

14. TF

14.1

	Multimedia Card	MMC		1997		NAND		Intel I
bits	MMC	SD	MMC	SD				
Secure Digital Card	SD	Secure Digital Memory Card			SD	MMC		MMC
Micro SD	TF	T-						
Flash	TransFlash		2004			TransFlash		1
SD	15	x 11	x 1	-	SD	1/4	SD	Memory Stick
eMMC (Embedded Multi Media Card	MMC					eMMC		
SD		SDIO	GPS	Wi-Fi		FM		

14.2

JEDEC	JESD84-B451	JESD84-B51	JEDEC
SD Card Association			
Physical_Layer_Simplified_Specification_Ver6.00			
SD Host_Controller_Simplified_Specification_Ver3.00			
SDIO	SDIO_Simplified_Specification_Ver3.00		
	SD Card Association		
	Chapter 58 : Ultra Secured Digital Host Controller (uSDHC)		

14.2.1

14.2.1.1 SD

-
-
- 1 SDSC Standard Capacity SD Memory Card 2GB
- 2 SDHC High Capacity SD Memory Card 2GB 32GB
- 3 SDXC, Extended Capacity SD Memory Card 32GB 2TB
-

- 1 SD 2.7-3.6V
- 2 UHS-II VDD1 2.7-3.6V VDD2 1.70V-1.95V

-
- 4
-
-
-
- SDMI
- CMD42-LOCK_UNLOCK
-
-
-
-
-
- 4

14.2.1.2 eMMC

eMMC €

•
image-20220112141205032

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- eMMC4.5 1bit 8bit eMMC5.1
- 1 0~200MHz

2	1bit	4bit	8bit
•			
•			
•	Erase	Trim	Sanitize
•			
•			
•			
•			
•			
•	boot		
•		RPMB	
•		512B	4KB
		HPI	Packed Commands

14.2.2

14.2.2.1 SD

Bus speed mode for UHS-I Card

image-20220112141322603

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Default Speed Mode 3.3V signaling, Frequency up to 25MHz, up to 12.5MB/sec

High Speed Mode 3.3V signaling, Frequency up to 50MHz, up to 25MB/sec

SDR12 UHS-I 1.8V signaling, Frequency up to 25MHz, up to 12.5MB/sec

SDR25 UHS-I 1.8V signaling, Frequency up to 50MHz, up to 25MB/sec

SDR50 UHS-I 1.8V signaling, Frequency up to 100MHz, up to 50MB/sec

SDR104 UHS-I 1.8V signaling, Frequency up to 208MHz, up to 104MB/sec

DDR50 UHS-I 1.8V signaling, Frequency up to 50MHz, up to 50MB/sec

UHS156 UHS-II RCLK Frequency Range 26MHz~52MHz, up to 1.56Gbps per lane

UHS624 UHS-II RCLK Frequency Range 26MHz~52MHz, up to 6.24Gbps per lane

SD	3.3v	SD	default speed	High speed
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14.2.2.2 eMMC

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eMMC 3.3v default speed high speed

14.2.3 SD eMMC

14.2.3.1 sd

image-20220112141429981

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SD VDD GND CLK CMD DAT0~DAT3 9

14.2.3.2 sd

CID	128	Card identification number	
RCA	16	Relative Card Address	
DSR	16	Driver Stage Register	
CSD	128	Card Specific Data	
SCR	64	SD Configuration Register SD	
OCR	32	Operation Condition Register	
SSR	512	SD status SD	
CSR	32	Card status Card	

14.2.3.3 MMC

image-20220112141532242

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eMMC Nand flash Device Controller Device Controller flash

14.2.3.4 eMMC

image-20220112141550937

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CID	16	Device Identification number	
RCA	2	Relative Device Address	
DSR	2	Driver Stage Register	
CSD	16	Device Specific Data	
OCR	4	Operations Conditions Register	
EXT_CSD	512	Extended Device Specific Data	v4.0

14.2.4 COMMAND RESPONSE

14.2.4.1

image-20220112141618129

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“ 0” “ 1” 48 CRC

SD eMMC 4

- bc Broadcast commands
- bcr Broadcast commands
- ac addressed point-to-point commands DATA
- adtc addressed point-to-point data transfer commands DATA

image-20220112141644353

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CMD command CMD command response CMD

image-20220112141707356

Image not found or type unknown

adtc RCA CMD command response DAT

image-20220112141712729

Image not found or type unknown

adtc

14.2.4.2

CMD

SD eMMC

- R1 normal response command 48bit
- R1b R1 DATA0
- R2 CID CSD register 136bit CID CMD2 CMD10 CSD CMD
- R3 OCR register 48bit OCR CMD1

image-20220112141745166

Image not found or type unknown

SD SD

- R6 published RCA response 48bit
- R7 Card interface condition 48bit

image-20220112141756135

Image not found or type unknown

eMMC eMMC

- R4 fast IO 48bit
- R5 Interrupt request 48bit

14.3 IMX6ULL uSDHC

14.3.1 uSDHC

- SD Host Controller Standard Specification version 3.0
- MMC System Specification version 4.2/4.3/4.4/4.41/4.5
- SD Memory Card Specification version 3.0 Extended Capacity SD Memory Card
- SDIO Card Specification version 3.0

- SD Memory, miniSD Memory, SDIO, miniSDIO, SD Combo, MMC, MMC plus, and MMC RS cards
- 208MHz
- 1-bit/4-bit SD SDIO 1-bit/4-bit SD/8-bit MMC

1	4	SDR(Single Data Rate)	SDIO	832Mbps
2	4	DDR(Dual Data Rate)	SDIO	400Mbps
3	4	SDR(Single Data Rate)	SDXC	832Mbps
4	4	DDR(Dual Data Rate)	SDXC	400Mbps
5	8	SDR(Single Data Rate)	MMC	416Mbps
6	8	DDR(Dual Data Rate)	MMC	832Mbps

-
- Wie 1~4096
-
-
-
- SDIO (suspend) (resume)
- CMD12
-
- 1-bit 4-bit SDIO
- 128x32-bit FIFO
- DMA
- vendor
- ADMA

14.3.2

uSDHC

- SD 1-bit
- SD 4-bit
- MMC 1-bit
- MMC 4-bit
- MMC 8-bit
- 400 kHz
- MMC 26MHz
- MMC 52MHz
- MMC HS200 200MHz
- MMC DDR 52M

- SD/SDIO 25MHz
- SD/SDIO 50MHz
- SD/SDIO UHS-I SDR 208M DDR 50M

14.3.3

image-20220112142021189

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100sdk_imx6ull SD uSDHC1

image-20220112142025607

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100sdk_imx6ull eMMC uSDHC2

uSDHC 14 I/O

- CLK MMC SD SDIO
- CMD I/O
- 8 uSDHC
- CD WP CD# WP
- LCTL LED
- RST MMC
- VSELECT
- CD, WP, LCTL, RST VSELECT uSDHC 4bit DATA7~DATA4

14.3.4

Clock name	Clock Root	Description
hclk	ahb_clk_root	AHB bus clock
ipg_clk	ipg_clk_root	Peripheral clock
ipg_clk_perclk	usdhc_clk_root	Base clock
ipg_clk_s	ipg_clk_root	Peripheral access clock for register accesses

uSDHC hclk AHB ipg_clk Peripheral ipg_clk_perclk uSDHC ipg_clk_s

image-20220112142122012

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imx6ull reference manual chapter18 Clock Controller Module 18.3 CCM Clock
Tree CCM_CSCMR1[USDHCn_CLK_SEL] CSCDRn[USDHC1_PODF] USDHCn_CLK_RC
CCM_CSCMR1

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CSCDR1[USDHC1_PODF]

image-20220112142135423

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USDHC1 USDHC2 PLL2PFD0 PLL2PFD2 CCM_CSCMR1 CSCDR1[USDHCn_POD
D0 396M USDHCn_PODF 1 PLL2PFD2 USDHC1_CLK_ROOT USDHC1_CLK_ROOT
Card_clk peripheral source clock

image-20220112142205025

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uSDHCx_SYS_CTRL[DVS] DIV Base ase/2, Base/3, ..., Base/16
uSDHCx_SYS_CTRL[SDCLKFS] card_clk
SDR DDR CLK SDR CLK card_clk DDR CLK card_clk/2
Base USDHCx_CLK_ROOT USDHCx_CLK_ROOT 198M uSDHCx_SYS_CTRL[DVS] uSDHCx_SY
KFS] 400K 25M 26M 50M 52M

14.3.5 ADMA

SD DMA ADMA Advanced DMA advanced SDMA(Si
SDMA page boundary DMA DMA System Address (uSDHCx_DS_ADDR)
System addreass

ADMA	DMA	scatter gather algorithm	ADMA	desc
(uSDHCx_ADMA_SYS_ADDR)		DMA		CPU
ADMA	ADMA1	ADMA2	ADMA1	4KB
				ADMA2

image-20220112142231919

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PartA2_SD Host_Controller_Simplified_Specification_Ver3.00 page14				
ADMA2		address	length	attribute
ADMA2			ADMA2	
3				
1	4			
2	64KB			
3	Length1+length2+...+lengthn			
Block count	65535	ADMA2	65535	block count
				block size
				b

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image-20220112142245267

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32-bit	64	Nop	Rsv	NOP	Tran	32-b
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14.3.6

SD Host_Controller_Simplified_Specification_Ver3.00 SD

image-20220112142257497

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IMX6ULL

Absolute address (hex)	Register name	Width (in bits)	Access	Reset value	Section/ page
219_0000	DMA System Address (uSDHC1_DS_AD DR)	32	R/W	0000_0000h	58.8.1/4014
219_0004	Block Attributes (uSDHC1_BLK_AT T)	32	R/W	0000_0000h	58.8.2/4015
219_0008	Command Argument (uSDHC1_CMD_A RG)	32	R/W	0000_0000h	58.8.3/4017
219_000C	Command Transfer Type (uSDHC1_CMD_X FR_TYP)	32	R/W	0000_0000h	58.8.4/4017
219_0010	Command Response0 (uSDHC1_CMD_R SP0)	32	R	0000_0000h	58.8.5/4021
219_0014	Command Response1 (uSDHC1_CMD_R SP1)	32	R	0000_0000h	58.8.6/4021
219_0018	Command Response2 (uSDHC1_CMD_R SP2)	32	R	0000_0000h	58.8.7/4022
219_001C	Command Response3 (uSDHC1_CMD_R SP3)	32	R	0000_0000h	58.8.8/4022
219_0020	Data Buffer Access Port (uSDHC1_DATA_BUFF_ACC_PORT)	32	R/W	0000_0000h	58.8.9/4024
219_0024	Present State (uSDHC1_PRES_S TATE)	32	R	0000_8080h	58.8.10/ 4024
219_0028	Protocol Control (uSDHC1_PROT_C TRL)	32	R/W	0880_0020h	58.8.11/ 4030
219_002C	System Control (uSDHC1_SYS_CT RL)	32	R/W	8080_800Fh	58.8.12/ 4035

Absolute address (hex)	Register name	Width (in bits)	Access	Reset value	Section/ page
219_0030	Interrupt Status (uSDHC1_INT_ST ATUS)	32	w1c	0000_0000h	58.8.13/ 4038
219_0034	Interrupt Status Enable (uSDHC1_INT_ST ATUS_EN)	32	R/W	0000_0000h	58.8.14/ 4044
219_0038	Interrupt Signal Enable (uSDHC1_INT_SIG NAL_EN)	32	R/W	0000_0000h	58.8.15/ 4047
219_003C	Auto CMD12 Error Status (uSDHC1_AUTOC MD12_ERR_STAT US)	32	R	0000_0000h	58.8.16/ 4050
219_0040	Host Controller Capabilities (uSDHC1_HOST_ CTRL_CAP)	32	R	07F3_B407h	58.8.17/ 4053
219_0044	Watermark Level (uSDHC1_WTMK_ LVL)	32	R/W	0810_0810h	58.8.18/ 4056
219_0048	Mixer Control (uSDHC1_MIX_CT RL)	32	R/W	8000_0000h	58.8.19/ 4057
219_0050	Force Event (uSDHC1_FORCE_ EVENT)	32	W (always reads 0)	0000_0000h	58.8.20/ 4059
219_0054	ADMA Error Status Register (uSDHC1_ADMA_ ERR_STATUS)	32	R	0000_0000h	58.8.21/ 4062
219_0058	ADMA System Address (uSDHC1_ADMA_ SYS_ADDR)	32	R/W	0000_0000h	58.8.22/ 4064
219_0060	DLL (Delay Line) Control (uSDHC1_DLL_CT RL)	32	R/W	0000_0200h	58.8.23/ 4065
219_0064	DLL Status (uSDHC1_DLL_ST ATUS)	32	R	0000_0000h	58.8.24/ 4067

Absolute address (hex)	Register name	Width (in bits)	Access	Reset value	Section/ page
219_0068	CLK Tuning Control and Status (uSDHC1_CLK_TUNE_CTRL_STATUS)	32	R/W	0000_0000h	58.8.25/ 4068
219_00C0	Vendor Specific Register (uSDHC1_VEND_SPEC)	32	R/W	2000_7809h	58.8.26/ 4070
219_00C4	MMC Boot Register (uSDHC1_MMC_BOOT)	32	R/W	0000_0000h	58.8.27/ 4073
219_00C8	Vendor Specific 2 Register (uSDHC1_VEND_SPEC2)	32	R/W	0000_0006h	58.8.28/ 4074
219_00CC	Tuning Control Register (uSDHC1_TUNING_CTRL)	32	R/W	0021_2800h	58.8.29/ 4076

bit uSDHC SD

14.3.6.1 DMA System Address (uSDHCx_DS_ADDR)

SDMA ADMA2

image-20220112142313267

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14.3.6.2 Block Attributes (uSDHCx_BLK_ATT)

image-20220112142340224

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BLKCNT

BLKSIZE

14.3.6.3 Command Argument (uSDHCx_CMD_ARG)

SD/MMC

image-20220112142404487

Image not found or type unknown

14.3.6.4 Command Transfer Type (uSDHCx_CMD_XFR_TYP)

image-20220112142415095

Image not found or type unknown

Multi/Single Block Select	Block Count Enable	Block Count	Function
0	Don't Care	Don't Care	Single Transfer
1	0	Don't Care	Infinite Transfer
1	1	Positive Number	Multiple Transfer
1	1	Zero	No Data Transfer

Response Type	Index Check Enable	CRC Check Enable	Name of Response Type
00	0	0	No Response
01	0	1	R2
10	0	0	R3,R4
10	1	1	R1,R5,R6
11	1	1	R1b,R5b

CMDINDEX command index

CMDTYPE command type 0 normal command

DPSEL Data Present Select 1

CICEN command index check enable 1 response index

CCCEN command crc check enable response CRC

RSPTYP response type response 00 01 136 10 48 11 48

14.3.6.5 Command Response0 (uSDHCx_CMD_RSP0)

image-20220112142444186

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14.3.6.6 Command Response1 (uSDHCx_CMD_RSP1)

image-20220112142451825

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14.3.6.7 Command Response2 (uSDHCx_CMD_RSP2)

image-20220112142458607

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14.3.6.8 Command Response3 (uSDHCx_CMD_RSP3)

image-20220112142504119

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Response Type	Meaning of Response	Response Field	Response Register
R1,R1b (normal response)	Card Status	R[39:8]	CMDRSP0
R1b (Auto CMD12 response)	Card Status for Auto CMD12	R[39:8]	CMDRSP3
R2 (CID, CSD register)	CID/CSD register [127:8]	R[127:8]	{CMDRSP3[23:0], CMDRSP2, CMDRSP1, CMDRSP0}
R3 (OCR register)	OCR register for memory	R[39:8]	CMDRSP0
R4 (OCR register)	OCR register for I/O etc.	R[39:8]	CMDRSP0
R5, R5b	SDIO response	R[39:8]	CMDRSP0
R6 (Publish RCA)	New Published RCA[31:16] and card status[15:0]	R[39:9]	CMDRSP0

response reference manual P4022

14.3.6.9 Data Buffer Access Port(uSDHCx_DATA_BUFF_ACC_PORT)

DMA ADMA2 0

image-20220112142534276

Image not found or type unknown

14.3.6.10 Present State (uSDHCx_PRES_STATE)

image-20220112142541528

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DL[7:0] data line signal level	DATA	DATA0
CLSL CMD line Signal Level	CMD	
WPSPL Write Protect Swith Pin Level	WP	
CDPL Card Detect Pin Level	CD_B	CD_B uSDHC
CINST Card Inserted	uSDHC	
TSCD Tape Select Change Done	tuning	
RTR Re-Tuning Request	tuning	SD3.0 SDR104
BREN Buffer READ ENABLE	DMA	
BWEN Buffer Write ENABLE	DMA	
RTA READ Transfer active		
WTA Write Transfer Active		
SDOFF SDCLOCK Gated Off Internally	SD	
PEROFF IPG_PERCLK Gated Off Internally	IPG_PERCLK	
HCKOFF HCLK Gated Off Internally	HCLK	
IPGOFF IPG_CLK Gated Off Internally	IPG_CLK	
SDSTB SD		
DLA Data Line Active	Data	
CDIHB Command Inhibit(Data)	data	

14.3.6.11 Protocol Control (uSDHCx_PROT_CTRL)

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NON_EXACT_BK_READ SDIO

BURST_ELN_EN

WECRM Wakeup Event Enable On SD Card Removal

WECINS Wakeup Event Enable On SD Card Insert

WECINT Wakeup Event Enable On Card Interrupt

RD_DONE_NO_8CLK

IABG interrupt At Block GAP SDIO 4bit

RWCLT READ wait control SDIO

CREQ continue request

DMASEL DMA select DMA 00 DMA SDMA 01 ADMA1, 10 ADMA2

CDSS Card Detect Signal Selection

CDTL Card Detect Test Level

EMODE Endian Mode

D3CD Data3 as Card Detection Pin data3

DTW Data Transfer Width

LCTL LED

14.3.6.12 System Control (uSDHCx_SYS_CTRL)

image-20220112142639489

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RSTT Reset Tuning tuning

INITA Initialization Active80 SDCLK

RSTD Software Reset for DATA LineDMA SW

RSTC Software Reset for CMD line

RSTA Software Reset for ALL

IPP_RST_N

DTOCV Data Timeout Counter Value

SDCLKFS SDCLK Frequency Select SDCLK

DVS divisorSDCLK

14.3.6.13 Interrupt Status (uSDHCx_INT_STATUS)

Normal Interrupt Signal Enable10

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image-20220112142709227

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Command Complete	Command Timeout Error	Meaning of the Status
0	0	X
X	1	Response not received within 64 SDCLK cycles
1	0	Response received

Transfer Complete	Data Timeout Error	Meaning of the Status
0	0	X
0	1	Timeout occurred during transfer
1	X	Data Transfer Complete

Command Complete	Command Timeout Error	Meaning of the Status
0	0	No error
0	1	Response Timeout Error
1	0	Response CRC Error

Command Complete	Command Timeout Error	Meaning of the Status
1	1	CMD line conflict

DMAE DMAError DMA

TNE TuningERROR tuning

AC12E Auto CMD12 ERROR Auto CMD12

DEBE Data End Bit ERROR

DCE Data CRC ERROR CRC

DTOE data timeout ERROR

CIE Command Index Error

CEBE Command End Bit ERROR

CCE Command CRC error crc

CTOE Command timeout error

TP tuning pass tuning SD3.0 SDR104

RTE Re-Tuning Event Tuning SD3.0 SDR104

CINT card interrupt

CRM card remove

CINS card insert

BRR Buffer Read Ready

BWR Buffer Read Ready

DINT DMA interrupt DMA

BGE block gap event

TC Transfer Complete

CC Command Complete

14.3.6.14 Interrupt Status Enable (uSDHCx_INT_STATUS_EN)

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image-20220112142740821

Image not found or type unknown

Interrupt Status

uSDHCx_INT_STATUS_EN

0

Interrupt Status

14.3.6.15 Interrupt Signal Enable (uSDHCx INT SIGNAL EN)

image-20220112142801615

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14.3.6.16 Auto CMD12 Error Status (uSDHCx AUTOCMD12 ERR STATUS)

image-20220112142807960

Image not found or type unknown

Auto CMD12 CRC Error	Auto CMD12 Timeout Error	Type of Error
0	0	No Error
0	1	Response Timeout Error
1	0	Response CRC Error
1	1	CMD line conflict

SMP_CLK_SEL Sample Clock Select

EXECUTE TUNING execute tuning tuning

CNIBAC12E Command not Issued By Auto CMD12 Error Auto CMD12

AC12IE Auto CMD12/23 Index Error Auto CMD12

AC12CE Auto CMD12/23 CRC Error Auto CMD12 CRC

AC12EBE Auto CMD12/23 End Bit Error Auto CMD12

AC12TOE Auto CMD12/23 Timeout Error Auto CMD12

AC12NE Auto CMD12 Not Executed Auto CMD12

14.3.6.17 Host Controller Capabilities (uSDHCx_HOST_CTRL_CAP)

image-20220112142823623

Image not found or type unknown

image-20220112142827981

Image not found or type unknown

VS18 Voltage Support 1.8v 1.8v

VS30 Voltage Support 3.0v 3.0v

VS33 Voltage Support 3.3v 3.3v

SRS Suspend/Resume support suspend/resume

DMAS DMA support DMA

HSS high speed support HS

ADMAS ADMA support ADMA

MBL Max Block Length

RETURNIGN MODE retuning

USE_TUNING_SDR50 SDR50 tuning

TIMER_COUNT_RETUNING

DDR50_SUPPORT DDR50

SDR104_SUPPORT SDR104

SDR50_SUPPORT SDR50

14.3.6.18 Watermark Level (uSDHCx_WTMK_LVL)

image-20220112142845425

Image not found or type unknown

14.3.6.19 Mixer Control (uSDHCx_MIX_CTRL)

image-20220112142848599

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FBCLK_SEL FeedBack clock Source Selection SD3.0 SDR104

AUTO_TUNE_EN tune

SMP_CLK_SEL Tuned clk fixed clk data/cmd

EXE_TUNE Execute Tuning SD3.0 SDR104

AC23EN Auto CMD23 Enable Auto CMD23

NIBBLE_POS DDR 4bit

MSBSEL

DTDSEL Data transfer Direction Select

DDR_EN Dual Data rate Mode selection DDR

AC12EN Auto CMD12 Enable Auto CMD12

BCEN Block Count Enable

DMAEN DMA Enable DMA

14.3.6.20 Force Event (uSDHCx_FORCE_EVENT)

image-20220112142905813

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14.3.6.21 ADMA Error Status Register(uSDHCx_ADMA_ERR_STATUS)

ADMA ADMA Error Status Register ADMA ADMA System Address register

ST_STOP ADMA System Address register

ST_FDS ADMA System Address register

ST_CADR change ADDRESS

ST_TRF ADMA System Address register

ADMA Error State Coding

D01-D00	ADMA Error State (when error has occurred)	Contents of ADMA System Address Register
00	ST_STOP (Stop DMA)	Holds the address of the next executable Descriptor command
01	ST_FDS (Fetch Descriptor)	Holds the valid Descriptor address
10	ST_CADR (Change Address)	No ADMA Error is generated
11	ST_TFR (Transfer Data)	Holds the address of the next executable Descriptor command

image-20220112142915422

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ADMADCE ADMA Descriptor Error ADMA

ADMA

ADMALME ADMA Length Mismatch Error ADMA

BLOCK COUNT ENABLE

LENGTH

BLOCK LENGTH

ADMAAES ADMA Error State ADMA

14.3.6.22 ADMA System Address (uSDHCx_ADMA_SYS_ADDR)

ADMA

ADMA

image-20220112142922547

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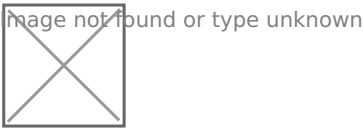
14.3.6.23 DLL (Delay Line) Control (uSDHCx_DLL_CTRL)

14.3.6.24 DLL Status (uSDHCx_DLL_STATUS)

14.3.6.25 CLK Tuning Control and Status (uSDHCx_CLK_TUNE_CTRL_STATUS)

tuning default speed high speed

14.3.6.26 Vendor Specific Register (uSDHCx_VEND_SPEC)



ADMA EXT_DMA_EN 0

14.3.6.27 MMC Boot Register (uSDHCx_MMC_BOOT)

image-20220112142955603

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BOOT_CLK_CNT

DISABLE_TIME_OUT 0 1

AUTO_SABG_EN boot

BOOT_EN fastboot

BOOT_MODE 0 normal boot 1 Alternative boot

BOOT_ACK boot ACK

DTOCVACK BOOT ack

14.3.6.28 Vendor Specific 2 Register (uSDHCx_VEND_SPEC2)

SDR tuning

image-20220112143020040

Image not found or type unknown

14.3.6.29 Tuning Control Register (uSDHCx_TUNING_CTRL)

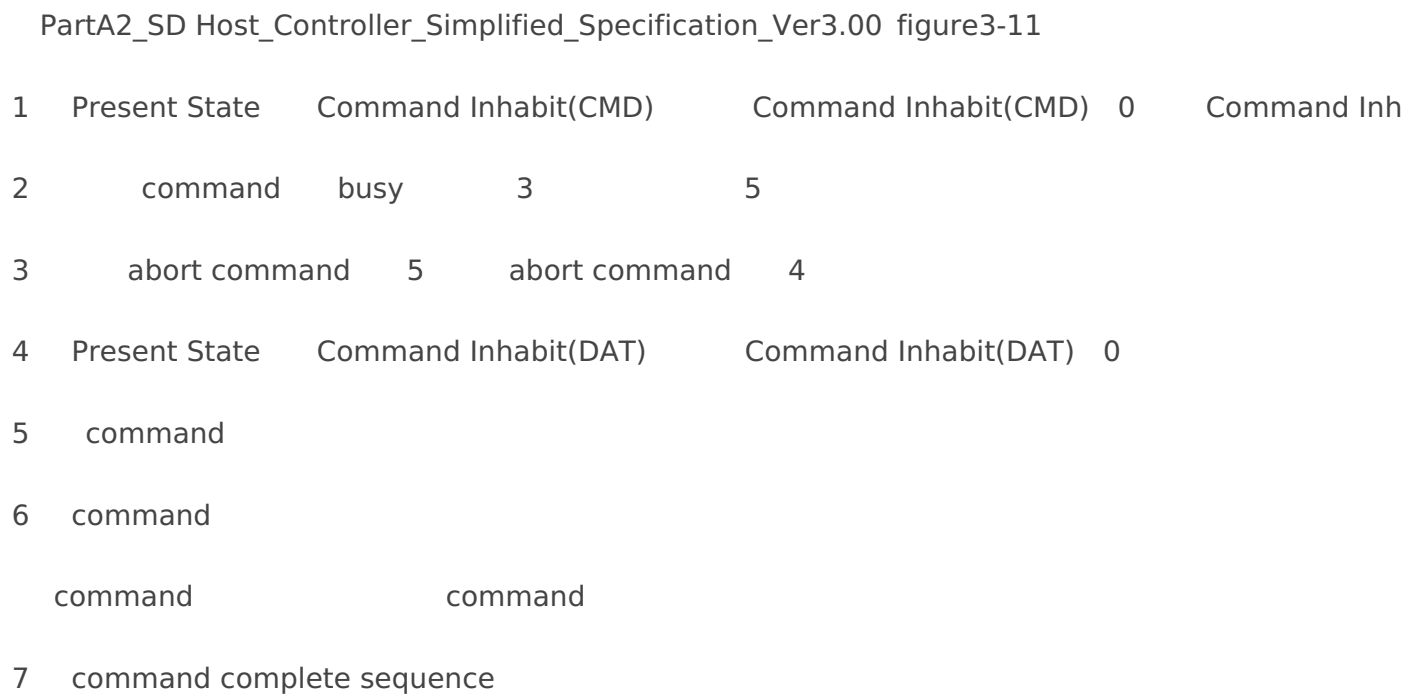
default speed high speed

14.3.7 CMD Response

14.3.7.1

14.3.7.1-14.3.7.3 SD Host_Controller_Simplified_Specification_Ver3.00 imx
image-20220112143043372

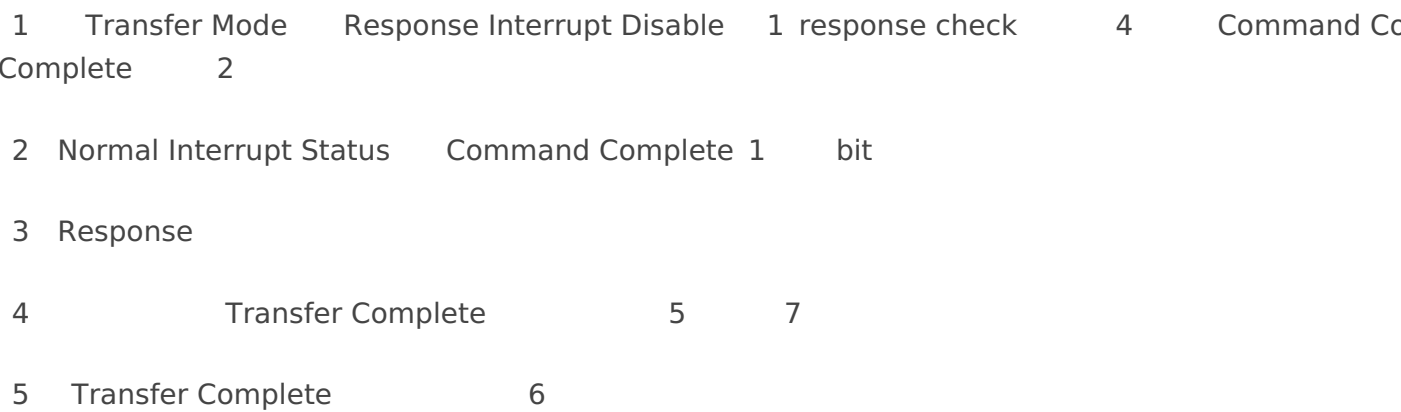
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14.3.7.2

PartA2_SD Host_Controller_Simplified_Specification_Ver3.00 figure3-12
image-20220112143222038

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- 6 Normal Interrupt Status Transfer Complete 1 bit
- 7 Response data 8 9
- 8 No ERROR
- 9 Response Contents Error

14.3.7.3 DAT ADMA

PartA2_SD Host_Controller_Simplified_Specification_Ver3.00 figure3-15

image-20220112143230507

Image not found or type unknown

- 1 ADMA
- 2 ADMA ADMA System Address
- 3 Block Size
- 4 Block Count
- 5 Argument
- 6 Transfer Mode Multi/Single Block Select Block Count Enable Data Transfer Direction
Enable DMA enable
- 7 Command
- 8 Response check 11 Command Complete Command Complete 1 9
- 9 Normal Interrupt Status Command Complete 1 bit
- 10 Response
- 11 Transfer Complete ADAM Error
- 12 Transfer Complete 1 13 ADAM Error 1 14
- 13 Normal Interrupt Status Transfer Complete 1 bit
- 14 Error Interrupt Status ADMA Error Interrupt Status 1 bit
- 15 abort ADMA

14.3.7.4 DATA

- 1CIHB 0
- 2CMDTYP, DPSEL, CICEN, CCCEN, RSTTYP, DTDSEL
- 3CMDARG
- 4XFERTYP
- 5INT_STATUSCC
- 61CC

14.3.7.5DATA

- 1CIHB 0
- 2CDIHB 0
- 3ADMA
- 4ADMA_SYS_ADDRADMA
- 5BLK_ATT
- 6PROT_CTRLDMAADMA2
- 7MIX_CTRLDTDSELDMAEN
- 8CMDARG
- 9XFERTYP
- 10INT_STATUSCC
- 111CC
- 12INT_STATUSTC
- 131TC

14.3.7.6/

- 1CIHB 0
- 2CDIHB 0

3 ADMA

4 ADMA_SYS_ADDR ADMA

5 BLK_ATT

6PROT_CTRL DMA ADMA2

7MIX_CTRL DTDSEL DMAEN 8 BCEN MSBSEL AUTO CMD12 AC12

9 CMDARG

10 XFERTYP

11 INT_STATUS CC

12 1 CC

13 INT_STATUS TC

14 1 TC

14.3.7.7 SD Version2.0

1 CMD0

2 SDHC CMD8

3 Version2.0 CMD8 legacy cards SD CMD8

4 ACMD41 OCR 0

5 1S ACMD41 HCS HCS 1, big31 1 CCS CCS 0 SDSC 1

6 1.8v ACMD41 S18R S18A 1 1.8v CMD11

7 CMD2 CID

8 CMD3 RCA 0

9 CMD9 RCA CSD

10 CMD7 RCA

11 ACMD51 RCA SCR

12 ACMD6 0 1bit 2 4bit

13 CMD6 function group 1 speed mode

14.3.7.8 eMMC

JESD84-B51

A.6

a.

- 1 (2.7~3.6v)
- 2 400k
- 3 1ms 74
- 4 CMD0
- 5 CMD1 0x00FF8000 0x00000080
- 6 R3
- 7 OCR busy 0 5 6
- 8 R3 High Voltage Dual Voltage 0x80FF8000 High Voltage 0x80FF8080
- 9 R3 inactive

16

- 10 Dual Voltage
- 11 1.70~1.95V
- 12 1ms 74
- 13 CMD1 0x00000080
- 14 R3 0x80FF8080
- 15 OCR busy 0 13 14

b. CID RCA

- 16 CMD2
- 17 R2 CID
- 18 CMD3 1

CSD

19 CMD9

20 R2 CSD

21 CSD SPEC_VERS V4.0 high speed SWITCH SEND_EXT_CSD

High Speed

high speed

high speed

22 CMD7 RCA tran state

23 CMD8 SEND_EXT_CSD EXT_CSD power class 26-37

24 CMD6 0x03B9_0100 EXT_CSD HS_TIMING 0x1

24.1 R1 busy

24.2 busy high speed timing

25 0~26/52MHz

a.

26 CMD19

27

27.1 8 MSB LSB 0x0000_0000_0000_AA55

27.2 4 MSB LSB 0x0000_AA55

27.3 1 0x80

28 NCR

29 CMD14

29.1 8 8

29.2 4 4

29.3 1 1

30 27 XNOR

31 MASK

31.1	8	MSB	LSB	0x0000_0000_0000_FFFF
------	---	-----	-----	-----------------------

31.2	4	MSB	LSB	0x0000_FFFF
------	---	-----	-----	-------------

```
31.3  1      0xC0
```

32 0

b

33

```
34 power class      power class      CMD6  EXT_CSD POWER_CLASS  power class
```

35 CMD6

36	CMD6	EXT_CSD	BUS_WIDTH	4bit	0x03B7_0100	8bit	0x03B7_0200
----	------	---------	-----------	------	-------------	------	-------------

14.3.8 eMMC

image-20220112143422049

Image not found or type unknown

AreaPartition RPMB Boot Area Partitions User Data Area Boot Area Partitions Replay Protected

- Boot Area Partitions 128 KB eMMC
- RPMB 128 KB
- General Purpose Area Partitions Write Protect Group

General Purpose Area Partition enhanced or extended technological features
media features boot RPMB

boot	RPMB	General Purpose Area Partitions
0	1	2
3	4	5
6	7	8
9	10	11
12	13	14
15	16	17
18	19	20
21	22	23
24	25	26
27	28	29
30	31	32
33	34	35
36	37	38
39	40	41
42	43	44
45	46	47
48	49	50
51	52	53
54	55	56
57	58	59
60	61	62
63	64	65
66	67	68
69	70	71
72	73	74
75	76	77
78	79	80
81	82	83
84	85	86
87	88	89
90	91	92
93	94	95
96	97	98
99	100	101
102	103	104
105	106	107
108	109	110
111	112	113
114	115	116
117	118	119
120	121	122
123	124	125
126	127	128
129	130	131
132	133	134
135	136	137
138	139	140
141	142	143
144	145	146
147	148	149
150	151	152
153	154	155
156	157	158
159	160	161
162	163	164
165	166	167
168	169	170
171	172	173
174	175	176
177	178	179
180	181	182
183	184	185
186	187	188
189	190	191
192	193	194
195	196	197
198	199	200
201	202	203
204	205	206
207	208	209
210	211	212
213	214	215
216	217	218
219	220	221
222	223	224
225	226	227
228	229	230
231	232	233
234	235	236
237	238	239
240	241	242
243	244	245
246	247	248
249	250	251
252	253	254
255	256	257
258	259	260
261	262	263
264	265	266
267	268	269
270	271	272
273	274	275
276	277	278
279	280	281
282	283	284
285	286	287
288	289	290
291	292	293
294	295	296
297	298	299
300	301	302
303	304	305
306	307	308
309	310	311
312	313	314
315	316	317
318	319	320
321	322	323
324	325	326
327	328	329
330	331	332
333	334	335
336	337	338
339	340	341
342	343	344
345	346	347
348	349	350
351	352	353
354	355	356
357	358	359
360	361	362
363	364	365
366</		

image-20220112143458999

Image not found or type unknown

14.4

led.imx TF eMMC

led.imx led.imx led.imx.h unsigned char led_imx_image I

14.4.1

image-20220112143657344

Image not found or type unknown

100sdk_imx6ull SD uSDHC1

image-20220112143701287

Image not found or type unknown

100sdk_imx6ull eMMC uSDHC2

TF USDHC1_CMD USDHC1_CLK USDHC1_DATA0-3 USDHC1_CD_B eMMC USDHC2_CMD USDHC2_CLK USDHC2_RESET_B USDHC2_DATA

PinMux IOMUXC_SetPinConfig

14.4.2

USDHCx_CLK_ROOT 198M uSDHCx_SYS_CTRL[DVS] uSDHCx_SYS_CTRL[SDCLKFS]

M

14.4.3 CMD_XFR_TYP 16bit

CRC DATA CMD_XFR_TYP 16bit


```

/*
 * CMDx: normal command,
 * ACMDx: app command,
 * SCMDx: sd command,
 * MCMDx: mmc command
 * R1 R1b R3 R6 R7 48bit;
 * R2 136bit
 * bit1-0(bit17-16) RSPTYP 00 no response; 01 length 136; 02 length 48; 03 length 48 and check
busy
 * bit3(bit19) CCCEN command crc check enable
 * bit4(bit20) CICEN Command index check enable
 * bit5(bit21) DPSEL data present select
*/

#define CMD0[0x0000]/* GO_IDLE_STATE[no response] */
#define CMD1[0x0102]/* SEND_OP_COND[R3] */
#define CMD2[0x0209]/* ALL_SEND_CID[R2] */
#define CMD3[0x031a]/* SET_RELATIVE_ADDR (R6/R1) */
#define ACMD6[0x061a]/* SET_BUS_WIDTH R1 */
#define ACMD23[0x171a]/* SET_WR_BLK_ERASE_CNT[R1] */
#define SCMD6[0x063a]/* SWITCH_BUSWIDTH[R1] */
#define MCMD6[0x061b]/* SET_EXT_CSD R1B */
#define CMD7[0x071b]/* SELECT_CARD R1B */
#define CMD8[0x081a]/* SEND_IF_COND[R7] */
#define MCMD8[0x083a]/* GET_EXT_CSD R1 */
#define CMD9[0x0909]/* GET_THE_CSD R2 */
#define CMD11[0x0b1a]/* SWITCH VOLTAGE R1 */
#define CMD13[0x0d1a]/* SEND_STATUS R1 */
#define ACMD13[0x0d3a]/* SEND_STATUS R1 */
#define CMD16[0x101a]/* SET_BLOCKLEN[R1] */
#define CMD17[0x113a]/* READ_SINGLE_BLOCK R1 */
#define CMD18[0x123a]/* READ_MULTIPLE_BLOCK R1 for SD R7 */
#define SCMD19 0x133a /* SEND_TUNING R1 */
#define MCMD21 0x153a /* SEND_TUNING R1 */
#define CMD24[0x183a]/* WRITE_BLOCK R1 */
#define CMD25[0x193a]/* WRITE_MULTIPLE_BLOCK[R1] */
#define CMD32[0x201a]/* ERASE_WR_BLK_START R1 */
#define CMD33[0x211a]/* ERASE_WR_BLK_END[R1] */
#define CMD35[0x231a]/* ERASE_GROUP_START R1 */
#define CMD36[0x241a]/* ERASE_GROUP_END[R1] */

```

```
#define CMD38 0x261b /* ERASE R1B */
#define ACMD41 0x2902 /* SD_SEND_OP_COND R3 */
#define ACMD42 0x2a1b /* LOCK_UNLOCK R1B */
#define ACMD51 0x333a /* SEND_SCR R1 */
#define CMD55 0x371a /* APP_CMD R1 */
```

14.4.4 DATA

CMD CMD PRES_STATE CIHB 0 CMD CMD_XFR_1

Git [NoosProgramProject/\(14_TF /006_sd/sd.c\)](#)

```
static int USDHC_SendCommand(USDHC_Type *base, u32 command, u32 argument)
{
    /* Wait until command/data bus out of busy status. */
    while (base->PRES_STATE & USDHC_PRES_STATE_CIHB_MASK) {
    }

    /* config the command xfertype and argument */
    base->CMD_ARG = argument;
    base->CMD_XFR_TYP = command << 16;

    return USDHC_WaitCommandDone(base);
}
```

INT_STATUS CC CRC

Git [NoosProgramProject/\(14_TF / 006_sd/sd.c\)](#)

```
static int USDHC_WaitCommandDone(USDHC_Type *base)
{
    int error = 0;
    uint32_t interruptStatus = 0U;

    /* Wait command complete or USDHC encounters error. */
    while (!(base->INT_STATUS & (USDHC_INT_STATUS_CC_MASK | kUSDHC_CommandErrorFlag))) {
    }

    interruptStatus = base->INT_STATUS;
    if ((interruptStatus & kUSDHC_CommandErrorFlag) != 0U)
```

```

{
    printf("cmd error, CMD is 0x%x, INT_STATUS is 0x%x\r\n", base->CMD_XFR_TYP, interruptStatus);
    USDHC_Dump_All(base);
    error = -1;
}

USDHC_ClearInterruptStatusFlags(
    base, (kUSDHC_CommandCompleteFlag | kUSDHC_CommandErrorFlag | kUSDHC_TuningErrorFlag));

return error;
}

```

14.4.5 ADMA

address length attribute ADMA2 DMA System

Git **NoosProgramProject/(14_TF /006_sd/sd.c)**

```

static int USDHC_CreateDescTable(u8 *data, u32 len)
{
    int i;
    u32 dma_len, entries;

    entries = len / USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY;
    if ((len % USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY) != 0U)
        entries++;

    for (i = 0; i < entries; i++)
    {
        if (len > USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY)
        {
            dma_len = USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY;
            len -= USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY;
        }
        else
        {

```

```

dma_len = len;

}

/* Each descriptor for ADMA2 is 64-bit in length */
g_adma2_tablbe[i].address = (uint32_t *)data;
g_adma2_tablbe[i].attribute = (dma_len << USDHC_ADMA2_DESCRIPTOR_LENGTH_SHIFT);
g_adma2_tablbe[i].attribute |= kUSDHC_Adma2DescriptorTypeTransfer;
data += dma_len;
}
g_adma2_tablbe[entries - 1].attribute |= kUSDHC_Adma2DescriptorEndFlag;
/*for (i = 0; i < entries; i++) {
    printf("g_adma2_tablbe[i] address is 0x%x, attribute is 0x%x\r\n",
        g_adma2_tablbe[i].address, g_adma2_tablbe[i].attribute);
}
*/

return 0;
}

```

14.4.6 DATA

	data	PRES_STATE	CIHB	CDIHB 0	CMD	DATA		CMD
A	ADMA	ADMA_SYS_ADDR	PROT_CTRL	ADMA		ADMA2		
	_WaitCommandDone		USDHC_WaitDataDone					
		USDHC_WaitDataDone	INT_STATUS		TC			
CMD12	DMA	USDHC_Dump_All	dump uSDHC				INT_STATUS	ADMA_ERR

NoosProgramProject/(14_TF /006_sd/sd.c)

```

static int USDHC_WaitDataDone(USDHC_Type *base)
{
    int error = 0;
    uint32_t interruptStatus = 0U;

    /* Wait command complete or USDHC encounters error. */
    while (!(base->INT_STATUS & (kUSDHC_DataCompleteFlag | kUSDHC_DataErrorFlag |
        kUSDHC_DmaErrorFlag))) {
    }
}

```

```

    interruptStatus = base->INT_STATUS;

    if ((interruptStatus & (kUSDHC_DataErrorFlag | kUSDHC_DmaErrorFlag)) != 0U) {
        printf("data or ADMA error, CMD is 0x%x, INT_STATUS is 0x%x\r\n", base->CMD_XFR_TYP,
            interruptStatus);
        USDHC_Dump_All(base);
        error = -1;
    }

    USDHC_ClearInterruptStatusFlags(
        base, (kUSDHC_DataCompleteFlag | kUSDHC_DataErrorFlag | kUSDHC_DmaErrorFlag));

    return error;
}

```

14.4.7

PRES_STATE	CIHB	CDIHB	0	CMD	data		ADMA	ADMA	ADM
MA2	MIX_CTRL	DTDSEL	1		DMAEN		MIX_CTRL	MSBSEL	BCEN
XFR_TYP									

Git NoosProgramProject/(14_TF /006_sd/sd.c)

```

int sd_read_blocks(USDHC_Type *base, uint8_t *buffer, uint32_t startBlock, uint32_t
blockCount)
{
    int err = 0;

    /* Wait until command/data bus out of busy status. */
    while (base->PRES_STATE & USDHC_PRES_STATE_CIHBMASK) {
    }
    while (base->PRES_STATE & USDHC_PRES_STATE_CDIHBMASK) {
    }
    /* set ADMA descriptor */
    USDHC_CreateDescTable(buffer, blockCount * 512);

    /* When use ADMA, disable simple DMA */
    base->DS_ADDR = 0U;
    base->ADMA_SYS_ADDR = (u32) g_adma2_table;
}

```

```

/* config data block size/block count */
base->BLK_ATT = (USDHC_BLK_ATT_BLKSIZE(512) | USDHC_BLK_ATT_BLKCNT(blockCount));

/* disable the external DMA if support */
base->VEND_SPEC &= ~USDHC_VEND_SPEC_EXT_DMA_EN_MASK;
/* select DMA mode and config the burst length */
base->PROT_CTRL &= ~(USDHC_PROT_CTRL_DMASEL_MASK | USDHC_PROT_CTRL_BURST_LEN_EN_MASK);
base->PROT_CTRL |=
    USDHC_PROT_CTRL_DMASEL(kUSDHC_DmaModeAdma2) |
    USDHC_PROT_CTRL_BURST_LEN_EN(kUSDHC_EnBurstLenForINCR);

if (blockCount == 1) {
    /* single block read*/
    /* direction:read, enable DMA */
    base->MIX_CTRL &= ~(USDHC_MIX_CTRL_MSBSEL_MASK | USDHC_MIX_CTRL_BCEN_MASK |
        USDHC_MIX_CTRL_DTDSEL_MASK |
        USDHC_MIX_CTRL_AC12EN_MASK | USDHC_MIX_CTRL_DMAEN_MASK);
    base->MIX_CTRL |= USDHC_MIX_CTRL_DTDSEL_MASK | USDHC_MIX_CTRL_DMAEN_MASK;

    /* config the command xfertype and argument */
    base->CMD_ARG = startBlock;
    base->CMD_XFR_TYP = CMD17 << 16;
} else {
    /* multi block read */
    /* block count enable, Multiblcok, direction:read, enable DMA */
    base->MIX_CTRL &= ~(USDHC_MIX_CTRL_MSBSEL_MASK | USDHC_MIX_CTRL_BCEN_MASK |
        USDHC_MIX_CTRL_DTDSEL_MASK |
        USDHC_MIX_CTRL_AC12EN_MASK | USDHC_MIX_CTRL_DMAEN_MASK);
    base->MIX_CTRL |= USDHC_MIX_CTRL_MSBSEL_MASK | USDHC_MIX_CTRL_BCEN_MASK |
        USDHC_MIX_CTRL_DTDSEL_MASK | USDHC_MIX_CTRL_AC12EN_MASK | USDHC_MIX_CTRL_DMAEN_MASK;

    /* config the command xfertype and argument */
    base->CMD_ARG = startBlock;
    base->CMD_XFR_TYP = CMD18 << 16;
}

err = USDHC_WaitCommandDone(base);
if (err < 0)

```

```

return err;

err = USDHC_WaitDataDone(base);
if (err < 0)
return err;

err = SD_WaitReadWriteComplete(base);
if (err & 0xc0200000) {
err = -1;
printf("%s read error\r\n", __func__);
}

return err;
}

```

14.4.8

MIX_CTRL DTDSEL 0

CMD24

CMD25

cmd13

Git **NoosProgramProject/(14_TF /006_sd/sd.c)**

```

int sd_write_blocks(USDHC_Type *base, uint8_t *buffer, uint32_t startBlock, uint32_t
blockCount)
{
int err = 0;

/* Wait until command/data bus out of busy status. */
while (base->PRES_STATE & USDHC_PRES_STATE_CIHBMASK) {
}
while (base->PRES_STATE & USDHC_PRES_STATE_CDIHBMASK) {
}
/* set ADMA descriptor */
USDHC_CreateDescTable(buffer, blockCount * 512);

/* When use ADMA, disable simple DMA */
base->DS_ADDR = 0U;
base->ADMA_SYS_ADDR = (u32) g_adma2_tablbe;

/* config data block size/block count */

```

```

base->BLK_ATT = (USDHC_BLK_ATT_BLKSIZE( 512) | USDHC_BLK_ATT_BLKCNT(blockCount));

/* disable the external DMA if support */
base->VEND_SPEC &= ~USDHC_VEND_SPEC_EXT_DMA_EN_MASK;
/* select DMA mode and config the burst length */
base->PROT_CTRL &= ~(USDHC_PROT_CTRL_DMASEL_MASK | USDHC_PROT_CTRL_BURST_LEN_EN_MASK);
base->PROT_CTRL |=
    USDHC_PROT_CTRL_DMASEL(kUSDHC_DmaModeAdma2) |
    USDHC_PROT_CTRL_BURST_LEN_EN(kUSDHC_EnBurstLenForINCR);

if (blockCount == 1) {
    /* single block write*/
    /* direction:read, enable DMA */
    base->MIX_CTRL &= ~(USDHC_MIX_CTRL_MSBSEL_MASK | USDHC_MIX_CTRL_BCEN_MASK |
        USDHC_MIX_CTRL_DTDSEL_MASK |
        USDHC_MIX_CTRL_AC12EN_MASK | USDHC_MIX_CTRL_DMAEN_MASK);
    base->MIX_CTRL |= USDHC_MIX_CTRL_DMAEN_MASK;

    /* config the command xfertype and argument */
    base->CMD_ARG = startBlock;
    base->CMD_XFR_TYP = CMD24 << 16;
} else {
    /* multi block write */
    /* block count enable, Multiblock, direction:read, enable DMA */
    base->MIX_CTRL &= ~(USDHC_MIX_CTRL_MSBSEL_MASK | USDHC_MIX_CTRL_BCEN_MASK |
        USDHC_MIX_CTRL_DTDSEL_MASK |
        USDHC_MIX_CTRL_AC12EN_MASK | USDHC_MIX_CTRL_DMAEN_MASK);
    base->MIX_CTRL |= USDHC_MIX_CTRL_MSBSEL_MASK | USDHC_MIX_CTRL_BCEN_MASK |
        USDHC_MIX_CTRL_AC12EN_MASK | USDHC_MIX_CTRL_DMAEN_MASK;

    /* config the command xfertype and argument */
    base->CMD_ARG = startBlock;
    base->CMD_XFR_TYP = CMD25 << 16;
}

err = USDHC_WaitCommandDone( base);
if (err < 0)
    return err;

```



```

    err = USDHC_WaitDataDone(base);
    if (err < 0)
        return err;

    err = SD_WaitReadWriteComplete(base);
    if (err & 0xe4000000) {
        err = -1;
        printf("%s write error\r\n", __func__);
    }

    return err;
}

```

14.4.9 TF

Git **NoosProgramProject/(14_TF /006_sd/sd.c**

```

int sd_init(USDHC_Type *base)
{
    int err;
    uint32 retries, acmd41arg = 0, resp[4], raw_scr[2];

    USDHC_Init(base);
    CardInsertDetect(base);

    /* set DATA bus width */
    USDHC_SetDataBusWidth(base, kUSDHC_DataBusWidth1Bit);
    /*set card freq to 400KHZ*/
    g_sd_card.busClock_Hz = USDHC_SetSdClock(base, 198000000U, SDMMC_CLOCK_400KHZ);
    /* send card active */
    USDHC_SetCardActive(base, 100U);
    /* Get host capability. ignore just decision form spec HOST_CTRL_CAP*/

    /* CMD0 - GO_IDLE_STATE software reset and set into idle */
    err = USDHC_SendCommand(base, CMD0, 0x0);
    if (err < 0)
        return -1;

    /* verify card interface operating condition. */

```

```

for (retries = 0; retries < 10; retries++) {
    /* CMD8 (physical layer spec Ver2.0 is mandatory) */
    err = USDHC_SendCommand(base, CMD8, 0x01aa);
    if (err == 0)
        break;
}

if (err == 0) {
    /* SDHC or SDXC card */
    acmd41arg |= kSD_OcrHostCapacitySupportFlag;
} else {
    /* SDSC card */
    err = USDHC_SendCommand(base, CMD0, 0x0);
    if (err != 0)
        return -1;
}

acmd41arg |= (kSD_OcrVdd32_33Flag | kSD_OcrVdd33_34Flag);
for(retries = 0; retries < 5000; retries++) {
    /* rca = 0 since card is in IDLE state */
    err = USDHC_SendCommand(base, CMD55, 0x0);
    if (err < 0)
        return -1;

    /* ACMD41 to query OCR */
    err = USDHC_SendCommand(base, ACMD41, acmd41arg);
    if (err < 0)
        return -1;

    if (base->CMD_RSP0 & kSD_OcrPowerUpBusyFlag) {
        g_sd_card.ocr = base->CMD_RSP0;
        printf("ocr is 0x%x\r\n", g_sd_card.ocr);
        break;
    }
}

if (retries >= 1000 ) {
    printf("HandShakeOperationConditionFailed\r\n");
    return -1;
}

```

```
}

```

```
/* check 1.8V support */

```

```
if (g_sd_card.ocr & kSD_0crSwitch18AcceptFlag) {

```

```
    printf("support 1.8v\r\n");

```

```


```

```
// our board just support 3.3v, ignore it

```

```
//SD_SwitchVoltage(card))

```

```
/* get CID number */

```

```
err = USDHC_SendCommand(base, CMD2, 0x0);

```

```
if (err < 0)

```

```
    return -1;

```

```
USDHC_GetResponse(base, resp);

```

```
memcpy(g_sd_card.rawCid, resp, sizeof(resp));

```

```
SD_DecodeCid(&g_sd_card, g_sd_card.rawCid);

```

```
/* publish a new relative card address(RCA) */

```

```
err = USDHC_SendCommand(base, CMD3, 0x0);

```

```
if (err < 0)

```

```
    return -1;

```

```
g_sd_card.relativeAddress = base->CMD_RSP0 >> 16;

```

```
printf("relative address is 0x%x\r\n", g_sd_card.relativeAddress);

```

```
/* get CID number */

```

```
err = USDHC_SendCommand(base, CMD9, g_sd_card.relativeAddress << 16);

```

```
if (err < 0)

```

```
    return -1;

```

```
USDHC_GetResponse(base, resp);

```

```
memcpy(g_sd_card.rawCsd, resp, sizeof(resp));

```

```
SD_DecodeCsd(&g_sd_card, g_sd_card.rawCsd);

```

```
printf("card is %s", g_sd_card.csd.csdStructure ? "SDHC/SDXC" : "SDSC");

```

```
printf("card block count is %d\r\n", g_sd_card.blockCount);

```

```
printf("card sector size is %d\r\n", g_sd_card.blockSize);

```

```
printf("card command class is 0x%x\r\n", g_sd_card.csd.cardCommandClass);

```

```
/* CMD7: SelectCard */

```

```
err = USDHC_SendCommand(base, CMD7, g_sd_card.relativeAddress << 16);

```

```
if (err < 0)

```

```

return err;

/* ACMD51: Read SCR */
err = USDHC_SendCommand(base, CMD55, g_sd_card.relativeAddress << 16);
if (err < 0)
return err;
err = USDHC_SendCommand_with_data(base, ACMD51, 0, raw_scr, 8);
if (err < 0)
return err;
raw_scr[0] = SWAP_32(raw_scr[0]);
raw_scr[1] = SWAP_32(raw_scr[1]);
memcpy(g_sd_card.rawScr, raw_scr, sizeof(raw_scr));
SD_DecodeScr(&g_sd_card, g_sd_card.rawScr);

printf("scr[0] is 0x%x, scr[1] is 0x%x\r\n", raw_scr[0], raw_scr[1]);
printf("sd specification is 0x%x\r\n", g_sd_card.scr.sdSpecification);
if ((g_sd_card.scr.sdBusWidths & 0x4U) == 0) {
printf("The card can not support 4bit width");
return -1;
}

/* speed class control cmd */
if ((g_sd_card.scr.commandSupport & 0x01U) == 0)
{
printf("The card can not support Speed Class Control (CMD20)\r\n");
}

/* set block count cmd */
if ((g_sd_card.scr.commandSupport & 0x02U) == 0)
{
printf("The card can not support Support SetBlockCountCmd (CMD23)\r\n");
}

/* Set to max frequency in non-high speed mode. */
g_sd_card.busClock_Hz = USDHC_SetSdClock(base, 198000000U, SD_CLOCK_25MHZ);

/* Set to 4-bit data bus mode. */
/* set card to 4 bit width*/
err = USDHC_SendCommand(base, CMD55, g_sd_card.relativeAddress << 16);
if (err < 0)
return err;

```

```

err = USDHC_SendCommand(base, ACMD6, 2);
if (err < 0)
return err;

/* set host to 4 bit width*/
base->PROT_CTRL = ((base->PROT_CTRL & ~USDHC_PROT_CTRL_DTW_MASK) | USDHC_PROT_CTRL_DTW(1));

/* set block size to 512 : CMD16 SET_BLOCKLEN */
err = USDHC_SendCommand(base, CMD16, FSL_SDMMC_DEFAULT_BLOCK_SIZE);
if (err < 0)
return err;

/* select high speed successful, switch clock to 50M */
if (SD_SelectBusTiming(base) == 0)
g_sd_card.busClock_Hz = USDHC_SetSdClock(base, 198000000U, SD_CLOCK_50MHZ);
//g_sd_card.busClock_Hz = USDHC_SetSdClock(base, 396000000U, SD_CLOCK_50MHZ);
//printf("clock is %d, base->SYS_CTRL is 0x%x\r\n", g_sd_card.busClock_Hz, base->SYS_CTRL);
printf("sd init sccessful\r\n");

return 0;
}

```

14.4.10 TF

led.imx

led.imx.h

led_imx_image 1024

TF

Git [NoosProgramProject/\(14_TF /006_sd/sd.c\)](#)

```

printf("start test sd\r\n");
sd_init(USDHC1);

memset(sd_read_buf, 0, sizeof(sd_read_buf));
sd_read_blocks(USDHC1, sd_read_buf, 2, 2);

printf("read 2 sectors from 2nd sector\r\n");
for(i = 0; i < 1024; i++) {
printf("%02x ", sd_read_buf[i]);
if((i + 1)%16 == 0)
printf("\r\n");
}

```

```

printf("burn led.imx to sd\r\n");
sd_write_blocks(USDHC1, led_imx_image + 1024, 2, (sizeof(led_imx_image) - 1024) >> 9);
printf("please set dip switch to SD boot, and push reset, then green led blink \r\n");

memset(sd_read_buf, 0, sizeof(sd_read_buf));
sd_read_blocks(USDHC1, sd_read_buf, 2, 2);

printf("read 2 sectors from 2nd sector after burn led_imx_image: \r\n");
for(i = 0; i < 1024; i++) {
    printf("%02x ", sd_read_buf[i]);
    if((i + 1)%16 == 0)
        printf("\r\n");
}
printf("please set dip switch to SD boot, and push reset, then green led blink \r\n");

```

eMMC

TF

TF

14.4.11 eMMC boot partition

Extended CSD register

PARTITION_CONFIG[179]

image-20220112144324646

Image not found or type unknown

image-20220112144330003

Image not found or type unknown

PARTITION_ACCESS 0 user partition 1 boot1 partition 2 boot2 partition

image-20220112144334889

Image not found or type unknown

CMD6

Bit31-26 0

Bit25-24 access mode

Bit23-16

Bit15-8

Bit7-3 0

Bit2-0 cmd set

image-20220112144339189

Image not found or type unknown

00 command set

01 value 1

10 value 1

11 value

user partition boot1 partition

$(1 \ll 24) \mid (179 \ll 16) \mid (1 \ll 8) \mid 0$

boot1 partition user partition

$(2 \ll 24) \mid (179 \ll 16) \mid (1 \ll 8) \mid 0$

Git NoosProgramProject/(14_TF /006_sd/sd.c)

```
static status_t MMC_SetExtendedCsdConfig(USDHC_Type *base, mmc_extended_csd_access_mode_t
access_mode, uint8_t index, uint8_t value)
{
    int err;

    err = USDHC_SendCommand(base, MCMD6, (access_mode << 24) | (index << 16) | (value << 8));
    if (err < 0)
        return -1;

    return 0;
}

static status_t MMC_SelectPartition(USDHC_Type *base, mmc_extended_csd_access_mode_t
access_mode, mmc_access_partition_t part_number)
```

```

{
    int err;

    err = MMC_SetExtendedCsdConfig(base, access_mode, 179, part_number);
    if (err < 0)
        return -1;

    err = SD_WaitReadWriteComplete(base);
    if (err & (1 << 7)) {
        printf("failed select partition\r\n");
        return -1;
    }

    return 0;
}

int MMC_SelectBoot1Partition(USDHC_Type *base)
{
    return MMC_SelectPartition(base, kMMC_ExtendedCsdAccessModeSetBits, 1);
}

```

14.4.12 eMMC

Git **NoosProgramProject/(14_TF /006_sd/sd.c)**

```

int mmc_init(USDHC_Type *base)
{
    int err;
    uint32 retries, resp[4], maxBusClock_Hz, bus_width = 4;

    USDHC_Init(base);

    /* set DATA bus width */
    USDHC_SetDataBusWidth(base, kUSDHC_DataBusWidth1Bit);
    /*set card freq to 400KHZ*/
    g_mmc_card.busClock_Hz = USDHC_SetSdClock(base, 198000000U, SDMMC_CLOCK_400KHZ);
    /* send card active */
    USDHC_SetCardActive(base, 100U);
}

```



```

/* Get host capability. ignore just decision form spec HOST_CTRL_CAP*/

/* CMD0 - GO_IDLE_STATE software reset the bus and set into idle */
err = USDHC_SendCommand(base, CMD0, 0x0);
if (err < 0)
    return -1;

    /* Hand-shaking with card to validate the voltage range Host first sending its expected
    information.*/
    err = USDHC_SendCommand(base, CMD1, 0x0);
    if (err < 0)
        return -1;
    g_mmc_card.ocr = base->CMD_RSP0;
    g_mmc_card.ocr |= 2 << 29; /* set access mode to sector mode */
    for (retries = 0; retries < 1000; retries++) {
        err = USDHC_SendCommand(base, CMD1, 0x0);
        if (err < 0)
            return -1;

        if ((base->CMD_RSP0 & MMC_OCR_BUSY_MASK))
            break;
    }

    if (retries >= 1000 ) {
        printf("HandShakeOperationConditionFailed\r\n");
        return -1;
    }
    g_mmc_card.ocr = base->CMD_RSP0;
    printf("ocr is 0x%x\r\n", g_mmc_card.ocr);

/* switch the host voltage which the card can support */
/* ignore switch voltage, our board just support 3.3v */

/* CMD2 Get card CID */
err = USDHC_SendCommand(base, CMD2, 0x0);
if (err < 0)
    return -1;
USDHC_GetResponse(base, resp);

```

```

memcpy(g_mmc_card.rawCid, resp, sizeof(resp));
MMC_DecodeCid(&g_mmc_card, g_mmc_card.rawCid);

/* Send CMD3 with a chosen relative address, with value greater than 1 */
g_mmc_card.relativeAddress = 2;
err = USDHC_SendCommand(base, CMD3, g_mmc_card.relativeAddress << 16);
if (err < 0)
    return -1;

/* CMD9 Get the CSD register content */
err = USDHC_SendCommand(base, CMD9, g_mmc_card.relativeAddress << 16);
if (err < 0)
    return -1;
USDHC_GetResponse(base, resp);
memcpy(g_mmc_card.rawCsd, resp, sizeof(resp));
MMC_DecodeCsd(&g_mmc_card, g_mmc_card.rawCsd);

/* Set to maximum speed in normal mode. */
/*used to calculate the max speed in normal
   mode not high speed mode.
   For cards supporting version 4.0, 4.1, and 4.2 of the specification, the value shall be
   20MHz (0x2A).
   For cards supporting version 4.3, the value shall be 26 MHz (0x32H). In High speed mode,
   the max
   frequency is decided by CARD_TYPE in Extended CSD. */
printf("csd tran speed is 0x%x\r\n", g_mmc_card.csd.transferSpeed);
if (g_mmc_card.csd.transferSpeed == 0x32)
    maxBusClock_Hz = 260000000;
else if ( g_mmc_card.csd.transferSpeed == 0x2A )
    maxBusClock_Hz = 200000000;

g_mmc_card.busClock_Hz = USDHC_SetSdClock(base, 198000000U, maxBusClock_Hz);

/* Send CMD7 with the card's relative address to place the card in transfer state. Puts
current selected card in
   transfer state. */
err = USDHC_SendCommand(base, CMD7, g_mmc_card.relativeAddress << 16);
if (err < 0)
    return err;

```

```

/* Get Extended CSD register content. */
err = USDHC_SendCommand_with_data(base, MCMD8, 0, g_mmc_card.rawExtendedCsd, 512);
if (err < 0)
    return err;
MMC_DecodeExtendedCsd(&g_mmc_card, g_mmc_card.rawExtendedCsd);
printf("g_mmc_card.extendedCsd.sectorCount is %d\r\n", g_mmc_card.extendedCsd.sectorCount);

/* set block size to 512 : CMD16 SET_BLOCKLEN */
err = USDHC_SendCommand(base, CMD16, FSL_SDMMC_DEFAULT_BLOCK_SIZE);
if (err < 0)
    return err;

    /* switch to host support speed mode, then switch MMC data bus width and select power
class */
/* select bus width */
err = MMC_SetBusWidth(base, bus_width);
if (err < 0)
    return -1;
printf("bus width is %d\r\n", bus_width);

/* switch to high speed mode */
err = MMC_SwitchBusMode(base, kMMC_HighSpeedTiming);
if (err < 0)
    return err;
g_mmc_card.busClock_Hz = USDHC_SetSdClock(base, 198000000U, MMC_CLOCK_52MHZ);

printf("init MMC sucessful\r\n");

return 0;
}

```

14.4.13 eMMC

eMMC
led
partition
boot1 partition
user partition
boot1 partition
partition
user partition

Git **NoosProgramProject/(14_TF /006_sd/sd.c)**

```
```c
```

```
mmc_init(USDHC2); MMC_SelectBoot1Partition(USDHC2);
```

```
memset(sd_read_buf, 0, sizeof(sd_read_buf));
sd_read_blocks(USDHC2, sd_read_buf, 2, 2);

printf("read 2 sectors from eMMC boot1 partition 2nd sector\r\n");
for(i = 0; i < 1024; i++) {
 printf("%02x ", sd_read_buf[i]);
 if((i + 1)%16 == 0)
 printf("\r\n");
}

/* write led_imx_image to eMMC boot1 partition */
sd_write_blocks(USDHC2, led_imx_image + 1024, 2, (sizeof(led_imx_image) - 1024) >> 9);
printf("please set dip switch to eMMC boot, and push reset, then green led blink\r\n");

printf("read 2 sectors from eMMC boot1 part 2nd sector after burn led_imx_image\r\n");
memset(sd_read_buf, 0, sizeof(sd_read_buf));
sd_read_blocks(USDHC2, sd_read_buf, 2, 2);
MMC_ExitBoot1Partition(USDHC2);

for(i = 0; i < 1024; i++) {
 printf("%02x ", sd_read_buf[i]);
 if((i + 1)%16 == 0)
 printf("\r\n");
}
 \ \ \
```

## 14.4.14 4-1.4

```
** Git NoosProgramProject/(14_009_timer_epit_poll)
```

## 14.4.15 3-1.4

## 14.4.16 SD

1. sd.imx emmc

2. TF emmc

3.

4. 1 SD

image-20220112144530783

Image not found or type unknown

C

image-20220112144536176

Image not found or type unknown

2 please set dip switch to SD boot, and push reset, then green led blink

## 14.4.17 EMMC

1. sd.imx TF

2. TF SD

3.

4. 2 EMMC

image-20220112144557698

Image not found or type unknown

boot1 partition 2 0

led.imx 2 0

TF

image-20220112144605048

Image not found or type unknown

---

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