Controlling SD Card using SSD192X

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1. Abstract

SSD192X architecture includes a SD Host Controller which is able to interface with most of the SD, SDIO and MMC card in the market.

The document describe on how to use the SD registers in SSD192X to initialize the SD card, read the first 512 bytes from the SD card without the need of any file system.

This document aims to help the user to be able to familiarize with SSD192X SD Host Controller fast, and be able to use it to communicate with the SD card for different project requirements.

Many references will be made to

SD Specifications
Part 1
Physical Layer
Simplified Specification
Version 2.00

A document of this specification can be downloaded from
http://www.sdcard.org/about/memory_card/pls/Simplified_Physical_Layer_Spec.pdf

Lastly, the application note of SSD 192X will contain many important references on how to calculate and set the register values. It will not be repeated in this document. The document will indicate from time to time when to refer back to the application notes for further explanation.

2. Preface

As the code is meant for testing the SD slot, hence there are some points to take note when using the code provided and the SD card.

1) Please use only SD memory card (**NOT** SDIO, MMC or High Capacity SD card). This is because different code is needed to initialize SDIO, MMC or High Capacity SD card.

2) The SD card shall be format with FAT32 file system. If one use other file system in the SD card, the values read back will not correspond to the one provided in this documentation.

3) The user shall have some basic knowledge on SSD192X. He/she shall have the code to read and write the register/memory of SSD192X.

4) The reference code (in C language) provided is a very basic code. Minor bugs may exist (the code had been proved working on a Zilog 8 bit MCU controlling 1926 DVK). This code can be downloaded to any MCU or ARM, the only changes needed is the code to map to the individual pins of different MCU / ARM. A fully functional code to initialize and control SDIO, MMC card is available upon request.

5) All register number of SSD192X in the document are highlighted in blue for easy reference.

3. Hardware setting

3.1 Hardware checking

Register 1126h will be used to test the hardware connection SSD192X with the SD controller

Present State Register 2 **REG[1126h]**

Bit	7	6	5	4	3	2	1	0
	DATA[3:0] Line Signal Level Bit 3	DATA[3:0] Line Signal Level Bit 2	DATA[3:0] Line Signal Level Bit 1	DATA[3:0] Line Signal Level Bit 0	Write Protect Switch Pin Level	Card Detect Pin Level	Card State Stable	Card Inserted
Type	RO	RO	RO	RO	RO	RO	RO	RO
Reset state	0	0	0	0	0	0	0	0

If the SD card is inserted into the slot, and the Write protect pin is not set, the value that is read back shall be : **0xF7**

If the SD card is NOT inserted into the slot, the value that read back shall be : **0xF2**

If one could not get the above value, please check all the hardware connectivity before proceeding.

3.2 Reset

The reset register, 112Fh, will clear the status of the Data line, Cmd line and the various status registers of the SD card. Please set it to “0x07” when first start. The exact details of what is being reset can be referred to the application notes.

3.3 Power

Register 1143h is used to check whether 3.3V is supported on the SD card system, if the value is not set, please do a reset to the system.

Once register 1143h is checked, set register 1129h to select the voltage level for SD Host Driver to the SD card.

Power Control Register **REG[1129h]**

Bit	7	6	5	4	3	2	1	0
	Reserved Bit	Reserved Bit	Reserved Bit	Reserved Bit	SD Bus Voltage Select Bit 2	SD Bus Voltage Select Bit 1	SD Bus Voltage Select Bit 0	SD Bus Power Bit
Type	RO	RO	RO	RO	RW	RW	RW	RW
Reset state	0	0	0	0	0	0	0	0

Set Bit 3-1 to "**111**" to select 3.3V. Set Bit 0 to **1** to turn ON the SD Bus power (only work if there is a SD card in the SD card slot).

3.4 Clock

Set register 112Dh to "**0x02**", it will give the SD clock a frequency of 20Mhz (assume that the MCLK = 80 MHz), which is sufficiently fast enough. Please refer to the application notes of SSD192X for the actual calculation and various setting values.

4. Sending command to SD card

4.1 Setting up the status registers

Various status registers must be clear so that the Host Controller can reflect the correct status as the process of initializing the SD card is on-going.

Set register 1130h – 113Ah (which indicate various error status and which error to show) according to different project requirements. The details of each registers can be found in the application notes.

4.2 Sending the command to SD card

Register 110F shall be set to the command number (CMD0-63, ACMD0-63) that is specified in bits 45-40 of the Command-Format in the SD Memory Card Physical Layer Specification.

When sending command to SD card, 2 other commands are usually send together.

4.2.1 Command argument

Register 1108h – 110Bh will send the 32 bits of command argument required by the SD card. The exact details can be found in the SD specification, page 46. Usually for most command sent, these values are filled with “0”. Specific values will be indicated in this manual for some commands.

4.2.2 Command and Response register

Different commands sent to the SD card will have different response. This register, 110Eh will set the expected response and the command type to set

4.3 Sending application command (ACMD) to SD card

Some commands are application specific, hence to send this type of command, send CMD 55 before sending out the application command number.

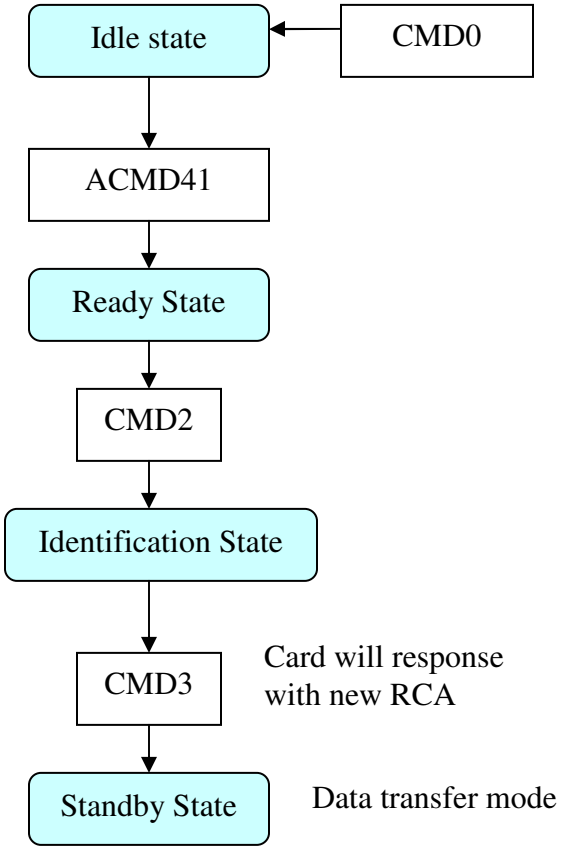
For example, to send ACMD 41 :

1) Send CMD 55 with the necessary arguments & response
2) Short delay
3) Send CMD 41 with the necessary arguments & response

5. Initialize SD card

The first step to control SD card is to initialize it and also to retrieve the SD card RCA (Relative Card Address) for identification purpose for the SD Host Controller.

The following is a simplified flow chart for the process :



The square boxes are the command sent from SSD192X host controller and the highlighted boxes are the state in which SD card is in.

5.1 Sending CMD 0

Sending CMD 0 will not have any response from SD card, check register 1130h (Normal Interrupt Status Register 0), bit 0, to ensure that the command is complete.

5.2 Sending ACMD 41

When sent ACMD41, the SD card will response with the host voltage range that it will not support. Since SSD1926 is a 3.3V IO pin, it's within the specification of the SD card.

After which, we will send ACMD41 again with the operating voltage of SSD1926. We will then wait for SD card to response to state that now its voltage level is steady and can be proceed on. We can check this response via register 1112h, bit 7. If it is not set, we will send ACMD41 again with the operating voltage.

5.3 Sending CMD2

This command is sent to the card to inform the SD card that it will go into identification state and will expect SD card to return a unique address for the host to identify with the SD card upon the next command.

5.4 Sending CMD3

After CMD3 is sent out, the SD card will return with a RCA. This RCA is used to identify the SD card. The value can be read back from register 1110h – 1112h (the value shall be a 16 bits word, different SD card shall have different value).

Please note that in the SD card version 2.0 spec, CMD 8 is expected to be sent before ACMD41. This is to check whether the card can operate under the supplied voltage. However, this step is skipped as the code was written earlier before the specification is released.

6. Card Setting

Once the RCA is obtained, the next step is to select the card using this RCA, set the SD card data width and the number of bytes each time the SD card give to the SD Host.

6.1 Selecting the card

Send CMD7 to SD card to tell the card that it is going to be selected. The command argument shall be the RCA address, the response expected can be checked from the SD simplified physical layer spec, page 58.

6.2 Setting the SD card data width

Send ACMD6 to set the data width of the SD card. Default data width is “1”. However, SSD192X support “4” data lines which is faster.

6.3 Setting the block length

Send CMD16 to set the length of the byte which the SD is supposed to return after each read. The value to set in the command argument shall be “512”. The internal buffer size of SD Host controller in SSD192X is 1024 bytes. Setting it to read 512 bytes will reduce the buffer overflow issue.

7. Reading from SD card

If the commands from step 3 – 5 are done correctly, the SD card is now initialize and being selected by the 192X's SD Host controller. The next step is to read the content from the SD card.

Since there is no file system, we will read the first 512 bytes from the SD card address from 0 – 512. (The SD card must be formatted in FAT32 system in order for one to see the value in the figure).

7.1 Reading from SD card

Step 1 : Do a soft reset
Set reset register 112Fh = 0x04

Step 2 : Set the transfer mode direction and SD to single read
Set Transfer mode register 0, 110Ch = 0x10

Step 3 : Set the block size to 512 bytes
Set register 1104h = 0, register 1105h = 02

Step 4 : Enable read interrupt and error status enable register
Set register 1134h = 0x23, 1136h = 0

Step 5: Set error interrupt status register 0 & 1
Set register 1132h = 0xFF, 1133h = 0x01

Step 6 : Send CMD17 to SD card (single read), the command argument shall be the address of the SD card where you want read. In this case, it shall be "0" since we are reading from address 0

Step 7 : Check register 1125h (Present State register 1), bit 3 to check is the buffer read is ready to be read or not.

Step 8 : Once bit 3 of register 1125h is set, start reading 512 bytes from register 1120h into an array.

Step 9 : Check register 1130h, bit 1, to ensure that the transfer is completed.

Step 10 : Please refer to figure 1 to ensure that the read value correspond to the value below. First value shall be "EB", last 2 values shall be "55 AA"

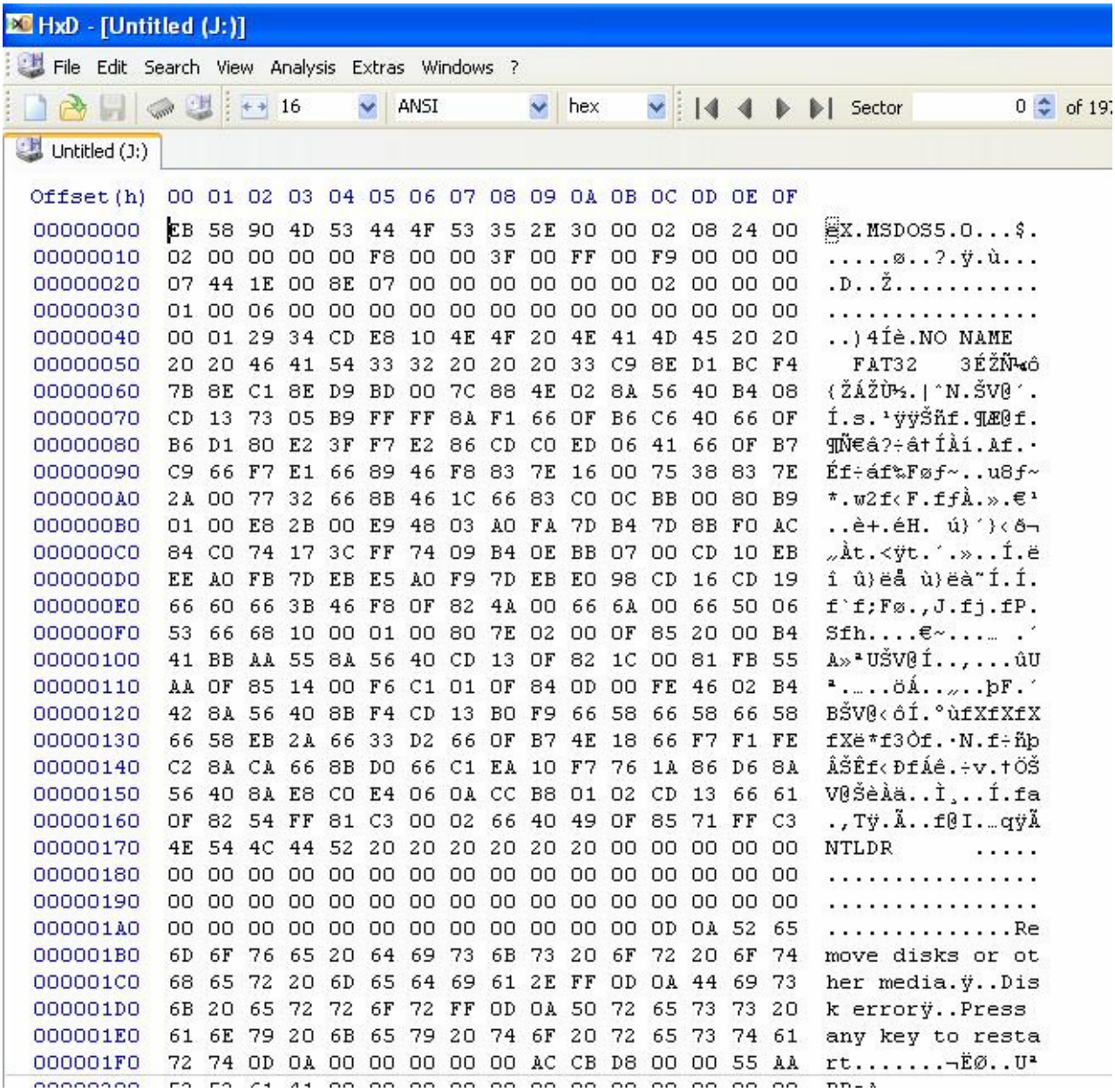


Figure 1 : File format of SD card FAT32 system

Do take note, that for some card (2GB) the first 512 bytes may not be shown as above. Instead it is located at some other memory location. The file system is supposed to be able to handle this case.

However, in this note, as we do not have the file system, thus the user may not read back correctly. The only way to get around it is to use SD card of 1GB or lower.

It must be noted that this application note is purely to test our SD card slot, and not with file system.

Revision	Date	Changes	Author
1.0	19-Mar-2008	Initial Revision	Aik Hong
1.1	8-Aug-2008	When sending command to initialize the SD card, ACMD 41 must be sent twice and also wait for its response before proceeding CMD 8 is needed to send to SD card prior to sending ACMD41 as stated in spec 2.0 of SD card. However, our code did not implement it as it was written before the spec is released. Some 2GB SD card may not show the same picture as shown in figure 1 after formatting. User is advised to use SD card of 1 GB or lower.	Aik Hong