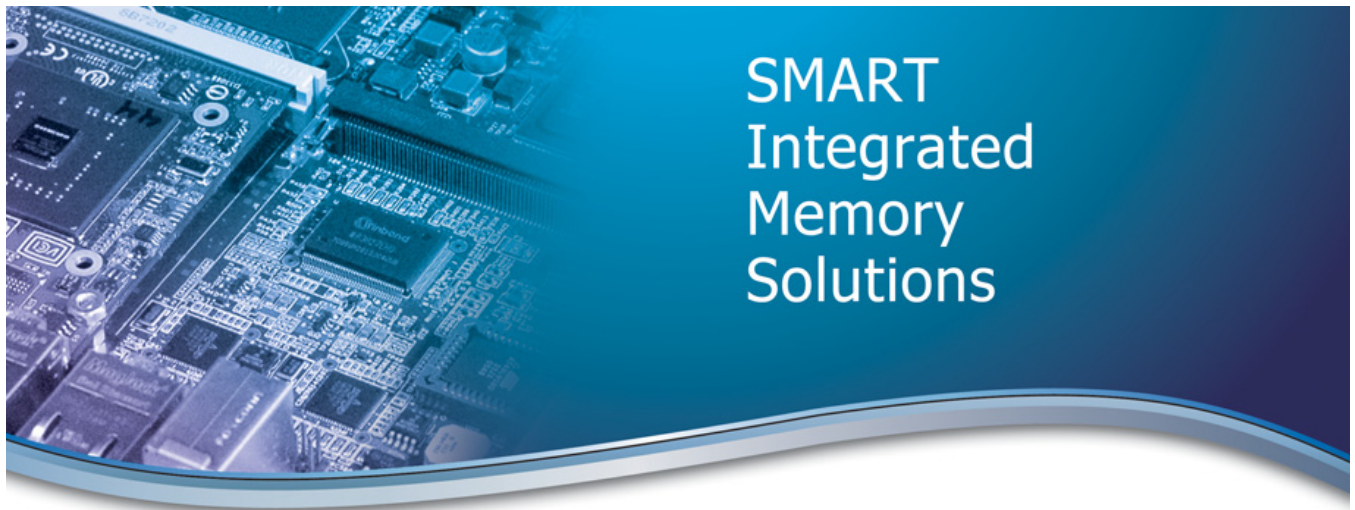




SMART Integrated Memory Solutions

Product Specification

SMART Modular eMMC v4.51+ Product Family

March 2015, Rev B



www.smartm.com

REVISION HISTORY

Date	Revision	Section(s)	Description
August 2014	A	All	Initial production release.
March 2015	B	5	Added information for parts with version 2 of firmware



ESD Caution – Handling

Static electricity may be discharged through this disk subsystem. In extreme cases, this may temporarily interrupt the operation or damage components. To prevent this, make sure you are working in an ESD-safe environment. For example, before handling the disk subsystem, touch a grounded device, such as a computer case, prior to handling.

This document is subject to change without notice.

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1.0 GENERAL DESCRIPTION

1.1 Overview

SMART Modular's eMMC Product Family is an embedded Flash storage solution in a small BGA package designed for applications requiring reliable code and data storage. The eMMC device includes NAND Flash Memory paired with an intelligent embedded MMC controller which runs advanced firmware to manage the NAND media and utilizes the industry standard eMMC interface for easy device integration into any system using a processor with an MMC host.

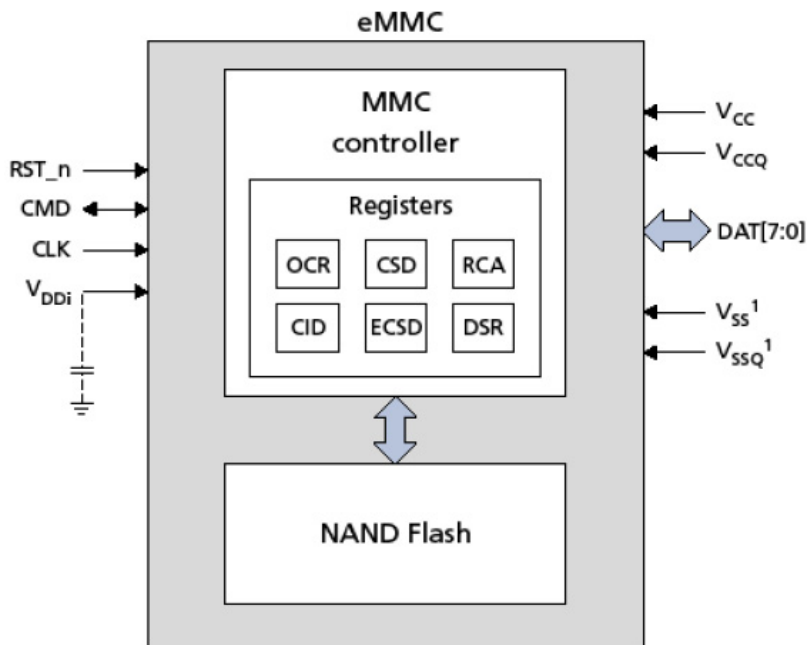
Designed specifically for the most demanding embedded and industrial applications, SMART's eMMC products address the need for enhanced reliability by incorporating on-board error detection and correction, static and dynamic wear leveling algorithms, and other data management techniques to provide reliable operation and maximum NAND media life expectancy over the product life cycle.

Additionally, the eMMC controller and firmware hide the increased complexities of NAND media from the host processor and allow for faster product development and time to market.

SMART has built its foundation by providing proven technology and quality products to the most demanding Fortune 100 OEMs. SMART engineers its products to perform at the highest degree of reliability and compatibility while backing these products with outstanding services and technology expertise.

Target applications for SMART's eMMC solution include but are not limited to Automotive Infotainment and Navigation, Industrial systems, Medical devices, and Networking appliances wanting a rugged yet cost effective high density mass storage solution.

Figure 1: eMMC Block Diagram



Note: 1. V_{SS} and V_{SSQ} are internally connected.

1.2 Features

- eMMC controller and NAND Flash
- Mechanical Form Factor: Fully compliant with JEDEC® MO-304 (100-Ball) or MO-276 (169-Ball)
- V_{CC} : 2.7-3.6V
- V_{CCQ} (dual voltage): 1.7-1.95V or 2.7-3.6V
- Temperature ranges
 - ◆ Operating temperature: -40°C to +85°C or -25°C to +85°C
 - ◆ Storage temperature: -40°C to +85°C

1.3 MMC-Specific Features

- JEDEC/MMC standard version 4.51-compliant (JEDEC Standard No. JESD84-B451) with additional firmware features included from version 5.01 (JEDEC Standard No. JESD84-B50-1)
 - NOTE: **HS400 Mode is NOT supported**
- Backward-compatible with previous MMC versions
- Advanced 11-signal interface
- Selectable x1, x4, and x8 I/O
- HS200 Mode
- SDR/DDR modes up to 52 MHz clock speed
- Replay-Protected Memory Block (RPMB)
- Hardware reset
- High-Priority Interrupt (HPI)
- Background operations
- Reliable Write
- Discard and Sanitize
- Packed Commands
- Secure Erase and Secure Trim support
- Field Firmware Update (FFU)

Note: Please refer to JEDEC standard documents No. JESD84-B451 and No. JESD84-B50-1 for details on all eMMC commands and features.

1.4 Performance

All listed values are typical unless otherwise stated.

Table 1: MLC Partition Performance

Performance ¹		8GB	16GB	32GB	Units
Sequential Read ²	DDR52	90	90	90	MB/s
	HS200	90	160	160	MB/s
Sequential Write ²	DDR52	12	24	48	MB/s
	HS200	12	24	48	MB/s
Random Read ³	DDR52	5800	7000	7100	IOPS
	HS200	6000	7200	7200	IOPS
Random Write ⁴	DDR52	1500	2000	2000	IOPS
	HS200	1500	2000	2100	IOPS

¹ Testmetrix VTESA-3100E; bus in x8 I/O mode.

² Sequential access measured using 1GB chunk.

³ Random Read measured using 4KB chunk after full-card sequential write operation (pre-conditioning).

⁴ Random Write measured using 4KB chunk after full-card sequential write operation (pre-conditioning).

Table 2: Enhanced User Data Partition Performance

Performance ¹		8GB	16GB	32GB	Units
Sequential Read ²	DDR52	90	90	90	MB/s
	HS200	90	170	170	MB/s
Sequential Write ²	DDR52	33	62	71	MB/s
	HS200	33	65	109	MB/s
Random Read ³	DDR52	7100	7100	7100	IOPS
	HS200	7400	7200	7200	IOPS
Random Write ⁴	DDR52	1800	2000	2100	IOPS
	HS200	1800	2000	2200	IOPS

¹ Testmetrix VTESA-3100E; bus in x8 I/O mode.

² Sequential access measured using 1GB chunk.

³ Random Read measured using 4KB chunk after full-card sequential write operation (pre-conditioning).

⁴ Random Write measured using 4KB chunk after full-card sequential write operation (pre-conditioning).

2.0 PACKAGE INFORMATION

2.1 Electrical Interface

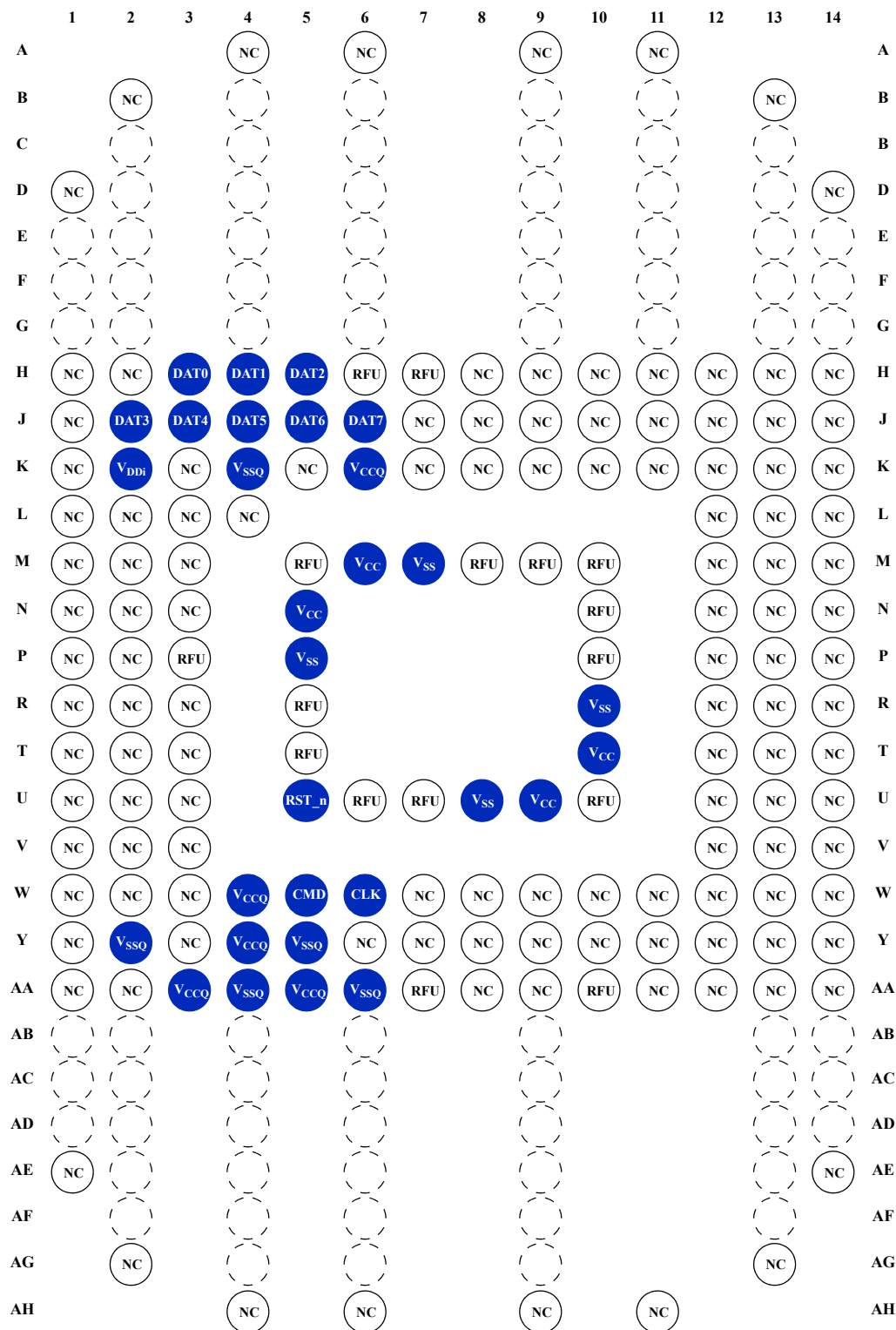
2.1.1 100-Ball eMMC Ball-out Diagram

Table 3: 100-Ball LFBGA (Package Code: AE) (Top View, Ball Down)

	1	2	3	4	5	6	7	8	9	10	
A	NC	NC							NC	NC	A
B	NC									NC	B
C											C
D		RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU		D
E		RFU	RFU	V _{DDi}	RFU	RFU	RFU	RFU	RFU		E
F		V _{CC}	V _{CC}	V _{CC}	V _{CC}	V _{CC}	V _{CC}	V _{CC}	V _{CC}		F
G		V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{SS}		G
H		V _{SSQ}	V _{CCQ}	RFU	RFU	RFU	RFU	V _{CCQ}	V _{SSQ}		H
J		RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU		J
K		DAT0	DAT2	RFU	RFU	RFU	RFU	DAT5	DAT7		K
L		V _{CCQ}	V _{SSQ}	V _{CCQ}	RFU	RFU	V _{CCQ}	V _{SSQ}	V _{CCQ}		L
M		RFU	RFU	V _{SSQ}	RST_n	RFU	V _{SSQ}	RFU	RFU		M
N		DAT1	DAT3	RFU	RFU	RFU	RFU	DAT4	DAT6		N
P		V _{SSQ}	V _{CCQ}	RFU	CMD	CLK	RFU	V _{CCQ}	V _{SSQ}		P
R											R
T	NC									NC	T
U	NC	NC							NC	NC	U

2.1.2 169-Ball eMMC Ball-out Diagram

Table 4: 169-Ball VFBGA / TFBGA / LFBGA (Package Code: CA / CC / CE) (Top View, Ball Down)



2.1.3 Signal Descriptions

Table 5: Signal Description

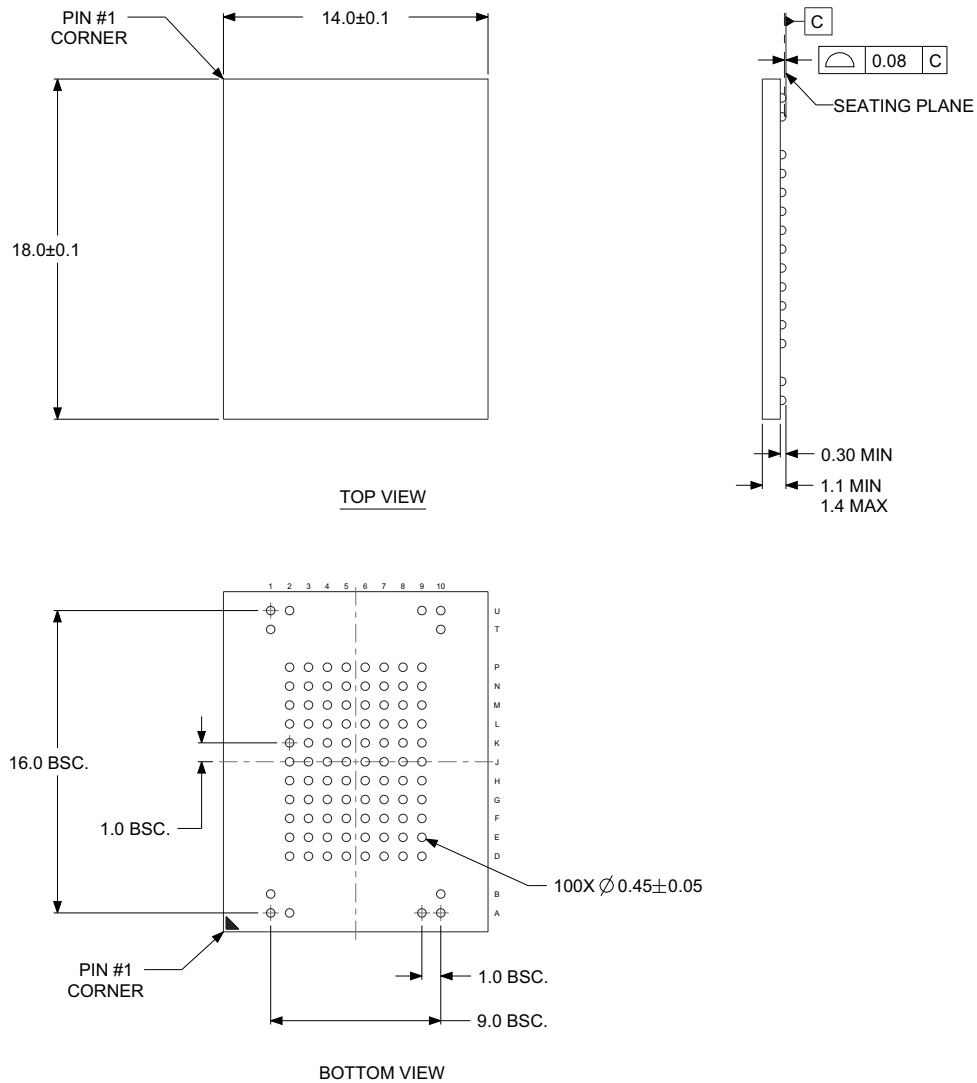
Symbol	Type	Description
CLK	Input	Clock: Each cycle of this signal directs a transfer on the command line and on the data lines. The frequency can vary between the minimum and the maximum clock frequency.
RST_n	Input	Reset: The RST_n signal is used by the host for resetting the device, moving the device to the pre-idle state. By default, the RST_n signal is temporarily disabled in the device. The host must set ECSD register byte 162, bits[1:0] to 0x1 to enable this functionality before the host can use it.
CMD	I/O	Command: This signal is a bidirectional command channel used for device initialization and transfer of commands. The CMD signal has two operation modes: open-drain mode and push-pull. Commands are sent from the eMMC host controller to the eMMC device and responses are sent from the device to the host.
DAT[7:0]	I/O	Data I/O: These are bidirectional data signals. The DAT signals operate in push-pull mode. By default, after power-on or assertion of the RST_n signal, only DAT0 is used for data transfer. The MMC controller can configure a wider data bus for data transfer either using DAT[3:0] (4-bit mode) or DAT[7:0] (8-bit mode). eMMC includes internal pull-up resistors for data lines DAT[7:1]. Immediately after entering the 4-bit mode, the device disconnects the internal pull-up resistors on the DAT[3:1] lines. Upon entering the 8-bit mode, the device disconnects the internal pull-ups on the DAT[7:1] lines.
V _{CC}	Supply	V _{CC} : NAND interface (I/F) I/O and NAND Flash power supply.
V _{CCQ}	Supply	V _{CCQ} : eMMC controller core and eMMC I/F I/O power supply.
V _{SS} ¹	Supply	V _{SS} : NAND I/F I/O and NAND Flash ground connection.
V _{SSQ} ¹	Supply	V _{SSQ} : eMMC controller core and eMMC I/F ground connection.
V _{DDi}		Internal voltage node: At least a 0.1μF capacitor is required to connect V _{DDi} to ground. A 1μF capacitor is recommended. Do not tie to supply voltage or ground.
NC	-	No connect: No internal connection is present.
RFU	-	Reserved for future use: No internal connection is present. Leave it floating externally.

¹ V_{SS} and V_{SSQ} are connected internally.

2.2 eMMC Dimensions

2.2.1 100-Ball Package Dimensions

Figure 2: 100-Ball LFBGA Dimensions - 14.0mm x 18.0mm x 1.4mm (Package Code: AE)



2.2.2 169-Ball Package Dimensions

Figure 3: 169-Ball VFBGA Dimensions - 12.0mm x 16.0mm x 1.0mm (Package Code: CA)

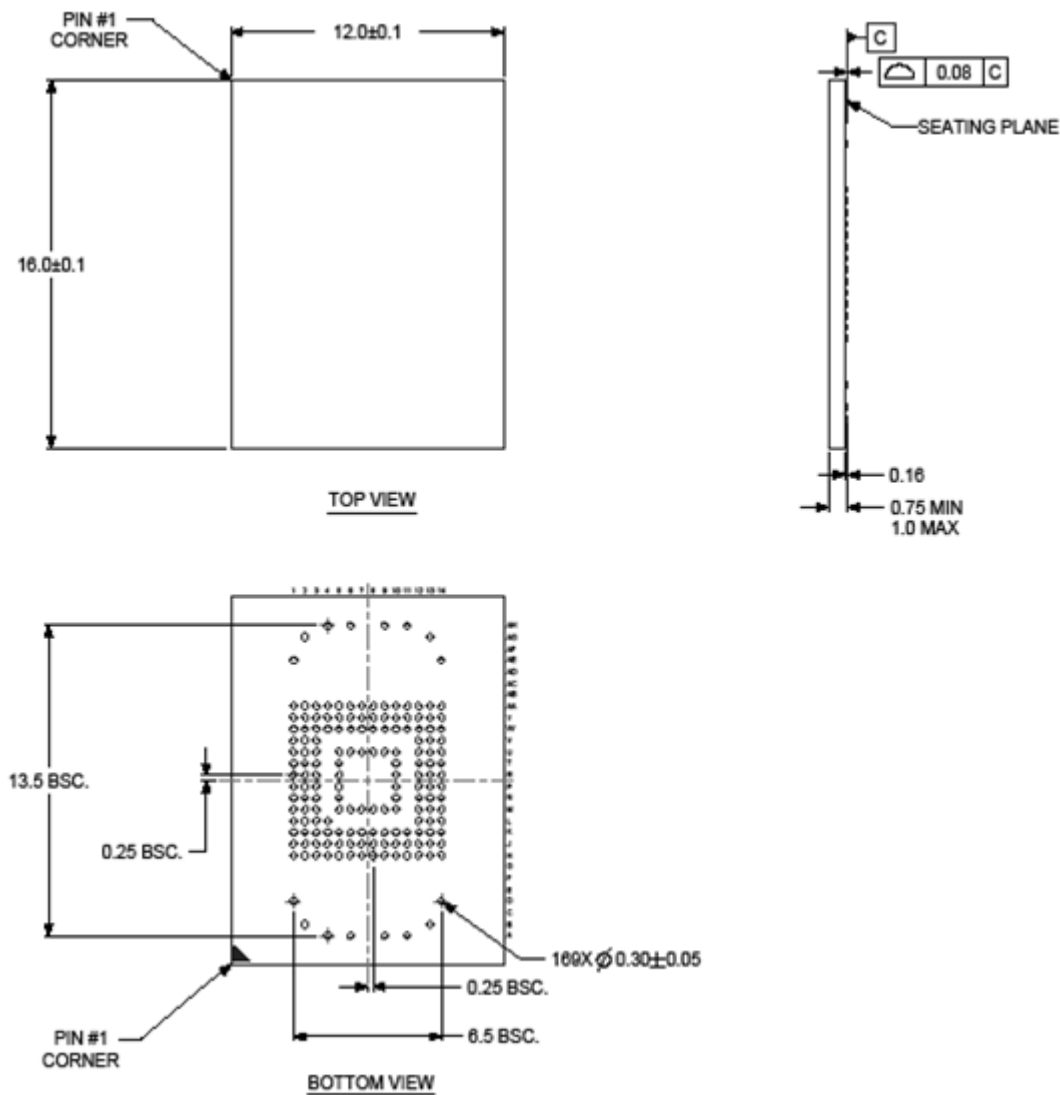


Figure 4: 169-Ball TFBGA Dimensions - 12.0mm x 16.0mm x 1.2mm (Package Code: CC)

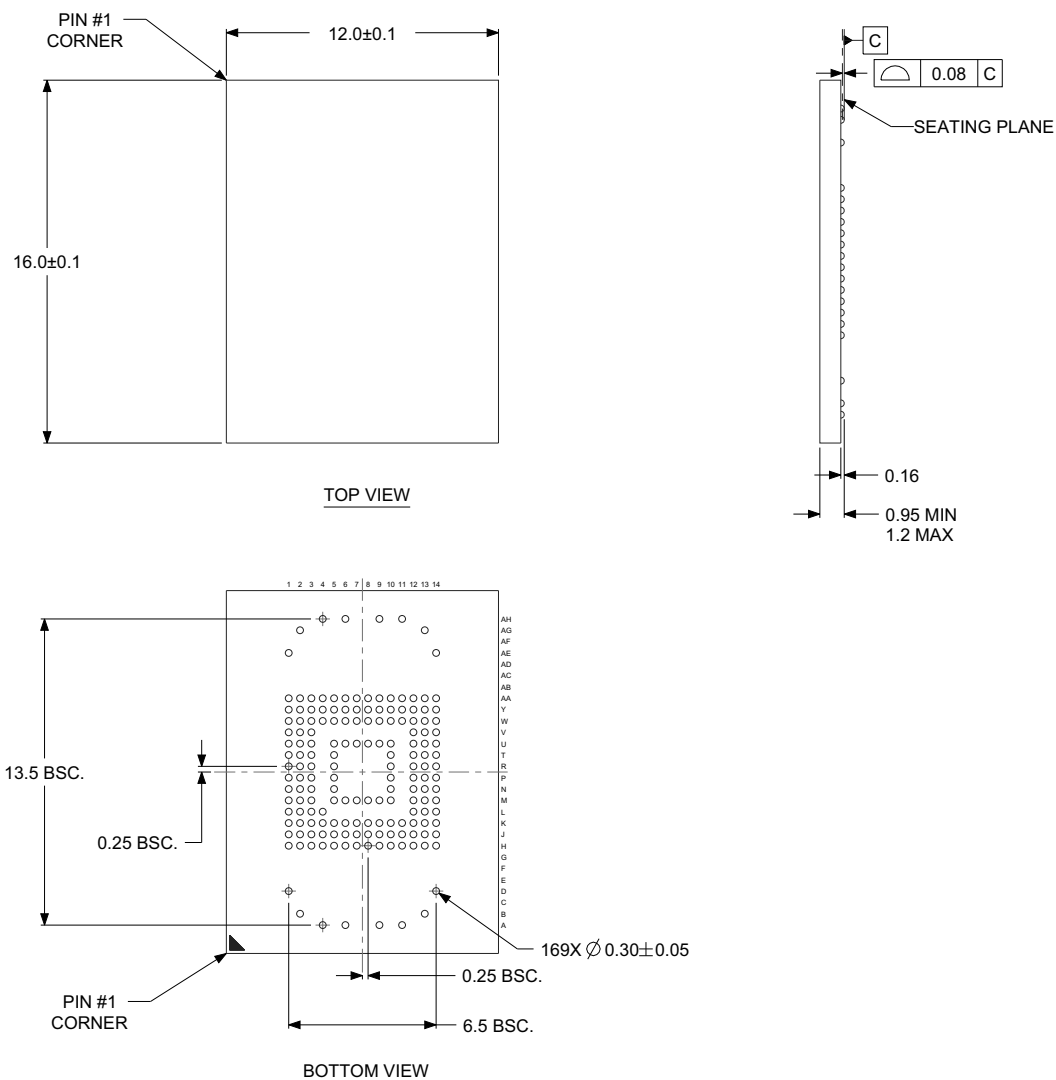


Table 6: Recommended Reflow Profile

Reflow Parameters	Suggested Range
Peak Temperature	235-250°C
Time Above Liquids	45 to 75 seconds
Cooling Rate	< 4°C/sec

Table 7: Soldering Pad Dimension

Package Type	Pad Diameter	Pad Type
169-Ball, 0.5 mm pitch	0.25mm	NSMD
100-Ball, 1.0 mm pitch	0.40mm	NSMD

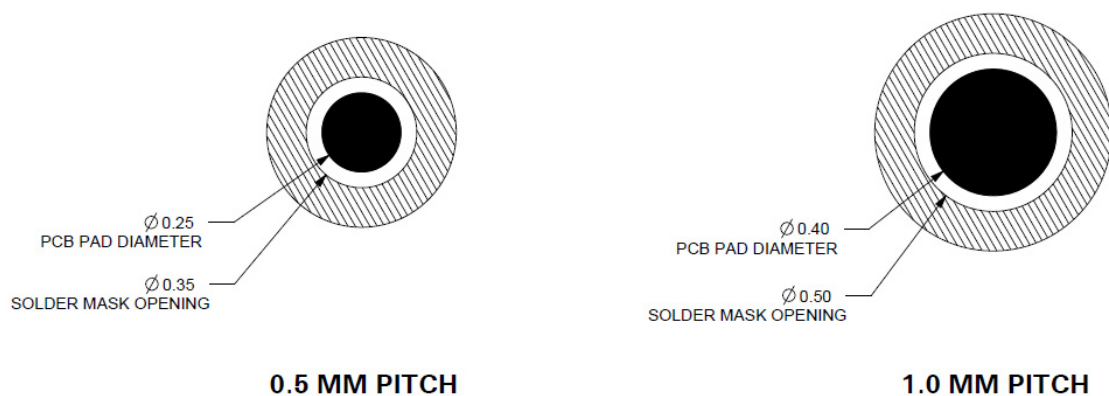
Figure 5: Non Solder Mask Defined (NSMD) Pad Illustration


Table 8: Reliability

Test Model		Result		Test Method
ESD	Human Body Model (HBM)	ESD Sensitivity Passed	± 2000V	AEC-Q100-002-E
		AECQ Classification	H2	
	Machine Model (MM)	ESD Sensitivity Passed	± 200V	AEC-Q100-003-E
		AECQ Classification	M3	
	Charge Device Mode (CDM)	ESD Sensitivity Passed	±750V	AEC-Q100-011 Rev-C
		AECQ Classification	C5	
Latch-up Testing		Latch-up condition	100mA @ 90°C	JESD78D,
		JESD78D Classification	II	AEC-Q100-004-D
Moisture Resistance Test (MRT) ¹		MSL 3		JESD22-A113

1. Recommended baking temperature: 90C (Refer to JEDEC J-STD-033 for corresponding baking time based on package thickness).

3.0 DC SPECIFICATIONS

The device current consumption for various device configurations is defined in the power class fields of the ECSD register.

V_{CC} is used for the NAND Flash device and its interface voltage; V_{CCQ} is used for the controller and the eMMC interface voltage.

Figure 6: Device Power Diagram

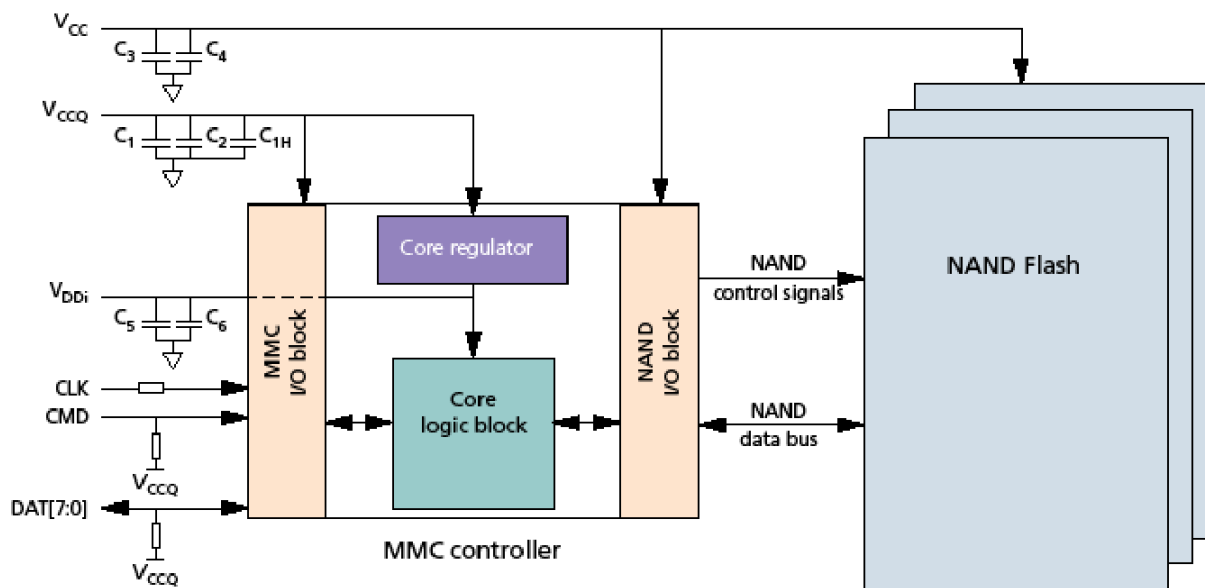


Table 9: Power Domains

Parameter	Symbol	Description
Host Interface	V_{CCQ}	High voltage range = 3.3V (nominal) Low voltage range = 1.8V (nominal)
Memory	V_{CC}	High voltage range = 3.3V (nominal)
Internal	V_{DDi}	The internal regulator connection to an external decoupling capacitor

Table 10: Capacitor and Resistance Specifications

Parameter	Symbol	Min	Typ	Max	Units	Notes
Pull-up resistance: CMD	R_CMD	4.7	10	50	kΩ	1
Pull-up resistance: DAT[7:0]	R_DAT	10	50	50	kΩ	1
Pull-up resistance: RST_n	R-RSTn	4.7	50	50	kΩ	2
CLK/CMD/DAT[7:0] impedance		45	50	55	Ω	3
Serial resistance on CLK	SR_CLK	0	22	47	Ω	
V _{CCQ} capacitor	C _{1H}	1 ± 0.05	1	2.2 ± 0.1	μF	7
	C ₁ , C ₂	2.2 ± 0.1	2.2	4.7 ± 0.22	μF	4
V _{CC} capacitor (≤8GB)	C ₃ , C ₄	2.2 ± 0.1	2.2	4.7 ± 0.22	μF	5
V _{CC} capacitor (>8GB)			4.7		μF	
V _{DDi} capacitor (C _{reg})	C ₅ , C ₆	1 ± 0.05	1	2.2 ± 0.1	μF	6

¹ Used to prevent bus floating.

² If host does not use H/W RESET (RST_n), pull-up resistance is not needed on RST_n line (Extended CSD register [162] = 0 b).

³ Impedance match.

⁴ The coupling capacitor should be connected with V_{DDQ} and V_{SSQ} as closely as possible.

⁵ The coupling capacitor should be connected with V_{DD} and V_{SS} as closely as possible.

⁶ The coupling capacitor should be connected with V_{DDi} and V_{SSi} as closely as possible.

⁷ C_{1H} should be adjacent to V_{CCQ}-V_{SSQ} balls (#K6/C6 and K4/C4 accordingly, next to DAT[7:0] balls). It should be located as close as possible to the balls defined in order to minimize parasitic effects.

3.1 Operational Characteristics

3.1.1 Current Consumption

Table 11: Current Consumption

Condition ¹		Typical Values (I_{CC}/I_{CCQ})			Units
		8GB	16GB	32GB	
Write	DDR52	49/15	79/19	121/21	mA
	HS200	49/17	79/22	148/23	mA
Read	DDR52	61/26	62/30	76/38	mA
	HS200	72/47	97/33	126/65	mA
Sleep ²		31/88	49/94	81/100	μ A
Auto-Standby		31/88	49/94	81/100	μ A

¹ Bus in x8 I/O mode; 25°C; $V_{CCQ} = 1.95V$. Measurements done as average RMS current consumption over 100 milliseconds.

² V_{CC} Power switched off.

4.0 REGISTERS

4.1 CID Register

The card identification (CID) register is 128 bits wide. It contains the device identification information used during the card identification phase as required by eMMC protocol. Each device is created with a unique identification number.

Table 12: CID Register Field Parameters

Name	Field	Width	CID Bits	CID Value
Manufacturer ID	MID	8	[127:120]	F6h
Reserved	-	6	[119:114]	-
Card/BGA	CBX	2	[113:112]	01h
OEM/application ID	OID	8	[111:104]	00h
Product name	PNM	8GB	[103:56]	08GTEA
		16GB		16GTEA
		32GB		32GTEA
Product revision	PRV	8	[55:48]	01h
Product serial number	PSN	32	[47:16]	_ ¹
Manufacturing date	MDT	8	[15:8]	_ ²
CRC7 checksum	CRC	7	[7:1]	_ ³
Not used; always 1	-	1	0	01h

¹ Unique for each device. 32-bit unsigned binary integer.

² 2 hex digits for device manufacturing month and year.

³ CRC for CID register. Different for each device.

4.2 OCR Register

The 32-bit operations conditions register (OCR) stores the V_{DD} voltage profile of the device and the access mode indication. In addition, this register includes a status information bit. This status bit is set if the device power up procedure has been finished.

Table 13: OCR Register Definitions

V_{DD} Voltage Window	Width	OCR Bits	OCR Value
Ready/Busy	1	[31]	card power up status bit (busy) ¹
Access Mode	2	[30:29]	02h
Reserved	5	[28:24]	00h
2.7-3.6V	9	[23:15]	1FFh
2.0-2.6V	7	[14:8]	00h
1.70-1.95V	1	[7]	01h
Reserved	7	[6:0]	00h

¹ This bit is set to LOW if the device has not finished the power up routine.

4.3 CSD Register

The card-specific data (CSD) register provides information about accessing the device contents. The CSD register defines the data format, error correction type, maximum data access time, and data transfer speed, as well as whether the DS register can be used. The programmable part of the register (entries marked with W or E in the following table) can be changed by the PROGRAM_CSD (CMD27) command.

Table 14: CSD Register Field Parameters

Name	Field	Width	Cell Type ¹	CSD Bits	CSD Value
CSD structure	CSD_structure	2	R	[127:126]	03h
System specification version	SPEC_VERS	4	R	[125:122]	04h
Reserved ²	-	2	-	[121:120]	-
Data read access time 1	TAAC	8	R	[119:112]	4Fh
Data read access time 2 in CLK cycles (NSAC x 100)	NSAC	8	R	[111:104]	01h
Maximum bus clock frequency	TRAN_SPEED	8	R	[103:96]	32h
Card command classes	CCC	12	R	[95:84]	0F5h
Maximum read data block length	READ_BL_LEN	4	R	[83:80]	09h
Partial blocks for reads supported	READ_BL_PARTIAL	1	R	[79]	00h
Write block misalignment	WRITE_BLK_MISALIGN	1	R	[78]	00h
Read block misalignment	READ_BLK_MISALIGN	1	R	[77]	00h
DS register implemented	DSR_IMP	1	R	[76]	00h
Reserved ²	-	2	-	[75:74]	-
Device size	C-SIZE	12	R	[73:62]	FFFh
Maximum read current as $V_{DD,min}$	VDD_R_CURR_MIN	3	R	[61:59]	07h
Maximum read current as $V_{DD,max}$	VDD_R_CURR_MAX	3	R	[58:56]	07h
Maximum write current as $V_{DD,min}$	VDD_W_CURR_MIN	3	R	[55:53]	07h
Maximum write current as $V_{DD,max}$	VDD_W_CURR_MAX	3	R	[52:50]	07h
Device size multiplier	C-SIZE_MULT	3	R	[49:47]	07h
Erase group size	ERASE_GRP_SIZE	5	R	[46:42]	1Fh
Erase group size multiplier	ERASE_GRP_SIZE_MULT	5	R	[41:37]	1Fh
Write protect group size	WP_GRP_SIZE	8GB	5	[36:32]	0Fh
		16GB			1Fh
		32GB			1Fh
Write protect group enable	WP_GRP_ENABLE	1	R	[31]	01h
Manufacturer default ECC	DEFAULT_ECC	2	R	[30:29]	00h
Write-speed factor	R2W_FACTOR	3	R	[28:26]	02h
Maximum write data block length	WRITE_BL_LEN	4	R	[25:22]	09h
Partial blocks for writes supported	WRITE_BL_PARTIAL	1	R	[21]	00h
Reserved ²	-	4	-	[20:17]	-

Table 14: CSD Register Field Parameters

Name	Field	Width	Cell Type ¹	CSD Bits	CSD Value
Content protection application	CONTENT_PROT_APP	1	R	[16]	00h
File-format group	FILE_FORMAT_GRP	1	R/W	[15]	00h
Copy flag (OTP)	COPY	1	R/W	[14]	00h
Permanent write protection	PERM_WRITE_PROTECT	1	R/W	[13]	00h
Temporary write protection	TEMP_WRITE_PROTECT	1	R/W/E	[12]	00h
File format	FILE_FORMAT	2	R/W	[11:10]	00h
ECC	ECC	2	R/W/E	[9:8]	00h
CRC	CRC	7	R/W/E	[7:1]	Note 3
Not used; always 1	-	1	-	[0]	-

¹ R = Read-only

R/W = One-time programmable and readable

R/W/E = Multiple writable with value kept after a power cycle, assertion of the RST_n signal, and any CMD0 reset, and readable

TBD = To be determined

² Reserved bits should be read as 0.

³ CRC for CSD register. Different for each density

4.4 ECSD Register

The 512-byte extended card-specific data (ECSD) register defines device properties and selected modes. The most significant 320 bytes are the properties segment. This segment defines device capabilities and cannot be modified by the host. The lower 192 bytes are the modes segment. The modes segment defines the configuration in which the device is working. The host can change the properties of modes segments using the SWITCH command.

Table 15: ECSD Register Field Parameters

Name	Field	Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Reserved ²	-	6	-	[511:506]	-
Extended Security Commands Error	EXT_SECURITY_ERR	1	R	[505]	00h
Supported command sets	S_CMD_SET	1	R	[504]	01h
HPI features	HPI_FEATURES	1	R	[503]	01h
Background operations support	BKOPS_SUPPORT	1	R	[502]	01h
Max packed read commands	MAX_PACKED_READS	1	R	[501]	3Ch
Max packed write commands	MAX_PACKED_WRITES	1	R	[500]	3Ch
Data tag support	DATA_TAG_SUPPORT	1	R	[499]	01h
Tag unit size	TAG_UNIT_SIZE	1	R	[498]	03h
Tag resources size	TAG_RES_SIZE	1	R	[497]	00h
Context management capabilities	CONTEXT_CAPABILITIES	1	R	[496]	05h
Large unit size	LARGE_UNIT_SIZE_M1	8GB	1	[495]	03h
		16GB			07h
		32GB			0Fh
Extended partitions attribute support	EXT_SUPPORT	1	R	[494]	03h
Supported Modes	SUPPORTED_MODES	1	R	[493]	01h
FFU features	FFU_FEATURES	1	R	[492]	00h
Operations code timeout	OPERATION_CODE_TIMEOUT	1	R	[491]	00h
FFU Argument	FFU_ARG	4	R	[490:487]	00000000h
Reserved ²	-	181	-	[486:306]	-
Number of FW sectors correctly programmed	NUMBER_OF_FW_SECTORS_CORRECTLY_PROGRAMMED	4	R	[305:302]	00000000h
Vendor proprietary health report	VENDOR_PROPRIETARY_HEALTH_REPORT	32	R	[301:270]	00h (x32)
Device life time estimation type B	DEVICE_LIFE_TIME_EST_TYP_B	1	R	[269]	01h

Table 15: ECSD Register Field Parameters

Name	Field	Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Device life time estimation type A	DEVICE_LIFE_TIME_EST_TYP_A	1	R	[268]	01h
Pre EOL information	PRE_EOL_INFO	1	R	[267]	01h
Optimal read size	OPTIMAL_READ_SIZE	1	R	[266]	01h
Optimal write size	OPTIMAL_WRITE_SIZE	1	R	[265]	04h
Optimal trim unit size	OPTIMAL_TRIM_UNIT_SIZE	1	R	[264]	01h
Reserved ²	-	2	-	[263:262]	-
Firmware version	FIRMWARE_VERSION	8	R	[261:254]	64 or 67 ⁴
Reserved ²	-	1	-	[253]	-
Cache size	CACHE_SIZE	4	R	[252:249]	00000000h
Generic CMD6 timeout	GENERIC_CMD6_TIME	1	R	[248]	19h
Power off notification (long) timeout	POWER_OFF_LONG_TIME	1	R	[247]	FFh
Background operations status	BKOPS_STATUS	1	R	[246]	00h
Number of correctly programmed sectors	CORRECTLY_PRG_SECTORS_NUM	4	R	[245:242]	00000000h
First initialization time after partitioning (first CMD1 to device ready)	INI_TIMEOUT_PA	1	R	[241]	32h
Reserved ²	-	1	-	[240]	-
Power class for 52 MHz, DDR at 3.6V	PWR_CL_DDR_52_360	1	R	[239]	00h
Power class for 52 MHz, DDR at 1.95V	PWR_CL_DDR_52_195	1	R	[238]	00h
Power class for 200 MHz at 1.95V	PWR_CL_200_195	1	R	[237]	00h
Power class for 200 MHz at 1.3V	PWR_CL_200_130	1	R	[236]	00h
Minimum write performance for 8-bit at 52 MHz in DDR mode	MIN_PERF_DDR_W_8_52	1	R	[235]	08h
Minimum read performance for 8-bit at 52 MHz in DDR mode	MIN_PERF_DDR_R_8_52	1	R	[234]	08h
Reserved ²	-	1	-	[233]	-
TRIM multiplier	TRIM_MULT	1	R	[232]	0Fh
Secure feature support	SEC_FEATURE_SUPPORT	1	R	[231]	55h
SECURE ERASE multiplier	SEC_ERASE_MULT	1	R	[230]	06h
SECURE TRIM multiplier	SEC_TRIM_MULT	1	R	[229]	09h

Table 15: ECSD Register Field Parameters

Name	Field		Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Boot information	BOOT_INFO		1	R	[228]	07h
Reserved ²	-		1	-	[227]	-
Boot partition size	BOOT_SIZE_MULT		1	R	[226]	80h
Access size	ACC_SIZE	8GB	1	R	[225]	06h
		16GB				07h
		32GB				08h
High-capacity erase unit size	HC_ERASE_GRP_SIZE	8GB	1	R	[224]	08h
		16GB				10h
		32GB				20h
High-capacity erase timeout	ERASE_TIMEOUT_MULT		1	R	[223]	01h
Reliable write-sector count	REL_WR_SEC_C		1	R	[222]	01h
High-capacity write protect group size	HC_WP_GRP_SIZE		1	R	[221]	02h
Sleep current (V _{CC})	S_C_VCC		1	R	[220]	08h
Sleep current (V _{CCQ})	S_C_VCCQ		1	R	[219]	08h
Production state awareness timeout	PRODUCTION_STATE_AWARENESS_TIMEOUT		1	R	[218]	14h
Sleep/awake timeout	S_A_TIMEOUT		1	R	[217]	10h
Sleep Notification Timeout	SLEEP_NOTIFICATION_TIME		1	R	[216]	0Fh
Sector count	SEC-COUNT	8GB	4	R	[215:212]	00E68000h
		16GB				01CD0000h
		32GB				039A0000h
Reserved ²	-		1	-	[211]	-
Minimum write performance for 8-bit at 52 MHz	MIN_PERF_W_8_52		1	R	[210]	08h
Minimum read performance for 8-bit at 52 MHz	MIN_PERF_R_8_52		1	R	[209]	08h
Minimum write performance for 8-bit at 26 MHz and 4-bit at 52 MHz	MIN_PERF_W_8_26_4_52		1	R	[208]	08h
Minimum read performance for 8-bit at 26 MHz and 4-bit at 52 MHz	MIN_PERF_R_8_26_4_52		1	R	[207]	08h
Minimum write performance for 4-bit at 26 MHz	MIN_PERF_W_4_26		1	R	[206]	08h
Minimum read performance for 4-bit at 26 MHz	MIN_PERF_R_4_26		1	R	[205]	08h

Table 15: ECSD Register Field Parameters

Name	Field	Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Reserved ²	-	1	-	[204]	-
Power class for 26 MHz at 3.6V	PWR_CL_26_360	1	R	[203]	00h
Power class for 52 MHz at 3.6V	PWR_CL_52_360	1	R	[202]	00h
Power class for 26 MHz at 1.95V	PWR_CL_26_195	1	R	[201]	00h
Power class for 52 MHz at 1.95V	PWR_CL_52_195	1	R	[200]	00h
Partition switching timing	PARTITION_SWITCH_TIME	1	R	[199]	03h
Out-of-interrupt busy timing	OUT_OF_INTERRUPT_TIME	1	R	[198]	04h
I/O driver strength	DRIVER_STRENGTH	1	R	[197]	0Fh
Card type	CARD_TYPE	1	R	[196]	17h
Reserved ²	-	1	-	[195]	-
CSD structure version	CSD_STRUCTURE	1	R	[194]	02h
Reserved ²	-	1	-	[193]	-
Extended CSD revision	EXT_CSD_REV	1	-	[192]	06h
Command set	CMD_SET	1	R/W/E_P	[191]	00h
Reserved ²	-	1	-	[190]	-
Command set revision	CMD_SET_REV	1	R	[189]	00h
Reserved ²	-	1	-	[188]	-
Power class	POWER_CLASS	1	R/W/E_P	[187]	00h
Reserved ²	-	1	-	[186]	-
High-speed interface timing	HS_TIMING	1	R/W/E_P	[185]	00h ³
Reserved ²	-	1	-	[184]	-
Bus width mode	BUS_WIDTH	1	W/E_P	[183]	00h ³
Reserved ²	-	1	-	[182]	-
Erased memory content	ERASED_MEM_CONT	1	R	[181]	00h
Reserved ²	-	1	-	[180]	-
Partition configuration	PARTITION_CONFIG	1	R/W/E, R/W/E_P	[179]	00h
Boot configuration protection	BOOT_CONFIG_PROT	1	R/W, R/ W/C_P	[178]	00h
Boot bus width	BOOT_BUS_CONDITIONS	1	R/W/E	[177]	00h
Reserved ²	-	1	-	[176]	-
High-density erase group definition	ERASE_GROUP_DEF	1	R/W/E_P	[175]	00h

Table 15: ECSD Register Field Parameters

Name	Field	Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Boot write protection status registers	BOOT_WP_STATUS	1	R	[174]	00h
Boot area write protection register	BOOT_WP	1	R/W, R/W/C_P	[173]	00h
Reserved ²	-	1	-	[172]	-
User write protection register	USER_WP	1	R/W, R/W/C_P, R/W/E_P	[171]	00h
Reserved ²	-	1	-	[170]	-
Firmware configuration	FW_CONFIG	1	R/W	[169]	00h
RPMB size	RPMB_SIZE_MULT	1	R	[168]	01h
Write reliability setting register	WR_REL_SET	1	R/W	[167]	00h
Write reliability parameter register	WR_REL_PARAM	1	R	[166]	05h
Start sanitize operation	SANITIZE_START	1	W/E_P	[165]	00h
Manually start background operations	BKOPS_START	1	W/E_P	[164]	00h
Enable background operations handshake	BKOPS_EN	1	R/W	[163]	00h
Hardware reset function	RST_n_FUNCTION	1	R/W	[162]	00h
HPI management	HPI_MGMT	1	R/W/E/P	[161]	00h
Partitioning support	PARTITIONING_SUPPORT	1	R/W/E, R/W/E_P	[160]	07h
Maximum enhanced area size	MAX_ENH_SIZE_MULT	3	R	[159:157]	0001CDh
Partitions attribute	PARTITIONS_ATTRIBUTE	1	R/W	[156]	00h
Partitioning setting	PARTITIONING_SETTING-COMPLETED	1	R/W	[155]	00h
General-purpose partition size	GP_SIZE_MULT_GP4	12	R/W	[154:152]	000000h
	GP_SIZE_MULT_GP3			[151:149]	000000h
	GP_SIZE_MULT_GP2			[148:146]	000000h
	GP_SIZE_MULT_GP1			[145:143]	000000h
Enhanced user data area size	ENH_SIZE_MULT	3	R/W	[142:140]	000000h
Enhanced user data start address	ENH_START_ADDR	4	R/W	[139:136]	00000000h
Reserved ²	-	1	-	[135]	-
Bad block management mode	SEC_BAD_BLK_MGMNT	1	R/W	[134]	00h

Table 15: ECSD Register Field Parameters

Name	Field		Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Production state awareness	PRODUCTION_STATE_AWARENESS		1	R/W/E	[133]	00h
Package case temperature is controlled	TCASE_SUPPORT		1	W/E_P	[132]	00h
Periodic wake-up	PERIODIC_WAKEUP		1	R/W/E	[131]	00h
Program CID/CSD in DDR mode support	PROGRAM_CID_CSD_DDR_SUPPORT		1	R	[130]	01h
Reserved ²	-		2	-	[129:128]	-
Vendor specific fields	VENDOR_SPECIFIC_NFIELD		64	<vendor specific>	[127:64]	00h (x64)
Native sector size	NATIVE_SECTOR_SIZE		1	R	[63]	00h
Sector size emulation	USE_NATIVE_SECTOR		1	R/W	[62]	00h
Sector size	DATA_SECTOR_SIZE		1	R	[61]	00h
1st initialization after disabling sector size emulation	INI_TIMEOUT_EMU		1	R	[60]	0Ah
Class 6 command control	CLASS_6_CTRL		1	R/W/E_P	[59]	00h
Number of addressed groups to be released	DYNCAP_NEEDED		1	R	[58]	00h
Exception events control	EXCEPTION_EVENTS_CTRL		2	R/W/E_P	[57:56]	00h
Exception events status	EXCEPTION_EVENTS_STATUS		2	R	[55:54]	00h
Extended partitions attribute	EXT_PARTITIONS_ATTRIBUTE		2	R/W	[53:52]	00h
Context configuration	CONTEXT_CONF		15	R/W/E_P	[51:37]	00h
Packed command status	PACKED_COMMAND_STATUS		1	R	[36]	00h
Packed command failure index	PACKED_FAILURE_INDEX		1	R	[35]	00h
Power off notification	POWER_OFF_NOTIFICATION		1	R/W/E_P	[34]	00h
Control to turn the cache on/off	CACHE_CTRL		1	R/W/E_P	[33]	00h
Flushing of the cache	FLUSH_CACHE		1	W/E_P	[32]	00h
Reserved ²	-		1	-	[31]	-
Mode config	MODE_CONFIG		1	R/W/E_P	[30]	00h
Mode operation codes	MODE_OPERATION_CODES		1	W/E_P	[29]	00h
Reserved ²	-		2	-	[28:27]	-
FFU status	FFU_STATUS		1	R	[26]	00h
Pre loading data size	PRE_LOADING_DATA_SIZE		4	R/W/E_P	[25:22]	00000000h
Max pre loading data size	MAX_PRE_LOADING_DATA_SIZE	8GB	4	R	[21:18]	734000h
		16GB				E68000h
		32GB				1CD0000h

Table 15: ECSD Register Field Parameters

Name	Field	Size (Bytes)	Cell Type ¹	ECSD Bytes	ECSD Values
Product state awareness enablement	PRODUCT_STATE_AWARENESS_ENABLEMENT	1	R/W/E & R	[17]	01h
Secure removal type	SECURE_REMOVAL_TYPE	1	R/W & R	[16]	00h
Reserved ²	-	16	-	[15:0]	-

¹ R = Read-only

R/W = One-time programmable and readable

R/W/E = Multiple writable with the value kept after a power cycle, assertion of the RST_n signal, and any CMD0 reset, and readable

R/W/C_P = Writable after the value is cleared by a power cycle and assertion of the RST_n signal (the value not cleared by CMD0 reset) and readable

R/W/E_P = Multiple writable with the value reset after a power cycle, assertion of the RST_n signal, and any CMD0 reset, and readable

W/E_P = Multiple writable with the value reset after power cycle, assertion of the RST_n signal, and any CMD0 reset, and not readable

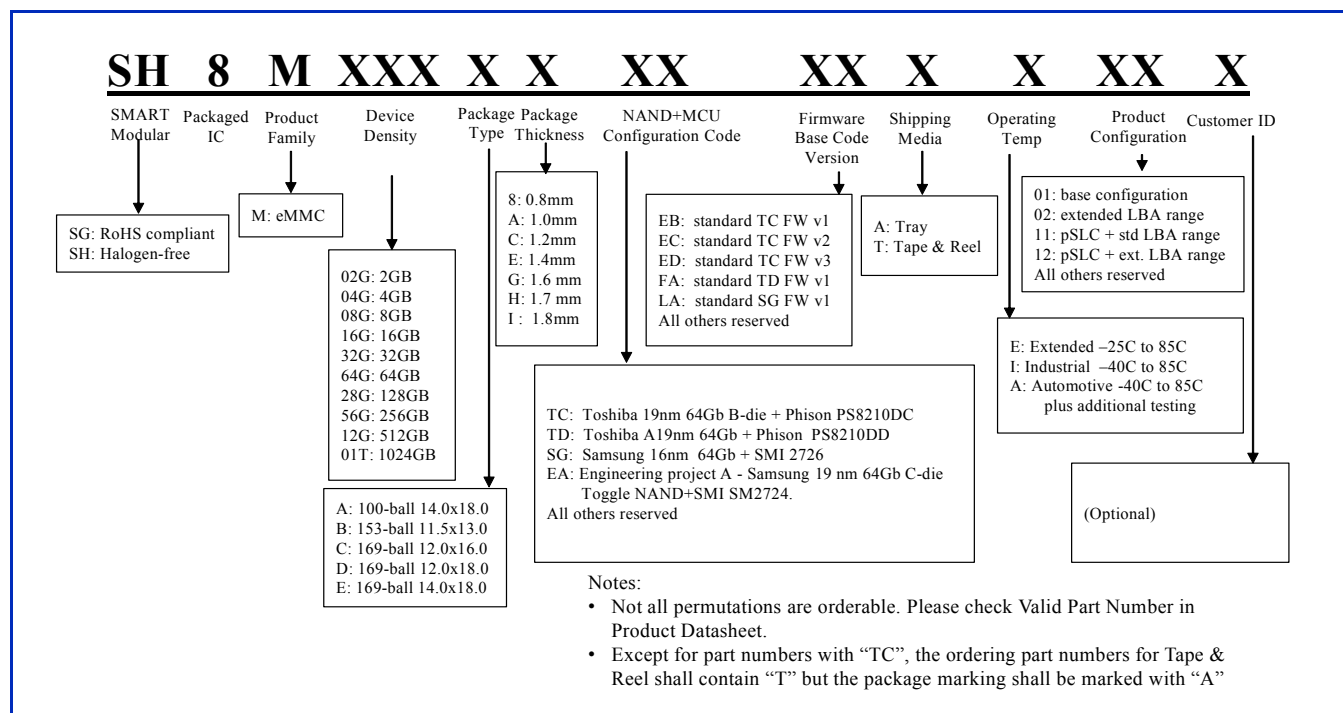
² Reserved bits should be read as 0.

³ Set by host during device initialization. Default is 00h.

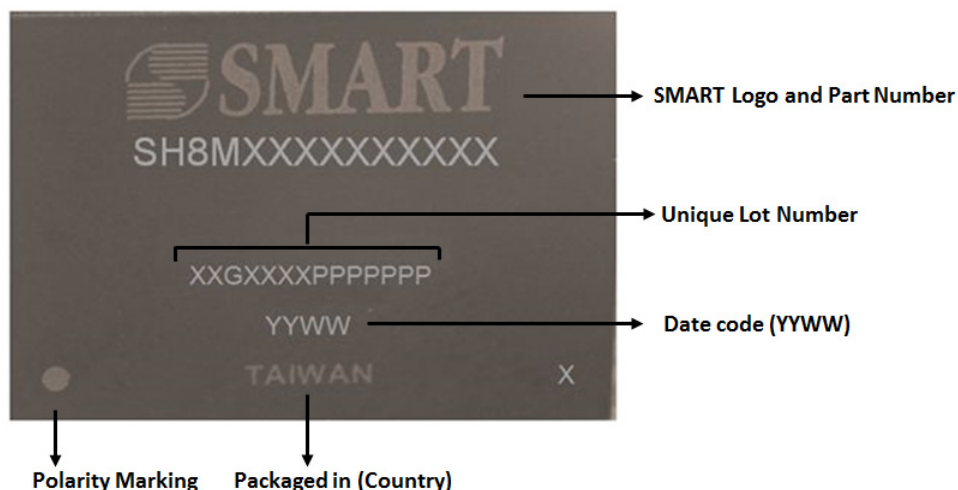
⁴ Firmware version = 64 for FW6.64 and 67 for FW6.67

5.0 PART NUMBERS

5.1 Part Number Decoder



5.2 Marking Decoder



5.3 Part Numbering Information

Table 16: Automotive eMMC - JEDEC 0.5mm 169-Ball

Part Number	Density	NAND Vendor	NAND Litho	Tech	NAND Die	# of Die	Package	Temp	Controller	eMMC Spec
SH8M08GCATCEyxA01	8GB	Toshiba	19nm	MLC	64Gb	1	169-Ball 12x16x1.0	-40°C to +85°C	PS8210	4.51+
SH8M16GCATCEyxA01	16GB	Toshiba	19nm	MLC	64Gb	2	169-Ball 12x16x1.0	-40°C to +85°C	PS8210	4.51+
SH8M32GCCTCEyxA01	32GB	Toshiba	19nm	MLC	64Gb	4	169-Ball 12x16x1.2	-40°C to +85°C	PS8210	4.51+

y = C for v4.51+ firmware v2 (FW v6.64)

y = D for v4.51+ firmware v3 (FW v6.67)

x = A for tray

x = T for tape & reel

Table 17: Automotive eMMC - 1.0mm 100-Ball

Part Number	Density	NAND Vendor	NAND Litho	Tech	NAND Die	# of Die	Package	Temp	Controller	eMMC Spec
SH8M08GAETCEyxA01	8GB	Toshiba	19nm	MLC	64Gb	1	100-Ball 14x18x1.4	-40°C to +85°C	PS8210	4.51+
SH8M16GAETCEyxA01	16GB	Toshiba	19nm	MLC	64Gb	2	100-Ball 14x18x1.4	-40°C to +85°C	PS8210	4.51+
SH8M32GAETCEyxA01	32GB	Toshiba	19nm	MLC	64Gb	4	100-Ball 14x18x1.4	-40°C to +85°C	PS8210	4.51+

y = C for v4.51+ firmware v2 (FW v6.64)

y = D for v4.51+ firmware v3 (FW v6.67)

x = A for tray

x = T for tape & reel

PRODUCT SPECIFICATION

Table 18: Industrial Temperature eMMC - JEDEC 0.5mm 169-Ball

Part Number	Density	NAND Vendor	NAND Litho	Tech	NAND Die	# of Die	Package	Temp	Controller	eMMC Spec
SH8M08GCATCEyxl01	8GB	Toshiba	19nm	MLC	64Gb	1	169-Ball 12x16x1.0	-40°C to +85°C	PS8210	4.51+
SH8M16GCATCEyxl01	16GB	Toshiba	19nm	MLC	64Gb	2	169-Ball 12x16x1.0	-40°C to +85°C	PS8210	4.51+
SH8M32GCCTCEyxl01	32GB	Toshiba	19nm	MLC	64Gb	4	169-Ball 12x16x1.2	-40°C to +85°C	PS8210	4.51+

y = C for v4.51+ firmware v2 (FW v6.64)

y = D for v4.51+ firmware v3 (FW v6.67)

x = A for tray

x = T for tape & reel

Table 19: Industrial Temperature eMMC - 1.0mm 100-Ball

Part Number	Density	NAND Vendor	NAND Litho	Tech	NAND Die	# of Die	Package	Temp	Controller	eMMC Spec
SH8M08GAETCEyxl01	8GB	Toshiba	19nm	MLC	64Gb	1	100-Ball 14x18x1.4	-40°C to +85°C	PS8210	4.51+
SH8M16GAETCEyxl01	16GB	Toshiba	19nm	MLC	64Gb	2	100-Ball 14x18x1.4	-40°C to +85°C	PS8210	4.51+
SH8M32GAETCEyxl01	32GB	Toshiba	19nm	MLC	64Gb	4	100-Ball 14x18x1.4	-40°C to +85°C	PS8210	4.51+

y = C for v4.51+ firmware v2 (FW v6.64)

y = D for v4.51+ firmware v3 (FW v6.67)

x = A for tray

x = T for tape & reel

Table 20: Extended Temperature eMMC - JEDEC 0.5mm 169-Ball

Part Number	Density	NAND Vendor	NAND Litho	Tech	NAND Die	# of Die	Package	Temp	Controller	eMMC Spec
SH8M08GCATCEyxE01	8GB	Toshiba	19nm	MLC	64Gb	1	169-Ball 12x16x1.0	-25°C to +85°C	PS8210	4.51+
SH8M16GCATCEyxE01	16GB	Toshiba	19nm	MLC	64Gb	2	169-Ball 12x16x1.0	-25°C to +85°C	PS8210	4.51+
SH8M32GCCTCEyxE01	32GB	Toshiba	19nm	MLC	64Gb	4	169-Ball 12x16x1.2	-25°C to +85°C	PS8210	4.51+

y = C for v4.51+ firmware v2 (FW v6.64)

y = D for v4.51+ firmware v3 (FW v6.67)

x = A for tray

x = T for tape & reel

Table 21: Extended Temperature eMMC - 1.0mm 100-Ball

Part Number	Density	NAND Vendor	NAND Litho	Tech	NAND Die	# of Die	Package	Temp	Controller	eMMC Spec
SH8M08GAETCEyxE01	8GB	Toshiba	19nm	MLC	64Gb	1	100-Ball 14x18x1.4	-25°C to +85°C	PS8210	4.51+
SH8M16GAETCEyxE01	16GB	Toshiba	19nm	MLC	64Gb	2	100-Ball 14x18x1.4	-25°C to +85°C	PS8210	4.51+
SH8M32GAETCEyxE01	32GB	Toshiba	19nm	MLC	64Gb	4	100-Ball 14x18x1.4	-25°C to +85°C	PS8210	4.51+

y = C for v4.51+ firmware v2 (FW v6.64)

y = D for v4.51+ firmware v3 (FW v6.67)

x = A for tray

x = T for tape & reel

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