INVERTING\_INPUT\_NONE: gain or follower mode

**Example:**

```
/* op1 vim select vm0*/
op_set_input_inverting(OP1, OP_INVERTING_INPUT_INM0);
```

### 5.14.8 op\_input\_non\_inverting\_switch function

The table below describes the function op\_input\_non\_inverting\_switch.

**Table 430. op\_input\_non\_inverting\_switch function**

Name	Description
Function name	op_input_non_inverting_switch
Function prototype	void op_input_non_inverting_switch(op_type *op_x, op_non_inverting_input_type non_inverting_input)
Function description	OP non-inverting input switch
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	non_inverting_input: op non-inverting input
Output parameter	NA
Return value	NA

Name	Description
Required preconditions	NA
Called functions	NA

**non\_inverting\_input**

op non-inverting input select.

OP\_NON\_INVERTING\_INPUT\_INP0: non-inverting inp0

OP\_NON\_INVERTING\_INPUT\_INP1: non-inverting inp1

OP\_NON\_INVERTING\_INPUT\_INP2: non-inverting inp2

OP\_NON\_INVERTING\_INPUT\_INP3: non-inverting inp3

**Example:**

```
/* op1 inp mux select inp1*/
op_input_non_inverting_switch (OP1, OP_NON_INVERTING_INPUT_INP1);
```

## 5.14.9 op\_input\_inverting\_switch function

The table below describes the function op\_input\_inverting\_switch.

**Table 431. op\_input\_inverting\_switch function**

Name	Description
Function name	op_input_inverting_switch
Function prototype	void op_input_inverting_switch(op_type *op_x, op_inverting_input_type inverting_input)
Function description	OP inverting input switch
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	non_inverting_input: op non-inverting input
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**inverting\_input**

op inverting input select.

OP\_INVERTING\_INPUT\_INM0: inverting input inm0

OP\_INVERTING\_INPUT\_INM1: inverting input inm1

OP\_INVERTING\_INPUT\_NONE: gain or follower mode

**Example:**

```
/* op1 vinn mux select vm1*/
op_input_inverting_switch (OP1, OP_INVERTING_INPUT_INM1);
```

## 5.14.10 op\_input\_mux\_enable function

The table below describes the function op\_input\_mux\_enable.

**Table 432. op\_input\_mux\_enable function**

Name	Description
Function name	op_input_mux_enable
Function prototype	void op_input_mux_enable(op_type *op_x, confirm_state new_state)
Function description	Enable OP input channel switch
Input parameter 1	op_x: op select

Name	Description
	This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	new_state: preset op state This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* op1 switch mode enable */
op_input_mux_enable (OP1, TRUE);
```

### 5.14.11 op\_internal\_output\_select function

The table below describes the function op\_internal\_output\_select.

**Table 433. op\_internal\_output\_select function**

Name	Description
Function name	op_internal_output_select
Function prototype	void op_internal_output_select(op_type *op_x, op_internal_output_type internal_output)
Function description	Select OP output
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	internal_output: op output connection select
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**internal\_output**

OP output connection select.

OP\_INTERNAL\_OUTPUT\_GPIO: op output to GPIO

OP\_INTERNAL\_OUTPUT\_ADC: op output to ADC channels

**Example:**

```
/* op1 output to gpio */
op_internal_output_select (OP1, OP_INTERNAL_OUTPUT_GPIO);
```

### 5.14.12 op\_set\_trimming\_mode function

The table below describes the function op\_set\_trimming\_mode.

**Table 434. op\_set\_trimming\_mode function**

Name	Description
Function name	op_set_trimming_mode
Function prototype	void op_set_trimming_mode(op_type *op_x, op_trimming_type trimming)
Function description	Select OP calibration mode
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.

Name	Description
Input parameter 2	Trimming: OP calibration mode select
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Trimming:**

Select OP trimming mode.

OP\_TRIMMING\_FACTORY: Factory-trimmed value

OP\_TRIMMING\_USER: User-trimmed value

**Example:**

```
/* op1 trimming mode select */
op_set_trimming_mode (OP1, OP_TRIMMING_USER);
```

### 5.14.13 op\_calibration\_select function

The table below describes the function op\_calibration\_select.

**Table 435. op\_calibration\_select function**

Name	Description
Function name	op_calibration_select
Function prototype	void op_calibration_select(op_type *op_x, op_calibrate_type cal_sel)
Function description	Select OP calibration value
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	cal_sel: Select OP calibration value
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**cal\_sel**

Select OP calibration value.

OP\_TRIMMING\_3\_3VDDA: OP input 0.033 x VDDA

OP\_TRIMMING\_PMOS: OP input 0.1 x VDDA to calibrate PMOS

OP\_TRIMMING\_50VDDA: OP input 0.5 x VDDA

OP\_TRIMMING\_NMOS: OP input 0.9 x VDDA to calibrate NMOS

**Example:**

```
/* op1 trimming pmos */
op_calibration_select (OP1, OP_TRIMMING_PMOS);
```

## 5.14.14 op\_calout\_status\_get function

The table below describes the function op\_calout\_status\_get.

**Table 436. op\_calout\_status\_get function**

Name	Description
Function name	op_calout_status_get
Function prototype	flag_status op_calout_status_get(op_type *op_x)
Function description	Get calibration status
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Output parameter	NA
Return value	flag_status: calibration status This parameter can be SET or RESET
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get op1cal sts */
if(op_calout_status_get (OP1) != RESET)
```

## 5.14.15 op\_set\_trimming\_value function

The table below describes the function op\_set\_trimming\_value.

**Table 437. op\_set\_trimming\_value function**

Name	Description
Function name	op_set_trimming_value
Function prototype	void op_set_trimming_value(op_type *op_x, op_calibrate_type cal_sel, uint16_t trimming_value)
Function description	Set OP trimming value
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	cal_sel: OP calibration select OP_TRIMMING_PMOS OP_TRIMMING_NMOS
Input parameter 3	trimming_value: 0x0...0x1f
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* op trimming value set */
op_set_trimming_value (OP1, OP_TRIMMING_PMOS, 0x10);
```

## 5.14.16 op\_wpc\_enable function

The table below describes the function op\_wpc\_enable.

**Table 438. op\_wpc\_enable function**

Name	Description
Function name	op_wpc_enable
Function prototype	void op_wpc_enable(op_type *op_x, op_wpc_type wpc_reg)
Function description	OP register write protection
Input parameter 1	op_x: op select This parameter can be from OP1, OP2, OP3 or OP4.
Input parameter 2	wpc_reg: op write protection register OP_WPC_CSR OP_WPC_TMCR
Output parameter	NA
Return value	flag_status: calibration status This parameter can be SET or RESET
Required preconditions	NA
Called functions	NA

**Example:**

```
/* get op1cal sts */  
if(op_calout_status_get (OP1) != RESET)
```

## 5.15 Power controller (PWC)

The PWC register structure pwc\_type is defined in the “AT32M412\_416\_pwc.h”:

```
/*
 * @brief type define pwc register all
 */
typedef struct
{
    .....
} pwc_type;
```

The table below gives a list of the PWC registers

**Table 439. Summary of PWC registers**

Register	Description
ctrl	Power control register
ctrlsts	Power control/status register
clr	Power flag clear register
ldoov	LDO calibration register

The table below gives a list of PWC library functions.

**Table 440. Summary of PWC library functions**

Function name	Description
pwc_reset	Reset PWC registers to their reset values.
pwc_batteryPoweredDomainAccess	Enable battery powered domain access
pwc_pvmLevelSelect	Select PVM threshold
pwc_powerVoltageMonitorEnable	Enable Voltage monitor
pwc_wakeupPinEnable	Enable standby-mode wakeup pin
pwc_flagClear	Clear flag
pwc_flagGet	Get flag status
pwc_sleepModeEnter	Enter Sleep mode
pwc_deepSleepModeEnter	Enter Deepsleep mode
pwc_voltageRegulateSet	Select voltage regulator status in Deepsleep mode
pwc_standbyModeEnter	Enter Standby mode
pwc_ldoOutputVoltageSet	Set LDO output voltage

## 5.15.1 pwc\_reset function

The table below describes the function pwc\_reset.

**Table 441. pwc\_reset function**

Name	Description
Function name	pwc_reset
Function prototype	void pwc_reset(void)
Function description	Reset all PWC registers to their reset values.
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset()

**Example:**

```
/* deinitialize pwc */
pwc_reset();
```

## 5.15.2 pwc\_battery\_powered\_domain\_access function

The table below describes the function pwc\_battery\_powered\_domain\_access.

**Table 442. pwc\_battery\_powered\_domain\_access function**

Name	Description
Function name	pwc_battery_powered_domain_access
Function prototype	void pwc_battery_powered_domain_access(confirm_state new_state)
Function description	Battery powered domain access enable
Input parameter	new_state: indicates the pre-configured status of battery powered domain This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable the battery-powered domain write operations */
pwc_battery_powered_domain_access(TRUE);
```

*Note: Access to battery powered domain (such as, ERTC) is allowed only after enabling it through this function.*

### 5.15.3 pwc\_pvm\_level\_select function

The table below describes the function pwc\_pvm\_level\_select.

**Table 443. pwc\_pvm\_level\_select function**

Name	Description
Function name	pwc_pvm_level_select
Function prototype	void pwc_pvm_level_select(pwc_pvm_voltage_type pvm_voltage)
Function description	Select PVM threshold
Input parameter	pvm_voltage: indicates the selected PVM threshold This parameter can be any enumerated value in the pwc_pvm_voltage_type.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### pvm\_voltage

pvm\_voltage is used to select a PVM threshold from the optional parameters below:

PWC\_PVM\_VOLTAGE\_2V3: PVM threshold is 2.3V  
 PWC\_PVM\_VOLTAGE\_2V4: PVM threshold is 2.4V  
 PWC\_PVM\_VOLTAGE\_2V5: PVM threshold is 2.5V  
 PWC\_PVM\_VOLTAGE\_2V6: PVM threshold is 2.6V  
 PWC\_PVM\_VOLTAGE\_2V7: PVM threshold is 2.7V  
 PWC\_PVM\_VOLTAGE\_2V8: PVM threshold is 2.8V  
 PWC\_PVM\_VOLTAGE\_2V9: PVM threshold is 2.9V

#### Example:

```
/* set the threshold voltage to 2.9v */
pwc_pvm_level_select(PWC_PVM_VOLTAGE_2V9);
```

### 5.15.4 pwc\_power\_voltage\_monitor\_enable function

The table below describes the function pwc\_power\_voltage\_monitor\_enable.

**Table 444. pwc\_power\_voltage\_monitor\_enable function**

Name	Description
Function name	pwc_power_voltage_monitor_enable
Function prototype	void pwc_power_voltage_monitor_enable(confirm_state new_state)
Function description	Enable power voltage monitor (PVM)
Input parameter	new_state: indicates the pre-configured status of PVM This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### Example:

```
/* enable power voltage monitor */
pwc_power_voltage_monitor_enable(TRUE);
```

## 5.15.5 pwc\_wakeup\_pin\_polarity\_select function

The table below describes the function pwc\_wakeup\_pin\_polarity\_select.

**Table 445. pwc\_wakeup\_pin\_polarity\_select function**

Name	Description
Function name	pwc_wakeup_pin_polarity_select
Function prototype	void pwc_wakeup_pin_polarity_select(uint32_t pin_num, pwc_wakeup_pin_polarity_type wakeup_pin_polarity)
Function description	Select wakeup pin polarity
Input parameter 1	pin_num: select a standby wakeup pin This parameter can be any pin that is capable of waking up from Standby mode.
Input parameter 2	wakeup_pin_polarity: pre-set state of the wakeup pin polarity This parameter can be PWC_RISING_EDGE_WAKEUP or PWC_FALLING_EDGE_WAKEUP.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### pin\_num

pin\_num is used to select Standby-mode wakeup pin, including:

PWC\_WAKEUP\_PIN\_1: Standby wakeup pin 1 (corresponding GPIO is PA0)

PWC\_WAKEUP\_PIN\_2: Standby wakeup pin 2 (corresponding GPIO is PC13)

PWC\_WAKEUP\_PIN\_6: Standby wakeup pin 6 (corresponding GPIO is PB5)

PWC\_WAKEUP\_PIN\_7: Standby wakeup pin 7 (corresponding GPIO is PB15)

### wakeup\_pin\_polarity

wakeup\_pin\_polarity is used to select the polarity of a wakeup pin, from the following:

PWC\_RISING\_EDGE\_WAKEUP: wakeup at rising edge

PWC\_FALLING\_EDGE\_WAKEUP: wakeup at falling edge

### Example:

```
/* wakeup pin1 polarity set */
pwc_wakeup_pin_polarity_select(PWC_WAKEUP_PIN_1, PWC_RISING_EDGE_WAKEUP);
```

## 5.15.6 pwc\_wakeup\_pin\_enable function

The table below describes the function pwc\_wakeup\_pin\_enable.

**Table 446. pwc\_wakeup\_pin\_enable function**

Name	Description
Function name	pwc_wakeup_pin_enable
Function prototype	void pwc_wakeup_pin_enable(uint32_t pin_num, confirm_state new_state)
Function description	Enable Standby wakeup pin
Input parameter 1	pin_num: select a standby wakeup pin See the “pin_num” below for details.
Input parameter 2	new_state: indicates the pre-configured status of Standby wakeup pins This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### pin\_num

pin\_num is used to select Standby-mode wakeup pin, including:

PWC\_WAKEUP\_PIN\_1: Standby wakeup pin 1 (corresponding GPIO is PA0)

PWC\_WAKEUP\_PIN\_2: Standby wakeup pin 2 (corresponding GPIO is PC13)

PWC\_WAKEUP\_PIN\_6: Standby wakeup pin 6 (corresponding GPIO is PB5)

PWC\_WAKEUP\_PIN\_7: Standby wakeup pin 7 (corresponding GPIO is PB15)

### Example:

```
/* enable wakeup pin - pa0 */
pwc_wakeup_pin_enable(PWC_WAKEUP_PIN_1, TRUE);
```

## 5.15.7 pwc\_flag\_clear function

The table below describes the function pwc\_flag\_clear.

**Table 447. pwc\_flag\_clear function**

Name	Description
Function name	pwc_flag_clear
Function prototype	void pwc_flag_clear(uint32_t pwc_flag)
Function description	Clear flag
Input parameter	pwc_flag: to-be-cleared flag Refer to the “pwc_flag” description below for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### pwc\_flag

pwc\_flag is used to select a flag from the optional parameters below:

PWC\_WAKEUP\_PIN1\_FLAG : Standby wakeup pin 1 wakeup event flag

PWC\_WAKEUP\_PIN2\_FLAG : Standby wakeup pin 2 wakeup event flag

PWC\_WAKEUP\_PIN6\_FLAG : Standby wakeup pin 6 wakeup event flag

PWC\_WAKEUP\_PIN7\_FLAG : Standby wakeup pin 7 wakeup event flag

PWC\_STANDBY\_FLAG: Standby mode entry flag  
 PWC\_WAKEUP\_INTERNAL\_FLAG : Internal wakeup event flag  
 PWC\_PVM\_OUTPUT\_FLAG : Power voltage detection output flag (this event cannot be cleared by software)

**Example:**

```
/* wakeup pin1 event flag clear */
pwc_flag_clear(PWC_WAKEUP_PIN1_FLAG);
```

## 5.15.8 pwc\_flag\_get function

The table below describes the function pwc\_flag\_get.

**Table 448. pwc\_flag\_get function**

Name	Description
Function name	pwc_flag_get
Function prototype	flag_status pwc_flag_get(uint32_t pwc_flag)
Function description	Get flag status
Input parameter	pwc_flag: select a flag. Refer to <a href="#">pwc_flag</a> for details.
Output parameter	NA
Return value	flag_status: indicates flag status Return SET or RESET.
Required preconditions	NA
Called functions	NA

**Example:**

```
/* check if wakeup pin1 event flag is set */
if(pwc_flag_get(PWC_WAKEUP_PIN1_FLAG) != RESET)
```

## 5.15.9 pwc\_sleep\_mode\_enter function

The table below describes the function pwc\_sleep\_mode\_enter.

**Table 449. pwc\_sleep\_mode\_enter function**

Name	Description
Function name	pwc_sleep_mode_enter
Function prototype	void pwc_sleep_mode_enter(pwc_sleep_enter_type pwc_sleep_enter)
Function description	Enter Sleep mode
Input parameter	pwc_sleep_enter: select a command to enter Sleep mode This parameter can be any enumerated value in the pwc_sleep_enter_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**pwc\_sleep\_enter**

pwc\_sleep\_enter is used to select a command to enter Sleep mode from the optional parameters below:

PWC\_SLEEP\_ENTER\_WFI: Enter Sleep mode by WFI

PWC\_SLEEP\_ENTER\_WFE: Enter Sleep mode by WFE

**Example:**

```
/* enter sleep mode */
```

```
pwc_sleep_mode_enter(PWC_SLEEP_ENTER_WFI);
```

### 5.15.10 pwc\_deep\_sleep\_mode\_enter function

The table below describes the function pwc\_deep\_sleep\_mode\_enter.

**Table 450. pwc\_deep\_sleep\_mode\_enter function**

Name	Description
Function name	pwc_deep_sleep_mode_enter
Function prototype	void pwc_deep_sleep_mode_enter(pwc_deep_sleep_enter_type pwc_deep_sleep_enter)
Function description	Enter Deepsleep mode
Input parameter	pwc_deep_sleep_enter: select a command to enter Deepsleep mode This parameter can be any enumerated value in the pwc_deep_sleep_enter_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### pwc\_deep\_sleep\_enter

pwc\_deep\_sleep\_enter is used to select a command to enter Deepsleep mode, including:

PWC\_DEEP\_SLEEP\_ENTER\_WFI: Enter Deepsleep mode by WFI

PWC\_DEEP\_SLEEP\_ENTER\_WFE: Enter Deepsleep mode by WFE

#### Example:

```
/* enter deep sleep mode */  
pwc_deep_sleep_mode_enter(PWC_DEEP_SLEEP_ENTER_WFI);
```

### 5.15.11 pwc\_voltage\_regulate\_set function

The table below describes the function pwc\_voltage\_regulate\_set.

**Table 451. pwc\_voltage\_regulate\_set function**

Name	Description
Function name	pwc_voltage_regulate_set
Function prototype	void pwc_voltage_regulate_set(pwc_regulator_type pwc_regulator)
Function description	Select the status of voltage regulator in Deepsleep mode
Input parameter	pwc_regulator: select voltage regulator status This parameter can be any enumerated value in the pwc_regulator_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### pwc\_regulator

pwc\_regulator is used to select the status of voltage regulator from the optional parameters below:

PWC\_REGULATOR\_ON: Voltage regulator ON in Deepsleep mode

PWC\_REGULATOR\_LOW\_POWER: Voltage regulator low-power mode in Deepsleep mode

#### Example:

```
/* config the voltage regulator mode */  
pwc_voltage_regulate_set(PWC_REGULATOR_LOW_POWER);
```

### 5.15.12 pwc\_ldo\_output\_voltage\_set function

The table below describes the function pwc\_ldo\_output\_voltage\_set.

Table 452. pwc\_ldo\_output\_voltage\_set function

Name	Description
Function name	pwc_ldo_output_voltage_set
Function prototype	pwc_ldo_output_voltage_set(val)
Function description	LDO output voltage setting
Input parameter	Val: LDO output voltage value This parameter can be any enumerated value in the pwc_ldo_output_voltage_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### val

val 用于选择 LDO 输出电压值，其可选参数罗列如下

PWC\_LDO\_OUTPUT\_1V0: LDO output 1.0V

PWC\_LDO\_OUTPUT\_1V2: LDO output 1.2V

PWC\_LDO\_OUTPUT\_1V3: LDO output 1.3V

#### Example:

```
/* reduce ldo before enter deepsleep mode */  
pwc_ldo_output_voltage_set(PWC_LDO_OUTPUT_1V0);
```

### 5.15.13 pwc\_standby\_mode\_enter function

The table below describes the function pwc\_standby\_mode\_enter

Table 453. pwc\_standby\_mode\_enter function

Name	Description
Function name	pwc_standby_mode_enter
Function prototype	void pwc_standby_mode_enter(void)
Function description	Enter Standby mode
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enter standby mode */  
pwc_standby_mode_enter();
```

## 5.16 System configuration controller (SCFG)

The SCFG register structure scfg\_type is defined in the “AT32M412\_416\_scfg.h”

```
/*
 * @brief type define scfg register all
 */
typedef struct
{
    ...
} scfg_type;
```

The table below gives a list of the SCFG registers

**Table 454. Summary of SCFG registers**

Register	Description
scfg_cfg1	SCFG configuration register 1
scfg_cfg2	SCFG configuration register 2
scfg_exintc1	SCFG external interrupt configuration register 1
scfg_exintc2	SCFG external interrupt configuration register 2
scfg_exintc3	SCFG external interrupt configuration register 3
scfg_exintc4	SCFG external interrupt configuration register 4
scfg_uhdrv	SCFG ultra-high drive capability register
scfg_iocfg	IO configuration register
scfg_iokey	IO write protection register

The table below gives a list of SCFG library functions.

**Table 455. Summary of SCFG library functions**

函数名	描述
scfg_reset	SCFG reset
scfg_infrared_config	infrared configuration
scfg_mem_map_get	Get memory address map
scfg_pa11pa12_pin_remap	PA11/PA12 pin remapping
scfg_pvm_lock_enable	PVM Lock enable
scfg_lockup_enable	Lockup lock enable
scfg_can_timestamp_source_get	CAN timestamp source select
scfg_exint_line_config	External interrupt line configuration
scfg_pins_ultra_driven_enable	Pin ultra-high current sinking capability enable
scfg_nrst_rmp_config	NRST pin multiplexed function mapping configuration

## 5.16.1 scfg\_reset function

The table below describes the function scfg\_reset.

**Table 456. scfg\_reset function**

Name	Description
Function name	scfg_reset
Function prototype	void scfg_reset(void);
Function description	Reset SCFG
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
scfg_reset();
```

## 5.16.2 scfg\_infrared\_config function

The table below describes the function scfg\_infrared\_config.

**Table 457. scfg\_infrared\_config function**

Name	Description
Function name	scfg_infrared_config
Function prototype	void scfg_infrared_config(scfg_ir_source_type source, scfg_ir_polarity_type polarity);
Function description	Infrared configuration
Input parameter 1	Source: infrared modulation signal source
Input parameter 2	Polarity: output signal polarity
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### scfg\_ir\_source\_type

Select infrared signal source.

SCFG\_IR\_SOURCE\_TMR10: Infrared signal source is TMR10

### scfg\_ir\_polarity\_type

Select infrared signal polarity.

SCFG\_IR\_POLARITY\_NO\_AFFECTE: Infrared output signal not inverted

SCFG\_IR\_POLARITY\_REVERSE: Infrared output signal inverted

**Example:**

```
scfg_infrared_config(SCFG_IR_SOURCE_TMR10, SCFG_IR_POLARITY_NO_AFFECTE);
```

### 5.16.3 scfg\_mem\_map\_get function

The table below describes the function scfg\_mem\_map\_get.

**Table 458. scfg\_mem\_map\_get function**

Name	Description
Function name	scfg_mem_map_set
Function prototype	scfg_mem_map_type scfg_mem_map_get(void);
Function description	Get memory mapped to address 0x00000000
Input parameter	NA
Output parameter	NA
Return value	uint8_t: memory address map type
Required preconditions	NA
Called functions	NA

#### scfg\_mem\_map\_type

Select a memory to be mapped onto address 0x00000000

SCFG\_MEM\_MAP\_MAIN\_MEMORY: Main memory is mapped to 0x00000000

SCFG\_MEM\_MAP\_BOOT\_MEMORY: Boot memory is mapped to 0x00000000

SCFG\_MEM\_MAP\_INTERNAL\_SRAM: Internal memory is mapped to 0x00000000

#### Example:

```
scfg_mem_map_type value;
value = scfg_mem_map_get();
```

### 5.16.4 scfg\_pa11pa12\_pin\_remap function

The table below describes the function scfg\_pa11pa12\_pin\_remap.

**Table 459. scfg\_pa11pa12\_pin\_remap function**

Name	Description
Function name	scfg_pa11pa12_pin_remap
Function prototype	void scfg_pa11pa12_pin_remap(scfg_pa11pa12_remap_type pin_remap);
Function description	PA11/PA12 pin remap
Input parameter	pin_remap: pin remap
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### pin\_remap

Pin remap:

SCFG\_PA11PA12\_NO\_REMAP: PA11/PA12 not remapped

SCFG\_PA11PA12\_TO\_PA9PA10: PA11/PA12 mapped to PA9/PA10

#### Example:

```
scfg_pa11pa12_pin_remap (SCFG_PA11PA12_TO_PA9PA10);
```

## 5.16.5 scfg\_pvm\_lock\_enable function

The table below describes the function scfg\_adc\_dma\_channel\_remap.

**Table 460. scfg\_adc\_dma\_channel\_remap function**

Name	Description
Function name	scfg_pvm_lock_enable
Function prototype	void scfg_pvm_lock_enable(confirm_state new_state);
Function description	PVM Lock enable
Input parameter	new_state: enabled or disables This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
scfg_pvm_lock_enable(TRUE);
```

## 5.16.6 scfg\_lockup\_enable function

The table below describes the function scfg\_usart1\_tx\_dma\_channel\_remap.

**Table 461. scfg\_usart1\_tx\_dma\_channel\_remap function**

Name	Description
Function name	scfg_lockup_enable
Function prototype	void scfg_lockup_enable(confirm_state new_state);
Function description	Lockup lock enable
Input parameter	new_state: enabled or disables This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
scfg_lockup_enable(TRUE);
```

## 5.16.7 scfg\_can\_timestamp\_source\_set function

The table below describes the function scfg\_can\_timestamp\_source\_set..

**Table 462. scfg\_can\_timestamp\_source\_set function**

Name	Description
Function name	scfg_can_timestamp_source_set
Function prototype	void scfg_can_timestamp_source_set(scfg_can_type can_index, scfg_can_timestamp_source_type source);
Function description	CAN timestamp count source select
Input parameter	can_index: can peripheral
Output parameter	Source: timestamp counting source
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* config timestamp counting timer with tmr3 */
scfg_can_timestamp_source_set(SCFG_CAN1, SCFG_CAN_TIMESTAMP_TMR3);
```

## 5.16.8 scfg\_exint\_line\_config function

The table below describes the function scfg\_exint\_line\_config.

**Table 463. scfg\_exint\_line\_config function**

Name	Description
Function name	scfg_exint_line_config
Function prototype	void scfg_exint_line_config(scfg_port_source_type port_source, scfg_pins_source_type pin_source);
Function description	External interrupt line configuration
Input parameter 1	port_source: port source
Input parameter 2	pin_source: pin source
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**scfg\_port\_source\_type**

SCFG\_PORT\_SOURCE\_GPIOA: port A

SCFG\_PORT\_SOURCE\_GPIOB: port B

SCFG\_PORT\_SOURCE\_GPIOC: port C

SCFG\_PORT\_SOURCE\_GPIOF: port F

**scfg\_pins\_source\_type**

SCFG\_PINS\_SOURCE0: pin 0

SCFG\_PINS\_SOURCE1: pin 1

SCFG\_PINS\_SOURCE2: pin 2

.....

SCFG\_PINS\_SOURCE13: pin 13

SCFG\_PINS\_SOURCE14: pin 14

SCFG\_PINS\_SOURCE15: pin15

**Example:**

```
scfg_exint_line_config(SCFG_PORT_SOURCE_GPIOA, SCFG_PINS_SOURCE1);
```

## 5.16.9 scfg\_pins\_ultra\_driven\_enable function

The table below describes the function scfg\_pins\_ultra\_driven\_enable.

**Table 464. scfg\_pins\_ultra\_driven\_enable function**

Name	Description
Function name	scfg_pins_ultra_driven_enable
Function prototype	void scfg_pins_ultra_driven_enable(scfg_ultra_driven_pins_type value, confirm_state new_state);
Function description	Enable pin ultra-high current sinking capability
Input parameter 1	Value: pin
Input parameter 2	new_state: enabled or disabled This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### scfg\_ultra\_driven\_pins\_type

SCFG\_ULTRA\_DRIVEN\_PB8: PB8

SCFG\_ULTRA\_DRIVEN\_PB9: PB9

SCFG\_ULTRA\_DRIVEN\_PA11: PA11

SCFG\_ULTRA\_DRIVEN\_PA12: PA12

**Example:**

```
scfg_pins_ultra_driven_enable(SCFG_ULTRA_DRIVEN_PB8, TRUE);
```

## 5.16.10 scfg\_nrst\_rmp\_config function

The table below describes the function scfg\_nrst\_rmp\_config.

**Table 465. scfg\_nrst\_rmp\_config function**

Name	Description
Function name	scfg_nrst_rmp_config
Function prototype	void scfg_nrst_rmp_config(scfg_nrst_rmp_type remap);
Function description	NRST remapping configuration
Input parameter 1	remap: NRST remapping configuration
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### remap

SCFG\_NRST\_RMP\_NRST: No remap, used as NRST pin

SCFG\_NRST\_RMP\_PF2: Remap, used as PF2 pin

### Example:

```
/* config nrst pin remap */  
scfg_nrst_rmp_config (SCFG_NRST_RMP_PF2);
```

## 5.17 Serial peripheral interface (SPI)/ I<sup>2</sup>S

The SPI register structure spi\_type is defined in the “AT32M412\_416\_spi.h”:

```
/*
 * @brief type define spi register all
 */
typedef struct
{
    ...
} spi_type;
```

The table below gives a list of the SPI registers

**Table 466. Summary of SPI registers**

Register	Description
ctrl1	SPI control register 1
ctrl2	SPI control register 2
sts	SPI status register
dt	SPI data register
cpoly	SPI CRC register
rcrc	SPI RxCRC register
tcrc	SPI TxCRC register
i2sctrl	SPI_I2S configuration register
i2sclkp	SPI_I2S prescaler register

The table below gives a list of SPI library functions.

**Table 467. Summary of SPI library functions**

Function name	Description
spi_i2s_reset	Reset SPI/I <sup>2</sup> S registers to their reset values
spi_default_para_init	Configure the SPI initialization structure with an initial value
spi_init	Initialize SPI
spi_ti_mode_enable	SPI TI mode enable
spi_crc_next_transmit	Next data transfer is CRC command
spi_crc_polynomial_set	SPI CRC polynomial configuration
spi_crc_polynomial_get	Get SPI CRC polynomial
spi_crc_enable	Enable SPI CRC
spi_crc_value_get	Get CRC result of SPI receive/transmit
spi_hardware_cs_output_enable	Enable hardware CS output
spi_software_cs_internal_level_set	Set software CS internal level
spi_frame_bit_num_set	Set the number of frame bits
spi_half_duplex_direction_set	Set transfer direction of single-wire bidirectional half-duplex mode
spi_enable	Enable SPI
i2s_default_para_init	Set an initial value for the I <sup>2</sup> S initialization structure
i2s_init	Initialize I <sup>2</sup> S
i2s_enable	Enable I <sup>2</sup> S
spi_i2s_interrupt_enable	Enable SPI/I <sup>2</sup> S interrupts

spi_i2s_dma_transmitter_enable	Enable SPI/I <sup>2</sup> S DMA transmit
spi_i2s_dma_receiver_enable	Enable SPI/I <sup>2</sup> S DMA receive
spi_i2s_data_transmit	SPI/I <sup>2</sup> S transmits data
spi_i2s_data_receive	SPI/I <sup>2</sup> S receives data
spi_i2s_flag_get	Get SPI/I <sup>2</sup> S flag
spi_i2s_interrupt_flag_get	Get SPI/I <sup>2</sup> S interrupt flag
spi_i2s_flag_clear	Clear SPI/I <sup>2</sup> S flags

### 5.17.1 spi\_i2s\_reset function

The table below describes the function spi\_i2s\_reset.

**Table 468. spi\_i2s\_reset function**

Name	Description
Function name	spi_i2s_reset
Function prototype	void spi_i2s_reset(spi_type *spi_x);
Function description	Reset SPI/I <sup>2</sup> S registers to their reset values.
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset();

**Example:**

```
spi_i2s_reset (SPI1);
```

### 5.17.2 spi\_default\_para\_init function

The table below describes the function spi\_default\_para\_init.

**Table 469. spi\_default\_para\_init function**

Name	Description
Function name	spi_default_para_init
Function prototype	void spi_default_para_init(spi_init_type* spi_init_struct);
Function description	Set an initial value for the SPI initialization structure
Input parameter 1	spi_init_struct: <a href="#">spi_init_type</a> pointer
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of spi_init_type before starting.
Called functions	NA

**Example:**

```
spi_init_type spi_init_struct;  
spi_default_para_init (&spi_init_struct);
```

### 5.17.3 spi\_init function

The table below describes the function spi\_init.

**Table 470. spi\_init function**

Name	Description
Function name	spi_init
Function prototype	void spi_init(spi_type* spi_x, spi_init_type* spi_init_struct);
Function description	Initialize SPI
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2, SPI3, SPI4.
Input parameter 2	spi_init_struct: <i>spi_init_type</i> pointer
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of <i>spi_init_type</i> before starting.
Called functions	NA

*spi\_init\_type* is defined in the AT32M412\_416\_spi.h:

typedef struct

```
{
    spi_transmission_mode_type      transmission_mode;
    spi_master_slave_mode_type     master_slave_mode;
    spi_mclk_freq_div_type        mclk_freq_division;
    spi_first_bit_type            first_bit_transmission;
    spi_frame_bit_num_type        frame_bit_num;
    spi_clock_polarity_type       clock_polarity;
    spi_clock_phase_type          clock_phase;
    spi_cs_mode_type              cs_mode_selection;
}
```

*spi\_init\_type*;

#### spi\_transmission\_mode

SPI transmission mode.

SPI\_TRANSMIT\_FULL\_DUPLEX: Two-wire unidirectional full-duplex mode

SPI\_TRANSMIT\_SIMPLEX\_RX: Two-wire unidirectional receive-only mode

SPI\_TRANSMIT\_HALF\_DUPLEX\_RX: Single-wire bidirectional receive-only mode

SPI\_TRANSMIT\_HALF\_DUPLEX\_TX: Single-wire bidirectional transmit-only mode

#### master\_slave\_mode

Master/slave mode selection.

SPI\_MODE\_SLAVE: Slave mode

SPI\_MODE\_MASTER: Master mode

#### mclk\_freq\_division

Frequency division factor selection.

SPI\_MCLK\_DIV\_2: Divided by 2

SPI\_MCLK\_DIV\_4: Divided by 4

SPI\_MCLK\_DIV\_8: Divided by 8

SPI\_MCLK\_DIV\_16: Divided by 16

SPI\_MCLK\_DIV\_32: Divided by 32

SPI\_MCLK\_DIV\_64: Divided by 64

SPI\_MCLK\_DIV\_128: Divided by 128

SPI\_MCLK\_DIV\_256: Divided by 256

SPI\_MCLK\_DIV\_512: Divided by 512

SPI\_MCLK\_DIV\_1024: Divided by 1024

#### **first\_bit\_transmission**

SPI MSB-first/LSB-first selection

SPI\_FIRST\_BIT\_MSB: MSB-first

SPI\_FIRST\_BIT\_LSB: LSB-first

#### **frame\_bit\_num**

Set the number of bits in a frame

SPI\_FRAME\_8BIT: 8-bit data in a frame

SPI\_FRAME\_16BIT: 16-bit data in a frame

#### **clock\_polarity**

Select Clock polarity.

SPI\_CLOCK\_POLARITY\_LOW: Clock output low in idle state

SPI\_CLOCK\_POLARITY\_HIGH: Clock output high in idle state

#### **clock\_phase**

Select clock phase.

SPI\_CLOCK\_PHASE\_1EDGE: Sample on the first clock edge

SPI\_CLOCK\_PHASE\_2EDGE: Sample on the second clock edge

#### **cs\_mode\_selection**

Select CS mode.

SPI\_CS\_HARDWARE\_MODE: Hardware CS mode

SPI\_CS\_SOFTWARE\_MODE: Software CS mode

#### **Example:**

```
spi_init_type spi_init_struct;
spi_default_para_init(&spi_init_struct);
spi_init_struct.transmission_mode = SPI_TRANSMIT_FULL_DUPLEX;
spi_init_struct.master_slave_mode = SPI_MODE_MASTER;
spi_init_struct.mclk_freq_division = SPI_MCLK_DIV_8;
spi_init_struct.first_bit_transmission = SPI_FIRST_BIT_MSB;
spi_init_struct.frame_bit_num = SPI_FRAME_16BIT;
spi_init_struct.clock_polarity = SPI_CLOCK_POLARITY_LOW;
spi_init_struct.clock_phase = SPI_CLOCK_PHASE_2EDGE;
spi_init_struct.cs_mode_selection = SPI_CS_SOFTWARE_MODE;
spi_init(SPI1, &spi_init_struct);
```

## 5.17.4 spi\_ti\_mode\_enable function

The table below describes the function spi\_crc\_next\_transmit.

**Table 471. spi\_ti\_mode\_enable function**

Name	Description
Function name	spi_ti_mode_enable
Function prototype	void spi_ti_mode_enable(spi_type* spi_x, confirm_state new_state);
Function description	Enable SPI TI mode
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	new_state: enabled or disabled This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* spi ti mode enable */
spi_ti_mode_enable (SPI1, TRUE);
```

## 5.17.5 spi\_crc\_next\_transmit function

The table below describes the function spi\_crc\_next\_transmit.

**Table 472. spi\_crc\_next\_transmit function**

Name	Description
Function name	spi_crc_next_transmit
Function prototype	void spi_crc_next_transmit(spi_type* spi_x);
Function description	The next data to be sent is CRC command
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
spi_crc_next_transmit (SPI1);
```

## 5.17.6 spi\_crc\_polynomial\_set function

The table below describes the function spi\_crc\_polynomial\_set.

**Table 473. spi\_crc\_polynomial\_set function**

Name	Description
Function name	spi_crc_polynomial_set
Function prototype	void spi_crc_polynomial_set(spi_type* spi_x, uint16_t crc_poly);
Function description	Set SPI CRC polynomial
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	crc_poly: CRC polynomial Value is 0x0000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/*set spi crc polynomial value */
spi_crc_polynomial_set (SPI1, 0x07);
```

## 5.17.7 spi\_crc\_polynomial\_get function

The table below describes the function spi\_crc\_polynomial\_get.

**Table 474. spi\_crc\_polynomial\_get function**

Name	Description
Function name	spi_crc_polynomial_get
Function prototype	uint16_t spi_crc_polynomial_get(spi_type* spi_x);
Function description	Get SPI CRC polynomial
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Output parameter	NA
Return value	CRC polynomial Value is 0x0000~0xFFFF
Required preconditions	NA
Called functions	NA

**Example:**

```
/*get spi crc polynomial value */
uint16_t crc_poly;
crc_poly = spi_crc_polynomial_get (SPI1);
```

## 5.17.8 spi\_crc\_enable function

The table below describes the function spi\_crc\_enable.

**Table 475. spi\_crc\_enable function**

Name	Description
Function name	spi_crc_enable
Function prototype	void spi_crc_enable(spi_type* spi_x, confirm_state new_state);
Function description	Enable SPI CRC
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	new_state: enabled or disabled This parameter can be FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* spi crc enable */
spi_crc_enable (SPI1, TRUE);
```

## 5.17.9 spi\_crc\_value\_get function

The table below describes the function spi\_crc\_value\_get.

**Table 476. spi\_crc\_value\_get function**

Name	Description
Function name	spi_crc_value_get
Function prototype	uint16_t spi_crc_value_get(spi_type* spi_x, spi_crc_direction_type crc_direction);
Function description	Get SPI receive/transmit CRC result
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>crc_direction</i> : Select receive/transmit CRC
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**crc\_direction**

Select receive/transmit CRC

SPI\_CRC\_RX: Receive CRC

SPI\_CRC\_TX: Transmit CRC

**Example:**

```
/* get spi rx & tx crc enable */
uint16_t spi_rx_crc, spi_tx_crc;
spi_rx_crc = spi_crc_value_get (SPI1, SPI_CRC_RX);
spi_tx_crc = spi_crc_value_get (SPI1, SPI_CRC_TX);
```

### 5.17.10 spi\_hardware\_cs\_output\_enable function

The table below describes the function spi\_hardware\_cs\_output\_enable.

**Table 477. spi\_hardware\_cs\_output\_enable function**

Name	Description
Function name	spi_hardware_cs_output_enable
Function prototype	void spi_hardware_cs_output_enable(spi_type* spi_x, confirm_state new_state);
Function description	Enable hardware CS output
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	new_state: enabled or disabled This parameter can FALSE or TRUE
Output parameter	NA
Return value	NA
Required preconditions	This setting is applicable to SPI master mode only.
Called functions	NA

**Example:**

```
/* enable the hardware cs output */
spi_hardware_cs_output_enable (SPI1, TRUE);
```

### 5.17.11 spi\_software\_cs\_internal\_level\_set function

The table below describes the function spi\_software\_cs\_internal\_level\_set.

**Table 478. spi\_software\_cs\_internal\_level\_set function**

Name	Description
Function name	spi_software_cs_internal_level_set
Function prototype	void spi_software_cs_internal_level_set(spi_type* spi_x, spi_software_cs_level_type level);
Function description	Set software CS internal level
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>level</i> : set software CS internal level
Output parameter	NA
Return value	NA
Required preconditions	1. This setting is applicable to software CS mode only; 2. In master mode, the "level" value must be "SPI_SWCS_INTERNAL_LEVEL_HIGHT".
Called functions	NA

**level**

Set software CS internal level

SPI\_SWCS\_INTERNAL\_LEVEL\_LOW: Software CS internal low level

SPI\_SWCS\_INTERNAL\_LEVEL\_HIGHT: Software CS internal high level

**Example:**

```
/* set the internal level high */
spi_software_cs_internal_level_set (SPI1, SPI_SWCS_INTERNAL_LEVEL_HIGHT);
```

## 5.17.12 spi\_frame\_bit\_num\_set function

The table below describes the function spi\_frame\_bit\_num\_set.

**Table 479. spi\_frame\_bit\_num\_set function**

Name	Description
Function name	spi_frame_bit_num_set
Function prototype	void spi_frame_bit_num_set(spi_type* spi_x, spi_frame_bit_num_type bit_num);
Function description	Set the number of bits in a frame
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>bit_num</i> : Set the number of bits in a frame
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### bit\_num

Set the number of bits in a frame

SPI\_FRAME\_8BIT: 8-bit data in a frame

SPI\_FRAME\_16BIT: 16-bit data in a frame

### Example:

```
/* set the data frame bit num as 8 */
spi_frame_bit_num_set (SPI1, SPI_FRAME_8BIT);
```

## 5.17.13 spi\_half\_duplex\_direction\_set function

The table below describes the function spi\_half\_duplex\_direction\_set.

**Table 480. spi\_half\_duplex\_direction\_set function**

Name	Description
Function name	spi_half_duplex_direction_set
Function prototype	void spi_half_duplex_direction_set(spi_type* spi_x, spi_half_duplex_direction_type direction);
Function description	Set the transfer direction of single-wire bidirectional half-duplex mode
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>direction</i> : transfer direction
Output parameter	NA
Return value	NA
Required preconditions	This setting is applicable to the single-wire bidirectional half-duplex mode only.
Called functions	NA

### direction

Transfer direction

SPI\_HALF\_DUPLEX\_DIRECTION\_RX: Receive

SPI\_HALF\_DUPLEX\_DIRECTION\_TX: Transmit

### Example:

```
/* set the data transmission direction as transmit */
spi_half_duplex_direction_set (SPI1, SPI_HALF_DUPLEX_DIRECTION_TX);
```

## 5.17.14 spi\_enable function

The table below describes the function spi\_enable.

**Table 481. spi\_enable function**

Name	Description
Function name	spi_enable
Function prototype	void spi_enable(spi_type* spi_x, confirm_state new_state);
Function description	Enable SPI
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	new_state: enabled or disabled This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable spi */
spi_enable (SPI1, TRUE);
```

## 5.17.15 i2s\_default\_para\_init function

The table below describes the function i2s\_default\_para\_init.

**Table 482. i2s\_default\_para\_init function**

Name	Description
Function name	i2s_default_para_init
Function prototype	void i2s_default_para_init(i2s_init_type* i2s_init_struct);
Function description	Set an initial value for the I <sup>2</sup> S initialization structure
Input parameter 1	i2s_init_struct: <i>spi_i2s_flag</i> pointer
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of i2s_init_type before starting.
Called functions	NA

**Example:**

```
i2s_init_type i2s_init_struct;
i2s_default_para_init (&i2s_init_struct);
```

## 5.17.16 i2s\_init function

The table below describes the function i2s\_init.

Table 483. i2s\_init function

Name	Description
Function name	i2s_init
Function prototype	void i2s_init(spi_type* spi_x, i2s_init_type* i2s_init_struct);
Function description	Initialize I <sup>2</sup> S
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	i2s_init_struct: <i>spi_i2s_flag</i> pointer
Output parameter	NA
Return value	NA
Required preconditions	It is necessary to define a variable of i2s_init_type before starting.
Called functions	NA

i2s\_init\_type is defined in the AT32M412\_416\_spi.h:

typedef struct

{

i2s_operation_mode_type	operation_mode;
i2s_audio_protocol_type	audio_protocol;
i2s_audio_sampling_freq_type	audio_sampling_freq;
i2s_data_channel_format_type	data_channel_format;
i2s_clock_polarity_type	clock_polarity;
confirm_state	mclk_output_enable;

} i2s\_init\_type;

**operation\_mode**

I<sup>2</sup>S transfer mode

I2S_MODE_SLAVE_TX:	I2S slave transmit
I2S_MODE_SLAVE_RX:	I2S slave receive
I2S_MODE_MASTER_TX:	I2S master transmit
I2S_MODE_MASTER_RX:	I2S master receive

**audio\_protocol**

I<sup>2</sup>S audio protocol standards

I2S_AUDIO_PROTOCOL_PHILLIPS:	Phillips
I2S_AUDIO_PROTOCOL_MSB:	MSB aligned (left-aligned)
I2S_AUDIO_PROTOCOL_LSB:	LSB aligned (right-aligned)
I2S_AUDIO_PROTOCOL_PCM_SHORT:	PCM short frame synchronization
I2S_AUDIO_PROTOCOL_PCM_LONG:	PCM long frame synchronization

**audio\_sampling\_freq**

I<sup>2</sup>S audio sampling frequency.

I2S\_AUDIO\_FREQUENCY\_DEFAULT:

Kept at its reset value (sampling frequency changes with SCLK)

I2S_AUDIO_FREQUENCY_8K:	I2S sampling frequency 8K
I2S_AUDIO_FREQUENCY_11_025K:	I2S sampling frequency 11.025K
I2S_AUDIO_FREQUENCY_16K:	I2S sampling frequency 16K
I2S_AUDIO_FREQUENCY_22_05K:	I2S sampling frequency 22.05K
I2S_AUDIO_FREQUENCY_32K:	I2S sampling frequency 32K

I2S_AUDIO_FREQUENCY_44_1K:	I2S sampling frequency 44.1K
I2S_AUDIO_FREQUENCY_48K:	I2S sampling frequency 48K
I2S_AUDIO_FREQUENCY_96K:	I2S sampling frequency 96K
I2S_AUDIO_FREQUENCY_192K:	I2S sampling frequency 192K

**data\_channel\_format**I<sup>2</sup>S data/channel bits format

I2S_DATA_16BIT_CHANNEL_16BIT:	16-bit data, 16-bit channel
I2S_DATA_16BIT_CHANNEL_32BIT:	16-bit data, 32-bit channel
I2S_DATA_24BIT_CHANNEL_32BIT:	24-bit data, 32-bit channel
I2S_DATA_32BIT_CHANNEL_32BIT:	32-bit data, 32-bit channel

**clock\_polarity**I<sup>2</sup>S clock polarity

I2S_CLOCK_POLARITY_LOW:	Clock output low in idle state
I2S_CLOCK_POLARITY_HIGH:	Clock output high in idle state

**mclk\_output\_enable**

Enable mclk clock output

This parameter can be FALSE or TRUE.

**Example:**

```
i2s_init_type i2s_init_struct;
i2s_default_para_init(&i2s_init_struct);
i2s_init_struct.audio_protocol = I2S_AUDIO_PROTOCOL_PHILLIPS;
i2s_init_struct.data_channel_format = I2S_DATA_16BIT_CHANNEL_32BIT;
i2s_init_struct.mclk_output_enable = FALSE;
i2s_init_struct.audio_sampling_freq = I2S_AUDIO_FREQUENCY_48K;
i2s_init_struct.clock_polarity = I2S_CLOCK_POLARITY_LOW;
i2s_init_struct.operation_mode = I2S_MODE_MASTER_TX;
i2s_init(SPI2, &i2s_init_struct);
```

### 5.17.17 i2s\_enable function

The table below describes the function i2s\_enable.

**Table 484. i2s\_enable function**

Name	Description
Function name	i2s_enable
Function prototype	void i2s_enable(spi_type* spi_x, confirm_state new_state);
Function description	Enable I <sup>2</sup> S
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable i2s*/
i2s_enable (SPI1, TRUE);
```

## 5.17.18 spi\_i2s\_interrupt\_enable function

The table below describes the function spi\_i2s\_interrupt\_enable.

**Table 485. spi\_i2s\_interrupt\_enable function**

Name	Description
Function name	spi_i2s_interrupt_enable
Function prototype	void spi_i2s_interrupt_enable(spi_type* spi_x, uint32_t spi_i2s_int, confirm_state new_state);
Function description	Enable SPI/I <sup>2</sup> S interrupts
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>spi_i2s_int</i> : select SPI interrupts
Input parameter 3	new_state: Enable or disable This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### spi\_i2s\_int

Select SPI/I<sup>2</sup>S interrupt selection.

SPI\_I2S\_ERROR\_INT: SPI/I<sup>2</sup>S error interrupts (including CRC error, overflow error, underflow error and mode error)

SPI\_I2S\_RDBF\_INT: Receive data buffer full

SPI\_I2S\_TDBE\_INT: Transmit data buffer empty

### Example:

```
/* enable the specified spi/i2s interrupts */
spi_i2s_interrupt_enable (SPI1, SPI_I2S_ERROR_INT);
spi_i2s_interrupt_enable (SPI1, SPI_I2S_RDBF_INT);
spi_i2s_interrupt_enable (SPI1, SPI_I2S_TDBE_INT);
```

## 5.17.19 spi\_i2s\_dma\_transmitter\_enable function

The table below describes the function spi\_i2s\_dma\_transmitter\_enable.

**Table 486. spi\_i2s\_dma\_transmitter\_enable function**

Name	Description
Function name	spi_i2s_dma_transmitter_enable
Function prototype	void spi_i2s_dma_transmitter_enable(spi_type* spi_x, confirm_state new_state);
Function description	Enable SPI/I <sup>2</sup> S DMA transmitter
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	new_state: enabled or disabled This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable spi transmitter dma */
spi_i2s_dma_transmitter_enable (SPI1, TRUE);
```

**5.17.20 spi\_i2s\_dma\_receiver\_enable function**

The table below describes the function `spi_i2s_dma_receiver_enable`.

**Table 487. `spi_i2s_dma_receiver_enable` function**

Name	Description
Function name	<code>spi_i2s_dma_receiver_enable</code>
Function prototype	<code>void spi_i2s_dma_receiver_enable(spi_type* spi_x, confirm_state new_state);</code>
Function description	Enable SPI/I <sup>2</sup> S DMA receiver
Input parameter 1	<code>spi_x</code> : the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<code>new_state</code> : enabled or disabled This parameter can be FALSE or TRUE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable spi dma transmitter */
spi_i2s_dma_transmitter_enable (SPI1, TRUE);
```

**5.17.21 spi\_i2s\_data\_transmit function**

The table below describes the function `spi_i2s_data_transmit`.

**Table 488. `spi_i2s_data_transmit` function**

Name	Description
Function name	<code>spi_i2s_data_transmit</code>
Function prototype	<code>void spi_i2s_data_transmit(spi_type* spi_x, uint16_t tx_data);</code>
Function description	SPI/I <sup>2</sup> S sends data
Input parameter 1	<code>spi_x</code> : the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<code>tx_data</code> : data to send Value range (for 8-bit bit in a frame): 0x00~0xFF Value range (for 16-bit in a frame): 0x0000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* spi data transmit */
uint16_t tx_data = 0x6666;
spi_i2s_data_transmit (SPI1, tx_data);
```

## 5.17.22 spi\_i2s\_data\_receive function

The table below describes the function spi\_i2s\_data\_receive.

**Table 489. spi\_i2s\_data\_receive function**

Name	Description
Function name	spi_i2s_data_receive
Function prototype	uint16_t spi_i2s_data_receive(spi_type* spi_x);
Function description	SPI/I <sup>2</sup> S receives data
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Output parameter	rx_data: data to receive Value range (for 8-bit bit in a frame): 0x00~0xFF Value range (for 16-bit in a frame): 0x0000~0xFFFF
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* spi data receive */
uint16_t rx_data = 0;
rx_data = spi_i2s_data_receive (SPI1);
```

## 5.17.23 spi\_i2s\_flag\_get function

The table below describes the function spi\_i2s\_flag\_get.

**Table 490. spi\_i2s\_flag\_get function**

Name	Description
Function name	spi_i2s_flag_get
Function prototype	flag_status spi_i2s_flag_get(spi_type* spi_x, uint32_t spi_i2s_flag);
Function description	Get SPI/I <sup>2</sup> S flags
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<a href="#">spi_i2s_flag</a> : flag selection Refer to the “spi_i2s_flag” description below for details.
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

### spi\_i2s\_flag

SPI/I<sup>2</sup>S is used to select a flag from the optional parameters below:

- SPI\_I2S\_RDBF\_FLAG: SPI/I<sup>2</sup>S receive data buffer full
- SPI\_I2S\_TDBE\_FLAG: SPI/I<sup>2</sup>S transmit data buffer empty
- I2S\_ACS\_FLAG: I2S audio channel state (indicating left/right channel)
- I2S\_TUERR\_FLAG: I2S transmitter underload error
- SPI\_CCERR\_FLAG: SPI CRC error

SPI_MMERR_FLAG:	SPI master mode error
SPI_I2S_ROERR_FLAG:	SPI/I <sup>2</sup> S receive overflow error
SPI_I2S_BF_FLAG:	SPI/I <sup>2</sup> S busy
SPI_CSPAS_FLAG:	SPI CS pulse error

**Example:**

```
/* get receive data buffer full flag */
flag_status status;
status = spi_i2s_flag_get(SPI1, SPI_I2S_RDBF_FLAG);
```

### 5.17.24 **spi\_i2s\_interrupt\_flag\_get** function

The table below describes the function `spi_i2s_interrupt_flag_get`.

**Table 491. `spi_i2s_interrupt_flag_get` function**

Name	Description
Function name	<code>spi_i2s_interrupt_flag_get</code>
Function prototype	<code>flag_status spi_i2s_interrupt_flag_get(spi_type* spi_x, uint32_t spi_i2s_flag);</code>
Function description	Get SPI/I <sup>2</sup> S interrupt flag status
Input parameter 1	<code>spi_x</code> : the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>spi_i2s_flag</i> : select a flag to clear Refer to the “ <code>spi_i2s_flag</code> ” description below for details.
Output parameter	NA
Return value	<code>flag_status</code> : SET or RESET.
Required preconditions	NA
Called functions	NA

**spi\_i2s\_flag:**

SPI/I<sup>2</sup>S is used for flag selection, including:

SPI_I2S_RDBF_FLAG:	SPI/I <sup>2</sup> S receive data buffer full
SPI_I2S_TDBE_FLAG:	SPI/I <sup>2</sup> S transmit data buffer empty
I2S_TUERR_FLAG:	I2S transmitter underload error
SPI_CCERR_FLAG:	SPI CRC error
SPI_MMERR_FLAG:	SPI master mode error
SPI_I2S_ROERR_FLAG:	SPI/I <sup>2</sup> S receive overflow error
SPI_CSPAS_FLAG:	SPI CS pulse error

**Example:**

```
/* get receive data buffer full flag */
flag_status status;
status = spi_i2s_interrupt_flag_get(SPI1, SPI_I2S_RDBF_FLAG);
```

## 5.17.25 spi\_i2s\_flag\_clear function

The table below describes the function spi\_i2s\_flag\_clear.

Table 492. spi\_i2s\_flag\_clear function

Name	Description
Function name	spi_i2s_flag_clear
Function prototype	void spi_i2s_flag_clear(spi_type* spi_x, uint32_t spi_i2s_flag)
Function description	Clear SPI/I <sup>2</sup> S flags
Input parameter 1	spi_x: the selected SPI peripheral This parameter can be SPI1, SPI2
Input parameter 2	<i>spi_i2s_flag</i> : select a flag to clear Refer to the “spi_i2s_flag” description below for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### spi\_i2s\_flag:

SPI/I<sup>2</sup>S is used for flag selection, including:

SPI_I2S_RDBF_FLAG:	SPI/I <sup>2</sup> S receive data buffer full
I2S_TUERR_FLAG:	I2S transmitter underload error
SPI_CCERR_FLAG:	SPI CRC error
SPI_MMERR_FLAG:	SPI master mode error
SPI_I2S_ROERR_FLAG:	SPI/I <sup>2</sup> S receive overflow error
SPI_CSPAS_FLAG:	SPI CS pulse error

*Note: the SPI\_I2S\_TDBE\_FLAG (SPI/I<sup>2</sup>S transmit data buffer empty), the I2S\_ACS\_FLAG (Audio channel state) and the SPI\_I2S\_BF\_FLAG (SPI/I<sup>2</sup>S busy) are all set and cleared by hardware to indicate communication state, without the intervention of software.*

### Example:

```
/* clear receive data buffer full flag */  
spi_i2s_flag_clear (SPI1, SPI_I2S_RDBF_FLAG);
```

## 5.18 SysTick

The SysTick register structure SysTick\_Type is defined in the “core\_cm4.h”:

```
typedef struct
```

```
{
```

```
...
```

```
}
```

The table below gives a list of the SysTick registers

**Table 493. Summary of SysTick registers**

Register	Description
ctrl	Controls status register
load	Reload value register
val	Current counter value register
calib	Calibration register

The table below gives a list of SysTick library functions.

**Table 494. Summary of SysTick library functions**

Function name	Description
systick_clock_source_config	Configure SysTick clock sources
SysTick_Config	Configure SysTick counter reload value and interrupts

### 5.18.1 systick\_clock\_source\_config function

The table below describes the function systick\_clock\_source\_config.

**Table 495. systick\_clock\_source\_config function**

Name	Description
Function name	systick_clock_source_config
Function prototype	void systick_clock_source_config(systick_clock_source_type source);
Function description	Configure SysTick clock source
Input parameter 1	Source: systick clock source
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### source

SYSTICK\_CLOCK\_SOURCE\_AHBCLK\_DIV8: AHB/8 as SysTick clock

SYSTICK\_CLOCK\_SOURCE\_AHBCLK\_NODIV: AHB as SysTick clock

#### Example:

```
/* config systick clock source */
systick_clock_source_config(SYSTICK_CLOCK_SOURCE_AHBCLK_NODIV);
```

## 5.18.2 SysTick\_Config function

The table below describes the function SysTick\_Config

**Table 496. SysTick\_Config function**

Name	Description
Function name	SysTick_Config
Function prototype	uint32_t SysTick_Config(uint32_t ticks);
Function description	Configure SysTick counter reload value and enable interrupt
Input parameter 1	Ticks: SysTick counter interrupt reload value
Output parameter	NA
Return value	Return the setting status of this function, success (0) or failure (1)
Required preconditions	NA
Called functions	NA

**Example:**

```
/* config systick reload value and enable interrupt */  
SysTick_Config(1000);
```

## 5.19 TMR

The TMR register structure tmr\_type is defined in the "AT32M412\_416\_tmr.h".

```
/*
 * @brief type define tmr register all
 */
typedef struct
{

} tmr_type;
```

The table below gives a list of the TMR registers

**Table 497. Summary of TMR registers**

Register	Description
ctrl1	TMR control register 1
ctrl2	TMR control register 2
stctrl	TMR slave timer control register
iden	TMR DMA/ interrupt enable register
ists	TMR interrupt status register
swevt	TMR software event register
cm1	TMR channel mode register 1
cm2	TMR channel mode register 2
cctrl	TMR channel control register
cval	TMR counter value register
div	TMR division register
pr	TMR period register
rpr	TMR repetition period channel
c1dt	TMR channel 1 data register
c2dt	TMR channel 2 data register
c3dt	TMR channel 3 data register
c4dt	TMR channel 4 data register
brk	TMR break register
dmactrl	TMR DMA control register
dmadt	TMR DMA data register
rmp	TMR channel input remap register
cm3	TMR channel mode register 3
c5dt	TMR channel 5 data register

The table below gives a list of TMR library functions.

Table 498. Summary of TMR library functions

Function name	Description
tmr_reset	TMR is reset by CRM reset register
tmr_counter_enable	Enable or disable TMR
tmr_output_default_para_init	Initialize TMR output default parameters
tmr_input_default_para_init	Initialize TMR input default parameters
tmr_brkdt_default_para_init	Initialize TMR brkdt default parameters
tmr_blk_default_para_init	Initialize TMR blanking default parameters
tmr_base_init	Initialize TMR period and division
tmr_clock_source_div_set	Set TMR clock source frequency division factor
tmr_cnt_dir_set	Set TMR counter direction
tmr_cnt_dir_get	Get TMR counting direction
tmr_repetition_counter_set	Set repetition period register
tmr_counter_value_set	Set TMR counter value
tmr_counter_value_get	Get TMR counter value
tmr_div_value_set	Set TMR division value
tmr_div_value_get	Get TMR division value
tmr_output_channel_config	Configure TMR output channels
tmr_output_channel_mode_select	Select TMR output channel mode
tmr_period_value_set	Set TMR period value
tmr_period_value_get	Get TMR period value
tmr_channel_value_set	Set TMR channel value
tmr_channel_value_get	Get TMR channel value
tmr_period_buffer_enable	Enable or disable TMR periodic buffer
tmr_output_channel_buffer_enable	Enable or disable TMR output channel buffer
tmr_output_channel_immediately_set	TMR output channel enable immediately
tmr_output_channel_switch_set	Set TMR output channel switch
tmr_one_cycle_mode_enable	Enable or disable TMR one-cycle mode
tmr_overflow_request_source_set	Select TMR overflow event source
tmr_overflow_event_disable	Enable or disable TMR overflow event generation
tmr_channel_enable	Enable or disable TMR channel
tmr_input_channel_filter_set	Set TMR input channel filter
tmr_pwm_input_config	Configure TMR pwm input
tmr_channel1_input_select	Select TMR channel 1 input
tmr_input_channel_divider_set	Set TMR input channel divider
tmr_primary_mode_select	Select TMR master mode
tmr_sub_mode_select	Select TMR slave timer mode
tmr_channel_dma_select	Select TMR channel DMA request source
tmr_hall_select	Select TMR hall mode
tmr_channel_buffer_enable	Enable or disable TMR channel buffer
tmr_trigger_input_select	Select TMR slave timer trigger input
tmr_sub_sync_mode_set	Set TMR slave timer synchronization mode
tmr_dma_request_enable	Enable or disable TMR DMA request
tmr_interrupt_enable	Enable or disable TMR interrupt
tmr_interrupt_flag_get	Get TMR interrupt flag bit

tmr_flag_get	Get TMR flag
tmr_flag_clear	Clear TMR flags
tmr_event_sw_trigger	Software trigger TMR event
tmr_output_enable	Enable or disable TMR output
tmr_internal_clock_set	Set TMR internal clock
tmr_output_channel_polarity_set	Set TMR output channel polarity
tmr_external_clock_enable	Enable or disable TMR external clock
tmr_external_clock_config	Set TMR external clock
tmr_external_clock_mode1_config	Set TMR external clock mode 1
tmr_external_clock_mode2_config	Set TMR external clock mode 2
tmr_encoder_mode_config	Set TMR encode mode
tmr_force_output_set	Set TMR forced output
tmr_dma_control_config	Set TMR DMA control
tmr_brkdt_config	Set TMR break mode and dead-time
tmr_brk_filter_value_set	Set TMR break filter value
tmr_brk2_config	Configure TMR break 2 function
tmr_input_channel_blk_config	Configure TMR input channel blanking function
tmr_overflow_flag_remap	Overflow flag remap
tmr_primary_mode2_select	Select TMR primary mode 2
tmr_coraw_clear_set	Set TMR CORAW clear source
tmr_overflow_cpy_get	Get copied overflow flag status
tmr_brk_bidir_enable	Enable or disable TMR bidirectional break
tmr_brk_release	Release break output
tmr_brk_release_check	Check whether break is released or not
tmr_ch5_combined_set	Set TMR channel 5 combined mode
tmr_brk_input_config	Configure TMR break input channel
tmr_external_source_select	Select TMR external input channel source
tmr_input_ch_select	Select TMR input channel source
tmr_iasym_mode_enable	Enable or disable TMR isolated asymmetric PWM mode

## 5.19.1 tmr\_reset function

The table below describes the function tmr\_reset.

Table 499. tmr\_reset function

Name	Description
Function name	tmr_reset
Function prototype	void tmr_reset(tmr_type *tmr_x);
Function description	TMR is reset by CRM reset register.
Input parameter	tmr_x: the selected TMR peripheral, including: TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset();

Example:

```
tmr_reset(TMR1);
```

## 5.19.2 tmr\_counter\_enable function

The table below describes the function tmr\_counter\_enable.

Table 500. tmr\_counter\_enable function

Name	Description
Function name	tmr_counter_enable
Function prototype	void tmr_counter_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR
Input parameter 1	tmr_x: the selected TMR peripheral, including: TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates counter status, ON (TRUE) or OFF (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

Example:

```
tmr_counter_enable(TMR1, TRUE);
```

### 5.19.3 tmr\_output\_default\_para\_init function

The table below describes the function tmr\_output\_default\_para\_init.

**Table 501. tmr\_output\_default\_para\_init function**

Name	Description
Function name	tmr_output_default_para_init
Function prototype	void tmr_output_default_para_init(tmr_output_config_type *tmr_output_struct);
Function description	Initialize tmr output default parameters
Input parameter	tmr_output_struct: tmr_output_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of members of the function tmr\_output\_struct.

**Table 502. tmr\_output\_struct default values**

Member	Default values
oc_mode	TMR_OUTPUT_CONTROL_OFF
oc_idle_state	FALSE
occ_idle_state	FALSE
oc_polarity	TMR_OUTPUT_ACTIVE_HIGH
occ_polarity	TMR_OUTPUT_ACTIVE_HIGH
oc_output_state	FALSE
occ_output_state	FALSE

**Example:**

```
tmr_output_config_type tmr_output_struct;
tmr_output_default_para_init(&tmr_output_struct);
```

### 5.19.4 tmr\_input\_default\_para\_init function

The table below describes the function tmr\_input\_default\_para\_init.

**Table 503. tmr\_input\_default\_para\_init function**

Name	Description
Function name	tmr_input_default_para_init
Function prototype	void tmr_input_default_para_init(tmr_input_config_type *tmr_input_struct);
Function description	Initialize TMR input default parameters
Input parameter	tmr_input_struct: tmr_input_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of members of the function tmr\_input\_struct.

**Table 504. tmr\_input\_struct default values**

Member	Default values
input_channel_select	TMR_SELECT_CHANNEL_1
input_polarity_select	TMR_INPUT_RISING_EDGE
input_mapped_select	TMR_CC_CHANNEL_MAPPED_DIRECT
input_filter_value	0x0

**Example:**

```
tmr_input_config_type tmr_input_struct;
tmr_input_default_para_init(&tmr_input_struct);
```

**5.19.5 tmr\_brkdt\_default\_para\_init function**

The table below describes the function tmr\_brkdt\_default\_para\_init.

**Table 505. tmr\_brkdt\_default\_para\_init function**

Name	Description
Function name	tmr_brkdt_default_para_init
Function prototype	void tmr_brkdt_default_para_init(tmr_brkdt_config_type *tmr_brkdt_struct);
Function description	Initialize TMR brkdt default parameters
Input parameter	tmr_brkdt_struct: tmr_brkdt_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of members of the function tmr\_brkdt\_struct.

**Table 506. tmr\_brkdt\_struct default values**

Member	Default values
brk_filter_value	0x0
deadtime	0x0
brk_polarity	TMR_BRK_INPUT_ACTIVE_LOW
wp_level	TMR_WP_OFF
auto_output_enable	FALSE
fcsoen_state	FALSE
fcsodis_state	FALSE
brk_enable	FALSE

**Example:**

```
tmr_brkdt_config_type tmr_brkdt_struct;
tmr_brkdt_default_para_init(&tmr_brkdt_struct);
```

## 5.19.6 tmr\_blk\_default\_para\_init function

The table below describes the function tmr\_blk\_default\_para\_init.

**Table 507. tmr\_blk\_default\_para\_init function**

Name	Description
Function name	tmr_blk_default_para_init
Function prototype	void tmr_blk_default_para_init(tmr_blk_config_type *tmr_blk_struct);
Function description	Initialize TMR blanking default parameters
Input parameter 1	tmr_blk_struct: pointer to the structure tmr_blk_config_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of the tmr\_blk\_struct.

**Table 508. tmr\_brkdt\_struct default values**

Member	Default values
input_channel_select	TMR_SELECT_CHANNEL_1
input_blk_state	TMR_BLK_STATE_LOW
blk_source_select	TMR_BLK_SOURCE_0
blk_source_polarity	TMR_BLK_SOURCE_ACTIVE_HIGH
blk_enable	FALSE

**Example:**

```
tmr_blk_config_type tmr_blk_struct;
tmr_blk_default_para_init(&tmr_blk_struct);
```

## 5.19.7 tmr\_base\_init function

The table below describes the function tmr\_base\_init.

**Table 509. tmr\_base\_init function**

Name	Description
Function name	tmr_base_init
Function prototype	void tmr_base_init(tmr_type* tmr_x, uint32_t tmr_pr, uint32_t tmr_div);
Function description	Initialize TMR period and division
Input parameter 1	tmr_x: the selected TMR peripheral, including: TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_pr: timer period value, 0x0000~0xFFFF for 16-bit timer, and 0x0000_0000~0xFFFF_FFFF for 32-bit timer,
Input parameter 3	tmr_div: timer division value, 0x0000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_base_init(TMR1, 0xFFFF, 0xFFFF);
```

## 5.19.8 tmr\_clock\_source\_div\_set function

The table below describes the function tmr\_clock\_source\_div\_set.

**Table 510. tmr\_clock\_source\_div\_set function**

Name	Description
Function name	tmr_clock_source_div_set
Function prototype	void tmr_clock_source_div_set(tmr_type *tmr_x, tmr_clock_division_type tmr_clock_div);
Function description	Set TMR clock source division
Input parameter 1	tmr_x: the selected TMR peripheral, including: TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_clock_div: timer clock source frequency division factor
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_clock\_div

Select TMR clock source frequency division factor

TMR\_CLOCK\_DIV1: Divided by 1

TMR\_CLOCK\_DIV2: Divided by 2

TMR\_CLOCK\_DIV4: Divided by 4

#### Example:

```
tmr_clock_source_div_set(TMR1, TMR_CLOCK_DIV4);
```

## 5.19.9 tmr\_cnt\_dir\_set function

The table below describes the function tmr\_cnt\_dir\_set.

**Table 511. tmr\_cnt\_dir\_set function**

Name	Description
Function name	tmr_cnt_dir_set
Function prototype	void tmr_cnt_dir_set(tmr_type *tmr_x, tmr_count_mode_type tmr_cnt_dir);
Function description	Set TMR counter direction
Input parameter 1	tmr_x: the selected TMR peripheral, including: TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_cnt_dir: timer counting direction
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_cnt\_dir

Select timer counting direction.

TMR\_COUNT\_UP: Up counting

TMR\_COUNT\_DOWN: Down counting

TMR\_COUNT\_TWO\_WAY\_1: Center-aligned mode (up/down counting) 1

TMR\_COUNT\_TWO\_WAY\_2: Center-aligned mode (up/down counting) 2

TMR\_COUNT\_TWO\_WAY\_3: Center-aligned mode (up/down counting) 3

**Example:**

```
tmr_cnt_dir_set(TMR1, TMR_COUNT_UP);
```

### 5.19.10 tmr\_cnt\_dir\_get function

The table below describes the function tmr\_cnt\_dir\_get.

**Table 512. tmr\_cnt\_dir\_get function**

Name	Description
Function name	tmr_cnt_dir_get
Function prototype	uint32_t tmr_cnt_dir_get(tmr_type *tmr_x);
Function description	Get TMR counting direction
Input parameter	tmr_x: =TMR peripheral TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Output parameter	NA
Return value	
Required preconditions	NA
Called functions	NA

**Example:**

```
uint32_t counter_dir;
counter_dir = tmr_cnt_dir_get(TMR1);
```

### 5.19.11 tmr\_repetition\_counter\_set function

The table below describes the function tmr\_repetition\_counter\_set.

**Table 513. tmr\_repetition\_counter\_set function**

Name	Description
Function name	tmr_repetition_counter_set
Function prototype	void tmr_repetition_counter_set(tmr_type *tmr_x, uint16_t tmr_rpr_value);
Function description	Set repetition period register (rpr)
Input parameter 1	tmr_x: TMR peripheral, it includes: TMR1, TMR9, TMR10, TMR11
Input parameter 2	tmr_rpr_value: timer repetition period value, it can be 0x0000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_repetition_counter_set(TMR1, 0x1000);
```

## 5.19.12 tmr\_counter\_value\_set function

The table below describes the function tmr\_counter\_value\_set.

**Table 514. tmr\_counter\_value\_set function**

Name	Description
Function name	tmr_counter_value_set
Function prototype	void tmr_counter_value_set(tmr_type *tmr_x, uint32_t tmr_cnt_value);
Function description	Set TMR counter value
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_cnt_value: timer counter value, 0x0000~0xFFFF for 16-bit timer; 0x0000_0000~0xFFFF_FFFF 32-bit timer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_counter_value_set(TMR1, 0xFFFF);
```

## 5.19.13 tmr\_counter\_value\_get function

The table below describes the function tmr\_counter\_value\_get.

**Table 515. tmr\_counter\_value\_get function**

Name	Description
Function name	tmr_counter_value_get
Function prototype	uint32_t tmr_counter_value_get(tmr_type *tmr_x);
Function description	Get TMR counter value
Input parameter	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Output parameter	NA
Return value	Timer counter value
Required preconditions	NA
Called functions	NA

**Example:**

```
uint32_t counter_value;
counter_value = tmr_counter_value_get(TMR1);
```

## 5.19.14 tmr\_div\_value\_set function

The table below describes the function tmr\_div\_value\_set.

**Table 516. tmr\_div\_value\_set function**

Name	Description
Function name	tmr_div_value_set
Function prototype	void tmr_div_value_set(tmr_type *tmr_x, uint32_t tmr_div_value);
Function description	Set TMR frequency division value
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_div_value: timer frequency division value. 0x0000~0xFFFF for 16-bit timer; 0x0000_0000~0xFFFF_FFFF for 32-bit timer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_div_value_set(TMR1, 0xFFFF);
```

## 5.19.15 tmr\_div\_value\_get function

The table below describes the function tmr\_div\_value\_get.

**Table 517. tmr\_div\_value\_get function**

Name	Description
Function name	tmr_div_value_get
Function prototype	uint32_t tmr_div_value_get(tmr_type *tmr_x);
Function description	Get TMR frequency division value
Input parameter	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Output parameter	NA
Return value	Timer frequency division value
Required preconditions	NA
Called functions	NA

**Example:**

```
uint32_t div_value;
div_value = tmr_div_value_get(TMR1);
```

## 5.19.16 tmr\_output\_channel\_config function

The table below describes the function tmr\_output\_channel\_config.

**Table 518. tmr\_output\_channel\_config function**

Name	Description
Function name	tmr_output_channel_config
Function prototype	void tmr_output_channel_config(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, tmr_output_config_type *tmr_output_struct);
Function description	Configure TMR output channels
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	tmr_output_struct: tmr_output_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Channel 1

TMR\_SELECT\_CHANNEL\_2: Channel 2

TMR\_SELECT\_CHANNEL\_3: Channel 3

TMR\_SELECT\_CHANNEL\_4: Channel 4

TMR\_SELECT\_CHANNEL\_5: Channel 5

### tmr\_output\_config\_type structure

tmr\_output\_config\_type is defined in the AT32M412\_416\_tmr.h:

typedef struct

```
{
    tmr_output_control_mode_type      oc_mode;
    confirm_state                     oc_idle_state;
    confirm_state                     occ_idle_state;
    tmr_output_polarity_type         oc_polarity;
    tmr_output_polarity_type         occ_polarity;
    confirm_state                     oc_output_state;
    confirm_state                     occ_output_state;
} tmr_output_config_type;
```

### oc\_mode

Set output channel mode, that is, to configure channel original signals (CxORAW).

TMR\_OUTPUT\_CONTROL\_OFF: Disconnect channel output (CxOUT) from CxORAW

TMR\_OUTPUT\_CONTROL\_HIGH: CxORAW high

TMR\_OUTPUT\_CONTROL\_LOW: CxORAW low

TMR\_OUTPUT\_CONTROL\_SWITCH: Switch CxORAW level

TMR\_OUTPUT\_CONTROL\_FORCE\_LOW: CxORAW forced low

TMR\_OUTPUT\_CONTROL\_FORCE\_HIGH: CxORAW forced high

TMR\_OUTPUT\_CONTROL\_PWM\_MODE\_A: PWM A mode

TMR\_OUTPUT\_CONTROL\_PWM\_MODE\_B: PWM B mode

**oc\_idle\_state**

Set output channel idle state.

FALSE: Output channel idle state is 0

TRUE: Output channel idle state is 1

**occ\_idle\_state**

Set complementary output channel idle state.

FALSE: Complementary output channel idle state is 0

TRUE: Complementary output channel idle state is 1

**oc\_polarity**

Set the polarity of output channels.

TMR\_OUTPUT\_ACTIVE\_HIGH: Active high

TMR\_OUTPUT\_ACTIVE\_LOW: Active low

**occ\_polarity**

Set the polarity of complementary output channels.

TMR\_OUTPUT\_ACTIVE\_HIGH: Active high

TMR\_OUTPUT\_ACTIVE\_LOW: Active low

**oc\_output\_state**

Set the state of output channels.

FALSE: Output channel OFF

TRUE: Output channel ON

**occ\_output\_state**

Set the state of complementary output channels.

FALSE: Complementary output channel OFF

TRUE: Complementary output channel ON

**Example:**

```
tmr_output_config_type tmr_output_struct;
tmr_output_struct.oc_mode = TMR_OUTPUT_CONTROL_OFF;
tmr_output_struct.oc_output_state = TRUE;
tmr_output_struct.oc_polarity = TMR_OUTPUT_ACTIVE_HIGH;
tmr_output_struct.oc_idle_state = TRUE;
tmr_output_struct.occ_output_state = TRUE;
tmr_output_struct.occ_polarity = TMR_OUTPUT_ACTIVE_HIGH;
tmr_output_struct.occ_idle_state = TRUE;
tmr_output_channel_config(TMR1, TMR_SELECT_CHANNEL_1, &tmr_output_struct);
```

## 5.19.17 tmr\_output\_channel\_mode\_select function

The table below describes the function tmr\_output\_channel\_mode\_select.

**Table 519. tmr\_output\_channel\_mode\_select function**

Name	Description
Function name	tmr_output_channel_mode_select
Function prototype	void tmr_output_channel_mode_select(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, tmr_output_control_mode_type oc_mode);
Function description	Select TMR output channel mode
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: refer to the “ <a href="#">tmr_channel</a> ” descriptions below for details
Input parameter 3	oc_mode: refer to the “ <a href="#">oc_mode</a> ” descriptions below for details
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

TMR\_SELECT\_CHANNEL\_5: Timer channel 5

### oc\_mode

Set output channel mode, that is, to configure channel original signals (CxORAW).

TMR\_OUTPUT\_CONTROL\_OFF: Disconnect channel output (CxOUT) from CxORAW

TMR\_OUTPUT\_CONTROL\_HIGH: CxORAW high

TMR\_OUTPUT\_CONTROL\_LOW: CxORAW low

TMR\_OUTPUT\_CONTROL\_SWITCH: Switch CxORAW level

TMR\_OUTPUT\_CONTROL\_FORCE\_LOW: CxORAW forced low

TMR\_OUTPUT\_CONTROL\_FORCE\_HIGH: CxORAW forced high

TMR\_OUTPUT\_CONTROL\_PWM\_MODE\_A: PWM A mode

TMR\_OUTPUT\_CONTROL\_PWM\_MODE\_B: PWM B mode

### Example:

```
tmr_output_channel_mode_select(TMR1, TMR_SELECT_CHANNEL_1, TMR_OUTPUT_CONTROL_SWITCH);
```

## 5.19.18 tmr\_period\_value\_set function

The table below describes the function tmr\_period\_value\_set.

**Table 520. tmr\_period\_value\_set function**

Name	Description
Function name	tmr_period_value_set
Function prototype	void tmr_period_value_set(tmr_type *tmr_x, uint32_t tmr_pr_value);
Function description	Set TMR period value
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_pr_value: timer period value., 0x0000~0xFFFF for 16-bit timer; 0x0000_0000~0xFFFF_FFFF for 32-bit timer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_period_value_set(TMR1, 0xFFFF);
```

## 5.19.19 tmr\_period\_value\_get function

The table below describes the function tmr\_period\_value\_get.

**Table 521. tmr\_period\_value\_get function**

Name	Description
Function name	tmr_period_value_get
Function prototype	uint32_t tmr_period_value_get(tmr_type *tmr_x);
Function description	Get TMR period value
Input parameter	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Output parameter	NA
Return value	Timer period value
Required preconditions	NA
Called functions	NA

**Example:**

```
uint32_t pr_value;
pr_value = tmr_period_value_get(TMR1);
```

## 5.19.20 tmr\_channel\_value\_set function

The table below describes the function tmr\_channel\_value\_set.

**Table 522. tmr\_channel\_value\_set function**

Name	Description
Function name	tmr_channel_value_set
Function prototype	void tmr_channel_value_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, uint32_t tmr_channel_value);
Function description	Set TMR channel value
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	tmr_channel_value: timer channel value. 0x0000~0xFFFF for 16-bit timer; 0x0000_0000~0xFFFF_FFFF for 32-bit timer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

- TMR\_SELECT\_CHANNEL\_1: Channel 1
- TMR\_SELECT\_CHANNEL\_2: Channel 2
- TMR\_SELECT\_CHANNEL\_3: Channel 3
- TMR\_SELECT\_CHANNEL\_4: Channel 4
- TMR\_SELECT\_CHANNEL\_5: Channel 5

### Example:

```
tmr_channel_value_set(TMR1, TMR_SELECT_CHANNEL_1, 0xFFFF);
```

## 5.19.21 tmr\_channel\_value\_get function

The table below describes the function tmr\_channel\_value\_get.

**Table 523. tmr\_channel\_value\_get function**

Name	Description
Function name	tmr_channel_value_get
Function prototype	uint32_t tmr_channel_value_get(tmr_type *tmr_x, tmr_channel_select_type tmr_channel);
Function description	Get TMR channel value
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Output parameter	Timer channel value
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: TMR channel 1  
 TMR\_SELECT\_CHANNEL\_2: TMR channel 2  
 TMR\_SELECT\_CHANNEL\_3: TMR channel 3  
 TMR\_SELECT\_CHANNEL\_4: TMR channel 4  
 TMR\_SELECT\_CHANNEL\_5: TMR channel 5

#### Example:

```
uint32_t ch_value;
ch_value = tmr_channel_value_get(TMR1, TMR_SELECT_CHANNEL_1);
```

## 5.19.22 tmr\_period\_buffer\_enable function

The table below describes the function tmr\_period\_buffer\_enable.

**Table 524. tmr\_period\_buffer\_enable function**

Name	Description
Function name	tmr_period_buffer_enable
Function prototype	void tmr_period_buffer_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR period buffer
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates the status of period buffer. It can be Enable (TRUE) or Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### Example:

```
tmr_period_buffer_enable(TMR1, TRUE);
```

## 5.19.23 tmr\_output\_channel\_buffer\_enable function

The table below describes the function tmr\_output\_channel\_buffer\_enable.

Table 525. tmr\_output\_channel\_buffer\_enable function

Name	Description
Function name	tmr_output_channel_buffer_enable
Function prototype	void tmr_output_channel_buffer_enable(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, confirm_state new_state);
Function description	Enable or disable TMR output channel buffer
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	new_state: indicates the status of output channel buffer. It can be Enable (TRUE) or Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

TMR\_SELECT\_CHANNEL\_5: Timer channel 5

### Example:

```
tmr_output_channel_buffer_enable(TMR1, TMR_SELECT_CHANNEL_1, TRUE);
```

## 5.19.24 tmr\_output\_channel\_immediately\_set function

The table below describes the function tmr\_output\_channel\_immediately\_set.

**Table 526. tmr\_output\_channel\_immediately\_set function**

Name	Description
Function name	tmr_output_channel_immediately_set
Function prototype	void tmr_output_channel_immediately_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, confirm_state new_state);
Function description	Enable TMR output channel immediately
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	new_state: indicates the status of output channel enable. This parameter can be Enable (TRUE) or Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

TMR\_SELECT\_CHANNEL\_5: Timer channel 5

### Example:

```
tmr_output_channel_immediately_set(TMR1, TMR_SELECT_CHANNEL_1, TRUE);
```

## 5.19.25 tmr\_output\_channel\_switch\_set function

The table below describes the function tmr\_output\_channel\_switch\_set.

**Table 527. tmr\_output\_channel\_switch\_set function**

Name	Description
Function name	tmr_output_channel_switch_set
Function prototype	void tmr_output_channel_switch_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, confirm_state new_state);
Function description	Set TMR output channel switch
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	new_state: indicates the status of output channel switch. This parameter can be Enable (TRUE) or Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**tmr\_channel:** Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

TMR\_SELECT\_CHANNEL\_5: Timer channel 5

**Example:**

```
tmr_output_channel_switch_set(TMR1, TMR_SELECT_CHANNEL_1, TRUE);
```

## 5.19.26 tmr\_one\_cycle\_mode\_enable function

The table below describes the function tmr\_one\_cycle\_mode\_enable.

**Table 528. tmr\_one\_cycle\_mode\_enable function**

Name	Description
Function name	tmr_one_cycle_mode_enable
Function prototype	void tmr_one_cycle_mode_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR one-cycle mode
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates the status of one-cycle mode. This parameter can be Enable (TRUE) or Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_one_cycle_mode_enable(TMR1, TRUE);
```

## 5.19.27 tmr\_overflow\_request\_source\_set function

The table below describes the function tmr\_overflow\_request\_source\_set.

Table 529. tmr\_overflow\_request\_source\_set function

Name	Description
Function name	tmr_overflow_request_source_set
Function prototype	void tmr_overflow_request_source_set(tmr_type *tmr_x, confirm_state new_state);
Function description	Select TMR overflow event sources
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates the overflow event source.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **new\_state**

Select an overflow event source.

FALSE: Counter overflow, OVFSWTR being set, overflow event from slave mode timer controller

TRUE: Counter overflow only.

### **Example:**

```
tmr_overflow_request_source_set(TMR1, TRUE);
```

## 5.19.28 tmr\_overflow\_event\_disable function

The table below describes the function tmr\_overflow\_event\_disable.

**Table 530. tmr\_overflow\_event\_disable function**

Name	Description
Function name	tmr_overflow_event_disable
Function prototype	void tmr_overflow_event_disable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR overflow event generation
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates the status of overflow event generation.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### new\_state

Select the status of overflow event generation.

FALSE: Enable overflow event generation, which can be generated from the following:

- Counter overflow
- Set OVFSWTR=1
- Overflow event from slave mode timer controller

TRUE: Disable overflow event generation

### Example:

```
tmr_overflow_event_disable(TMR1, TRUE);
```

## 5.19.29 tmr\_input\_channel\_init function

The table below describes the function tmr\_input\_channel\_init.

**Table 531. tmr\_input\_channel\_init function**

Name	Description
Function name	tmr_input_channel_init
Function prototype	void tmr_input_channel_init(tmr_type *tmr_x, tmr_input_config_type *input_struct, tmr_channel_input_divider_type divider_factor);
Function description	Initialize TMR input channels
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	input_struct: tmr_input_config_type pointer
Input parameter 3	divider_factor: input channel frequency division factor
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_input\_config\_type structure

tmr\_input\_config\_type is defined in the AT32M412\_416\_tmr.h:

typedef struct

{

tmr\_channel\_select\_type                                  input\_channel\_select;

```
    tmr_input_polarity_type          input_polarity_select;  
    tmr_input_direction_mapped_type input_mapped_select;  
    uint8_t                          input_filter_value;  
} tmr_input_config_type;
```

**input\_channel\_select**

Select a TMR input channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

**input\_polarity\_select**

Select the polarity of input channels.

TMR\_INPUT\_RISING\_EDGE: Rising edge

TMR\_INPUT\_FALLING\_EDGE: Falling edge

TMR\_INPUT\_BOTH\_EDGE: Both edges (Rising edge and Falling edge)

**input\_mapped\_select**

Select input channel mapping.

TMR\_CC\_CHANNEL\_MAPPED\_DIRECT:

TMR input channel 1,2,3 and 4 is linked to C1IRAW, C2IRAW, C3IRAW and C4IRAW respectively.

TMR\_CC\_CHANNEL\_MAPPED\_INDIRECT:

TMR input channel 1,2,3 and 4 is linked to C2IRAW, C1IRAW, C4IRAW and C3IRAW respectively.

TMR\_CC\_CHANNEL\_MAPPED\_STI:

TMR input channel is mapped on STI

**input\_filter\_value**

Select an input channel filter value, between 0x00~0x0F

**divider\_factor**

Select input channel frequency division factor.

TMR\_CHANNEL\_INPUT\_DIV\_1: Divided by 1

TMR\_CHANNEL\_INPUT\_DIV\_2: Divided by 2

TMR\_CHANNEL\_INPUT\_DIV\_4: Divided by 4

TMR\_CHANNEL\_INPUT\_DIV\_8: Divided by 8

**Example:**

```
tmr_input_config_type tmr_input_config_struct;  
tmr_input_config_struct.input_channel_select = TMR_SELECT_CHANNEL_2;  
tmr_input_config_struct.input_mapped_select = TMR_CC_CHANNEL_MAPPED_DIRECT;  
tmr_input_config_struct.input_polarity_select = TMR_INPUT_RISING_EDGE;  
tmr_input_config_struct.input_filter_value = 0x00;  
tmr_input_channel_init(TMR1, &tmr_input_config_struct, TMR_CHANNEL_INPUT_DIV_1);
```

### 5.19.30 tmr\_channel\_enable function

The table below describes the function tmr\_channel\_enable.

Table 532. tmr\_channel\_enable function

Name	Description
Function name	tmr_channel_enable
Function prototype	void tmr_channel_enable(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, confirm_state new_state);
Function description	Enable or disable TMR channels
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	new_state: indicates the status of timer channels. This parameter can be Enable (TRUE) or Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### tmr\_channel

Select a TMR channel.

- TMR\_SELECT\_CHANNEL\_1: Timer channel 1
- TMR\_SELECT\_CHANNEL\_1C: Complementary channel 1
- TMR\_SELECT\_CHANNEL\_2: Timer channel 2
- TMR\_SELECT\_CHANNEL\_2C: Complementary channel 2
- TMR\_SELECT\_CHANNEL\_3: Timer channel 3
- TMR\_SELECT\_CHANNEL\_3C: Complementary channel 3
- TMR\_SELECT\_CHANNEL\_4: Timer channel 4

#### Example:

```
tmr_channel_enable(TMR1, TMR_SELECT_CHANNEL_1, TRUE);
```

### 5.19.31 tmr\_input\_channel\_filter\_set function

The table below describes the function tmr\_input\_channel\_filter\_set.

**Table 533. tmr\_input\_channel\_filter\_set function**

Name	Description
Function name	tmr_input_channel_filter_set
Function prototype	void tmr_input_channel_filter_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, uint16_t filter_value);
Function description	Set TMR input channel filter
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	filter_value: set channel filter value, 0x00~0x0F
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

#### Example:

```
tmr_input_channel_filter_set(TMR1, TMR_SELECT_CHANNEL_1, 0x0F);
```

### 5.19.32 tmr\_pwm\_input\_config function

The table below describes the function tmr\_pwm\_input\_config.

**Table 534. tmr\_pwm\_input\_config function**

Name	Description
Function name	tmr_pwm_input_config
Function prototype	void tmr_pwm_input_config(tmr_type *tmr_x, tmr_input_config_type *input_struct, tmr_channel_input_divider_type divider_factor);
Function description	Configure TMR pwm input
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	input_struct: tmr_input_config_type pointer
Input parameter 3	divider_factor: input channel frequency division factor
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### input\_struct

Point to the tmr\_input\_config\_type, see [tmr\\_input\\_config\\_type](#) for details.

#### divider\_factor

Select input channel frequency division factor

TMR\_CHANNEL\_INPUT\_DIV\_1: Divided by 1

TMR\_CHANNEL\_INPUT\_DIV\_2: Divided by 2

TMR\_CHANNEL\_INPUT\_DIV\_4: Divided by 4

TMR\_CHANNEL\_INPUT\_DIV\_8: Divided by 8

**Example:**

```
tmr_input_config_type tmr_ic_init_structure;
tmr_ic_init_structure.input_filter_value = 0;
tmr_ic_init_structure.input_channel_select = TMR_SELECT_CHANNEL_2;
tmr_ic_init_structure.input_mapped_select = TMR_CC_CHANNEL_MAPPED_DIRECT;
tmr_ic_init_structure.input_polarity_select = TMR_INPUT_RISING_EDGE;
tmr_pwm_input_config(TMR1, &tmr_ic_init_structure, TMR_CHANNEL_INPUT_DIV_1);
```

### 5.19.33 tmr\_channel1\_input\_select function

The table below describes the function tmr\_channel1\_input\_select.

**Table 535. tmr\_channel1\_input\_select function**

Name	Description
Function name	tmr_channel1_input_select
Function prototype	void tmr_channel1_input_select(tmr_type *tmr_x, tmr_channel1_input_connected_type ch1_connect);
Function description	Select TMR channel 1 input
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	ch1_connect: channel 1 input selection
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**ch1\_connect**

Select channel 1 input.

TMR\_CHANNEL1\_CONNECTED\_C1IRAW: CH1 pin is connected to C1IRAW

TMR\_CHANNEL1\_2\_3\_CONNECTED\_C1IRAW\_XOR: Connect the XOR results of CH1, CH2 and CH3 pins to C1IRAW

**Example:**

```
tmr_channel1_input_select(TMR1, TMR_CHANNEL1_2_3_CONNECTED_C1IRAW_XOR);
```

### 5.19.34 tmr\_input\_channel\_divider\_set function

The table below describes the function tmr\_input\_channel\_divider\_set.

**Table 536. tmr\_input\_channel\_divider\_set function**

Name	Description
Function name	tmr_input_channel_divider_set
Function prototype	void tmr_input_channel_divider_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, tmr_channel_input_divider_type divider_factor);
Function description	Set TMR input channel divider
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	divider_factor: input channel frequency division factor
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### **tmr\_channel**

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

#### **divider\_factor**

Select input channel frequency division factor

TMR\_CHANNEL\_INPUT\_DIV\_1: Divided by 1

TMR\_CHANNEL\_INPUT\_DIV\_2: Divided by 2

TMR\_CHANNEL\_INPUT\_DIV\_4: Divided by 4

TMR\_CHANNEL\_INPUT\_DIV\_8: Divided by 8

#### **Example:**

```
tmr_input_channel_divider_set(TMR1, TMR_SELECT_CHANNEL_1, TMR_CHANNEL_INPUT_DIV_2);
```

### 5.19.35 tmr\_primary\_mode\_select function

The table below describes the function tmr\_primary\_mode\_select.

Table 537. tmr\_primary\_mode\_select function

Name	Description
Function name	tmr_primary_mode_select
Function prototype	void tmr_primary_mode_select(tmr_type *tmr_x, tmr_primary_select_type primary_mode);
Function description	Select TMR primary (master) mode
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9
Input parameter 2	primary_mode: master mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### primary\_mode

Select primary mode, that is, master timer output signal selection.

TMR_PRIMARY_SEL_RESET:	Reset
TMR_PRIMARY_SEL_ENABLE:	Enable
TMR_PRIMARY_SEL_OVERFLOW:	Overflow
TMR_PRIMARY_SEL_COMPARE:	Compare pulse
TMR_PRIMARY_SEL_C1ORAW:	C1ORAW
TMR_PRIMARY_SEL_C2ORAW:	C2ORAW
TMR_PRIMARY_SEL_C3ORAW:	C3ORAW
TMR_PRIMARY_SEL_C4ORAW:	C4ORAW

#### Example:

```
tmr_primary_mode_select(TMR1, TMR_PRIMARY_SEL_RESET);
```

### 5.19.36 tmr\_sub\_mode\_select function

The table below describes the function tmr\_sub\_mode\_select.

Table 538. tmr\_sub\_mode\_select function

Name	Description
Function name	tmr_sub_mode_select
Function prototype	void tmr_sub_mode_select(tmr_type *tmr_x, tmr_sub_mode_select_type sub_mode);
Function description	Select TMR slave timer mode
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9
Input parameter 2	sub_mode: slave timer mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### sub\_mode

Select slave timer modes.

TMR_SUB_MODE_DISABLE:	Disable
TMR_SUB_ENCODER_MODE_A:	Encoder mode A
TMR_SUB_ENCODER_MODE_B:	Encoder mode B
TMR_SUB_ENCODER_MODE_C:	Encoder mode C
TMR_SUB_RESET_MODE:	Reset
TMR_SUB_HANG_MODE:	Suspend
TMR_SUB_TRIGGER_MODE:	Trigger
TMR_SUB_EXTERNAL_CLOCK_MODE_A:	External clock A

#### Example:

```
tmr_sub_mode_select(TMR1, TMR_SUB_HANG_MODE);
```

### 5.19.37 tmr\_channel\_dma\_select function

The table below describes the function tmr\_channel\_dma\_select.

**Table 539. tmr\_channel\_dma\_select function**

Name	Description
Function name	tmr_channel_dma_select
Function prototype	void tmr_channel_dma_select(tmr_type *tmr_x, tmr_dma_request_source_type cc_dma_select);
Function description	Select TMR channel DMA request source
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	cc_dma_select: TMR channel DMA request source
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### cc\_dma\_select

Select DMA request source for TMR channels.

TMR\_DMA\_REQUEST\_BY\_CHANNEL: DMA request upon a channel event (CxIF = 1)

TMR\_DMA\_REQUEST\_BY\_OVERFLOW: DMA request upon an overflow event (OVFIF = 1)

#### Example:

```
tmr_channel_dma_select(TMR1, TMR_DMA_REQUEST_BY_OVERFLOW);
```

### 5.19.38 tmr\_hall\_select function

The table below describes the function tmr\_hall\_select

**Table 540. tmr\_hall\_select function**

Name	Description
Function name	tmr_hall_select
Function prototype	void tmr_hall_select(tmr_type *tmr_x, confirm_state new_state);
Function description	Select TMR hall mode
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates the status of TMR hall mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### new\_state

Select the status of TMR hall mode in order to refresh channel control bit.

FALSE: Refresh channel control bit through HALL

TRUE: Refresh channel control bit through HALL or the rising edge of TRGIN

#### Example:

```
tmr_hall_select(TMR1, TRUE);
```

### 5.19.39 tmr\_channel\_buffer\_enable function

The table below describes the function tmr\_channel\_buffer\_enable.

**Table 541. tmr\_channel\_buffer\_enable function**

Name	Description
Function name	tmr_channel_buffer_enable
Function prototype	void tmr_channel_buffer_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR channel buffer
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	new_state: indicates the status of TMR channel buffer. This parameter can be Enable (TRUE) or Disable (FALSE).
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_channel_buffer_enable(TMR1, TRUE);
```

### 5.19.40 tmr\_trgout2\_enable function

The table below describes the function tmr\_trgout2\_enable.

**Table 542. tmr\_trgout2\_enable function**

Name	Description
Function name	tmr_trgout2_enable
Function prototype	void tmr_trgout2_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR trigger output 2 signal
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1
Input parameter 2	new_state: indicates the status of TMR trigger output 2 signal. It can be enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_trgout2_enable(TMR1, TRUE);
```

### 5.19.41 tmr\_trigger\_input\_select function

The table below describes the function tmr\_trigger\_input\_select.

**Table 543. tmr\_trigger\_input\_select function**

Name	Description
Function name	tmr_trigger_input_select
Function prototype	void tmr_trigger_input_select(tmr_type *tmr_x, sub_tmr_input_sel_type trigger_select);
Function description	Select TMR slave timer trigger input
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9
Input parameter 2	trigger_select: select TMR slave timer trigger input
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**trigger\_select:** Select TMR slave timer trigger input.

- TMR\_SUB\_INPUT\_SEL\_IS0: Internal input 0
- TMR\_SUB\_INPUT\_SEL\_IS1: Internal input 1
- TMR\_SUB\_INPUT\_SEL\_IS2: Internal input 2
- TMR\_SUB\_INPUT\_SEL\_IS3: Internal input 3
- TMR\_SUB\_INPUT\_SEL\_C1INC: C1IRAW input detection
- TMR\_SUB\_INPUT\_SEL\_C1DF1: Filter input channel 1
- TMR\_SUB\_INPUT\_SEL\_C2DF2: Filter input channel 2
- TMR\_SUB\_INPUT\_SEL\_EXTIN: External input channel EXT

**Example:**

```
tmr_trigger_input_select(TMR1, TMR_SUB_INPUT_SEL_IS0);
```

### 5.19.42 tmr\_sub\_sync\_mode\_set function

The table below describes the function tmr\_sub\_sync\_mode\_set.

**Table 544. tmr\_sub\_sync\_mode\_set function**

Name	Description
Function name	tmr_sub_sync_mode_set
Function prototype	void tmr_sub_sync_mode_set(tmr_type *tmr_x, confirm_state new_state);
Function description	Set TMR slave timer synchronization mode
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9
Input parameter 2	new_state: indicates the status of TMR slave timer synchronization mode This parameter can be Enable (TRUE) or Disable (FALSE).
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_sub_sync_mode_set(TMR1, TRUE);
```

### 5.19.43 tmr\_dma\_request\_enable function

The table below describes the function tmr\_dma\_request\_enable.

**Table 545. tmr\_dma\_request\_enable function**

Name	Description
Function name	tmr_dma_request_enable
Function prototype	void tmr_dma_request_enable(tmr_type *tmr_x, tmr_dma_request_type dma_request, confirm_state new_state);
Function description	Enable or disable TMR DMA request
Input parameter 1	tmr_x: the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	dma_request: DMA request
Input parameter 3	new_state: the status of DMA request. This parameter can be Enable (TRUE) or Disable (FALSE).
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### dma\_request

Select a DMA request.

TMR_OVERFLOW_DMA_REQUEST:	Overflow event DMA request
TMR_C1_DMA_REQUEST:	Channel 1 DMA request
TMR_C2_DMA_REQUEST:	Channel 2 DMA request
TMR_C3_DMA_REQUEST:	Channel 3 DMA request
TMR_C4_DMA_REQUEST:	Channel 4 DMA request
TMR_HALL_DMA_REQUEST:	HALL event DMA request
TMR_TRIGGER_DMA_REQUEST:	Trigger event DMA request

#### Example:

```
tmr_dma_request_enable(TMR1, TMR_OVERFLOW_DMA_REQUEST, TRUE);
```

### 5.19.44 tmr\_interrupt\_enable function

The table below describes the function tmr\_interrupt\_enable.

**Table 546. tmr\_interrupt\_enable function**

Name	Description
Function name	tmr_interrupt_enable
Function prototype	void tmr_interrupt_enable(tmr_type *tmr_x, uint32_t tmr_interrupt, confirm_state new_state);
Function description	Enable or disable TMR interrupts
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_interrupt: TMR interrupts
Input parameter 3	new_state: indicates the status of TMR interrupts. This parameter can be Enable (TRUE) or Disable (FALSE).
Output parameter	NA
Return value	NA

Name	Description
Required preconditions	NA
Called functions	NA

**tmr\_interrupt**

Select a TMR interrupt.

TMR_OVF_INT:	Overflow event interrupt
TMR_C1_INT:	Channel 1 event interrupt
TMR_C2_INT:	Channel 2 event interrupt
TMR_C3_INT:	Channel 3 event interrupt
TMR_C4_INT:	Channel 4 event interrupt
TMR_HALL_INT:	HALL event interrupt
TMR_TRIGGER_INT:	Trigger event interrupt
TMR_BRK_INT:	Break event interrupt

**Example:**

```
tmr_interrupt_enable(TMR1, TMR_OVF_INT, TRUE);
```

### 5.19.45 tmr\_interrupt\_flag\_get function

The table below describes the function tmr\_interrupt\_flag\_get.

**Table 547. tmr\_interrupt\_flag\_get function**

Name	Description
Function name	tmr_interrupt_flag_get
Function prototype	flag_status tmr_interrupt_flag_get (tmr_type *tmr_x, uint32_t tmr_flag);
Function description	Get TMR interrupt flag status
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_flag: Flag selection Refer to the "tmr_flag" description below for details.
Output parameter	NA
Return value	flag_status: indicates the status of flags Return SET or RESET
Required preconditions	NA
Called functions	NA

**tmr\_flag**

This is used for flag selection, including:

TMR_OVF_FLAG:	Overflow interrupt flag
TMR_C1_FLAG:	Channel 1 interrupt flag
TMR_C2_FLAG:	Channel 2 interrupt flag
TMR_C3_FLAG:	Channel 3 interrupt flag
TMR_C4_FLAG:	Channel 4 interrupt flag
TMR_HALL_FLAG:	HALL interrupt flag
TMR_TRIGGER_FLAG:	Trigger interrupt flag
TMR_BRK_FLAG:	Break interrupt flag

**Example:**

```
if(tmr_interrupt_flag_get (TMR1, TMR_OVF_FLAG) != RESET)
```

### 5.19.46 tmr\_flag\_get function

The table below describes the function tmr\_flag\_get.

Table 548. tmr\_flag\_get function

Name	Description
Function name	tmr_flag_get
Function prototype	flag_status tmr_flag_get(tmr_type *tmr_x, uint32_t tmr_flag);
Function description	Get flag status
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_flag: Flag selection Refer to the “tmr_flag” description below for details.
Output parameter	NA
Return value	flag_status: indicates the status of flags Return SET or RESET
Required preconditions	NA
Called functions	NA

#### tmr\_flag

This is used for flag selection, including:

TMR_OVF_FLAG:	Overflow interrupt flag
TMR_C1_FLAG:	Channel 1 interrupt flag
TMR_C2_FLAG:	Channel 2 interrupt flag
TMR_C3_FLAG:	Channel 3 interrupt flag
TMR_C4_FLAG:	Channel 4 interrupt flag
TMR_HALL_FLAG:	HALL interrupt flag
TMR_TRIGGER_FLAG:	Trigger interrupt flag
TMR_BRK_FLAG:	Break interrupt flag
TMR_C1_RECAPTURE_FLAG:	Channel 1 recapture flag
TMR_C2_RECAPTURE_FLAG:	Channel 2 recapture flag
TMR_C3_RECAPTURE_FLAG:	Channel 3 recapture flag
TMR_C4_RECAPTURE_FLAG:	Channel 4 recapture flag

#### Example:

```
if(tmr_flag_get(TMR1, TMR_OVF_FLAG) != RESET)
```

## 5.19.47 tmr\_flag\_clear function

The table below describes the function tmr\_flag\_clear.

**Table 549. tmr\_flag\_clear function**

Name	Description
Function name	tmr_flag_clear
Function prototype	void tmr_flag_clear(tmr_type *tmr_x, uint32_t tmr_flag);
Function description	Clear flag
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_flag: flag selection Refer to <a href="#">tmr_flag</a> for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_flag_clear(TMR1, TMR_OVF_FLAG);
```

## 5.19.48 tmr\_event\_sw\_trigger function

The table below describes the function tmr\_event\_sw\_trigger

**Table 550. tmr\_event\_sw\_trigger function**

Name	Description
Function name	tmr_event_sw_trigger
Function prototype	void tmr_event_sw_trigger(tmr_type *tmr_x, tmr_event_trigger_type tmr_event);
Function description	Software triggers TMR events
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	tmr_event: select a TMR event
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**tmr\_event**

Set TMR events triggered by software.

TMR_OVERFLOW_SWTRIG:	Overflow event
TMR_C1_SWTRIG:	Channel 1 event
TMR_C2_SWTRIG:	Channel 2 event
TMR_C3_SWTRIG:	Channel 3 event
TMR_C4_SWTRIG:	Channel 4 event
TMR_HALL_SWTRIG:	HALL event
TMR_TRIGGER_SWTRIG:	Trigger event
TMR_BRK_SWTRIG:	Break event

**Example:**

```
tmr_event_sw_trigger(TMR1, TMR_OVERFLOW_SWTRIG);
```

### 5.19.49 tmr\_output\_enable function

The table below describes the function tmr\_output\_enable

**Table 551. tmr\_output\_enable function**

Name	Description
Function name	tmr_output_enable
Function prototype	void tmr_output_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR output
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	new_state: TMR output status This parameter can be Enable (TRUE) or Disable (FALSE).
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_output_enable(TMR1, TRUE);
```

### 5.19.50 tmr\_internal\_clock\_set function

The table below describes the function tmr\_internal\_clock\_set.

**Table 552. tmr\_internal\_clock\_set function**

Name	Description
Function name	tmr_internal_clock_set
Function prototype	void tmr_internal_clock_set(tmr_type *tmr_x);
Function description	Set TMR internal clock
Input parameter	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_internal_clock_set(TMR1);
```

## 5.19.51 tmr\_output\_channel\_polarity\_set function

The table below describes the function tmr\_output\_channel\_polarity\_set.

Table 553. tmr\_output\_channel\_polarity\_set function

Name	Description
Function name	tmr_output_channel_polarity_set
Function prototype	void tmr_output_channel_polarity_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, tmr_polarity_active_type oc_polarity);
Function description	Set TMR output channel polarity
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: Timer channel
Input parameter 3	oc_polarity: output channel polarity
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

- TMR\_SELECT\_CHANNEL\_1: Timer channel 1
- TMR\_SELECT\_CHANNEL\_1C: Complementary channel 1
- TMR\_SELECT\_CHANNEL\_2: Timer channel 2
- TMR\_SELECT\_CHANNEL\_2C: Complementary channel 2
- TMR\_SELECT\_CHANNEL\_3: Timer channel 3
- TMR\_SELECT\_CHANNEL\_3C: Complementary channel 3
- TMR\_SELECT\_CHANNEL\_4: Timer channel 4

### oc\_polarity

Select TMR channel polarity.

TMR\_POLARITY\_ACTIVE\_HIGH: Active high

TMR\_POLARITY\_ACTIVE\_LOW: Active low

### Example:

```
tmr_output_channel_polarity_set(TMR1, TMR_SELECT_CHANNEL_1, TMR_POLARITY_ACTIVE_HIGH);
```

## 5.19.52 tmr\_external\_clock\_enable function

The table below describes the function tmr\_external\_clock\_enable.

**Table 554. tmr\_external\_clock\_enable function**

Name	Description
Function name	tmr_external_clock_enable
Function prototype	void tmr_external_clock_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR external clock
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	new_state: TMR external clock status, TRUE (enable) or FALSE(disable)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
tmr_external_clock_enable(TMR1, TRUE);
```

## 5.19.53 tmr\_external\_clock\_config function

The table below describes the function tmr\_external\_clock\_config.

**Table 555. tmr\_external\_clock\_config function**

Name	Description
Function name	tmr_external_clock_config
Function prototype	void tmr_external_clock_config(tmr_type *tmr_x, tmr_external_signal_divider_type es_divide, tmr_external_signal_polarity_type es_polarity, uint16_t es_filter);
Function description	Configure TMR external clock
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	es_divide: external signal frequency division factor
Input parameter 3	es_polarity: external signal polarity
Input parameter 4	es_filter: external signal filter value, 0x00~0x0F
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**es\_divide**

Set TMR external signal frequency division factor.

TMR\_ES\_FREQUENCY\_DIV\_1: Divided by 1

TMR\_ES\_FREQUENCY\_DIV\_2: Divided by 2

TMR\_ES\_FREQUENCY\_DIV\_4: Divided by 4

TMR\_ES\_FREQUENCY\_DIV\_8: Divided by 8

**es\_polarity**

Select TMR external signal polarity.

TMR\_ES\_POLARITY\_NON\_INVERTED: High or rising edge

TMR\_ES\_POLARITY\_INVERTED: Low or falling edge

**Example:**

```
tmr_external_clock_config(TMR1, TMR_ES_FREQUENCY_DIV_1, TMR_ES_POLARITY_INVERTED, 0x0F);
```

## 5.19.54 tmr\_external\_clock\_mode1\_config function

The table below describes the function tmr\_external\_clock\_mode1\_config.

**Table 556. tmr\_external\_clock\_mode1\_config function**

Name	Description
Function name	tmr_external_clock_mode1_config
Function prototype	void tmr_external_clock_mode1_config(tmr_type *tmr_x, tmr_external_signal_divider_type es_divide, tmr_external_signal_polarity_type es_polarity, uint16_t es_filter);
Function description	Configure TMR external clock mode 1 (corresponding to external mode A in the reference manual)
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9
Input parameter 2	es_divide: external signal frequency division factor
Input parameter 3	es_polarity: external signal polarity
Input parameter 4	es_filter: external signal filter value, 0x00~0x0F
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**es\_divide**

Set TMR external signal frequency division factor, refer to [es\\_divide](#) for details.

**es\_polarity**

Set TMR external signal polarity, refer to [es\\_polarity](#) for details.

**Example:**

```
tmr_external_clock_mode1_config(TMR1, TMR_ES_FREQUENCY_DIV_1, TMR_ES_POLARITY_INVERTED,  
0x0F);
```

## 5.19.55 tmr\_external\_clock\_mode2\_config function

The table below describes the function tmr\_external\_clock\_mode2\_config.

Table 557. tmr\_external\_clock\_mode2\_config function

Name	Description
Function name	tmr_external_clock_mode2_config
Function prototype	void tmr_external_clock_mode2_config(tmr_type *tmr_x, tmr_external_signal_divider_type es_divide, tmr_external_signal_polarity_type es_polarity, uint16_t es_filter);
Function description	Configure TMR external clock mode 2 (corresponding to external mode B in the reference manual)
Input parameter 1	tmr_x : indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	es_divide: external signal frequency division factor
Input parameter 3	es_polarity: external signal polarity
Input parameter 4	es_filter: external signal filter value,0x00~0x0F
Output parameter	NA
Return value	NA
Input parameter 2	es_divide: external signal frequency division factor
Input parameter 3	es_polarity: external signal polarity

### es\_divide

Set TMR external signal frequency division factor, refer to [es\\_divide](#) for details.

### es\_polarity

Set TMR external signal polarity, refer to [es\\_polarity](#)

for details.

### Example:

```
tmr_external_clock_mode2_config(TMR1, TMR_ES_FREQUENCY_DIV_1, TMR_ES_POLARITY_INVERTED,  
0x0F);
```

## 5.19.56 tmr\_encoder\_mode\_config function

The table below describes the function tmr\_encoder\_mode\_config.

**Table 558. tmr\_encoder\_mode\_config function**

Name	Description
Function name	tmr_encoder_mode_config
Function prototype	void tmr_encoder_mode_config(tmr_type *tmr_x, tmr_encoder_mode_type encoder_mode, tmr_input_polarity_type ic1_polarity, tmr_input_polarity_type ic2_polarity);
Function description	Configure TMR encoder mode
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	encoder_mode: encoder mode
Input parameter 3	ic1_polarity: input channel 1 polarity
Input parameter 4	ic2_polarity: input channel 2 polarity
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### encoder\_mode

Select a TMR encoder mode.

TMR\_ENCODER\_MODE\_A: Encoder mode A

TMR\_ENCODER\_MODE\_B: Encoder mode B

TMR\_ENCODER\_MODE\_C: Encoder mode C

### ic1\_polarity

Select TMR input channel 1 polarity.

TMR\_INPUT\_RISING\_EDGE: Rising edge

TMR\_INPUT\_FALLING\_EDGE: Falling edge

TMR\_INPUT\_BOTH\_EDGE: Both edges (Rising edge and Falling edge)

### ic2\_polarity

Select TMR input channel 2 polarity.

TMR\_INPUT\_RISING\_EDGE: Rising edge

TMR\_INPUT\_FALLING\_EDGE: Falling edge

TMR\_INPUT\_BOTH\_EDGE: Both edges (Rising edge and Falling edge)

### Example:

```
tmr_encoder_mode_config(TMR1, TMR_ENCODER_MODE_A, TMR_INPUT_RISING_EDGE,
TMR_INPUT_RISING_EDGE);
```

## 5.19.57 tmr\_force\_output\_set function

The table below describes the function tmr\_force\_output\_set.

Table 559. tmr\_force\_output\_set function

Name	Description
Function name	tmr_force_output_set
Function prototype	void tmr_force_output_set(tmr_type *tmr_x, tmr_channel_select_type tmr_channel, tmr_force_output_type force_output);
Function description	Set TMR forced output
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	tmr_channel: timer channel
Input parameter 3	force_output: forced output level
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_channel

Select a TMR channel.

TMR\_SELECT\_CHANNEL\_1: Timer channel 1

TMR\_SELECT\_CHANNEL\_2: Timer channel 2

TMR\_SELECT\_CHANNEL\_3: Timer channel 3

TMR\_SELECT\_CHANNEL\_4: Timer channel 4

TMR\_SELECT\_CHANNEL\_5: Timer channel 5

### force\_output

Forced output level of output channels.

TMR\_FORCE\_OUTPUT\_HIGH: CxORAW forced high

TMR\_FORCE\_OUTPUT\_LOW: CxORAW forced low

### Example:

```
tmr_force_output_set(TMR1, TMR_SELECT_CHANNEL_1, TMR_FORCE_OUTPUT_HIGH);
```

## 5.19.58 tmr\_dma\_control\_config function

The table below describes the function tmr\_dma\_control\_config.

**Table 560. tmr\_dma\_control\_config function**

Name	Description
Function name	tmr_dma_control_config
Function prototype	void tmr_dma_control_config(tmr_type *tmr_x, tmr_dma_transfer_length_type dma_length, tmr_dma_address_type dma_base_address);
Function description	Configure TMR DMA control
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	dma_length: DMA transfer length
Input parameter 3	dma_base_address: DMA transfer offset address
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### **dma\_length**

Set DAM transfer bytes, including:

TMR\_DMA\_TRANSFER\_1BYTE: 1 byte

TMR\_DMA\_TRANSFER\_2BYTES: 2 bytes

TMR\_DMA\_TRANSFER\_3BYTES: 3 bytes

...

TMR\_DMA\_TRANSFER\_17BYTES: 17 bytes

TMR\_DMA\_TRANSFER\_18BYTES: 18 bytes

### **dma\_base\_address**

Set DMA transfer offset address, starting from TMR control register 1, including:

TMR\_CTRL1\_ADDRESS

TMR\_CTRL2\_ADDRESS

TMR\_STCTRL\_ADDRESS

TMR\_IDEN\_ADDRESS

TMRISTS\_ADDRESS

TMR\_SWEVT\_ADDRESS

TMR\_CM1\_ADDRESS

TMR\_CM2\_ADDRESS

TMR\_CCTRL\_ADDRESS

TMR\_CVAL\_ADDRESS

TMR\_DIV\_ADDRESS

TMR\_PR\_ADDRESS

TMR\_RPR\_ADDRESS

TMR\_C1DT\_ADDRESS

TMR\_C2DT\_ADDRESS

TMR\_C3DT\_ADDRESS

TMR\_C4DT\_ADDRESS

TMR\_BRK\_ADDRESS

TMR\_DMACTRL\_ADDRESS

**Example:**

```
tmr_dma_control_config(TMR1, TMR_DMA_TRANSFER_8BYTES, TMR_CTRL1_ADDRESS);
```

**5.19.59 tmr\_brkdt\_config function**

The table below describes the function tmr\_brkdt\_config.

**Table 561. tmr\_brkdt\_config function**

Name	Description
Function name	tmr_brkdt_config
Function prototype	void tmr_brkdt_config(tmr_type *tmr_x, tmr_brkdt_config_type *brkdt_struct);
Function description	Configure TMR break mode and dead time
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	brkdt_struct: tmr_brkdt_config_type pointer
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**tmr\_brkdt\_config\_type structure**

The tmr\_brkdt\_config\_type is defined in the AT32M412\_416\_tmr.h:

typedef struct

```
{
    uint8_t                deadline;
    tmr_brk_polarity_type brk_polarity;
    tmr_wp_level_type     wp_level;
    confirm_state          auto_output_enable;
    confirm_state          fcsoen_state;
    confirm_state          fcsodis_state;
    confirm_state          brk_enable;
}
```

} tmr\_brkdt\_config\_type;

**deadline**

Set dead time, between 0x00~0xFF

**brk\_polarity**

Set break input polarity

TMR\_BRK\_INPUT\_ACTIVE\_LOW: Active low

TMR\_BRK\_INPUT\_ACTIVE\_HIGH: Active high

**wp\_level**

Set write protection level.

TMR\_WP\_OFF: Write protection OFF

**TMR\_WP\_LEVEL\_3:**

Level 3 write protection, protecting the bits below:

- TMRx\_BRK: DTC, BRKEN, BRKV and AOEN
- TMRx\_CTRL2: CxIOS and CxCIOS

**TMR\_WP\_LEVEL\_2:**

Level 2 write protection, protecting the bits below in addition to level-3 protected bits:

- TMRx\_CCTRL: CxP and CxCP
- TMRx\_BRK: FCSODIS and FCSOEN

**TMR\_WP\_LEVEL\_1:**

Level 1 write protection, protecting the bits below in addition to level-2 protected bits:

- TMRx\_CMx: CxOCTRL and CxOBEN

**auto\_output\_enable**

Enable auto output, Enable (TRUE) or disable (FALSE)

**fcsoen\_state**

Indicates the frozen status when main output is ON. It is used to configure the status of complementary output channels when timer is OFF and output is enabled (OEN=1).

FALSE: Disable CxOUT/CxCOUT output

TRUE: Enable CxOUT/CxCOUT output, inactive level

**fcsodis\_state**

Indicates the frozen status when main output is OFF. It is used to configure the status of complementary output channels when timer is OFF and output is disabled (OEN=0).

FALSE: Disable CxOUT/CxCOUT output

TRUE: Enable CxOUT/CxCOUT output, idle level

**brk\_enable**

Enable break feature, Enable (TRUE) or disable (FALSE).

**Example**

```
tmr_brkdt_config_type tmr_brkdt_config_struct;
tmr_brkdt_config_struct.brk_enable = TRUE;
tmr_brkdt_config_struct.auto_output_enable = TRUE;
tmr_brkdt_config_struct.deadtime = 0;
tmr_brkdt_config_struct.fcsodis_state = TRUE;
tmr_brkdt_config_struct.fcsoen_state = TRUE;
tmr_brkdt_config_struct.brk_polarity = TMR_BRK_INPUT_ACTIVE_HIGH;
tmr_brkdt_config_struct.wp_level = TMR_WP_OFF;
tmr_brkdt_config(TMR1, &tmr_brkdt_config_struct);
```

## 5.19.60 tmr\_brk\_filter\_value\_set function

The table below describes the function tmr\_brk\_filter\_value\_set.

**Table 562. tmr\_brk\_filter\_value\_set function**

Name	Description
Function name	tmr_brk_filter_value_set
Function prototype	void tmr_brk_filter_value_set(tmr_type *tmr_x, uint8_t filter_value)
Function description	Set TMR break input filter value
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	filter_value: filter value (0x00~0x0F)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### Example

```
tmr_brk_filter_value_set(TMR1, 0x0F);
```

## 5.19.61 tmr\_brk2\_config function

The table below describes the function tmr\_brk2\_config.

**Table 563. tmr\_brk2\_config function**

Name	Description
Function name	tmr_brk2_config
Function prototype	void tmr_brk2_config(tmr_type *tmr_x, tmr_brk2_config_type *brk2_struct);
Function description	Configure TMR break 2 feature
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1
Input parameter 2	brk2_struct: pointer to the structure tmr_brk2_config_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_brk2\_config\_type structure

tmr\_brk2\_config\_type is defined in the AT32M412\_416\_tmr.h

typedef struct

```
{
    confirm_state          brk2_enable;
    tmr_brk_polarity_type brk2_polarity;
    uint8_t                brk2_filter;
}
```

} tmr\_brk2\_config\_type;

### brk2\_enable

Enable break 2: enable (TRUE) or disable (FALSE)

### brk\_polarity

Set break 2 input polarity

TMR\_BRK\_INPUT\_ACTIVE\_LOW: break 2 input active low

TMR\_BRK\_INPUT\_ACTIVE\_HIGH: break 2 input active high

#### **brk2\_filter**

break 2 filter value from 0x00 to 0x0F

#### **Example**

```
tmr_brk2_config_type tmr_brk2_config_struct;
tmr_brk2_config_struct.brk2_enable = TRUE;
tmr_brk2_config_struct.brk2_filter = 0;
tmr_brk2_config_struct.brk2_polarity = TMR_BRK_INPUT_ACTIVE_HIGH;
tmr_brk2_config(TMR1, &tmr_brk2_config_struct);
```

## **5.19.62 tmr\_input\_channel\_blk\_config function**

The table below describes the function tmr\_input\_channel\_blk\_config.

**Table 564. tmr\_input\_channel\_blk\_config function**

Name	Description
Function name	tmr_input_channel_blk_config
Function prototype	void tmr_input_channel_blk_config(tmr_type *tmr_x, tmr_blk_config_type *input_blk_struct);
Function description	Configure TMR input channel blanking feature
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR3, TMR4
Input parameter 2	input_blk_struct: pointer to the structure tmr_blk_config_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### **tmr\_blk\_config\_type structure**

tmr\_blk\_config\_type is defined in the AT32M412\_416\_tmr.h

typedef struct

```
{
    tmr_channel_select_type      input_channel_select;
    tmr_blk_state_type          input_blk_state;
    tmr_blk_source_type         blk_source_select;
    tmr_blk_source_polarity_type blk_source_polarity;
    confirm_state                blk_enable;
}
```

#### **input\_channel\_select**

Select input channel

TMR\_SELECT\_CHANNEL\_1: channel 1

TMR\_SELECT\_CHANNEL\_2: channel 2

TMR\_SELECT\_CHANNEL\_3: channel 3

TMR\_SELECT\_CHANNEL\_4: channel 4

#### **input\_blk\_state**

input blanking state

TMR\_BLK\_STATE\_LOW: blanking input signal 0 when blanking is active

TMR\_BLK\_STATE\_HIGH: blanking input signal 1 when blanking is active

#### **blk\_source\_select**

Blanking source select

TMR\_BLK\_SOURCE\_0: blanking source 0

TMR\_BLK\_SOURCE\_1: blanking source 1

TMR\_BLK\_SOURCE\_2: blanking source 2

TMR\_BLK\_SOURCE\_3: blanking source 3

#### **blk\_source\_polarity**

Set blanking source polarity

TMR\_BLK\_SOURCE\_ACTIVE\_HIGH: blanking source active high

TMR\_BLK\_SOURCE\_ACTIVE\_LOW: blanking source active low

#### **blk\_enable**

Enable blanking feature: enable (TRUE) or disable (FALSE)

#### **Example**

```
tmr_blk_config_type input_blk_struct;
input_blk_struct.input_channel_select = TMR_SELECT_CHANNEL_1;
input_blk_struct.input_blk_state = TMR_BLK_STATE_LOW;
input_blk_struct.blk_source_select = TMR_BLK_SOURCE_0;
input_blk_struct.blk_source_polarity = TMR_BLK_SOURCE_ACTIVE_HIGH;
input_blk_struct.blk_enable = TRUE;
tmr_input_channel_blk_config(TMR1, &input_blk_struct);
```

### **5.19.63 tmr\_overflow\_flag\_remap function**

The table below describes the function tmr\_overflow\_flag\_remap.

**Table 565. tmr\_overflow\_flag\_remap function**

Name	Description
Function name	tmr_overflow_flag_remap
Function prototype	void tmr_overflow_flag_remap(tmr_type *tmr_x, confirm_state new_state);
Function description	Set overflow flag remap
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Input parameter 2	new_state: TMR overflow flag remap status, enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### **Example**

```
tmr_overflow_flag_remap(TMR1, TRUE);
```

## 5.19.64 tmr\_primary\_mode2\_select function

The table below describes the function tmr\_primary\_mode2\_select.

**Table 566. tmr\_primary\_mode2\_select function**

Name	Description
Function name	tmr_primary_mode2_select
Function prototype	void tmr_primary_mode2_select(tmr_type *tmr_x, tmr_primary_select_type primary_mode);
Function description	Select TMR primary mode 2
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1
Input parameter 2	primary_mode: primary mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### primary\_mode

Select primary mode (master timer output signal select)

TMR\_PRIMARY\_SEL\_RESET: primary mode output signal select reset

TMR\_PRIMARY\_SEL\_ENABLE: primary mode outout signal select enable

TMR\_PRIMARY\_SEL\_OVERFLOW: primary mode outout signal select overflow

TMR\_PRIMARY\_SEL\_COMPARE: primary mode outout signal select compare pulse

TMR\_PRIMARY\_SEL\_C1ORAW: primary mode outout signal select C1ORAW

TMR\_PRIMARY\_SEL\_C2ORAW: primary mode outout signal select C2ORAW

TMR\_PRIMARY\_SEL\_C3ORAW: primary mode outout signal select C3ORAW

TMR\_PRIMARY\_SEL\_C4ORAW: primary mode outout signal select C4ORAW

TMR\_PRIMARY\_SEL\_C5ORAW: primary mode outout signal select C5ORAW

TMR\_PRIMARY\_SEL\_C6ORAW: primary mode outout signal select C6ORAW

TMR\_PRIMARY\_SEL\_C4ORAW\_EDGE: primary mode outout signal select C4ORAW edge

TMR\_PRIMARY\_SEL\_C6ORAW\_EDGE: primary mode outout signal select C4ORAW edge

TMR\_PRIMARY\_SEL\_C4\_RISING\_C6\_RISING: primary mode outout signal select C4 and C6 rising edge

TMR\_PRIMARY\_SEL\_C4\_RISING\_C6\_FALLING: primary mode outout signal select C4 rising edge and C6 falling edge

TMR\_PRIMARY\_SEL\_C5\_RISING\_C6\_RISING: primary mode outout signal select C5 and C6 rising edge

TMR\_PRIMARY\_SEL\_C5\_RISING\_C6\_FALLING: primary mode outout signal select C5 rising edge and C6 falling edge

### Example

```
tmr_primary_mode2_select(TMR1, TMR_PRIMARY_SEL_RESET);
```

## 5.19.65 tmr\_coraw\_clear\_set function

The table below describes the function tmr\_coraw\_clear\_set.

**Table 567. tmr\_coraw\_clear\_set function**

Name	Description
Function name	tmr_coraw_clear_set
Function prototype	void tmr_coraw_clear_set(tmr_type *tmr_x, tmr_coraw_clear_type coraw_clear);
Function description	Set TMR CORAW clear source
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	coraw_clear: CORAW clear source
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### coraw\_clear

Set TMR CORAW clear source.

TMR\_CORAW\_CLR\_EXT: CORAW cleared by EXT

TMR\_CORAW\_CLR\_CMP1: CORAW cleared by CMP1

TMR\_CORAW\_CLR\_CMP2: CORAW cleared by CMP2

### Example

```
tmr_coraw_clear_set(TMR1, TMR_CORAW_CLR_EXT);
```

## 5.19.66 tmr\_overflow\_cpy\_get function

The table below describes the function tmr\_overflow\_cpy\_get

**Table 568. tmr\_overflow\_cpy\_get function**

Name	Description
Function name	tmr_overflow_cpy_get
Function prototype	flag_status tmr_overflow_cpy_get(tmr_type *tmr_x);
Function description	Get copied overflow flag status
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR6, TMR7, TMR9, TMR10, TMR11
Output parameter	NA
Return value	flag_status: copied overflow flag status This parameter can be SET or RESET
Required preconditions	NA
Called functions	NA

### Example

```
if(tmr_overflow_cpy_get(TMR1) != RESET)
```

## 5.19.67 tmr\_brk\_bidir\_enable function

The table below describes the function tmr\_brk\_bidir\_enable

Table 569. tmr\_brk\_bidir\_enable function

Name	Description
Function name	tmr_brk_bidir_enable
Function prototype	void tmr_brk_bidir_enable(tmr_type *tmr_x, tmr_brk_type brk_sel, confirm_state new_state);
Function description	Enable or disable TMR bidirectional break
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	brk_sel: break select
Input parameter 3	new_state: TMR bidirectional break status: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### brk\_sel

Select break

TMR\_BRK\_SELECT\_1: break 1

TMR\_BRK\_SELECT\_2: break 2

### Example

```
tmr_brk_bidir_enable(TMR1, TMR_BRK_SELECT_1, TRUE);
```

## 5.19.68 tmr\_brk\_release function

The table below describes the function tmr\_brk\_release

**Table 570. tmr\_brk\_release function**

Name	Description
Function name	tmr_brk_release
Function prototype	void tmr_brk_release(tmr_type *tmr_x, tmr_brk_type brk_sel);
Function description	Release break output
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	brk_sel: break select
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### brk\_sel

Select break

TMR\_BRK\_SELECT\_1: break 1

TMR\_BRK\_SELECT\_2: break 2

### Example

```
tmr_brk_release(TMR1, TMR_BRK_SELECT_1);
```

## 5.19.69 tmr\_brk\_release\_check function

The table below describes the function tmr\_brk\_release\_check

**Table 571. tmr\_brk\_release\_check function**

Name	Description
Function name	tmr_brk_release_check
Function prototype	tmr_brk_release_status tmr_brk_release_check(tmr_type *tmr_x, tmr_brk_type brk);
Function description	Check whether break is released
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	brk_sel: break select
Output parameter	NA
Return value	tmr_brk_release_status: break release status The return value may be TMR_BRK_RELEASED or TMR_BRK_UNRELEASED
Required preconditions	NA
Called functions	NA

### brk\_sel

Select break

TMR\_BRK\_SELECT\_1: break 1

TMR\_BRK\_SELECT\_2: break 2

### Example

```
if(tmr_brk_release_check (TMR1, TMR_BRK_SELECT_1) != TMR_BRK_RELEASED)
```

## 5.19.70 tmr\_ch5\_combined\_set function

The table below describes the function tmr\_ch5\_combined\_set

**Table 572. tmr\_ch5\_combined\_set function**

Name	Description
Function name	tmr_ch5_combined_set
Function prototype	void tmr_ch5_combined_set(tmr_type *tmr_x, uint32_t ch5_comb);
Function description	Set TMR channel 5 combined mode
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1
Input parameter 2	ch5_comb: channel 5 combined mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### ch5\_comb

Set TMR channel 5 combined mode.

- TMR\_CH5\_COMBINED\_NONE: Chaneel 5 combined mode OFF
- TMR\_CH5\_COMBINED\_C1ORAW: Channel 5 and channel 1 combined
- TMR\_CH5\_COMBINED\_C2ORAW: Channel 5 and channel 2 combined
- TMR\_CH5\_COMBINED\_C3ORAW: Channel 5 and channel 3 combined

### Example

```
tmr_ch5_combined_set(TMR1, TMR_CH5_COMBINED_C1ORAW);
```

## 5.19.71 tmr\_brk\_input\_config function

The table below describes the function tmr\_brk\_input\_config

**Table 573. tmr\_brk\_input\_config function**

Name	Description
Function name	tmr_brk_input_config
Function prototype	void tmr_brk_input_config(tmr_type *tmr_x, tmr_brkin_config_type *brkin_struct);
Function description	Configure TMR break input channel
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR9, TMR10, TMR11
Input parameter 2	brk_sel: break select
Input parameter 3	brkin_struct: pointer to the structure tmr_brkin_config_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### tmr\_brkin\_config\_type structure

tmr\_brkin\_config\_type is defined in the AT32M412\_416\_tmr.h

typedef struct

```
{
    tmr_brk_type          brk_sel;
    tmr_brkin_src_type    source;
```

```

    confirm_state          enable;
    tmr_brkin_pol_type   polarity;
} tmr_brkin_config_type;

brk_sel
Select break
TMR_BRK_SELECT_1: break 1
TMR_BRK_SELECT_2: break 2

source
Select break input source
TMR_BRKIN_SOURCE_BRKIN: BRKIN
TMR_BRKIN_SOURCE_CMP1: CMP1
TMR_BRKIN_SOURCE_CMP2: CMP2

enable
Enable break input source: enable (TRUE) or disable (FALSE)

polarity
Set break input source polarity
TMR_BRKIN_SRC_POL_HIGH: break input source high
TMR_BRKIN_SRC_POL_LOW: break input source low

```

**Example**

```

tmr_brkin_config_type brkin_struct;
brkin_struct.source = TMR_BRKIN_SOURCE_BRKIN;
brkin_struct.enable = TRUE;
brkin_struct.polarity = TMR_BRKIN_SRC_POL_HIGH;
tmr_brk_input_config(TMR1, &brkin_struct);

```

## 5.19.72 tmr\_external\_source\_select function

The table below describes the function tmr\_external\_source\_select

**Table 574. tmr\_external\_source\_select function**

Name	Description
Function name	tmr_external_source_select
Function prototype	void tmr_external_source_select(tmr_type *tmr_x, uint32_t ext_src);
Function description	Select TMR external input channel source
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4
Input parameter 2	ext_src: external input source
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**ext\_src**

Select external input source

TMR\_EXT\_SOURCE\_GPIO: GPIO  
 TMR\_EXT\_SOURCE\_CMP1: CMP1  
 TMR\_EXT\_SOURCE\_CMP2: CMP2  
 For TMR1, the user can select the following source:  
 TMR\_EXT\_SOURCE\_ADC1\_VM: ADC1\_VM

TMR\_EXT\_SOURCE\_ADC2\_VM: ADC2\_VM

For TMR3, the user can select the following source:

TMR\_EXT\_SOURCE\_TMR4\_EXT: TMR4\_EXT

For TMR4, the user can select the following source:

TMR\_EXT\_SOURCE\_TMR3\_EXT: TMR3\_EXT

#### Example

```
tmr_external_source_select(TMR1, TMR_EXT_SOURCE_GPIO);
```

### 5.19.73 tmr\_input\_ch\_select function

The table below describes the function tmr\_input\_ch\_select

Table 575. tmr\_input\_ch\_select function

Name	Description
Function name	tmr_input_ch_select
Function prototype	void tmr_input_ch_select(tmr_type *tmr_x, uint32_t ch_src);
Function description	Select TMR input channel source
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1, TMR3, TMR4, TMR9, TMR10, TMR11
Input parameter 2	ch_src: input channel source
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### ch\_src

Input channel source:

For TMR1:

TMR\_TMR1\_CH1\_GPIO

TMR\_TMR1\_CH1\_CMP1

TMR\_TMR1\_CH1\_CMP2

TMR\_TMR1\_CH2\_GPIO

TMR\_TMR1\_CH2\_CMP1

TMR\_TMR1\_CH2\_CMP2

For TMR3:

TMR\_TMR3\_CH1\_GPIO

TMR\_TMR3\_CH1\_CMP1

TMR\_TMR3\_CH1\_CMP2

TMR\_TMR3\_CH1\_TMR4CH1

TMR\_TMR3\_CH2\_GPIO

TMR\_TMR3\_CH2\_CMP1

TMR\_TMR3\_CH2\_CMP2

TMR\_TMR3\_CH2\_TMR4CH2

TMR\_TMR3\_CH3\_GPIO

TMR\_TMR3\_CH3\_CMP1

TMR\_TMR3\_CH3\_TMR4CH3

TMR\_TMR3\_CH4\_GPIO

TMR\_TMR3\_CH4\_CMP2

For TMR4:

TMR\_TMR4\_CH1\_GPIO  
TMR\_TMR4\_CH1\_CMP1  
TMR\_TMR4\_CH1\_CMP2  
TMR\_TMR4\_CH1\_TMR3CH1  
TMR\_TMR4\_CH2\_GPIO  
TMR\_TMR4\_CH2\_CMP1  
TMR\_TMR4\_CH2\_CMP2  
TMR\_TMR4\_CH2\_TMR3CH2  
TMR\_TMR4\_CH3\_GPIO  
TMR\_TMR4\_CH3\_CMP2  
TMR\_TMR4\_CH3\_TMR3CH3  
TMR\_TMR4\_CH4\_GPIO  
TMR\_TMR4\_CH4\_CMP1

For TMR9:

TMR\_TMR9\_CH1\_GPIO  
TMR\_TMR9\_CH1\_CMP1  
TMR\_TMR9\_CH1\_CMP2  
TMR\_TMR9\_CH2\_GPIO  
TMR\_TMR9\_CH2\_CMP1  
TMR\_TMR9\_CH2\_CMP2

For TMR10:

TMR\_TMR10\_CH1\_GPIO  
TMR\_TMR10\_CH1\_CMP1  
TMR\_TMR10\_CH1\_CMP2

For TMR11:

TMR\_TMR11\_CH1\_GPIO  
TMR\_TMR11\_CH1\_CMP1  
TMR\_TMR11\_CH1\_CMP2  
TMR\_TMR11\_CH1\_CLKOUT  
TMR\_TMR11\_CH1\_HEXTDIV  
TMR\_TMR11\_CH1\_ERTCCLK  
TMR\_TMR11\_CH1\_LEXT  
TMR\_TMR11\_CH1\_LICK

### Example

```
tmr_input_ch_select(TMR1, TMR_TMR1_CH1_CMP1);
```

## 5.19.74 tmr\_iasym\_mode\_enable function

The table below describes the function tmr\_iasym\_mode\_enable

**Table 576. tmr\_iasym\_mode\_enable function**

Name	Description
Function name	tmr_iasym_mode_enable
Function prototype	void tmr_iasym_mode_enable(tmr_type *tmr_x, confirm_state new_state);
Function description	Enable or disable TMR isolated asymmetric PWM mode
Input parameter 1	tmr_x: indicates the selected TMR peripheral, it can be TMR1
Input parameter 2	new_state: TMR output status, enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### Example

```
tmr_iasym_mode_enable(TMR1, TRUE);
```

## 5.20 Universal synchronous/asynchronous receiver/transmitter (USART)

The USART register structure usart\_type is defined in the ““AT32M412\_416\_usart.h”:

```
/*
 * @brief type define usart register all
 */
typedef struct
{
    ...
} usart_type;
```

The table below gives a list of the USART registers

**Table 577. Summary of USART registers**

Register	Description
sts	Status register
dt	Data register
baudr	Baud rate register
ctrl1	Control register 1
ctrl2	Control register 2
ctrl3	Control register 3
gdiv	Guard time and divider Control register 1

The table below gives a list of USART library functions.

**Table 578. Summary of USART library functions**

Function name	Description
usart_reset	Reset USART peripheral registers
usart_init	Set baud rate, data bits and stop bits.
usart_parity_selection_config	Parity selection
usart_enable	Enable USART peripherals
usart_transmitter_enable	Enable USART transmitter
usart_receiver_enable	Enable USART receiver
usart_clock_config	Set clock polarity and phases for synchronization
usart_clock_enable	Set clock output for synchronization
usart_interrupt_enable	Enable interrupts
usart_dma_transmitter_enable	Enable DMA transmitter
usart_dma_receiver_enable	Enable DMA receiver
usart_wakeup_id_set	Set wakeup ID
usart_wakeup_mode_set	Set wakeup mode
usart_receiver_mute_enable	Enable receiver mute mode
usart_break_bit_num_set	Set break frame length
usart_lin_mode_enable	Enable LIN mode
usart_data_transmit	Data transmit
usart_data_receive	Data receive

uart_break_send	Send break frame
uart_smartcard_guard_time_set	Set smartcard guard time
uart_irda_smartcard_division_set	Set infrared and smartcard division
uart_smartcard_mode_enable	Enable smartcard mode
uart_smartcard_nack_set	Enable smartcard NACK
uart_single_line_halfduplex_select	Enable single-wire half-duplex mode
uart_irda_mode_enable	Enable infrared mode
uart_irda_low_power_enable	Enable infrared low-power mode
uart_hardware_flow_control_set	Enable hardware flow control
uart_flag_get	Get flag
uart_interrupt_flag_get	Get USART interrupt flag status
uart_flag_clear	Clear flag
uart_rs485_delay_time_config	Set latency for starting or ending consecutive data transmission in RS 485
uart_transmit_receive_pin_swap	Swap transmit/receive pins
uart_id_bit_num_set	Set ID bit count
uart_de_polarity_set	DE signal polarity selection
uart_rs485_mode_enable	RS485 mode enable
uart_low_power_wakeup_set	Set low-power wakeup
uart_deep_sleep_mode_enable	Deepsleep mode enable
uart_msb_transmit_first_enable	Enable MSB-first transmission
uart_dt_polarity_reverse	Enable data polarity reverse mode
uart_transmit_pin_polarity_reverse	Enable data transmit pin polarity reverse mode
uart_receive_pin_polarity_reverse	Enable data receive pin polarity reverse mode
uart_receiver_timeout_detection_enable	Enable data receive timeout detection
uart_receiver_timeout_value_set	Set data receive timeout value

### 5.20.1 usart\_reset function

The table below describes the function usart\_reset.

**Table 579. usart\_reset function**

Name	Description
Function name	usart_reset
Function prototype	void usart_reset(usart_type* usart_x);
Function description	Reset USART peripheral registers
Input parameter 1	usart_x: indicates the selected peripherals, it can be USART1 or, USART2,
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	crm_periph_reset

**Example:**

```
/* reset usart1 */
usart_reset(USART1);
```

## 5.20.2 usart\_init function

The table below describes the function usart\_init.

Table 580. usart\_init function

Name	Description
Function name	usart_init
Function prototype	void usart_init(usart_type* usart_x, uint32_t baud_rate, usart_data_bit_num_type data_bit, usart_stop_bit_num_type stop_bit);
Function description	Set baud rate, data bits and stop bits.
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	baud_rate: baud rate for serial interfaces
Input parameter 3	data_bit: data bit width for serial interfaces
Input parameter 4	stop_bit: stop bit width for serial interfaces
Output parameter	NA
Return value	NA
Required preconditions	This operation can be allowed only when external low-speed clock is disabled.
Called functions	NA

### data\_bit

Select data bit size for serial interface communication.

USART\_DATA\_8BITS: 8-bit

USART\_DATA\_9BITS: 9-bit

### stop\_bit

Select stop bit size for serial interface communication.

USART\_STOP\_1\_BIT: 1 bit

USART\_STOP\_0\_5\_BIT: 0.5 bit

USART\_STOP\_2\_BIT: 2 bit

USART\_STOP\_1\_5\_BIT: 1.5 bit

### Example:

```
/* configure uart param */  
usart_init(USART1, 115200, USART_DATA_8BITS, USART_STOP_1_BIT);
```

### 5.20.3 usart\_parity\_selection\_config function

The table below describes the function usart\_parity\_selection\_config.

**Table 581. usart\_parity\_selection\_config function**

Name	Description
Function name	usart_parity_selection_config
Function prototype	void usart_parity_selection_config(usart_type* usart_x, usart_parity_selection_type parity);
Function description	Parity selection
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	Parity: parity mode for serial interface communication
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### parity

Select parity mode for serial interface communication.

USART\_PARITY\_NONE: No parity

USART\_PARITY EVEN: Even

USART\_PARITY ODD: Odd

#### Example:

```
/* config usart even parity */
usart_parity_selection_config(USART1, USART_PARITY EVEN);
```

### 5.20.4 usart\_enable function

The table below describes the function usart\_enable.

**Table 582. usart\_enable function**

Name	Description
Function name	usart_enable
Function prototype	void usart_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable USART
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	new_state: Enable (TRUE) and disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### Example:

```
/* enable usart1 */
usart_enable(USART1, TRUE);
```

## 5.20.5 usart\_transmitter\_enable function

The table below describes the function usart\_transmitter\_enable.

**Table 583. usart\_transmitter\_enable function**

Name	Description
Function name	usart_transmitter_enable
Function prototype	void usart_transmitter_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable USART transmitter
Input parameter 1	usart_x: indicates the selected peripheral it can be USART1 or, USART2,
Input parameter 2	new_state: Enable (TRUE) and disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable usart1 transmitter */  
usart_transmitter_enable(USART1, TRUE);
```

## 5.20.6 usart\_receiver\_enable function

The table below describes the function usart\_receiver\_enable.

**Table 584. usart\_receiver\_enable function**

Name	Description
Function name	usart_receiver_enable
Function prototype	void usart_receiver_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable USART receiver
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	new_state: Enable (TRUE) and disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable usart1 receiver */  
usart_receiver_enable(USART1, TRUE);
```

## 5.20.7 usart\_clock\_config function

The table below describes the function usart\_clock\_config.

**Table 585. usart\_clock\_config function**

Name	Description
Function name	usart_clock_config
Function prototype	void usart_clock_config(usart_type* usart_x, usart_clock_polarity_type clk_pol, usart_clock_phase_type clk_pha, usart_lbcp_type clk_lb);
Function description	Configure clock polarity and phase for synchronization feature
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	clk_pol: clock polarity for synchronization
Input parameter 3	clk_pha: clock phase for synchronization
Input parameter 4	clk_lb: selects whether to output clock on the last bit (upper bit) of data sent through synchronization feature
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### clk\_pol

Clock polarity selection.

USART\_CLOCK\_POLARITY\_LOW: Low

USART\_CLOCK\_POLARITY\_HIGH: High

### clk\_pha

Clock phase selection.

USART\_CLOCK\_PHASE\_1EDGE: 1<sup>st</sup> edge

USART\_CLOCK\_PHASE\_2EDGE: 2<sup>nd</sup> edge

### clk\_lb

Select whether to output clock on the last bit of data.

USART\_CLOCK\_LAST\_BIT\_NONE: No clock output

USART\_CLOCK\_LAST\_BIT\_OUTPUT: Clock output

### Example:

```
/* config synchronous mode */  
usart_clock_config(USART1, USART_CLOCK_POLARITY_HIGH, USART_CLOCK_PHASE_2EDGE,  
USART_CLOCK_LAST_BIT_OUTPUT);
```

## 5.20.8 usart\_clock\_enable function

The table below describes the function usart\_clock\_enable.

**Table 586. usart\_clock\_enable function**

Name	Description
Function name	usart_clock_enable
Function prototype	void usart_clock_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable clock output
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable clock */
usart_clock_enable(USART1, TRUE);
```

## 5.20.9 usart\_interrupt\_enable function

The table below describes the function usart\_interrupt\_enable.

**Table 587. usart\_interrupt\_enable function**

Name	Description
Function name	usart_interrupt_enable
Function prototype	void usart_interrupt_enable(usart_type* usart_x, uint32_t usart_int, confirm_state new_state);
Function description	Enable interrupts
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or, USART2,
Input parameter 2	usart_int: interrupt type
Input parameter 3	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**usart\_int**

Defines a peripheral interrupt.

USART_IDLE_INT:	Bus idle
USART_RDBF_INT:	Receive data buffer full
USART_TDC_INT:	Transmit data complete
USART_TDBE_INT:	Transmit data buffer empty
USART_PERR_INT:	Parity error
USART_BF_INT:	Break frame receive
USART_ERR_INT:	Error interrupt
USART_CTSCF_INT:	CTS (Clear To Send) change
USART_CMD_INT:	byte match detection interrupt
USART_RTOD_INT:	receiver timeout detection interrupt

**Example:**

```
/* enable usart1 transmit complete interrupt */
usart_interrupt_enable (USART1, USART_TDC_INT, TRUE);
```

**5.20.10 usart\_dma\_transmitter\_enable function**

The table below describes the function usart\_dma\_transmitter\_enable.

**Table 588. usart\_dma\_transmitter\_enable function**

Name	Description
Function name	usart_dma_transmitter_enable
Function prototype	void usart_dma_transmitter_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable DMA transmitter
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable dma transmitter */
usart_dma_transmitter_enable (USART1, TRUE);
```

**5.20.11 usart\_dma\_receiver\_enable function**

The table below describes the function usart\_dma\_receiver\_enable.

**Table 589. usart\_dma\_receiver\_enable function**

Name	Description
Function name	usart_dma_receiver_enable
Function prototype	void usart_dma_receiver_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable DMA receiver
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable dma receiver */
usart_dma_receiver_enable (USART1, TRUE);
```

## 5.20.12 usart\_wakeup\_id\_set function

The table below describes the function usart\_wakeup\_id\_set.

**Table 590. usart\_wakeup\_id\_set function**

Name	Description
Function name	usart_wakeup_id_set
Function prototype	void usart_wakeup_id_set(usart_type* usart_x, uint8_t usart_id);
Function description	Set wakeup ID
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	usart_id: wakeup ID
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* config wakeup id */
usart_wakeup_id_set (USART1, 0x88);
```

## 5.20.13 usart\_wakeup\_mode\_set function

The table below describes the function usart\_wakeup\_mode\_set.

**Table 591. usart\_wakeup\_mode\_set function**

Name	Description
Function name	usart_wakeup_mode_set
Function prototype	void usart_wakeup_mode_set(usart_type* usart_x, usart_wakeup_mode_type wakeup_mode);
Function description	Set wakeup mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	wakeup_mode: wakeup mode
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**wakeup\_mode**

Set wakeup mode to wake up from silent state.

USART\_WAKEUP\_BY\_IDLE\_FRAME: Woke up by idle frame

USART\_WAKEUP\_BY\_MATCHING\_ID: Woke up by ID matching

**Example:**

```
/* config usart1 wakeup mode */
usart_wakeup_mode_set (USART1, USART_WAKEUP_BY_MATCHING_ID);
```

## 5.20.14 usart\_receiver\_mute\_enable function

The table below describes the function usart\_receiver\_mute\_enable.

**Table 592. usart\_receiver\_mute\_enable function**

Name	Description
Function name	usart_receiver_mute_enable
Function prototype	void usart_receiver_mute_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable USART receiver mute mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* config receiver mute */
usart_receiver_mute_enable (USART1, TRUE);
```

## 5.20.15 usart\_break\_bit\_num\_set function

The table below describes the function usart\_break\_bit\_num\_set.

**Table 593. usart\_break\_bit\_num\_set function**

Name	Description
Function name	usart_break_bit_num_set
Function prototype	void usart_break_bit_num_set(usart_type* usart_x, usart_break_bit_num_type break_bit);
Function description	Set USART break frame length
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	break_bit: break frame length type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**break\_bit**

Set break frame length.

USART\_BREAK\_10BITS: 10 bits

USART\_BREAK\_11BITS: 11 bits

**Example:**

```
/* config break frame length 10bits */
usart_break_bit_num_set (USART1, USART_BREAK_10BITS);
```

## 5.20.16 usart\_lin\_mode\_enable function

The table below describes the function usart\_lin\_mode\_enable.

**Table 594. usart\_lin\_mode\_enable function**

Name	Description
Function name	usart_lin_mode_enable
Function prototype	void usart_lin_mode_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable LIN mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable usart1 lin mode */
usart_lin_mode_enable (USART1, TRUE);
```

## 5.20.17 usart\_data\_transmit function

The table below describes the function usart\_data\_transmit.

**Table 595. usart\_data\_transmit function**

Name	Description
Function name	usart_data_transmit
Function prototype	void usart_data_transmit(usart_type* usart_x, uint16_t data);
Function description	Transmit data
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	Data: data to send
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* transmit data */
uint16_t data = 0x88;
usart_data_transmit (USART1, data);
```

## 5.20.18 usart\_data\_receive function

The table below describes the function usart\_data\_receive.

**Table 596. usart\_data\_receive function**

Name	Description
Function name	usart_data_receive
Function prototype	uint16_t usart_data_receive(usart_type* usart_x);
Function description	Receives data
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	NA
Output parameter	NA
Return value	uint16_t: return the received data
Required preconditions	NA
Called functions	NA

**Example:**

```
/* receive data */  
uint16_t data = 0;  
data = usart_data_receive (USART1);
```

## 5.20.19 usart\_break\_send function

The table below describes the function usart\_break\_send.

**Table 597. usart\_break\_send function**

Name	Description
Function name	usart_break_send
Function prototype	void usart_break_send(usart_type* usart_x);
Function description	Sends break frame
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* send break frame */  
usart_break_send (USART1);
```

## 5.20.20 usart\_smartcard\_guard\_time\_set function

The table below describes the function usart\_smartcard\_guard\_time\_set.

**Table 598. usart\_smartcard\_guard\_time\_set function**

Name	Description
Function name	usart_smartcard_guard_time_set
Function prototype	void usart_smartcard_guard_time_set(usart_type* usart_x, uint8_t guard_time_val);
Function description	Set smartcard guard time
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	guard_time_val: guard time, 0x00~0xFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* usart guard time set to 2 bit */
usart_smartcard_guard_time_set(USART1, 0x2);
```

## 5.20.21 usart\_irda\_smartcard\_division\_set function

The table below describes the function usart\_irda\_smartcard\_division\_set.

**Table 599. usart\_irda\_smartcard\_division\_set function**

Name	Description
Function name	usart_irda_smartcard_division_set
Function prototype	void usart_irda_smartcard_division_set(usart_type* usart_x, uint8_t div_val);
Function description	Infrared and smartcard frequency division settings
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	div_val: division value
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* usart clock set to (apbclk / (2 * 20)) */
usart_irda_smartcard_division_set(USART1, 20);
```

## 5.20.22 usart\_smartcard\_mode\_enable function

The table below describes the function usart\_smartcard\_mode\_enable.

**Table 600. usart\_smartcard\_mode\_enable function**

Name	Description
Function name	usart_smartcard_mode_enable
Function prototype	void usart_smartcard_mode_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable smartcode mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE), Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable the smartcard mode */
usart_smartcard_mode_enable(USART1, TRUE);
```

## 5.20.23 usart\_smartcard\_nack\_set function

The table below describes the function usart\_smartcard\_nack\_set.

**Table 601. usart\_smartcard\_nack\_set function**

Name	Description
Function name	usart_smartcard_nack_set
Function prototype	void usart_smartcard_nack_set(usart_type* usart_x, confirm_state new_state);
Function description	Enable smartcard NACK
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE), Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable the nack transmission */
usart_smartcard_nack_set(USART1, TRUE);
```

## 5.20.24 usart\_single\_line\_halfduplex\_select function

The table below describes the function usart\_single\_line\_halfduplex\_select.

**Table 602. usart\_single\_line\_halfduplex\_select function**

Name	Description
Function name	usart_single_line_halfduplex_select
Function prototype	void usart_single_line_halfduplex_select(usart_type* usart_x, confirm_state new_state);
Function description	Enable single-wire half-duplex mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE), Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable halfduplex */
usart_single_line_halfduplex_select(USART1, TRUE);
```

## 5.20.25 usart\_irda\_mode\_enable function

The table below describes the function usart\_irda\_mode\_enable.

**Table 603. usart\_irda\_mode\_enable function**

Name	Description
Function name	usart_irda_mode_enable
Function prototype	void usart_irda_mode_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable infrared mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE), Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable irda mode */
usart_irda_mode_enable(USART1, TRUE);
```

## 5.20.26 usart\_irda\_low\_power\_enable function

The table below describes the function usart\_irda\_low\_power\_enable.

**Table 604. usart\_irda\_low\_power\_enable function**

Name	Description
Function name	usart_irda_low_power_enable
Function prototype	void usart_irda_low_power_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable infrared low-power mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: Enable (TRUE), Disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable irda lowpower mode */
usart_irda_low_power_enable (USART1, TRUE);
```

## 5.20.27 usart\_hardware\_flow\_control\_set function

The table below describes the function usart\_hardware\_flow\_control\_set.

**Table 605. usart\_hardware\_flow\_control\_set function**

Name	Description
Function name	usart_hardware_flow_control_set
Function prototype	void usart_hardware_flow_control_set(usart_type* usart_x, usart_hardware_flow_control_type flow_state);
Function description	Set peripheral hardware flow control
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	flow_state: flow control type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**flow\_state**

USART_HARDWARE_FLOW_NONE:	No hardware flow control
USART_HARDWARE_FLOW_RTS:	RTS
USART_HARDWARE_FLOW_CTS:	CTS
USART_HARDWARE_FLOW_RTS_CTS:	RTS and CTS

**Example:**

```
/* hardware flow set none */
usart_hardware_flow_control_set (USART1, USART_HARDWARE_FLOW_NONE);
```

## 5.20.28 usart\_flag\_get function

The table below describes the function usart\_flag\_get.

Table 606. usart\_flag\_get function

Name	Description
Function name	usart_flag_get
Function prototype	flag_status usart_flag_get(usart_type* usart_x, uint32_t flag);
Function description	Get flag status
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	Flag: flag
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

### flag

USART_CMDF_FLAG:	Byte match detection flag
USART_RTODF_FLAG:	Receiver timeout detection flag
USART_CTSCF_FLAG:	CTS (Clear To Send) change flag
USART_BFF_FLAG:	Break frame receive flag
USART_TDBE_FLAG:	Transmit buffer empty flag
USART_TDC_FLAG:	Transmit complete flag
USART_RDBF_FLAG:	Receive data buffer full flag
USART_IDLEF_FLAG:	Idle frame flag
USART_ROERR_FLAG:	Receive overflow flag
USART_NERR_FLAG:	Noise error flag
USART_FERR_FLAG:	Frame error flag
USART_PERR_FLAG:	Parity error flag

### Example:

```
/* wait data transmit complete flag */
while(usart_flag_get (USART1, USART_TDC_FLAG) == RESET);
```

## 5.20.29 usart\_interrupt\_flag\_get function

The table below describes the function usart\_interrupt\_flag\_get.

**Table 607. usart\_interrupt\_flag\_get function**

Name	Description
Function name	usart_interrupt_flag_get
Function prototype	flag_status usart_interrupt_flag_get(usart_type* usart_x, uint32_t flag);
Function description	Check whether a flag is set or not
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	Flag: clear the selected flag
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

### flag

USART_RTODF_FLAG:	Receiver timeout detection flag
USART_CMDF_FLAG:	Byte match detection flag
USART_CTSCF_FLAG:	CTS (Clear To Send) change flag
USART_BFF_FLAG:	Break frame receive flag
USART_TDBE_FLAG:	Transmit buffer empty flag
USART_TDC_FLAG:	Transmit complete flag
USART_RDBF_FLAG:	Receive data buffer full flag
USART_IDLEF_FLAG:	Idle frame flag
USART_ROERR_FLAG:	Receive overflow flag
USART_NERR_FLAG:	Noise error flag
USART_FERR_FLAG:	Frame error flag
USART_PERR_FLAG:	Parity error flag

### Example:

```
/* check received data flag */
if(usart_interrupt_flag_get(USART1, USART_RDBF_FLAG) != RESET)
{
}
```

### 5.20.30 usart\_flag\_clear function

The table below describes the function usart\_flag\_clear.

**Table 608. usart\_flag\_clear function**

Name	Description
Function name	usart_flag_clear
Function prototype	void usart_flag_clear(usart_type* usart_x, uint32_t flag);
Function description	Clear flag
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	Flag: clear the selected flag
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### flag

USART_CMDF_FLAG:	Byte match detection interrupt
USART_RTODF_FLAG:	Receiver timeout detection interrupt
USART_CTSCF_FLAG:	CTS (Clear To Send) change flag
USART_BFF_FLAG:	Break frame receive flag
USART_TDC_FLAG:	Transmit complete flag
USART_RDBF_FLAG:	Receive data buffer full flag

#### Example:

```
/* clear data transmit complete flag */
usart_flag_clear (USART1, USART_TDC_FLAG );
```

### 5.20.31 usart\_rs485\_delay\_time\_config function

The table below describes the function usart\_rs485\_delay\_time\_config.

**Table 609. usart\_flag\_clear function**

Name	Description
Function name	usart_rs485_delay_time_config
Function prototype	void usart_rs485_delay_time_config(usart_type* usart_x, uint8_t start_delay_time, uint8_t complete_delay_time);
Function description	Delay time for setting and clearing data valid signal for continuous data transmission in RS485 mode
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	start_delay_time: After the first data is written in continuous transmit mode, data valid signal is set and “start_delay_time” is inserted before sending data. The time unit is 1/16 baud rate period.
Input parameter 3	complete_delay_time: After the last data is sent in continuous transmit mode, the “complete_delay_time” is inserted before clearing data valid signal. The time unit is 1/16 baud rate period.
Output parameter	NA
Return value	NA
Required preconditions	NA

Name	Description
Called functions	NA

**Example:**

```
/* config rs485 delay time */
uart_rs485_delay_time_config(USART1, 2, 2);
```

### 5.20.32 usart\_transmit\_receive\_pin\_swap function

The table below describes the function usart\_transmit\_receive\_pin\_swap.

**Table 610. usart\_transmit\_receive\_pin\_swap function**

Name	Description
Function name	usart_transmit_receive_pin_swap
Function prototype	void usart_transmit_receive_pin_swap(usart_type* usart_x, confirm_state new_state);
Function description	Swap transmit/receive pins
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable tx/rx swap */
uart_transmit_receive_pin_swap (USART1, TRUE);
```

### 5.20.33 usart\_id\_bit\_num\_set function

The table below describes the function usart\_id\_bit\_num\_set.

**Table 611. usart\_transmit\_receive\_pin\_swap function**

Name	Description
Function name	usart_id_bit_num_set
Function prototype	void usart_id_bit_num_set(usart_type* usart_x, usart_identification_bit_num_type id_bit_num);
Function description	Set ID bit number
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	id_bit_num: ID bit count
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**id\_bit\_num**

USART\_ID\_FIXED\_4\_BIT: 4-bit ID

USART\_ID RELATED DATA BIT: Current data bit -1

**Example:**

```
/* config ID bit width */
uart_id_bit_num_set (USART1, USART_ID_FIXED_4_BIT);
```

## 5.20.34 usart\_de\_polarity\_set function

The table below describes the function usart\_de\_polarity\_set.

**Table 612. usart\_de\_polarity\_set function**

Name	Description
Function name	usart_de_polarity_reverse
Function prototype	void usart_de_polarity_reverse(usart_type* usart_x, confirm_state new_state);
Function description	DE signal polarity selection
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: new state: Enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* config DE polarity */
usart_de_polarity_reverse (USART1, ENABLE);
```

## 5.20.35 usart\_rs485\_mode\_enable function

The table below describes the function usart\_rs485\_mode\_enable.

**Table 613. usart\_rs485\_mode\_enable function**

Name	Description
Function name	usart_rs485_mode_enable
Function prototype	void usart_rs485_mode_enable(usart_type* usart_x, confirm_state new_state);
Function description	RS485 mode enable
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable rs485 mode */
usart_rs485_mode_enable (USART1, TRUE);
```

### 5.20.36 usart\_msb\_transmit\_first\_enable function

The table below describes the function usart\_msb\_transmit\_first\_enable

**Table 614. usart\_msb\_transmit\_first\_enable function**

Name	Description
Function name	usart_msb_transmit_first_enable
Function prototype	void usart_msb_transmit_first_enable(usart_type* usart_x, confirm_state new_state);
Function description	Enable MSB-first transmit
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable msb first transmission */
usart_msb_transmit_first_enable (USART1, ENABLE);
```

### 5.20.37 usart\_dt\_polarity\_reverse function

The table below describes the function usart\_dt\_polarity\_reverse

**Table 615. usart\_dt\_polarity\_reverse function**

Name	Description
Function name	usart_dt_polarity_reverse
Function prototype	void usart_dt_polarity_reverse(usart_type* usart_x, confirm_state new_state);
Function description	Reverse data polarity
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* reverse data polarity */
usart_dt_polarity_reverse (USART1, ENABLE);
```

### 5.20.38 usart\_transmit\_pin\_polarity\_reverse function

The table below describes the function usart\_dt\_polarity\_reverse

**Table 616. usart\_dt\_polarity\_reverse function**

Name	Description
Function name	usart_transmit_pin_polarity_reverse
Function prototype	void usart_transmit_pin_polarity_reverse(usart_type* usart_x, confirm_state new_state);
Function description	Reverse data transmit pin polarity
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* reverse transmit pin polarity */
usart_transmit_pin_polarity_reverse (USART1, ENABLE);
```

### 5.20.39 usart\_receive\_pin\_polarity\_reverse function

The table below describes the function usart\_receive\_pin\_polarity\_reverse

**Table 617. usart\_receive\_pin\_polarity\_reverse function**

Name	Description
Function name	usart_receive_pin_polarity_reverse
Function prototype	usart_receive_pin_polarity_reverse (usart_type* usart_x, confirm_state new_state);
Function description	Reverse data receive pin polarity
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* reverse receive pin polarity */
usart_receive_pin_polarity_reverse (USART1, ENABLE);
```

## 5.20.40 usart\_receiver\_timeout\_detection\_enable function

The table below describes the function usart\_receiver\_timeout\_detection\_enable

**Table 618. usart\_receiver\_timeout\_detection\_enable function**

Name	Description
Function name	usart_receiver_timeout_detection_enable
Function prototype	usart_receiver_timeout_detection_enable (usart_type* usart_x, confirm_state new_state);
Function description	Enable data receive timeout detection
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	new_state: enabled (TRUE) or disabled (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* enable receive timeout detection */
usart_receiver_timeout_detection_enable (USART1, ENABLE);
```

## 5.20.41 usart\_receiver\_timeout\_value\_set function

The table below describes the function usart\_receiver\_timeout\_value\_set

**Table 619. usart\_receiver\_timeout\_value\_set function**

Name	Description
Function name	usart_receiver_timeout_value_set
Function prototype	void usart_receiver_timeout_value_set(usart_type* usart_x, uint32_t time);
Function description	Set data receive timeout value
Input parameter 1	usart_x: indicates the selected peripheral, it can be USART1 or USART2
Input parameter 2	Time: Set data receive timeout threshold
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
/* configure receive timeout value */
usart_receiver_timeout_value_set (USART1, 32);
```

## 5.21 Watchdog timer (WDT)

The WDT register structure `wdt_type` is defined in the “AT32M412\_416\_wdt.h”:

```
/**  
 * @brief type define wdt register all  
 */  
  
typedef struct  
{  
  
} wdt_type;
```

The table below gives a list of the WDT registers

**Table 620. Summary of WDT registers**

Register	Description
cmd	Command register
div	Divider register
rld	Reload register
sts	Status register
win	Window register

The table below gives a list of WDT library functions.

**Table 621. Summary of WDT library functions**

Function name	Description
wdt_enable	Enable watchdog
wdt_counter_reload	Reload counter
wdt_reload_value_set	Set reload value
wdt_divider_set	Set division value
wdt_register_write_enable	Unlock WDT_DIV and WDT_RLD register write protection
wdt_flag_get	Get flag
wdt_window_counter_set	Set window counter

## 5.21.1 wdt\_enable function

The table below describes the function wdt\_enable.

**Table 622. wdt\_enable function**

Name	Description
Function name	wdt_enable
Function prototype	void wdt_enable(void);
Function description	Enable watchdog
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wdt_enable();
```

## 5.21.2 wdt\_counter\_reload function

The table below describes the function wdt\_counter\_reload.

**Table 623. wdt\_counter\_reload function**

Name	Description
Function name	wdt_counter_reload
Function prototype	void wdt_counter_reload(void);
Function description	Reload counter
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wdt_counter_reload();
```

### 5.21.3 wdt\_reload\_value\_set function

The table below describes the function wdt\_reload\_value\_set.

**Table 624. wdt\_reload\_value\_set function**

Name	Description
Function name	wdt_reload_value_set
Function prototype	void wdt_reload_value_set(uint16_t reload_value);
Function description	Set reload value
Input parameter	reload_value: reload value, 0x000~0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wdt_reload_value_set(0xFFFF);
```

### 5.21.4 wdt\_divider\_set function

The table below describes the function wdt\_divider\_set.

**Table 625. wdt\_divider\_set function**

Name	Description
Function name	wdt_divider_set
Function prototype	void wdt_divider_set(wdt_division_type division);
Function description	Set division value
Input parameter	Division: watchdog division value Refer to the “division” description below for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

#### division

Select watchdog division value.

WDT\_CLK\_DIV\_4: Divided by 4

WDT\_CLK\_DIV\_8: Divided by 8

WDT\_CLK\_DIV\_16: Divided by 16

WDT\_CLK\_DIV\_32: Divided by 32

WDT\_CLK\_DIV\_64: Divided by 64

WDT\_CLK\_DIV\_128: Divided by 128

WDT\_CLK\_DIV\_256: Divided by 256

**Example:**

```
wdt_divider_set(WDT_CLK_DIV_4);
```

## 5.21.5 `wdt_register_write_enable` function

The table below describes the function `wdt_register_write_enable`.

**Table 626. `wdt_register_write_enable` function**

Name	Description
Function name	<code>wdt_register_write_enable</code>
Function prototype	<code>void wdt_register_write_enable( confirm_state new_state);</code>
Function description	Unlock WDT_DIV and WDT_RLD write protection
Input parameter	new_state: unlock register write protection This parameter can be TRUE or FALSE.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wdt_register_write_enable(TRUE);
```

## 5.21.6 `wdt_flag_get` function

The table below describes the function `wdt_flag_get`.

**Table 627. `wdt_flag_get` function**

Name	Description
Function name	<code>wdt_flag_get</code>
Function prototype	<code>flag_status wdt_flag_get(uint16_t wdt_flag);</code>
Function description	Get flag
Input parameter	Flag: flag selection Refer to the "flag" description below for details.
Output parameter	NA
Return value	flag_status: flag status This parameter can be SET or RESET.
Required preconditions	NA
Called functions	NA

### flag

This is used for flag selection, including:

`WDT_DIVF_UPDATE_FLAG`: Division value update complete

`WDT_RLDF_UPDATE_FLAG`: Reload value update complete

`WDT_WINF_UPDATE_FLAG`: Window value update complete

**Example:**

```
wdt_flag_get(WDT_DIVF_UPDATE_FLAG);
```

## 5.21.7 `wdt_window_counter_set` function

The table below describes the function `wdt_window_counter_set`.

**Table 628. `wdt_window_counter_set` function**

Name	Description
Function name	<code>wdt_window_counter_set</code>
Function prototype	<code>void wdt_window_counter_set(uint16_t window_cnt);</code>
Function description	Set window counter
Input parameter	<code>window_cnt</code> : window value, from 0x000 to 0xFFFF
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wdt_window_counter_set(0x7FF);
```

## 5.22 Window watchdog timer (WWDT)

The WWDT register structure wwdt\_type is defined in the “AT32M412\_416\_wwdt.h”:

```
/**  
 * @brief type define wwdt register all  
 */  
  
typedef struct  
{  
  
} wwdt_type;
```

The table below gives a list of the WWDT registers

**Table 629. Summary of WWDT registers**

Register	Description
ctrl	Control register
cfg	Configuration register
sts	Status register

The table below gives a list of WWDT library functions.

**Table 630. Summary of WWDT library functions**

Function name	Description
wwdt_reset	Reset window watchdog registers
wwdt_divider_set	Set divider
wwdt_flag_clear	Clear reload counter interrupt flag
wwdt_enable	Enable WWDT
wwdt_interrupt_enable	Enable reload counter interrupt
wwdt_flag_get	Get flag
wwdt_counter_set	Set counter value
wwdt_window_counter_set	Set window value

## 5.22.1 wwdt\_reset function

The table below describes the function wwdt\_reset.

**Table 631. wwdt\_reset function**

Name	Description
Function name	wwdt_reset
Function prototype	void wwdt_reset(void);
Function description	Reset window watchdog registers to their initial values.
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	void crm_periph_reset(crm_periph_reset_type value, confirm_state new_state);

**Example:**

```
wwdt_reset();
```

## 5.22.2 wwdt\_divider\_set function

The table below describes the function wwdt\_divider\_set.

**Table 632. wwdt\_divider\_set function**

Name	Description
Function name	wwdt_divider_set
Function prototype	void wwdt_divider_set(wwdt_division_type division);
Function description	Set divider
Input parameter	Division: WWDT division value Refer to the “division” description below for details.
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### division

Select WWDT division value.

WWDT\_PCLK1\_DIV\_4096: Divided by 4096

WWDT\_PCLK1\_DIV\_8192: Divided by 8192

WWDT\_PCLK1\_DIV\_16384: Divided by 16384

WWDT\_PCLK1\_DIV\_32768: Divided by 32768

**Example:**

```
wwdt_divider_set(WWDT_PCLK1_DIV_4096);
```

### 5.22.3 wwdt\_enable function

The table below describes the function wwdt\_enable.

**Table 633. wwdt\_enable function**

Name	Description
Function name	wwdt_enable
Function prototype	void wwdt_enable(uint8_t wwdt_cnt);
Function description	Enable WWDT
Input parameter	wwdt_cnt: WWDT counter initial value, 0x40~0x7F
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_enable(0x7F);
```

### 5.22.4 wwdt\_interrupt\_enable function

The table below 3 describes the function wwdt\_interrupt\_enable.

**Table 634. wwdt\_interrupt\_enable function**

Name	Description
Function name	wwdt_interrupt_enable
Function prototype	void wwdt_interrupt_enable(void);
Function description	Enable reload counter interrupt
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_interrupt_enable();
```

### 5.22.5 wwdt\_counter\_set function

The table below describes the function wwdt\_counter\_set.

**Table 635. wwdt\_counter\_set function**

Name	Description
Function name	wwdt_counter_set
Function prototype	void wwdt_counter_set(uint8_t wwdt_cnt);
Function description	Set counter value
Input parameter	wwdt_cnt: WWDT counter value, 0x40~0x7F
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_counter_set(0x7F);
```

## 5.22.6 wwdt\_window\_counter\_set function

The table below describes the function wwdt\_window\_counter\_set.

**Table 636. wwdt\_window\_counter\_set function**

Name	Description
Function name	wwdt_window_counter_set
Function prototype	void wwdt_window_counter_set(uint8_t window_cnt);
Function description	Set window counter value
Input parameter	wwdt_cnt: WWDT window value, 0x40~0x7F
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_window_counter_set(0x6F);
```

## 5.22.7 wwdt\_flag\_get function

The table below describes the function wwdt\_flag\_get.

**Table 637. wwdt\_flag\_get function**

Name	Description
Function name	wwdt_flag_get
Function prototype	flag_status wwdt_flag_get(void);
Function description	Get reload counter interrupt flag
Input parameter	NA
Output parameter	NA
Return value	flag_status: flag status Return SET or RESET
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_flag_get();
```

## 5.22.8 wwdt\_interrupt\_flag\_get function

The table below describes the function wwdt\_interrupt\_flag\_get.

**Table 638. wwdt\_interrupt\_flag\_get function**

Name	Description
Function name	wwdt_interrupt_flag_get
Function prototype	flag_status wwdt_interrupt_flag_get(void);
Function description	Get reload counter interrupt flag status, and check the corresponding interrupt enable bit
Input parameter	NA
Output parameter	NA
Return value	flag_status: SET or RESET
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_interrupt_flag_get();
```

## 5.22.9 wwdt\_flag\_clear function

The table below describes the function wwdt\_flag\_clear.

**Table 639. wwdt\_flag\_clear function**

Name	Description
Function name	wwdt_flag_clear
Function prototype	void wwdt_flag_clear(void);
Function description	Clear reload counter interrupt flag
Input parameter	NA
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
wwdt_flag_clear();
```

## 5.23 Comparator (CMP)

The CMP register structure cmp\_type is defined in the “AT32M412\_416\_wwdt.h”:

```
/**  
 * @brief type define cmp register all  
 */  
  
typedef struct  
{  
  
} cmp_type;
```

The table below gives a list of CMP registers

**Table 640. Summary of CMP registers**

Register	Description
ctrlsts	Control and status register
g_filter_en	Glitch filter enable register
high_pulse	Glitch filter high pulse register
low_pulse	Glitch filter low pulse register

The table below gives a list of CMP library functions.

**Table 641. Summary of CMP library functions**

Function name	Description
cmp_init	Initialize CMP peripheral
cmp_default_para_init	Initialize CMP default parameters
cmp_enable	Enable or disable comparator
cmp_output_value_get	Get comparator output value
cmp_write_protect_enable	Enable CMP write protection
cmp_filter_config	Configure CMP glitch high/low pulse
cmp_blanking_config	Configure CMP blanking

## 5.23.1 cmp\_init function

The table below describes the function cmp\_init

**Table 642. cmp\_init function**

Name	Description
Function name	cmp_init
Function prototype	cmp_init(cmp_sel_type cmp_sel, cmp_init_type* cmp_init_struct);
Function description	Initialize CMP peripheral
Input parameter 1	cmp_sel: select a comparator to initialize
Input parameter 2	cmp_init_struct: pointer to the cmp_init_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### cmp\_sel

Select a comparator to initialize.

CMP1\_SELECTION: CMP 1

CMP2\_SELECTION: CMP 2

### cmp\_init\_type structure

cmp\_init\_type is defined in the at32m412\_416\_cmp.h

typedef struct

```
{
    cmp_non_inverting_type      cmp_non_inverting;
    cmp_inverting_type          cmp_inverting;
    cmp_speed_type              cmp_speed;
    cmp_polarity_type           cmp_polarity;
    cmp_hysteresis_type         cmp_hysteresis;
}
```

### cmp\_non\_inverting

Configure CMP non-inverting input port.

CMP\_NON\_INVERTING\_INP0: CMP non-inverting input port 0

CMP\_NON\_INVERTING\_INP1: CMP non-inverting input port 1

CMP\_NON\_INVERTING\_INP2: CMP non-inverting input port 2

CMP\_NON\_INVERTING\_INP3: CMP non-inverting input port 3

### cmp\_inverting

Configure CMP inverting input port.

CMP\_INVERTING\_INM0: CMP inverting input port 0

CMP\_INVERTING\_INM1: CMP inverting input port 1

CMP\_INVERTING\_INM2: CMP inverting input port 2

CMP\_INVERTING\_INM3: CMP inverting input port 3

CMP\_INVERTING\_INM4: CMP inverting input port 4

CMP\_INVERTING\_INM5: CMP inverting input port 5

CMP\_INVERTING\_INM6: CMP inverting input port 6

CMP\_INVERTING\_INM7: CMP inverting input port 7

### cmp\_speed

Set CMP speed

CMP\_SPEED\_FAST: Fast speed/large power consumption  
 CMP\_SPEED\_MEDIUM: Medium speed/medium power consumption  
 CMP\_SPEED\_SLOW: Slow speed/slow power consumption  
 CMP\_SPEED\_ULTRALOW: Ultra-slow speed/ultra-slow power consumption

**cmp\_polarity**

Set CMP output polarity

CMP\_POL\_NON\_INVERTING: CMP output polarity non-inverting  
 CMP\_POL\_INVERTING: CMP output polarity inverting

**cmp\_hysteresis**

Set CMP hysteresis mode

CMP\_HYSTERESIS\_NONE: No hysteresis  
 CMP\_HYSTERESIS\_LOW: Low hysteresis  
 CMP\_HYSTERESIS\_MEDIUM: Medium hysteresis  
 CMP\_HYSTERESIS\_HIGH: High hysteresis

**Example:**

```
cmp_init_type cmp_init_struct;
cmp_default_para_init(&cmp_init_struct);
cmp_init_struct.cmp_non_inverting = CMP_NON_INVERTING_INP1;
cmp_init_struct.cmp_inverting = CMP_INVERTING_INM2;
cmp_init_struct.cmp_polarity = CMP_POL_NON_INVERTING;
cmp_init_struct.cmp_speed = CMP_SPEED_FAST;
cmp_init_struct.cmp_hysteresis = CMP_HYSTERESIS_NONE;
cmp_init(CMP1_SELECTION, &cmp_init_struct);
```

## 5.23.2 cmp\_default\_para\_initfunction

The table below describes the function cmp\_default\_para\_init

**Table 643. cmp\_default\_para\_init function**

Name	Description
Function name	cmp_default_para_init
Function prototype	void cmp_default_para_init(cmp_init_type *cmp_init_struct);
Function description	Initialize CMP default parameters
Input parameter 1	cmp_init_type: pointer to the cmp_init_type
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

The table below describes the default values of the cmp\_init\_type.

**Table 644. cmp\_init\_type default values**

Parameter	Default values
cmp_non_inverting	CMP_NON_INVERTING_INP0
cmp_inverting	CMP_INVERTING_INM0
cmp_speed	CMP_SPEED_FAST
cmp_polarity	CMP_POL_NON_INVERTING
cmp_hysteresis	CMP_HYSTERESIS_NONE

**Example:**

```
cmp_init_type cmp_init_struct;
cmp_default_para_init(&cmp_init_struct);
```

### 5.23.3 cmp\_enable function

The table below describes the function cmp\_enable.

**Table 645. cmp\_enable function**

Name	Description
Function name	cmp_enable
Function prototype	void cmp_enable(cmp_sel_type cmp_sel, confirm_state new_state);
Function description	Enable or disable CMP
Input parameter 1	cmp_sel: select a comparator, see " <a href="#">cmp_sel</a> " for value range.
Input parameter 2	new_state: enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
cmp_enable(CMP1_SELECTION, TRUE);
```

### 5.23.4 cmp\_output\_value\_get function

The table below describes the function cmp\_output\_value\_get.

**Table 646. cmp\_output\_value\_get function**

Name	Description
Function name	cmp_output_value_get
Function prototype	uint32_t cmp_output_value_get(cmp_sel_type cmp_sel);
Function description	Get CMP output value
Input parameter	cmp_sel: select a CMP, see " <a href="#">cmp_sel</a> " for value range
Output parameter	NA
Return value	Get CMP output value
Required preconditions	NA
Called functions	NA

**Example:**

```
uint32_t cmp_value;
cmp_value = cmp_output_value_get(CMP1_SELECTION);
```

## 5.23.5 cmp\_write\_protect\_enable function

The table below describes the function cmp\_write\_protect\_enable.

**Table 647. cmp\_write\_protect\_enable function**

Name	Description
Function name	cmp_write_protect_enable
Function prototype	void cmp_write_protect_enable(cmp_sel_type cmp_sel);
Function description	Enable CMP write protection
Input parameter	cmp_sel: select a CMP, see " <a href="#">cmp_sel</a> " for value range
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
cmp_write_protect_enable(CMP1_SELECTION);
```

## 5.23.6 cmp\_filter\_config function

The table below describes the function cmp\_filter\_config.

**Table 648. cmp\_filter\_config function**

Name	Description
Function name	cmp_filter_config
Function prototype	cmp_filter_config(cmp_sel_type cmp_sel, uint16_t high_pulse_cnt, uint16_t low_pulse_cnt, confirm_state new_state);
Function description	Configure glitch filter high pulse and low pulse count
Input parameter 1	cmp_sel: select a CMP, see " <a href="#">cmp_sel</a> " for value range
Input parameter 2	high_pulse_cnt: high pulse count 0x00~0x3F
Input parameter 3	low_pulse_cnt: low pulse count 0x00~0x3F
Input parameter 4	new_state: enable (TRUE) or disable (FALSE)
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

**Example:**

```
cmp_filter_config(CMP1_SELECTION, 0x3F, 0x00, TRUE);
```

## 5.23.7 cmp\_blankning\_config function

The table below describes the function cmp\_blankning\_config.

**Table 649. cmp\_blankning\_config function**

Name	Description
Function name	cmp_blankning_config
Function prototype	void cmp_blankning_config(cmp_sel_type cmp_sel, cmp_blankning_type blank_sel);
Function description	Configure CMP blanking source
Input parameter 1	cmp_sel: select a CMP, see " <a href="#">cmp_sel</a> " for value range
Input parameter 2	blank_sel: select blanking source
Output parameter	NA
Return value	NA
Required preconditions	NA
Called functions	NA

### blank\_sel

Select blanking source.

CMP\_BLANKING\_NONE: no blanking function

CMP\_BLANKING\_TMR1\_CH4: TMR1 channel 4

CMP\_BLANKING\_TMR1\_CH5: TMR1 channel 5

CMP\_BLANKING\_TMR3\_CH3: TMR3 channel 3

CMP\_BLANKING\_TMR9\_CH2: TMR9 channel 2

CMP\_BLANKING\_TMR9\_CH1: TMR9 channel 1

CMP\_BLANKING\_TMR4\_CH3: TMR4 channel 3

### Example:

```
cmp_blankning_config(CMP1_SELECTION, CMP_BLANKING_TMR1_CH4);
```

## 6 Precautions

### 6.1 Device model replacement

While replacing the device part number in an existing project or demo with another one, if necessary, it is necessary to check the macro definitions corresponding to the device defined in [Table 1](#) before replacement. The subsequent sections give a detailed description of how to replace a device in KEIL and IAR environments (Just taking the at32f403avgt7 as an example as other devices share similar operations).

There are two steps to get this happen:

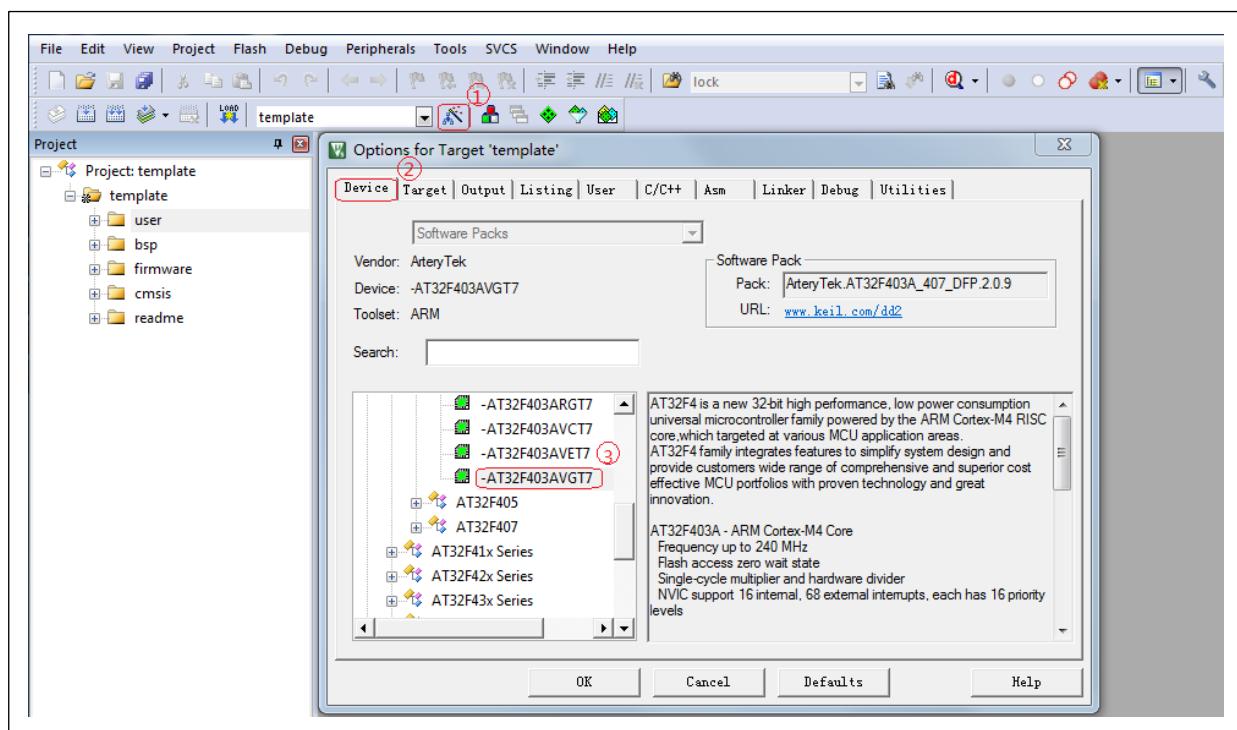
1. By changing device
2. By changing macro definition

#### 6.1.1 KEIL environment

Follow the steps and illustration below for device replacement in Keil environment:

- ① Click on magic stick “Options for Target”
- ② Click on “Device”
- ③ Select the desired device part number

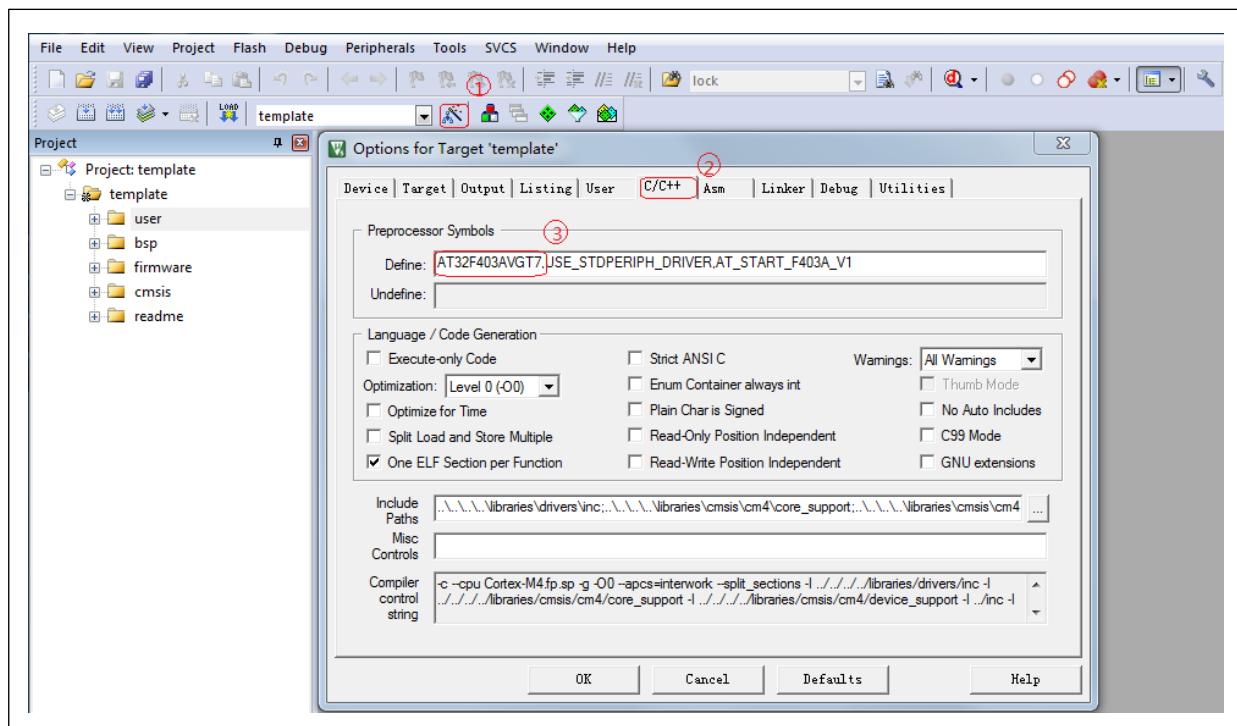
**Figure 29. Change device part number in Keil**



Follow the steps and illustration below to change macro definition.

- ① Click on magic stick “Options for Target”
- ② Click on “C/C++”
- ③ Delete the original macro definition in “Define” box, and write the desired one corresponding to the selected device part number based o [Table 1](#).

Figure 30. Change macro definition in Keil

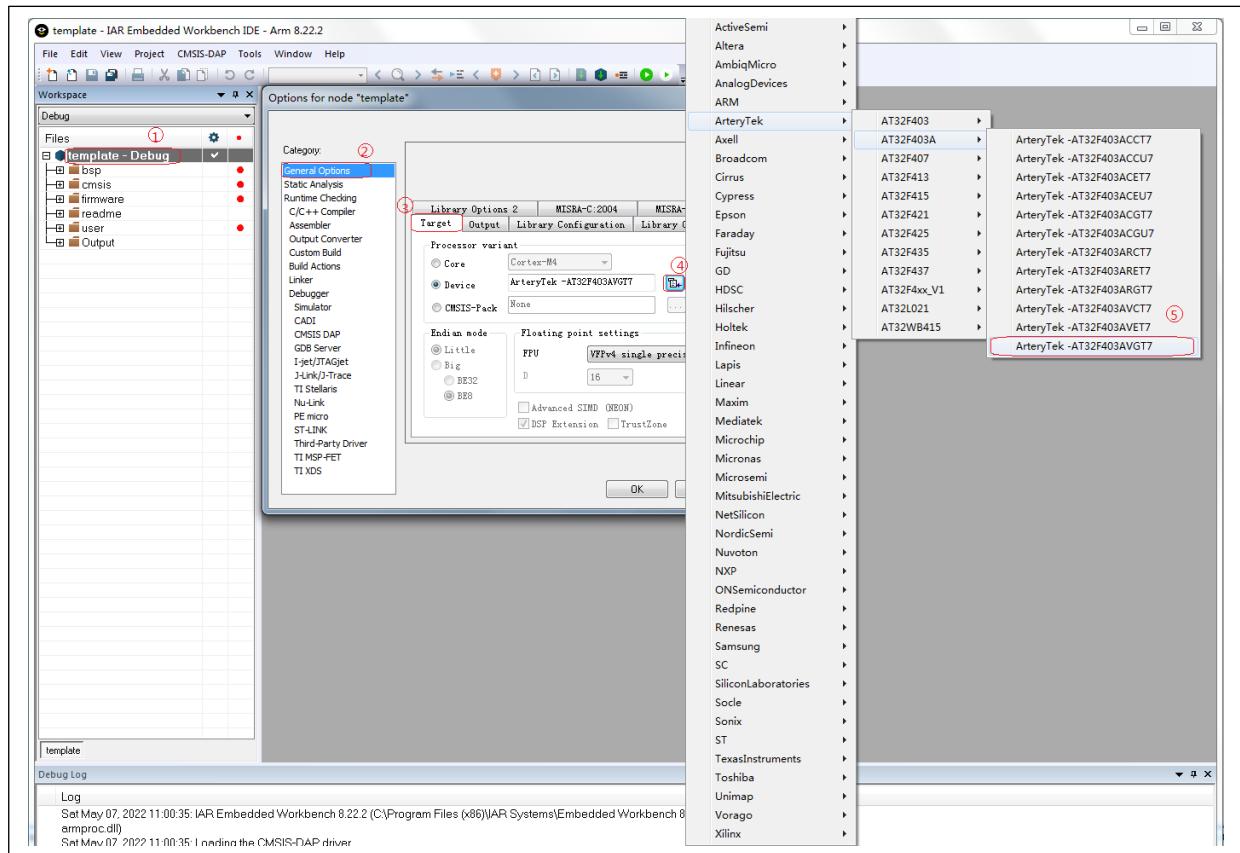


## 6.1.2 IAR environment

Follow the steps and illustration below for device replacement in IAR environment.

- ① Right click on the file name, and select “Options...”
- ② Select “General Options”
- ③ Select “Target”
- ④ Click on check box
- ⑤ Select the desired device part number.

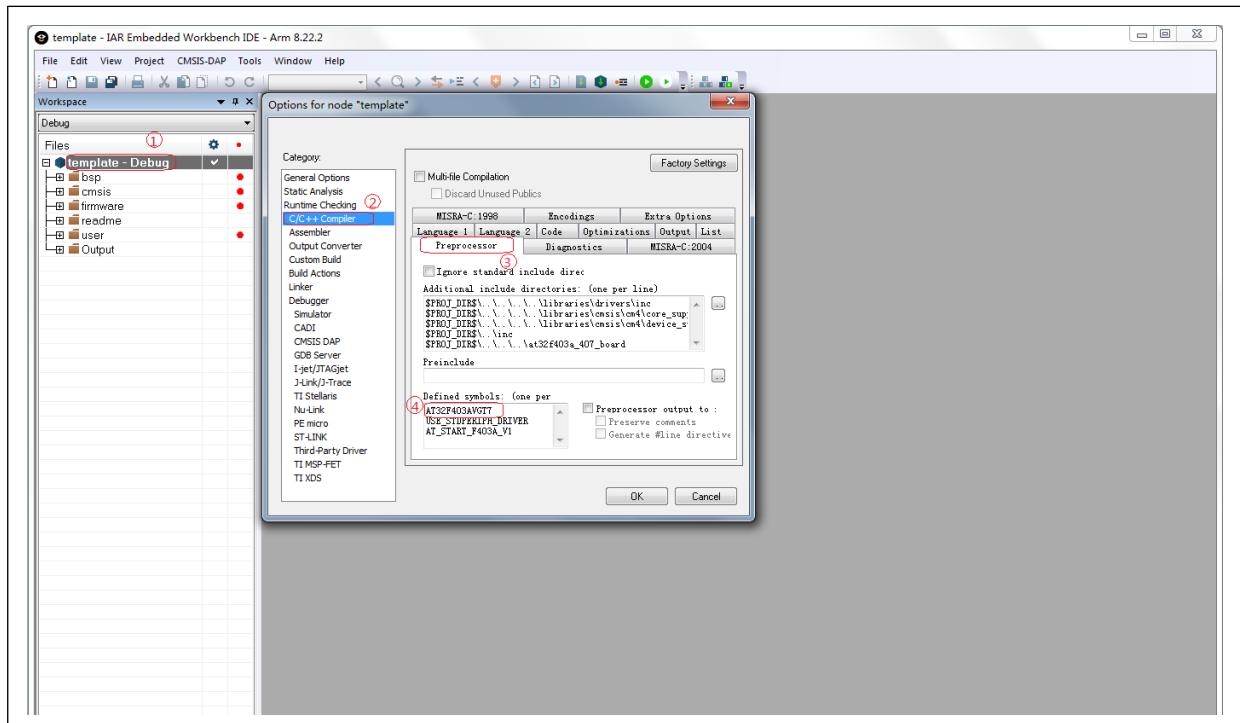
Figure 31. Change device part number in IAR



Follow the steps and illustration below to change macro definition in IAR environment.

- ① Right click on the file name, and select “Options...”
- ② Select “C/C++ Compiler”
- ③ Click on “Preprocessor”
- ④ Delete the original macro definition in “Defined symbols” column, and write the desired one corresponding to the selected device part number based on [Table 1](#).

Figure 32. Change macro definition in IAR



## 6.2 Unable to identify IC by JLink software in Keil

In special circumstances, the Keil project compiled by an engineer is unknown to the J-Link software even if it can be compiled by other engineers and identified by ICP software. For example, some warnings like below will be displayed.

Figure 33. Error warning 1

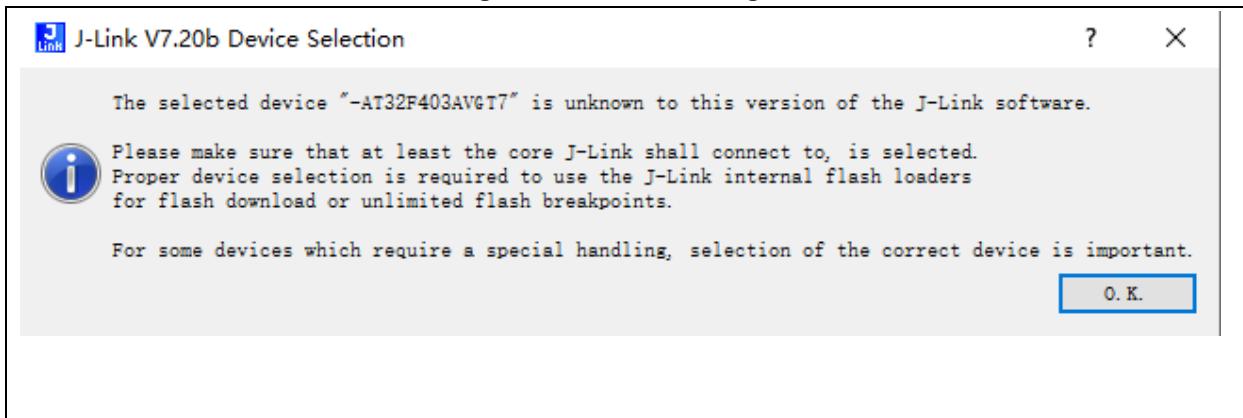


Figure 34. Error warning 2

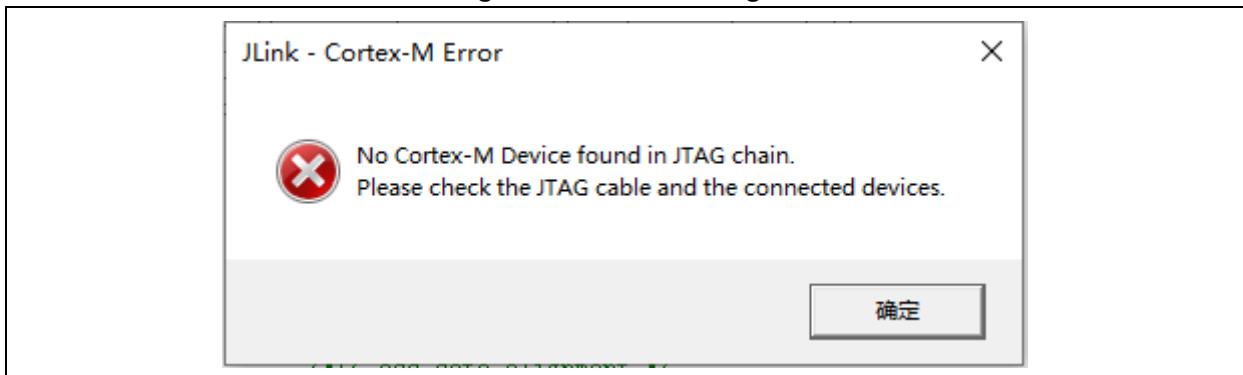
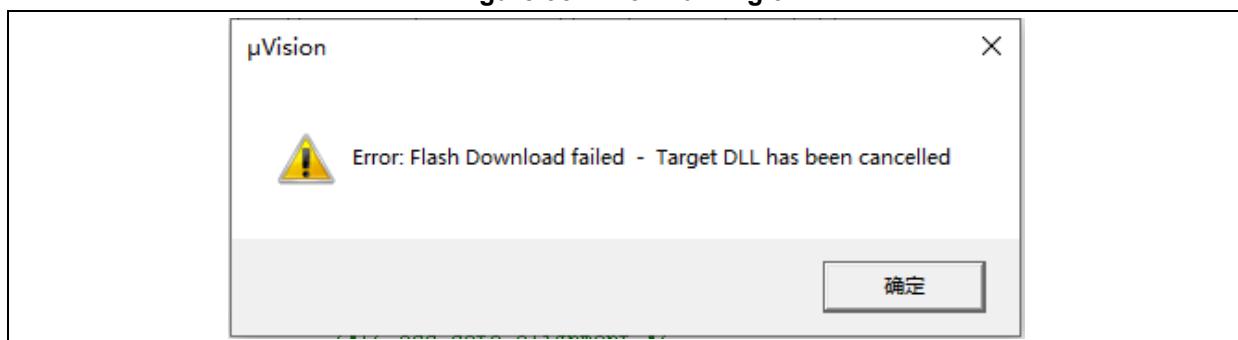


Figure 35. Error warning 3

**How to solve this problem?**

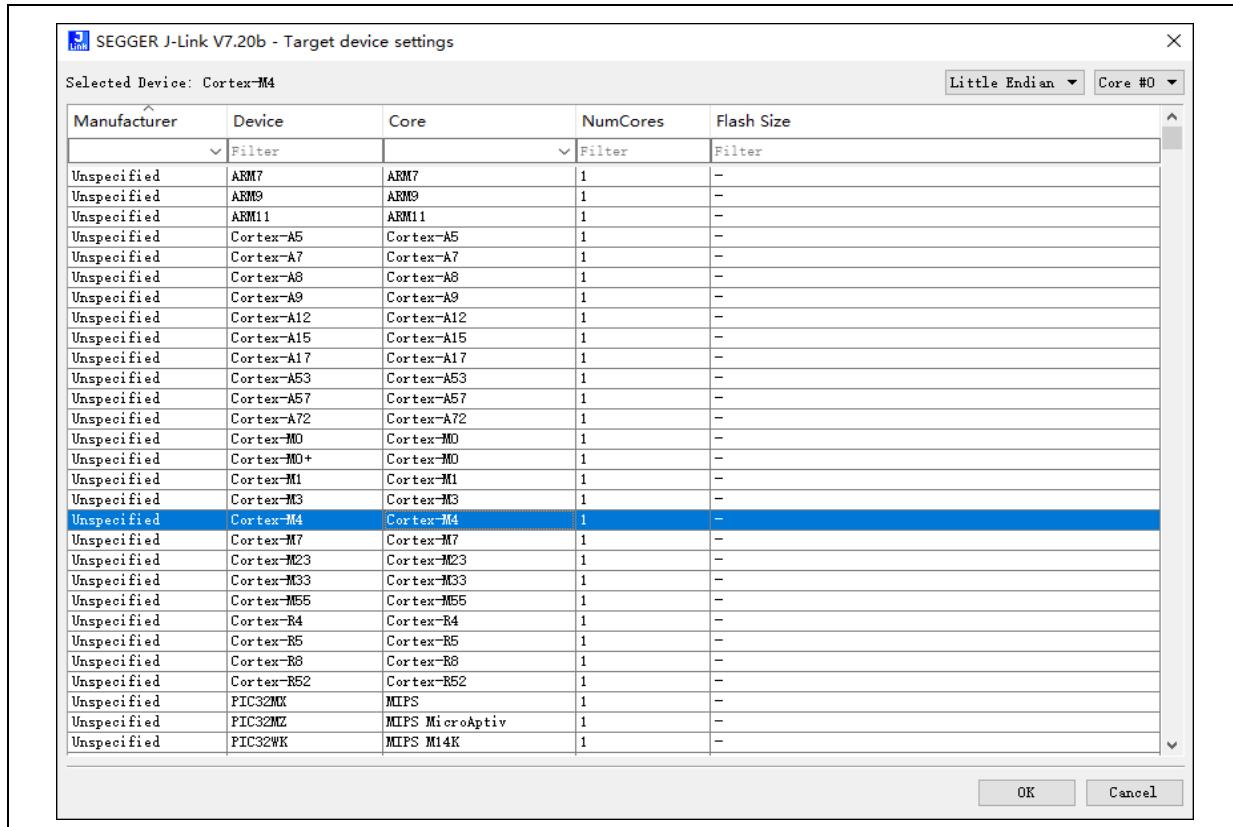
Step 1: Find “JLinkLog” and “JLinkSettings” files according to project path, and delete them.

Figure 36. JLinkLog and JLinkSettings

名称	修改日期	类型	大小
listings	2022/2/22 19:28	文件夹	
objects	2022/2/22 19:28	文件夹	
combine_mode_ordinary_simult.uvoptx	2022/2/22 19:28	UVOPTX 文件	12 KB
combine_mode_ordinary_simult	2022/2/22 19:28	Minision5 Project	17 KB
JLinkLog	2022/2/22 19:28	文本文档	7 KB
JLinkSettings	2022/2/22 19:27	配置设置	1 KB

Step 2: Click on magic wand, go to “Debug”, select “Unspecified Cortex-M4”

Figure 37. Unspecified Cortex-M4



## 6.3 How to change HEXT crystal

All examples used in BSP implements frequency multiplication based on 8 MHz external high-speed crystal oscillator on the evaluation board. If a non-8 MHz external crystal is used in actual scenarios, it is necessary to modify clock configuration in BSP to allow for accurate and stable clock frequency.

Therefore, the “AT32\_New\_Clock\_Configuration” tool is specially developed by Artery to generate the desired BSP system clock code file, including external clock source, frequency division factor, frequency multiplication factor, clock source selection and other parameters, marked in red in Figure 38. After the completion of parameter configuration, it is ready to generate code file, avoiding complicated operations involved in code modification.

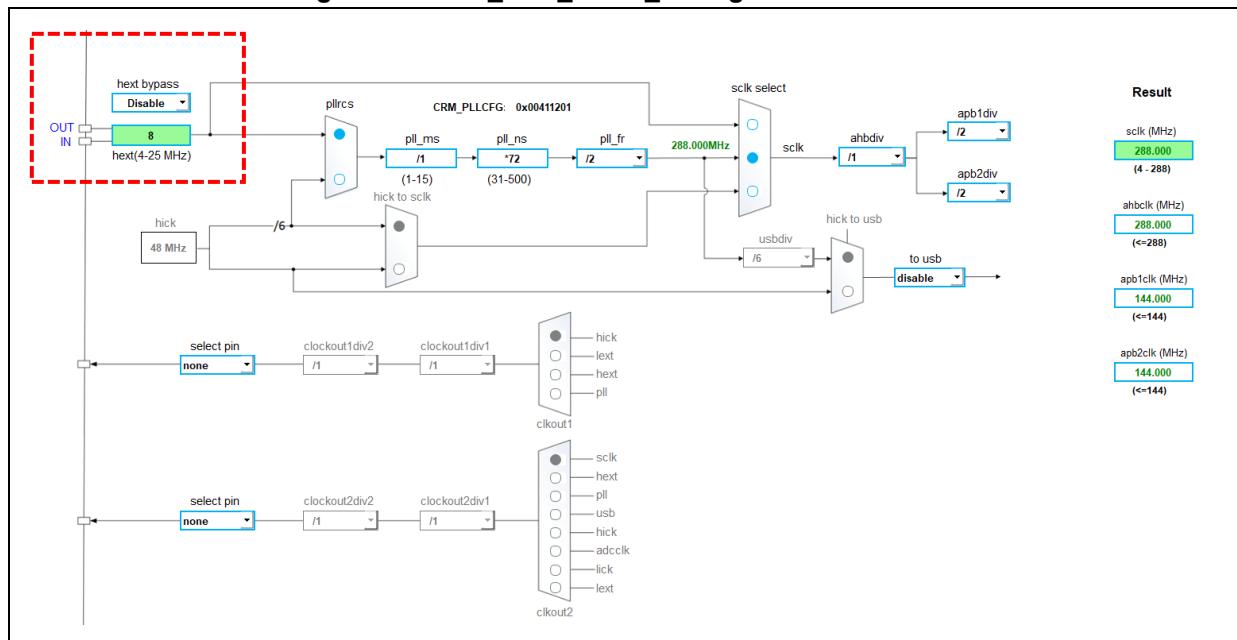
The users simply need to replace the original one in BSP demo with the newly generated clock code file (at32f4xx\_clock.c/ at32f4xx\_clock.h/ at32f4xx\_conf.h), and call the function system\_clock\_config in main function.

Also, it is necessary to replace the macro definition HEXT\_VALUE in the at32f4xx\_conf.h. Taking the AT32F403A as an example, the HEXT\_VALUE of the at32f403a\_407\_conf.h is defined as:

```
#define HEXT_VALUE ((uint32_t)80000000) /*!< value of the high speed external crystal in hz */
```

Figure 38 shows the window of AT32\_New\_Clock\_Configuration tool.

**Figure 38. AT32\_New\_Clock\_Configuration window**



For more information on the AT32\_New\_Clock\_Configuration, please refer to the corresponding Application Note shown in the table below, which are all available from the official website of Artery.

**Table 650. Clock configuration guideline**

Part number	Application note
AT32F403A/407 clock configuration	AN0082
AT32F435/437 clock configuration	AN0084
AT32F421 clock configuration	AN0116
AT32F415 clock configuration	AN0117
AT32F413 clock configuration	AN0118
AT32F425 clock configuration	AN0121
AT32F423 clock configuration	AN0158
AT32L021 clock configuration	AN0134
AT32F423 clock configuration	AN0158
AT32F402/405 clock configuration	AN0177
AT32M412/416 clock configuration	AN0222

## 7 Revision history

Table 651. Document revision history

Date	Revision	Changes
2024.10.18	2.0.0	Initial release

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

Purchasers are solely responsible for the selection and use of ARTERY's products and services, and ARTERY assumes no liability whatsoever relating to the choice, selection or use of the ARTERY products and services described herein

No license, express or implied, to any intellectual property rights is granted under this document. If any part of this document deals with any third party products or services, it shall not be deemed a license granted by ARTERY for the use of such third party products or services, or any intellectual property contained therein, or considered as a warranty regarding the use in any manner of such third party products or services or any intellectual property contained therein.

Unless otherwise specified in ARTERY's terms and conditions of sale, ARTERY provides no warranties, express or implied, regarding the use and/or sale of ARTERY products, including but not limited to any implied warranties of merchantability, fitness for a particular purpose (and their equivalents under the laws of any jurisdiction), or infringement on any patent, copyright or other intellectual property right.

Purchasers hereby agree that ARTERY's products are not designed or authorized for use in: (A) any application with special requirements of safety such as life support and active implantable device, or system with functional safety requirements; (B) any aircraft application; (C) any aerospace application or environment; (D) any weapon application, and/or (E) or other uses where the failure of the device or product could result in personal injury, death, property damage. Purchasers' unauthorized use of them in the aforementioned applications, even if with a written notice, is solely at purchasers' risk, and Purchasers are solely responsible for meeting all legal and regulatory requirements in such use.

Resale of ARTERY products with provisions different from the statements and/or technical characteristics stated in this document shall immediately void any warranty grant by ARTERY for ARTERY's products or services described herein and shall not create or expand any liability of ARTERY in any manner whatsoever.