AN0032

Application Note

One Time Programmable (OTP) ON AT32 MCU

Introduction

AT32 MCUs have factory-default bootloader, which can be programmed by users in application. With the increasing use of embedded applications, product security becomes more and more important, including hardware protection and protecting the product from being hacked. In the embedded system, all codes and data are stored in the Flash (it can be erased and programmed for several times, and internal data is not lost in case of power off) To protect data in the Flash, many Flash vendors provide an OTP (One Time Programmable) register that can be programmed only once and cannot be modified after programming. Users can store special information in the OTP register, such as the product's software version number, hardware version number, secret keys, etc.

This application note introduces how to use AT32 MCUs (with sLib) to implement functions similar to OTP register.

Reference:

Flash memory controller section of the reference manual for each series

Applicable products:

Part number

AT32 series with sLib

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1 Overview

Different AT32 MCUs may have different sLib (security library) configurations due to function improvement and optimization. Users can use the OTP function to store special data that can be read but not be modified or erased.

The sLib of AT32 MCUs mainly consists of:

- I-BUS area where instructions can be read through I-Code bus only;
- D-BUS area where data can be read through D-Code bus only;
- READ-ONLY area that can be read through I-Code and D-Code bus.

As long as the area is accessible through D-Code bus, the data in this area can be read but cannot be erased or modified (unless the original developer enters a custom secret key to disable sLib protection to perform mass erase), implementing the OTP function. Therefore, the developer only needs to store the data requiring OTP function in the area that is accessible through D-Code bus, so that the data can be read only but not be erased or modified.

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2 Operation instruction

According to the structure of AT32 MCU sLib, the OTP data to be stored must be placed in the area (D-BUS area or READ-ONLY area) that is accessible through D-Code bus.

2.1 Operation through codes

This section introduces how to enable sLib on the demo AT-START-403A evaluation board and place the data to D-Code area.

Operating procedures:

- 1) Press USER button to trigger;
- If the program is executed for the first time (MCU with sLib disabled), go to step 3; otherwise (MCU with sLib enabled), go to step 7;
- 3) Configure sLib, including password and range;
- 4) Write OTP data to the sLib D-code area;
- 5) LED2/3/4 light up simultaneously;
- 6) Press RESET button to reset, and repeat step 1;
- 7) The OTP function is enabled; sLib is enabled and cannot be configured again, and data in the corresponding area cannot be erased or modified; LED2 lights up;
- 8) Press USER button to trigger;
- 9) Disable sLib (when the program runs in the Flash, executing this step will trigger Flash mass erase, so that the program cannot continue running), and perform system reset.

Notes:

- In the demo, 256 bytes of data is defined as OTP data, and the selected sLib D-Code area is the last sector in the configurable sLib range of the corresponding MCU. For details about the configurable sLib range, refer to the sLib application note of each AT32 MCU series.
- After the demonstration is completed, disable sLib for follow-up MCU debugging. In practical application, after being enabled, the sLib OTP function will not be disabled.

2.2 Operation through ICP/ISP

Users can implement OTP function more conveniently by using upper-computer software (such as ICP/ISP) provided by Artery. When programming the project file, the OTP data to be saved should be programmed together to implement sLib OTP function.

For online programming with ICP programmer, the following procedures are recommended:

1) Add the corresponding files to be programmed: *LED.bin* is the project file, and *OTP_DATA.bin* is the OTP data to be saved;



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Artery ICP F	Program	mme	er_V2	2.5.02		_				_		_						×
File J-Lin	k setti	ings	A	T-Link	sett	tings	Targ	et	Lang	uag	je H	elp						
Disconnect	Pai	rt N	umk	oer: A	Т32	2F403A	VGT7	'	Flash	Siz	e: 102	4KB		<u>, 1</u>	2	ΓΞ	5/	Y
	AT	-Lin	k	FW: \	/1.5	5.17 /	AIN: 9	B 811	17624	FOE	F919			πμ	, ⁻	+	<u> </u>	
AT-Link	- AT	-Lin	k SN	: 471	59C	0100400	5420	5177	D02					猚		狩	フ	7
		SPIN	1		FLA	SH_DA	0x	0		0	Rema	50 (U	lse PA	11/P/	412 p	oins)		
	Тур	e						Sele	ct		Rema	b1 (U	lse PE	8 10/ PE	311 p	oins)		
Memory re	ad set	ting	s															
Address 0x	080f	f800)	Rea	d si	ize Ox	100			Dat	a bits	8 bi	ts 🔹	-		Rea	d	1
File info																		
No. File	e name Dhin								File si	ze	Add	ress	rang n nor	e(Ux)	,		4aa	J
2 OT	P DAT	A.bir	n						256	1	080	F800	0-080	FF8FF			elete	
	-																	
							(Fla	ash CR	20	F	e CR	Cver	ify	D	ownl	heo	ī.
[] I a h i a fa	File:OT	ים פי	ΛΤΛ Ι	hin			l							,			oau	
Address ran	ge:[0x0	80FF	800 0	x080FF8	FF]	checks	um: 0x	00007	7F80									-
Address	-	0	1	2 3	-	4 5	6	7	8			B	6	D	F	E	A. 4	
0x080FF800	0	00	01	02 03	3	04 05	06	07	08	0	9 0A	0B	00	0D	0E	OF		
0x080FF810	1	LO	11	12 13	3	14 15	16	17	18	1	9 1A	18	1C	1D	1E	1F	00	
0x080FF820	2	20	21	22 23	3	24 25	26	27	28	2	9 2A	2B	2C	2D	2E	2F	1.4	
0x080FF830	3	30	31	32 33	3	34 35	36	37	38	3	9 3A	ЗB	3C	3D	3E	3F	01:	
0x080FF840	4	10	41	42 43	3	44 45	46	47	48	4	9 4A	4B	4C	4D	4E	4F	@/	-
•					n	11											+	
10:38:59 : AT-	Link co	nnec	tion	is succes	sful	L											1	•
10:38:59 : Part	Numb	er: /	AT32	403AVG	T7	FlashS	ize: 10	24KB										
10:38:59 : Targ	get devi	ice co	onne	ction suc	ces	sfully!												
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2) Configure the corresponding sLib parameters, and start download;

sLib status	
eLib status: Disable	Remaining usage times: 241
Enable password 0x 55665566	sLib position: Main Flash
Disable password 0x	Start sector Sector5100x080FF000 💌
Disable sLib	DATA start sector Sector5110x080FF800 -
	End sector Sector5110x080FF800 V
Extra options	
Erase options	
Erase the sectors of file size	•
Disable sLib before download C Enable sLib Disable FAP before download Enable FAP after download	Write software serial number(SN) Write address 0x 08010000 Current SN 0x 0000001 Increase step 0x 00000001 Jump to the user program Ruther free mode
Write user system data User system data file path	



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3) Verify OTP function: execute the main memory erase operation, and then read the OTP data storage location (the data cannot be erased, so it is valid).

71001055	0	1	2	3	4	5	6	7	8	9	Α	В	С	D	E	F	A	*
0x080FF800	00	01	02	03	04	05	06	07	08	09	0 A	0B	0C	0D	0E	0F	.0	Ξ
0x080FF810	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	00	_
0x080FF820	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	! " #	
0x080FF830	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	01	
0x080FF840	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	@/	

Figure 3. Verification result



3 Revision history

Table 1. Document revision history

Date	Version	Revision note
2022.01.18	2.0.0	Initial release.

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