

Bootload manual based on UDS

VO.1

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Introduction

This paper introduces a general Bootloader implementation method of the TLE989X series. Bootloader can remotely upgrade the product firmware (program) through any communication port, which solves the problem that the MCU needs to dismantle the device or professional personnel, special tools, and on-site operation. The Bootloader provided this time integrates part of UDS (14229, 15765 specifications) services with the TSMaster host computer to download APP programs through the CANFD interface.

Overview

The content of this article includes: how to download the APP program through Bootload with the host computer. TSMaster was used as the host computer of Bootloader, and UDS protocol was used to transfer APP.HEX file to MCU (the underlying communication protocol was CANFD). The Bootloader program parses the data packets transmitted from the host computer, combines the APP code packets, and writes them into the target Flash space in order. The Bootloader program will automatically guit running after the APP program in the target Flash area is started successfully. The APP starts working. The flow chart of the process is as follows Figure 1:



Figure 1

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1.UDS

1.1 Introduction to UDS

UDS (Unified Diagnostic Services) diagnostic protocol is a diagnostic communication protocol in the environment of automotive electronic ECU, which is specified in ISO14229. At present, new cars on the market have diagnostic interfaces for out-of-vehicle diagnostics, which allows us to connect diagnostic tools to the bus system of the vehicle. Therefore, messages defined in the UDS can be sent to controllers (ECUs in the industry) that support the UDS service. In this way we can access the fault memory of the individual control units or the program to update the ECU with new firmware.

1.2UDS Common services

Category Name	SID(0x)	Diagnostic Service Name
	10	Diagnostic Session Control
	11	ECU Reset
	27	Security Access
Diagnostic and communication	28	Communication Control
management	3e	Tester Present
function unit	83	Access Timing Parameter
	84	Secured Data Transmission
	85	Control DTC Setting
	86	Response On Event
	87	Link Control
	22	Read Data By Identifier
	23	Read Memory By Address
	24	Read Scaling Data By Identifier
Data transfer function unit	2A	Read Data By Periodic Identifier
	2C	Dynamically Define Data Identifier
	2E	Write Data By Identifier
	3D	Write Memory By Address
Storage data transfer	14	Clear Diagnostic Information
function unit	19	Read DTC Information
Input and output control function unit	2F	Input Output Control By Identifier
Routine function unit	31	Routine Control
	34	Request Download
	35	Request Upload
Upload and download function unit	36	Transfer Data



37	Request Transfer Exit
38	Request File Transfer

Figure 2

1.3UDS download program flow

Step1: 10 03	<pre>//10 Service switch to 03 extension mode</pre>
Step3: 85 02	//Off DTC(empty service, no concrete implementation)
Step4: 28 03 01	//Service gateway packet (empty service, no specific implementation)
Step5: 10 02	//10 Service switches to 02 programming session
Step6: 27 01	//27 Service, unlocked, security verified.
Step7: 27 02	
Step8: 2e 00 00	
Step9: 31 00 00	
Step10:(34、36、37) server	//Downloading the APP.
Step11:11	//ECU reset.

2. Introduction of Infineon TLE989X MCU Board

2.1Infineon TLE989X series microcontroller storage space mapping

The storage space of Infineon TLE989X series microcontroller is designed to be arranged according to linear address. The benefit of this is that RAM, ROM, Flash and register addressing is more convenient and intuitive. The physical address range for IROM1 is from 0x11000000 to 0x11006000, and for IROM2 is from 0x12002000 to 0x12040000,IRAM1 has the physical address range 0x18000000 to 0x18002000, and IRAM2 has the physical address range 0x18002000 to 0x18002000. The specific situation is shown in Figure 3 below.





2.2The code storage distribution of Infineon TLE989X series microcontroller

The Bootloader of Infineon TLE989X series microcontroller is placed in the low address space of Flash starting from 0x11000000 address. After MCU is powered on, it will automatically start from Bootloader to check whether APP program code exists, and then jump to APP for execution. If it does not exist, it enters bootload and waits for TSMster to initiate UDS service request. The APP program is placed in an area behind the Flash. The APP program of this routine is stored from the address 0x1200 2000. In fact, this start address can be changed to any other start address, as long as it does not coincide with the Bootloader area and there is enough Flash space left to store the APP. The ld files for Bootload and APP are shown in Figures 4 and 5 below:



```
*.o (RESET, +First)
  * (InRoot$$Sections)
  .ANY (+RO)
  .ANY (+XO)
 1
 RW IRAM1 0x01800008 0x00001FF8 { ; RW data
  .ANY (+RW +ZI)
 RW IRAM2 0x18002000 0x00005C00 {
  .ANY (+RW +ZI)
 1
}
LR IROM2 0x12002000 0x0000D000 {
 ER IROM2 0x12002000 0x0000D000 { ; load address = execution address
  .ANY (+RO)
 }
}
```

Figure 4

```
LR_IROM2 0x12010000 0x0002E000 {    ; load region size_region
    ER_IROM2 0x12010000 0x0002E000 {    ; load address = execution address
    *.o (RESET, +First)
    *(InRoot$$Sections)
    .ANY (+RO)
    .ANY (+RO)
    .ANY (+RO)
    .ANY (+RW +ZI)
    .
    RW_IRAM2 0x18002000 0x00005C00 {
    .ANY (+RW +ZI)
    .
}
```



2.3Infineon TLE989X series microcontroller interrupt vector table

The interrupt vector table is essential at program startup and during the execution of interrupt service functions, which is equivalent to the "directory" of the program. In particular, 0x00000100-0x00000103 holds the stack space MSP - the value of the stack top pointer. Also, 0x0000 0104-0x0000 0107 holds the pointer to the Reset_Handler function. The following screenshot shows the contents of a partial Vector.c file:



Vectors	DCD	initial sp	
	DCD	Reset Handler	
	DCD	NMI Handler	; NMI Handler
	DCD	HardFault Handler	; Hard Fault Handler
	DCD	MemManage Handler	; MPU Fault Handler
	DCD	BusFault Handler	; Bus Fault Handler
	DCD	UsageFault Handler	; Usage Fault Handler
	DCD	0	; Reserved
	DCD	0	; Reserved
	DCD	0	; Reserved
	DCD	0	; Reserved
	DCD	SVC Handler	; SVCall Handler
	DCD	DebugMon Handler	; Debug Monitor Handler
	DCD	0	; Reserved
	DCD	PendSV Handler	; PendSV Handler
	DCD	SysTick_Handler	; SysTick Handler

Figure 6

When the Bootloader boots the APP, it needs to use the interrupt vector table of the APP. After the APP starts, it needs to switch the Bootloader's vector table to the APP's own vector table. This process is called vector table remapping. In the conventional program, after the interrupt is generated, the hardware automatically addresses the corresponding interrupt service function entry and jumps to the interrupt function execution after the stack is pushed in the interrupt field. The jump code is as follows Figure 7:

```
SELVICE HUBBINOUS /
PMU serviceFailSafeWatchdogSOW();
GPIO->P1 OMR.reg = 0x00010001;
/* Disable all interrupts */
disable irq();
/* point VTOR to new vector table */
CPU->VTOR.reg = USER APPLICATION VTAB ADDRESS;
/*Jump to new application */
BootJumpASM( Address[ 0 ], Address[ 1 ] );
```

Figure 7

2.4Download the APP process

The microcontroller is powered on and started, the CAN is initialized, and the delay is 50 milliseconds to wait for whether to enter the Bootload mode. If the Bootload mode is not entered, check whether there is an APP program at the address 0x12002000. If the APP exists and there is no UDS service request, the MCU restarts and jumps to the address 0x12002000 to execute the APP program. If the APP program is not detected and there is no UDS service request, the MCU



will enter the Bootload mode to respond to the UDS service (such as 24, 26, 27 download service) request initiated by the host computer. Until the host computer initiates the 11 service (microcontroller reset) request, the microcontroller is reset to detect whether the APP code is downloaded. If the APP download is completed, the bootload mode will exit and the APP code program will be executed at 0x12002000. If the download is not completed, the current state will still be bootload mode. If the APP program has been downloaded before, the APP program can be directly re-downloaded in APP mode without power down and restart. If there is an error in the APP, it can power off and restart. Before the 50ms delay ends, it can send the instruction to enter bootload mode to download the APP again. The flow chart of Bootload downloading APP is as follows Figure 8:



Figure 8

2.5MCU Status Introduction

Get a new chip, MCU is in state 0, then start to download bootload code, when the bootload code download success will enter state 1, bootload code start to work. Once the MUC is in state 1, you can start downloading the APP code. If the APP code download fails, it will enter state 3, at this time, the MCU is in bootload mode, and it can retry to download the

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APP program. If APP is downloaded successfully, it will enter state 2, the MUC will jump from bootload mode to APP mode, and the APP will start to work. If the APP code needs to be re-downloaded, if the process of downloading APP is interrupted or an error occurs, the MCU will re-enter state 3 and wait for the APP code to be re-downloaded until the re-download of APP is successful, then enter state 2 and run the APP program.



Figure 9



3. Download the experiment

3.1Software support package

As shown in Figure 10 below, APP1, APP2, bootload, TSmaster_bootload, and bootload usage documents are provided in the file. APP1 file and APP2 file are APP routines for LED flashing at different frequencies. TSmaster_bootload file is the configured TSmaster host computer software routine, combined with bootload can realize the function of downloading APP. The bootload file contains the bootload source code.

APP1	2023/4/11 11:07	文件夹	
APP2	2023/4/11 11:16	文件夹	
DOOTLOAD	2023/4/11 11:16	文件夹	
75_Master_bootload	2023/4/11 11:15	文件夹	
📄 test.hex	2023/4/6 14:14	HEX 文件	571 KB
💁 Bootload使用文档.docx	2023/4/6 16:15	DOCX 文档	14,103 KB

Figure 10

3.2bootload program download

Step 1: The chip is connected to the downloader.



Figure 11



Step 2: Open the bootload file, click compile, and then download to the MCU.



Figure 12

After Bootload download is successful, the LED light of P1.4 pin flashes at 500ms interval.



Figure 13



3.3Download the APP via TSMaster



Step 1: Connect the CANFD channel of the same star TC1012P to the CANFD channel of the MCU.

Figure 14

Step 2: Open boot_TSmaster file, click Hardware - > Channel selection, select CAN, configure the number of channels in the application, and finally configure the hardware channel selection to TOSUN TC1014 CANFD channel 1.

7 •	- 4	💕 💾 🖻	<u> * </u>					TSI	Master	v2023	8.4.10.8	54. Buil	t @202	23-04	-10 06
<u></u>	Analysis	Hardware	Program	Simulation	Application	Project	то	ols	Help						
-	-	6	Q												
Channel Selection	Network Hardware	Channel Mapping	Vendor Selection												
1	Channels		Vendors												
► TSMaster	r Applica	tion Channel	Selection - TS	Master								_			×
002	é 🖻 🤅	Auto N	lapping 🝶 S	elect Vendor	🕜 Help 🔳	Video T	utorials .	-							
CAN	2 Sele	ct Application	Channel Count	3	1	Availabl	e CAN C	hanne	el Cour	t: 6					
O LIN	Jere	et Application	channer courn	· · ·	<u> </u>										
FlexRay Ethornot	3	Application	n Channel	Alias N	lame	Active			Hard	dware C	hannel	Selectio	n		_
U Ethernet	0	CAN	11	CAN	1		SOL 🔕	SUN TO	1014 1	CAN F	D Chan	nel 1 (64	2565D	783D8	3) ~
							4								
										5					
			Cannot	find your devic	e? Please check	: "Select Ve	ndor" on	top to	olbar	~	• ок		8	Cancel	

Figure 15



Step 3: Go to App - > Diagnostic Module - > Basic Diagnostic Configuration - >343637 Download File - > File Path to load the hex file you want to download (e.g. App_lef2.hex).



Figure 16

Step 4: Click Automatic diagnosis module - > Download file - >343637 Download file - > Download (label 4), you can download APP_LED2.hex to the MCU.

						Diagnostic				
🔸 🌒 🗹 Enable 💕 🗒 🖉			a				۹ - 🗟 🕻	3		
💷 Protocol (ISO TP) 🗧 Basic Diagnostic	Config 🔰 [Diagnostic Cons	ole 🖪 Automatic Diagn	ostic 1						
≝ ঢ় ঢ়	×	Unlock	Lock 🛛 🗘	Enable Cy	dic Run 100 🌻	Real Run Time: 0				
UDS Test Flows	🔮 Valid	Туре	abc ServiceName	Address		Request(0x)		Response(0x)	🕒 Delay	Property
		SelectConfig	诊断会话控制1	Physic	10 03		50 03		0	[Retry:0][Stop]
		SelectConfig	控制DTC设置	Physic	85 02		C5 02		0	[Retry:10][Stop]
		SelectConfig	通讯控制	Physic	28 03 01		68 03		0	[Retry:0][Stop]
		SelectConfig	诊断会话控制	Physic	10 02		50 02		0	[Retry:0][Stop]
		SelectConfig	安全访问	Physic	Seed Level:1		Fixed		0	[Retry:0][Stop]
		SelectConfig	根据标识符写入数据	Physic	2E 00 00 00		6E 00 00	1	50	[Retry:0][Stop]
	V	SelectConfig	下载文件	Physic	getting_started.hex		Fixed		Û	[Retry:0][Stop]
		Normal	🕀 📕 \$2E WriteDataByld	ntifer C	11		No Respo	onse	0	[Retry:0][Stop]
	<		Input and Outpue Cont Input and Outpue Cont Input and Outpue Cont Input and Outpue Control Input and Download N Input and	ol anager			•	_		
	🕂 Service	Information 📔	IS Contractor							
		XITO								
	O Abso.	lute	∎ Ident ⊠ Me	ssage Co	mment Type	Data 00 01	02 03 04 05 06 07 04	8 09 10 11 12 13 14 15 16 17	18 19 20 21 22	23 24 25 26 2





After successful APP download, it will change the frequency of P.13 and P.14 pin LED lights flashing.



Figure 18



4.TSMaster downloads the APP configuration

4.1Open the diagnostic module operation

Step 1: Open TSMaster's diagnostic module.



Figure 19

4.2Configure diagnostic transport layer parameters

Step 1: Click the Transport Layer (ISO TP) button. Step 2: Go to the Diagnostic Transport layer page. Step 3: Configure the bus type as CAN/CANFD; Channels are configured on demand (Channel1) The request ID is configured to 0x755. The request ID type is set to Standard. The reply ID is configured to 0x7FF. The reply ID type is configured to be Standard. Function ID is configured to 0x7DD. The function ID type is set to Standard. Padding bytes can be configured arbitrarily. The maximum DLC of FC is set to [15]64Bytes. FD variable baud rate can be checked (checked to speed up the transmission rate).

			Diagnostic			
🕘 🗹 Enable 💅 🗒					A - 🗟 🖸	
Protocol (ISO TP)	ostic Config 👌 Diagnostic Console	Automatic Diag	nostic			
1		- Hatomate blag	100110			
Basic Diagnostic Service						
DiagnosticECU	3 Aa Name		Value	Aa	Comment	
Transport Layer 2	Bus Type	FD	CANFD	Communication Bus Type		
🖉 Diagnostic Layer	Channel		Channel 1	Transport layer channel		
Description	Request Id		0x755	Transport layer request identifier		
	Request Id Type		Standard	Transport layer request identifier to	/pe	
	Response Id		0x7FF	Transport layer response identifier		
	Response Id Type		Standard	Transport layer response identifier	type	
	Functional Id		0x7DD	Transport layer functional identifier		
	Functional Id Type		Standard	Transport layer functional identifier	type	
	Filed Byte		0xAA	Filed byte of frame		
	ST Min		0	ST Min		
	Block Size		0	Size of every tp package		
	FC Delay		10	The time between first FC frame an	id CF Frame	
	FD Max DLC		[15]64 Bytes	Max DLC of every FD Frame, this	parameter is valid only in FD mode	
	FD BRS			Bit Rate Switchable in FD mode		
	Max Length		1026	Max length of every service packa	1e	



Figure 20

4.3Configure the diagnostic service layer parameters

Step 1: Click the Transport Layer (ISO TP) button. Step 2: Go to the diagnostic service layer page. Step 3: Configure P2Time(on demand) Step 4 Configure the online parameters of the diagnostic instrument (configure according to requirements). Step 5 config the seed key for the 27 service.

				Diagnos	tic				×		
🗲 🔲 🗹 Enable 💕 🖽 🕙								۹	6.0		
💷 Protocol (ISO TP) 📄 Basic Diag	nostic Config 🛛 Diagnosti	c Console 🛛 🛪 A	utomat	ic Diagnosti	c						
1 Basic Diagnostic Service											
DiagnosticECU	P2 Time	P2 Tme									
Transport Layer Diagnostic Layer 2 Description	P2 Timeout	6000	ms	O Detail	3						
	P2 Extended	50000	ms								
	Tester Present	Tester Present									
	S3 Server Time	30000 🔶	ms	O Datai	4						
	S3 Client Time	30000	ms	Detail							
		O Default Reque	st	3E 80							
	Tester Present	O From Basic Co	nfig								
	Functional ~	O Manual Definiti	on								
	SeedKey										
	O SeedKey DLL							+ × 🗄			
	SeedKey Code	SeedKey_UserD	ef.mp	15					[]		
Refresh parameter of transport layer succ	cessfully								11.		

Figure 21



Figure 22





Figure 23

4.4Create a new diagnostic service (consider the 27 service)

The first step is to go to the basic configuration page. Step 2: Right-click 27 Secure access to create a new 27 service; Step 3: Modify the security anti-access type.

		Diagnostic		×
🗲 🔵 🗹 Enable 🛸 🗒 🖉				۹ - 🗟 🖒
D Protocol (ISO TP) 🖪 Basic Diagnostic	Config 🔰 Diagnostic Console	Automatic Diagnostic		
1				
E 🚓 Diagnosic and Communication Mana	Aa ItemName 🖉	Value	3	
\$10 DiagnosticSessionControl	ServiceName 安全访问	1		
🗄 📕 \$11 EcuReset	Request 27 02 [gi PDU[ReadOnly]	enerate by dl]		
■ \$27 SecurityAccess	Response 67 02			
2 9 27 02 安全流同1	PDU[ReadOnly]			
528 CommunicationControl	Is Function ID			
\$3E TesterPresent	Has Response			
# \$85 ControlDTCSetting				
\$87 LinkControl				
🖃 🚠 Data Transmission				
\$22 ReadDataByIdentifier	+ Request 1 Pernonse			
\$23 ReadMemoryByAddress	ID Parameters			
\$24 ReadScalingDataByIdentifier	Aa Name	(#)	Value	
\$2A ReadDataByPeriodicIdentifie	SecurityAccessType	0x02		
\$2E WriteDataByIdentiller				
Stored Data Transmission	Parameters			
\$14 ClearDiagnosticInformation	Buto Order Motorola	Conorato Kay Automatic		
\$19 ReadDTCInformation	Byte Order [ristoriou	Generate Key Automatic		
🖻 🚠 Input and Outpue Control				
\$2F InputOutputControlByIdent				
E 🚠 Remote Routine				
🗄 🏢 \$31 RoutineControl				
• Helend and Doumland Management				
Please switch to console form if want to execute	the service			

Figure 24

When the host computer initiates 27 01 request, the lower computer responds positively and returns 67 01+seed (red box in the following picture). After the host computer obtains the seed, it generates the key (blue box in the following picture). It initiates 27 02+key request. If the verification sends a positive response through the upper computer 67 02 o

₩ 1.103371	1	7DD	Positive Request	req	TX	2	27	01				
-⊠ 1.103586	1	7FF	Positive Response	Pos	Rx	6	67	01	FD	35	21	05
☑ 1.207365	1	7DD	Positive Request	req	Тх	6	27	02	34	01	EB	42
☑ 1.207604	1	7FF	Positive Response	Pos	Rx	2	67	02				





The Key generation rule can be modified by modifying the seedkey in step 5 of Chapter 1.3 (loading dynamic link library or writing code with seedkey).



Figure 26

4.5 \$34 36 37 Download the file description

The first step is to create a new 34 36 37 download service. The second step is to load the *.hex file in the file path. Enable block erasure to be configured without automatic erasure. The routine identification symbol is configured to 8900. The transfer exit command is configured without validation (\$37). Enable block validation is configured to do no block validation. The blue box contains some information about the loaded *.hex file (the download address should be greater than 0x12002000).

-		Diagnostic			
🛑 🔟 Enable 💕 🗒 🖉					ې - 🛃
Protocol (ISO TP) Basic Diagnostic	Config 🔰 Diagnostic Console	Automatic Diagnostic			
SUL TEXEFFERENCE SSE ControlDTCSetting SSE ControlDTCSetting	Aa ItemName Service Name	■ Vak 下執文件 CRC32 getting_started.hex No Auto Erase 8900 00 Block Check(\$37 + Block Cl 37 xx xx xx Block Checksum (Checksum 0202	e ecksum) e every block)		
\$31 RoutineControl	\$44				
Upload and Download Management	Expected Response	Motorola			
\$34 RequestDownload	User Define MaxNumOfBlockLength				
\$35 KequestUpload \$36 TransferData \$37 RequestTransferExit	User Define(0x)	202			
CombineServices	Blocks	Start Address	EndAddress	Length	Checsum Checksum: 0x398DCC3
	Block 0 Star	t Address: 0x12010000	End Address: 0x12015747	Data Length: 0x00005748=22344	Checksum: 0x398DCC3

Figure 27



4.6Download the file description

The first step is to enter the automatic diagnosis process interface. The second step is to create a UDS FLOW. The third step is to load the UDS service request process (the request download process should conform to the UDS specification). Step 4 Click the Download button to start downloading the *.hex file. The blue box gives feedback on service requests and service responses.

			Dia	gnostic						
🔴 🖾 Enable 🖬 🗒										2 - 6
Protocol (ISO TP) Resic Diac	nostic Config	Diagnostic Cons	ole 🖪 Automatic Dia	anostic 1						
		Uplack	lack b	Enable Overic Run	100	Dool Dup Timor 1				
Li Li	4				100	Real Run Time:				
UDS Test Flows	🕑 Valid	Туре	abc ServiceName	Address 🖂	Request(0x)	Respo	onse(0x)	🕒 Delay	=>	Property
→ Uds Flow 1	3 🔽	SelectConfig	诊断会话控制1	Physic 10 03		50 03		0	[Retry:0	[Stop]
		SelectConfig	控制DTC设置	Physic 85 02		C5 02		0	[Retry:1	0][Stop]
		SelectConfig	通讯控制	Physic 28 03 01		68 03		0	[Retry:0	[Stop]
		SelectConfig	诊断会话控制	Physic 10 02		50 02		0	[Retry:0	[Stop]
		SelectConfig	安全访问	Physic Seed Lev	el:1	Fixed		0	[Retry:0	[Stop]
		SelectConfig	根据标识符写入数据	Physic 2E 00 00	00	6E 00 00		50	[Retry:0	[Stop]
		SelectConfig	下载文件	Physic getting_s	tarted.hex	Fixed		0	[Retry:0	[Stop]
		Normal	FCU重启	Physic 11		No Response	1	0	[Retry:C	I[Stop]
	<									
					~					
	📲 Servi	ce Information 🖬	ISO15765-2							
	1 1	XIIO								
	OAbs	olute	Ident ⊠N	lessage Comment	Type	Data	00 01	02 03 0	4 05 0	6 07 0
	1	.041361 1	L 7DD Po	sitive Request	req	Tx 2	10 02			
	🖂 1	1.041573 1	L 7FF Po	sitive Response	Pos	Rx 6	50 02	01 F4 0	1 F4	
	- 🖂 1	1.103371 1	L 7DD PO	sitive Request	req	TX 2	27 01			
	291	1.103586	L /FF PO	sitive Response	Pos	KX 6	67 01	FU 35 Z	1 05	
		207502	L 700 PO	sitive Request	Pee	IX O	67 02	34 01 E	B 4Z	
	-53 1	335308 1	1 700 PO	sitive Response	PUS	NX Z	07 02	44 12 0	1 00 0	
			EV.				3/1 ////			0 00 00
	- 53 1	.341091 1	7FF Po	sitive Response	Pos	Rx 11	74 20	04 02	1 00 0	0 00 00
	- 🖂 1 - 🖂 1	1.341091 1 1.404973 1	L 7FF Po	sitive Response	Pos	1X 11 Rx 4 Tx 1026	74 20 36 01	04 02 01 FF 0	1 FF 0	0 00 00 0 00 00

Figure 28



5.Introduction to bootload

The bootload program is downloaded to the MCU, and then bootload with the TSMster host computer can realize the purpose of downloading APP through CANFD °

5.1The bootload directory is structured as follows





5.2How to add or delete the UDS service in bootload

Add or remove the UDS service by changing the service code in the server.c file in the UDS_serice directory.



The UDS service interface function is as follows: uint8_t udsServer_requestProcess(const uint8_t payload[],uint32_t size) can be called to implement the UDS service response. The payload[] parameter is a pointer to the buffer of the received data, and the size parameter is the size of the received data. The UDS service ID and UDS service function inside server.c can be added or deleted to achieve the purpose of service increase or decrease, as shown in Figure 31 below:

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TOSU同星 L海同星智能科技有限公司 Shanghai TOSUN Technology Ltd. void UdsServerRequestProcess(const uint8 t * payload, uint32 t size) 1 ServerData.rxMsgLength= size; ServerData.sid=payload[0]; if (ServerData.rxMsgLength>0) { for (uint32 t i = 0;i<ServerData.rxMsgLength;i++)</pre> -ServerData.rxMsgData[i]=payload[i]; 1 } else { 1 switch (ServerData.sid) { case UDS SID DiagnosticSessionControl: UDS Serice DiagnosticSessionControl(); break:

Figure 31

5.3 Modify the functions and unlocking functions of the 27 service generation seed

The service provides the Creating_Seed(){} seed generation function; PasswordGenerator(){} key generator function; SecurityAccess_unlock(){} Secure access to the unlock function; The Creating_Seed(){} function is used to generate the seed needed for secure access. Users can modify the internal algorithm to generate different seeds according to their own requirements. The UDS_SericeAccess_Seed[Access_num] array is used to store the generated seed. Access_num indicates the number of bytes occupied by the seed. PasswordGenerator(){} This generates the key needed to secure the unlock from the Seed; The variable UDS_SericeAccess_Key[Access_num] is used to store the generated key, and Access_num indicates the number of bytes in the key. PasswordGenerator(){} This function validates keys and UDS_ passed in from outside Whether SericeAccess_Key[Access_num] is consistent. If the consistent function returns 0, the secure access unlocking is successful. If not, the function returns 1, the secure access unlocking is failed. The function looks like this:

```
uint8 t UDS SericeAccess Seed[ACCESS NUM]={0};
uint8_t UDS_SericeAccess_Key[ACCESS_NUM]={0};
1**
 * @brief Generate random seeds
 * @param
 * @return None.
 * Oprivate
 * /
void Creating_Seed(uint8_t UDS_SericeAccess_Seednum[],uint8_t keynum)
    //You can modify the Seed required for production by yourself
    if(keynum==4)
      UDS_SericeAccess_Seednum[0]=(uint8_t)(UDS27_RN%256);
      UDS_SericeAccess_Seednum[1] = (uint8_t) (UDS27_RN&100);
UDS_SericeAccess_Seednum[2] = (uint8_t) (UDS27_RN&55);
      UDS_SericeAccess_Seednum[3]=(uint8_t)(UDS27_RN%8);
    3
3
```



```
/**
* @brief Keys are generated according to the algorithm, and the algorithm for generating keys can be changed
* @param
* @return None.
 * @private
*/
 void PasswordGenerator(const uint8 t UDS SericeAccess Seednum[],uint8 t UDS SericeAccess keynum[],uint8 t keynum]
    //You can modify the Key according to the Seed
    uint8_t i;
     uint32_t key = 0xffffffff;
     while (keynum--)
     1
        key ^= (uint32 t) (UDS SericeAccess Seednum[keynum]) << 24;</pre>
        for (i = 0; i < 8; ++i)
        {
            if ( key & 0x80000000 )
    key = (key << 1) ^ 0x04C11DB7;</pre>
            else
                key <<= 1;
        }
    }
    UDS_SericeAccess_keynum[0]=(uint8_t) key;
    UDS SericeAccess keynum[1]=(uint8 t) (key>>8);
    UDS SericeAccess keynum[2] = (uint8 t) (key>>16);
    UDS SericeAccess keynum[3] = (uint8 t) (key>>24);
 }
      return 0;
      }
       }
         return 1;
        {
        else
        }
        {
       if (UDS_SericeAccess_TX[i]==UDS_SericeAccess_Keynum[i])
 I.
      {
      for(int i=0;i<keynum;i++)</pre>
 1{
  uint8 t SecurityAccess unlock(uint8 t UDS SericeAccess IX[], uint8 t UDS SericeAccess Keynum[], uint8 t keynum)
 · *1
  * @private
            1:Talse
  * @return 0:success
  * Gparam
  * @brief Check that the key is authentic
 1/**
```



/**
* @brief Check that the key is authentic
* @param
* @return 0:success
1:false
* @private
*/
<pre>uint8_t SecurityAccess_unlock(uint8_t UDS_SericeAccess_TX[],uint8_t UDS_SericeAccess_Keynum[],uint8_t keynum) {</pre>
<pre>for(int i=0;i<kevnum;i++)< pre=""></kevnum;i++)<></pre>
if (UDS SericeAccess TX[i]==UDS SericeAccess Keynum[i])
else
return 1;
}
}
return 0;
}

Figure 32



6. test report

6.1test report

Test entries	expected result	actual result	Remark/explanation
(using TSMaster) Use the host computer software to burn the APP application	The APP functions normally	ОК	
After the APP has been flushed, it can be flushed multiple times in a row (e.g., 5 or more times)	The APP functions normally	Flush more than 5 times, OK	
Bootloader software modifies the start address of App (within the normal address range)	It can be brushed normally, the APP jumps correctly, and the function runs normally	ОК	Addresses start from 0x12002000 to 12040000
When the App is flushed for the first time, power down operation is performed on the ECU during the connection phase. After power on again, you can re-brush again.	The APP functions normally	OK	
When the App is flushed for the first time, power down operation is performed on the ECU in the erase Flash stage of APP program flushing.	The APP can be flushed normally	ОК	



After power on again, you			
can re-brush again.			
After the App is	The APP can be flushed	ОК	
successfully flushed, the	normally		
APP program is flushed			
again. In the connection			
phase, the power down			
operation is performed on			
the ECU. After power on			
again, you can re-brush			
again.			
In the flush process, the	The APP can be flushed	ОК	
ECU is disturbed to the	normally		
BusOFF state, and the ECU			
can recover itself and			
respond to the flush			
instructions normally.			
In the connection phase of	The APP can be flushed	ОК	
the APP program flush,	normally		
interrupt the host			
computer communication			
(including the following			
ways: click the stop button			
in the host computer			
software; Unplug the CAN			
communication line;			
Unplug the USBCAN			
interface card) and resume			
communication (including			
the following ways: the			
host computer software			
starts running again;			
Restore the CAN			
communication line;			
Connect the USBCAN			
interface card), can again			
normal flush.			
In the Flash erase phase of	The APP can be flushed	ОК	
the APP program flush,	normally		
interrupt the host			
computer communication			



(ditto above) and resume			
the communication (ditto			
above), and the normal			
flush can be performed			
again.			
	The APP can be flushed	ОК	
During the flush process,	normally		
CANH is disconnected, and			
after recovery, it can be			
flushed normally again.			
During the flush process,	The APP can be flushed	ОК	
the CANH short-circuits	normally		
the power supply, and			
after recovery, it can flush			
normally again.			

6.2Test phenomenon

1.A mock test.hex file was downloaded 5 times without failure.

UDS Test Flows ② Vaid Type ##: ServiceName Address ② Request(0x) ③ Response(0x) ④ Deby 詳 3 SelectConfig 诊断会话注謝1 Physic 10 03 50 03 0 0 [Re ③ SelectConfig 控制で注意器 Physic 85 02 (CS 02 00 [Re ③ SelectConfig 控制で注意器 Physic 28 03 01 68 03 0 [Re ④ SelectConfig 诊断会话注制 Physic 28 03 01 68 03 0 [Re ④ SelectConfig 诊断会话注制 Physic 28 03 01 68 03 0 [Re ④ SelectConfig 诊断会话注制 Physic 28 03 01 68 03 0 [Re ④ SelectConfig 计数元计算 Physic 28 00 00 6E 00 00 0 [Re ④ SelectConfig 中分的 Physic 28 00 00 6E 00 00 0 [Re ④ SelectConfig 中分数提 Physic 2E 00 00 00 6E 00 00 0 [Re ④ SelectConfig 下载文件 Physic 2E 00 00 00 6E 00 00 0 [Re ④ SelectConfig 下载文件 Physic 11 No Response 50 [Re
Inds Flow 1 マ SelectConfg 诊断会能技制1 Physic 10 03 50 03 0 [Re マ SelectConfg 注制DTC设置 Physic 85 02 CS 02 0 [Re SelectConfg 造讯注制 Physic 28 03 01 66 03 0 [Re SelectConfg 造讯注制 Physic 10 02 50 02 0 [Re SelectConfg 送给会法投制 Physic 28 03 01 66 03 0 [Re SelectConfg 送给会法投制 Physic 28 00 00 6E 00 00 0 [Re SelectConfg 下執法(投新公務) Physic 28 00 00 6E 00 00 0 [Re SelectConfg 下執法(投新公務) Physic 28 00 00 6E 00 00 0 [Re SelectConfg 下執法(投新公務) Physic 11 No Response 50 [Re Normal EOU重台 Physic 11 No Response 50 [Re
② SelectConfg 控制力TC设置 Physic 8502 C502 0 [Re ② SelectConfg 逆制式控制 Physic 280301 6803 0 [Re ③ SelectConfg 诊断式控制 Physic 1002 5002 0 [Re ④ SelectConfg 诊断式控制 Physic 1002 5002 0 [Re ④ SelectConfg 安全访问 Physic 260000 66000 0 [Re ⑤ SelectConfg 電揚振行符写入数据 Physic 260000 66000 0 [Re ③ SelectConfg 市動式件 Physic getting_started.hex Fixed 0 [Re ③ SelectConfg 市動式件 Physic getting_started.hex Fixed 0 [Re ③ SelectConfg 市動式件 Physic 11 No Response 50 [Re ④ Normal EOU重点 Physic 11 No Response 50 [Re
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V Service Information Laboration 2
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U 1 370.70 1 733 POSICIVE Request 1 Fed 1X 1020 30 14 80 05
☐ 570.81 1 7FF Positive Response Pos Rx 2 76 14
□ 570.81 1 7FF Positive Response Pos Rx 2 76 14 □ 570.82 1 755 Positive Request req Tx 1026 36 15 FF E7
G 570.81 1 7FF Positive Response Pos Rx 2 76 14 D 570.82 1 7FF Positive Response Pos Rx 2 76 14 D 570.82 1 755 Positive Request req Tx 1026 36 15 FF F7 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 776 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88 1 7FF Positive Response Pos Rx 2 76 15 D 570.88
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2. Artificially simulate a test. Hex file from 0x12002000 to 12040000.

Valid	Type SelectConfig	abc ServiceName	Address	M Re	equest(0x)	Response(0x)	Delay	111	Proper
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		心的 本 頃江 利士	Physic	10 03		50 03	0	[Retry:3	3][Stop]
	SelectConfig	控制DTC设置	Physic	85 02		C5 02	0	[Retry:0)[Stop]
\sim	SelectConfig	通讯控制	Physic	28 03 01		68 03	0	[Retry:0	[Stop]
	SelectConfig	诊断会话控制	Physic	10 02		50 02	0	[Retry:0	[Stop]
	SelectConfig	安全访问	Physic	Seed Level	1	Fixed	0	[Retry:0	[Stop]
	SelectConfig	根据标识符写入数据	Physic	2E 00 00 0	0	6E 00 00	0	[Retry:0	[Stop]
	SelectConfig	下载文件	Physic	getting_sta	rted.hex	Fixed	0	[Retry:0)[Stop]
	Normal	ECU重启	Physic	11		No Response	50	[Retry:()[Stop]
Service	Information	ISO15765-2							
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57	0.88	7FF Pos	itive Re	sponse	Pos	Rx 2 7	6 15		
₫ 57	'0.89	1 755 Pos	itive Re	quest	req	Tx 1018 3	6 16 20 0	69 6E	73 65
M 57	0.95	7FF Post	itive Re	sponse	Pos	Rx 2 7	6 16		
57	1.00	L 755 Post	itive Re	quest	req	Tx 2 3	7 8B		
I 57 I 57 I 57	1.00	755 Post	itive Re itive Re	quest sponse	req Pos	Tx 2 3 Rx 1 7	7 8B		
 ☑ 57 ☑ 57 ☑ 57 ☑ 57 ☑ 57 	71.00 71.00 71.07	L 755 Pos L 7FF Pos 755 Pos	itive Re itive Re itive Re	quest sponse quest	req Pos req	Tx 2 3 Rx 1 7 Tx 8 3	7 8B 7 1 01 02 0	02 8B	16 EF
	 Service Service Abso 57 57<td> SelectConfig SelectConfig SelectConfig SelectConfig SelectConfig Normal SelectConfig Absolute 570.76 570.78.1 570.81 570.82 570.88 570.88 </td><td>SelectConfig 安全访问 SelectConfig 安全访问 SelectConfig 市較文件 SelectConfig 下較文件 Normal ECU重启 SelectConfig 「「較文件 Normal ECU重启 SelectConfig 「「「較文件 SelectConfig 「「較文件 Image: SelectConfig 「「「「「「」」」 SelectConfig 「「「」」 SelectConfig 「「」」 SelectConfig 「「」」 SelectConfig 「「」」 SelectConfig 「」」 SelectConfig 「」」</td><td>○ SelectConfig 受法访问 Physic ○ SelectConfig 根据标识符写入数据 Physic ○ SelectConfig 市数文件 Physic ② SelectConfig 下载文件 Physic ② SelectConfig 下载文件 Physic ③ SelectConfig 下载文件 Physic ③ Normal ECU重点 Physic ④ Normal ECU重点 Physic ④ Solo SelectConfig Title ● Solo SelectConfig Title ● Solo SelectConfig Title ● Solo SelectConfig Title ● Solo Solo Solo ● Solo Top Top ● Solo Solo Top ● Solo Top Positive Re ● Solo Solo Top</td><td>○ SelectConfig 受力に同 Physic Seed Level ○ SelectConfig 現法所识符与入数据 Physic Seed Level ○ SelectConfig 市放大井 Physic 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Physic 11	Occurrent Type Data O SelectConfig 安全访同 Physic Seed Level:1 Fixed SelectConfig 根据标识符写入数据 Physic 2E 00 00 00 6E 00 00 SelectConfig 下載文件 Physic getting_started.hex Fixed SelectConfig 下載文件 Physic 11 No Response Normal ECU重合 Physic 11 No Response SelectConfig Table File Physic 11 No Response SelectConfig Table Image: SelectConfig Table Table Table SelectConfig Table Physic 11 No Response SelectConfig Table Table Table Table Absolute In Ident Message Comment Type Data Configure Stole Stole Table Table SelectConfigure Top Top Stole Table SelectConfigure Top Top Table </td <td>② SelectConfig 受益/新同 Physic Seed Level:1 Fixed 0 ③ SelectConfig 受益/新同 Physic Seed Level:1 Fixed 0 ③ SelectConfig 根据标识符写入数据 Physic 2E 00 00 00 6E 00 00 0 ④ SelectConfig 下数文件 Physic 2E 00 00 00 6E 00 00 0 ④ SelectConfig 下数文件 Physic 11 No Response 50 ● Normal ECU重信 Physic 11 No Response 50 ● SelectConfig 下数文件 Physic 11 No Response 50 ● Stol.structure Int Ident Message Comment Positive Request Positive Request 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