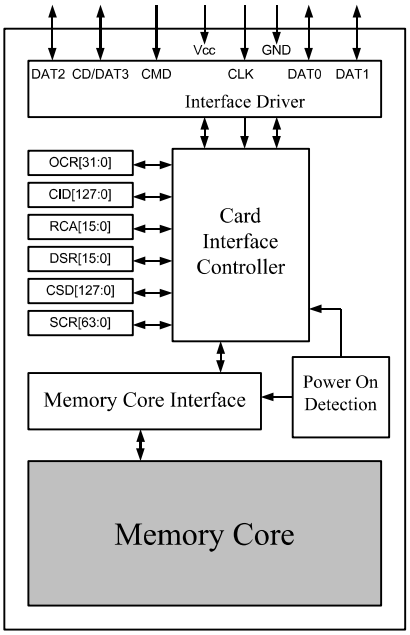
SD Card



Pinout

SD Mode

Pin	Name	Type	Description
1	DAT2	I/O/PP	Data Bit 2
2	CD/DAT3	I/O/PP	Card Detect / Data Bit 3
3	CMD	PP	Command / Response
4	Vcc	S	Supply Voltage
5	CLK	I	Clock
6	Vss	S	Ground
7	DAT0	I/O/PP	Data Bit 0
8	DAT1	I/O/PP	Data Bit 1

SPI Mode

Pin	Name	Type	Description
1	RSV	---	Reserved
2	CS	I	Chip Select
3	DI	I	Data In
4	Vcc	S	Supply Voltage
5	SCLK	I	Clock
6	Vss	S	Ground
7	DO	O/PP	Data Out
8	RSV	---	Reserved

Commands

47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
0	1	Command Number						Command Argument Bits 31:24							

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Command Argument Bits 23:8															

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command Argument Bits 7:0								CRC7 ($x^7 + x^3 + 1$)							1

SPI Commands

Command Number	Command Description	Command Class	Command Argument	Response
0	Reset SD Memory Card	0	ignored	R1
1	Send HCS and Activate Initialization Process	0	bit 30 is HCS, remaining bits 0	R1
6	Check (0) / Change (1) Switchable Functions	10	bit 31 sets check/change, other bits control	R1
8	Send SD Interface Condition	0	11:8 supply voltage, 7:0 check pattern	R7
9	Send CSD (Card Specific Data)	0	ignored	R1
10	Send CID (Card Identification)	0	ignored	R1
12	Force Stop During Multi-Block Read	0	ignored	R1b
13	Send Status Register	0	ignored	R2
16	Set Block Length of Standard Capacity Card	2 / 4 / 7	block length	R1
17	Read a Single Block	2	data address (byte v1.x, block v2.x)	R1
18	Read Multiple Blocks	2	data address (byte v1.x, block v2.x)	R1
24	Write a Single Block	4	data address (byte v1.x, block v2.x)	R1
25	Write Multiple Blocks	4	data address (byte v1.x, block v2.x)	R1

SPI Commands

Command Number	Command Description	Command Class	Command Argument	Response
27	Program programmable CSD bits	4	ignored	R1
28	Set Write Protection bit for address	6	data address (byte)	R1b
29	Clear Write Protection bit for address	6	data address (byte)	R1b
30	Get Write Protection status for address	6	data address (byte)	R1
32	Set Erase Block Start Address	5	data address (byte v1.x, block v2.x)	R1
33	Set Erase Block End Address	5	data address (byte v1.x, block v2.x)	R1
38	Erase selected blocks	5	ignored	R1b
42	Set/Reset Password or lock/unlock card	7	ignored	R1
55	Next Command is Application Specific Cmd	8	ignored	R1
56	Transfer Data Block to/from card for ASC	8	bit 0 is RD/WR, other bits ignored	R1
58	Read OCR Register	0	ignored	R3
59	Turn CRC on or off	0	bit 0 is CRC on/off, other bits ignored	R1

SPI Application Specific Commands

Command Number	Command Description	Command Class	Command Argument	Response
13	Send SD Status	8	ignored	R2
18	Reserved for SD Security Applications	8	---	---
22	Send Number of Blocks Written w/o Errors	8	ignored	R1
23	Set Blocks Count to Pre-Erase before Write	8	number of blocks to pre-erase	R1
25	Reserved for SD Security Applications	8	---	---
26	Reserved for SD Security Applications	8	---	---
38	Reserved for SD Security Applications	8	---	---
41	Send HCS and Activate Card Initialization	8	bit 30 is HCS, remaining bits 0	R1
42	Connect/Disconnect Pull-Up on CS	8	bit 0 is connect/disconnect, rest ignored	R1
43 – 49	Reserved for SD Security Applications	8	---	---
51	Read SD Configuration Register	8	ignored	R1

Responses

Format R1

7	6	5	4	3	2	1	0
0	Parameter Error	Address Error	Erase Seq. Error	CRC Error	Illegal Command	Erase Reset	In Idle State

Format R2

15	14	13	12	11	10	9	8
0	Parameter Error	Address Error	Erase Seq. Error	CRC Error	Illegal Command	Erase Reset	In Idle State

7	6	5	4	3	2	1	0
Out of Range CSD Overwrite	Erase Parameter	Write Protect Violation	Card ECC Failure	Card Controller Error	General Error	WP Erase Lock Failure	Card Locked

Format R3

Format R1 followed by OCR Register (40 bits total)

Format R7

Format R1 followed by 32 bits (40 bits total)

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Command Version															

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
				Voltage Accepted				echo back of check pattern							

Data Write Response

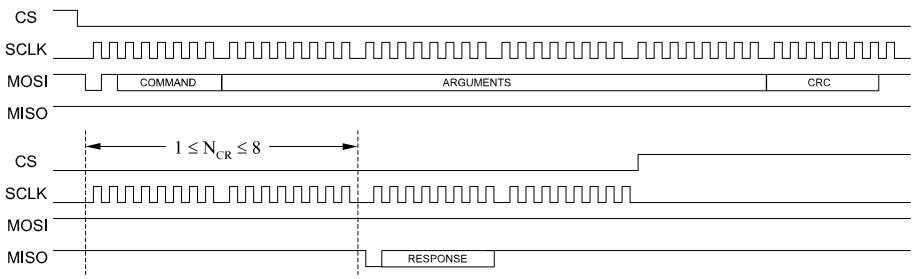
7	6	5	4	3	2	1	0
X	X	X	0	Status			1

010 Data Accepted
101 Data Rejected due to CRC Error
110 Data Rejected due to Write Error

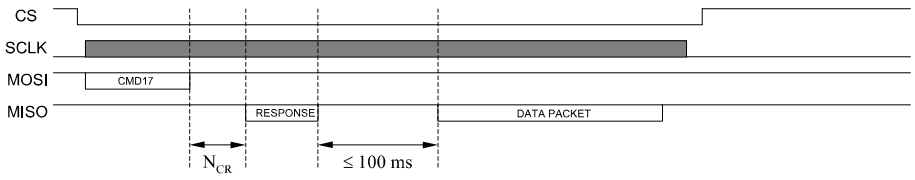
Data Read Error Token

7	6	5	4	3	2	1	0
0	0	0	Card is Locked	Out of Range	Card ECC Failure	Card Controller Error	General Error

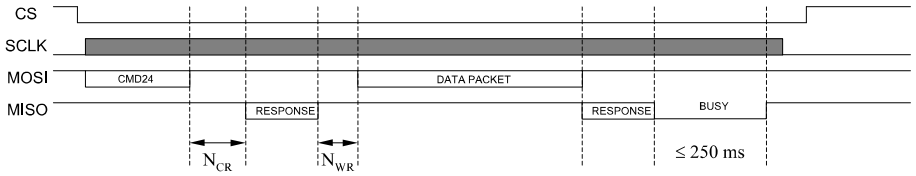
Command Timing (R1 Response)



Command Timing (Single Block Read)



Command Timing (Single Block Write)



Data Packets

Single Block Read/Write
Multi-Block Read

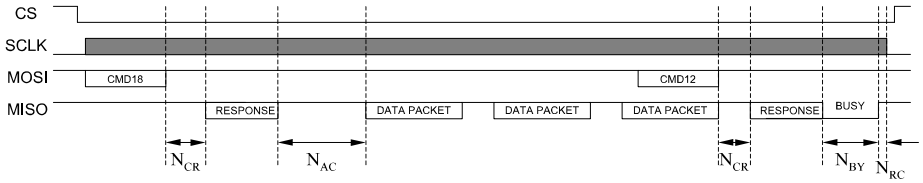
Byte 1: 0xFE
Byte 2-513: user data
Byte 514-515: 16-bit CRC

Multi-Block Write

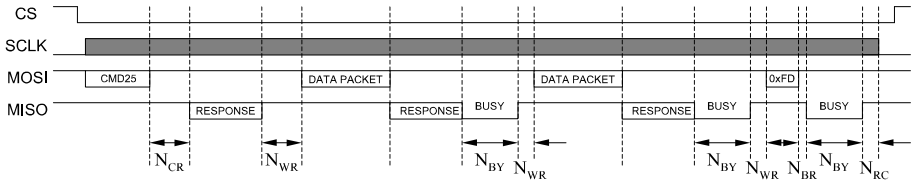
Byte 1: 0xFC
Byte 2-513: user data
Byte 514-515: 16-bit CRC

Stop Transmission:
Byte 1: 0xFD

Command Timing (Multi-Block Read)



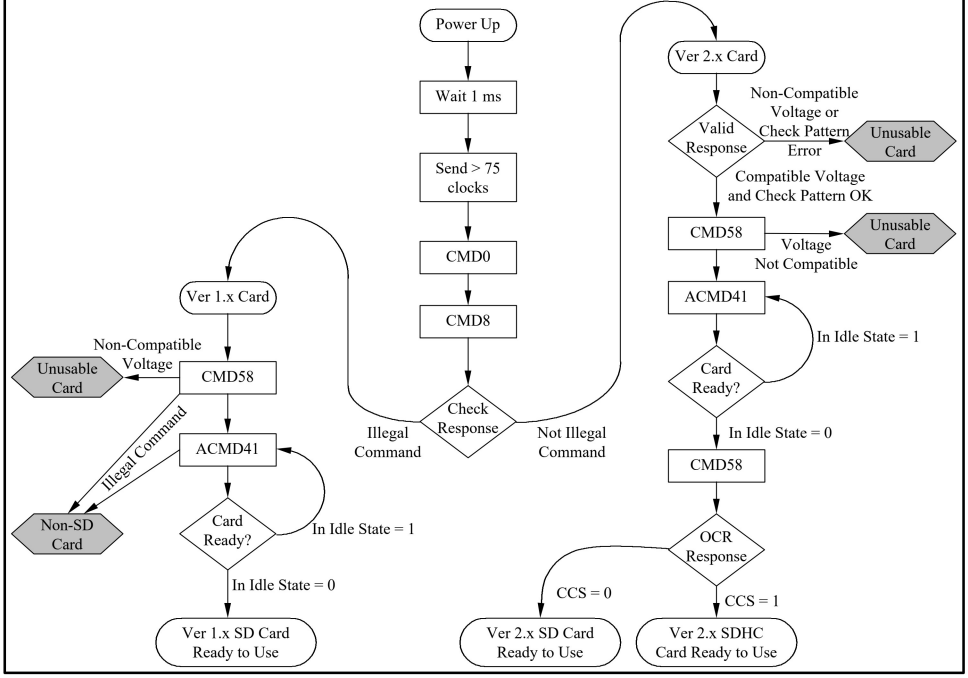
Command Timing (Multi-Block Write)



	min	max	units
N_{CR}	1	8	8 clock cycles
N_{WR}	1	---	8 clock cycles
N_{AC}	0.02	100	ms

	min	max	units
N_{BR}	0	1	8 clock cycles
N_{RC}	1	---	8 clock cycles
N_{BY}	0	250	ms

SD Card SPI Mode Initialization Sequence



OCR Register

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
RDY	CCS							3.5-3.6	3.4-3.5	3.3-3.4	3.2-3.3	3.1-3.2	3.0-3.1	2.9-3.0	2.8-2.9

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2.7-2.8															

CID Register

Field	Width	Bits
Manufacturer ID	8	127:120
OEM/Application ID	16	119:104
Product Name	40	103:64
Product Revision	8	63:56
Product Serial Number	32	55:24
reserved	4	23:20
Manufacturing Date	12	19:8
CRC7 Checksum	7	7:1
always 1	1	0

CSD Register (version 1.0)

Field	Width	Value	R/W	Bits
CSD Structure Type	2	00	R	127:126
reserved	6	000000	R	125:120
Data Read Access Time (TAAC)	8		R	119:112
Data Read Access Time (NSAC * 100)	8		R	111:104
Maximum Data Transfer Rate	8	0x32 or 0x5A	R	103:96
Card Command Classes	12	01x110110101	R	95:84
Maximum Read Block Length	4		R	83:80
Partial Blocks for Read Allowed	1	1	R	79:79
Write Block Misalignment	1		R	78:78
Read Block Misalignment	1		R	77:77
DSR Implemented	1		R	76:76
reserved	2	00	R	75:74
device size	12		R	73:62
Maximum Read Current @ VDD min	3		R	61:59
Maximum Read Current @ VDD max	3		R	58:56
Maximum Write Current @ VDD min	3		R	55:53
Maximum Write Current @ VDD max	3		R	52:50
Device Size Multiplier	3		R	49:47
Erase Single Block Enable	1		R	46:46
Erase Sector Size	7		R	45:39
Write Protect Group Size	7		R	38:32
Write Protect Group Enable	1		R	31:31
reserved	2	00	R	30:29
Write Speed Factor	3		R	28:26
Maximum Write Data Block Length	4		R	25:22
Partial Blocks for Write Allowed	1		R	21:21
reserved	5	00000	R	20:16
File Format Group	1		R/W	15:15
Copy Flag (OTP)	1		R/W	14:14
Permanent Write Protection	1		R/W	13:13
Temporary Write Protection	1		R/W	12:12
File Format	2		R/W	11:10
reserved	2	00	R	9:8
CRC	7		R/W	7:1
always 1	1	1	R	0

CSD Register (version 2.0)

Field	Width	Value	R/W	Bits
CSD Structure Type	2	01	R	127:126
reserved	6	000000	R	125:120
Data Read Access Time (TAAC)	8	00001110	R	119:112
Data Read Access Time (NSAC * 100)	8	00000000	R	111:104
Maximum Data Transfer Rate	8	0x32 or 0x5A	R	103:96
Card Command Classes	12	01x110110101	R	95:84
Maximum Read Block Length	4	9	R	83:80
Partial Blocks for Read Allowed	1	0	R	79:79
Write Block Misalignment	1	0	R	78:78
Read Block Misalignment	1	0	R	77:77
DSR Implemented	1		R	76:76
reserved	6	000000	R	75:70
device size	22		R	69:48
reserved	1	0	R	47:47
Erase Single Block Enable	1	1	R	46:46
Erase Sector Size	7	1111111	R	45:39
Write Protect Group Size	7	0000000	R	38:32
Write Protect Group Enable	1	0	R	31:31
reserved	2	00	R	30:29
Write Speed Factor	3	010	R	28:26
Maximum Write Data Block Length	4	9	R	25:22
Partial Blocks for Write Allowed	1	0	R	21:21
reserved	5	00000	R	20:16
File Format Group	1	0	R	15:15
Copy Flag (OTP)	1		R/W	14:14
Permanent Write Protection	1		R/W	13:13
Temporary Write Protection	1		R/W	12:12
File Format	2	00	R	11:10
reserved	2	00	R	9:8
CRC	7		R/W	7:1
always 1	1	1	R	0