S34MS16G2

16 Gb,1.8 V, 4-bit ECC, x8 I/O, SLC NAND Flash Memory for Embedded

Distinctive Characteristics

- Density
  - 16 Gb (4 Gb × 4)
- Architecture (For each 4 Gb device)
  - Input / Output Bus Width: 8-bits
  - Page Size: (2048 + 128) bytes; 128-byte spare area
  - Block Size: 64 Pages or (128k + 8k) bytes
  - Plane Size
    - 2048 Blocks per Plane or (256M + 16M) bytes
  - Device Size
    - 2 Planes per Device or 512 Mbyte
- NAND Flash Interface
  - Open NAND Flash Interface (ONFI) 1.0 compliant
  - Address, Data and Commands multiplexed
- Supply Voltage
  - 1.8V device: V_{CC} = 1.7V ~ 1.95V
- Security
  - One Time Programmable (OTP) area
  - Serial number (unique ID)
  - Hardware program/erase disabled during power transition
- Additional Features
  - Supports Multiplane Program and Erase commands
  - Supports Copy Back Program
  - Supports Multiplane Copy Back Program
  - Supports Read Cache
- Electronic Signature
  - Manufacturer ID: 01h
- Operating Temperature
  - Industrial: –40°C to 85°C

Performance

- Page Read / Program
  - Random access: 30 µs (Max)
  - Sequential access: 45 ns (Min)
  - Program time / Multiplane Program time: 300 µs (Typ)
- Block Erase / Multiplane Erase
  - Block Erase time: 3.5 ms (Typ)
- Reliability
  - 100,000 Program / Erase cycles (Typ) (with 4-bit ECC per 528 bytes)
  - 10 Year Data retention (Typ)
  - Blocks zero and one are valid and will be valid for at least 1000 program-erase cycles with ECC
- Package Options
  - Lead Free and Low Halogen
  - 63-Ball BGA 9 × 11 × 1.2 mm

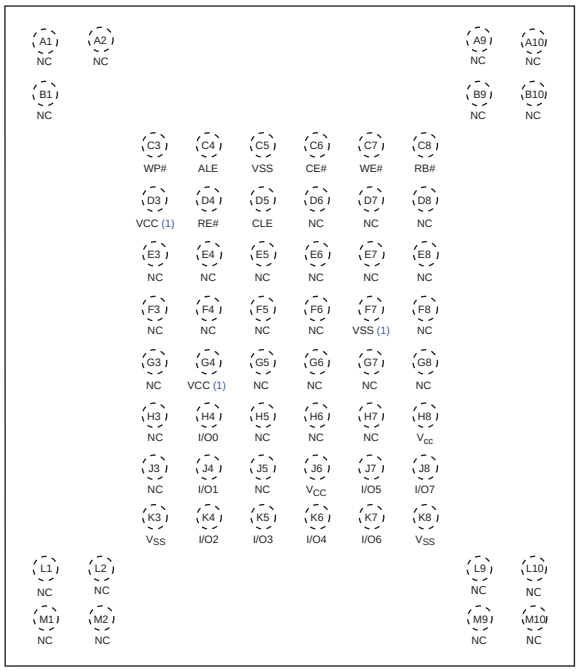
Contents

1. General Description

The SkyHigh S34MS16G2 16-Gb NAND is offered in 1.8V V_{CC} with x8 I/O interface. This document contains information for the S34MS16G2 device, which is a quad-die stack of four S34MS04G2 die. For detailed specifications, please refer to the discrete die data sheet: S34MS01G2_04G2.

2. Connection Diagram

Figure 2.1 63-BGA Contact, x8 Device (Balls Down, Top View)



3. Pin Description

Table 3.1 Pin Description

Pin Name	Description
I/O0 - I/O7	**Inputs/Outputs**. The I/O pins are used for command input, address input, data input, and data output. The I/O pins float to High-Z when the device is deselected or the outputs are disabled.
CLE	**Command Latch Enable.** This input activates the latching of the I/O inputs inside the Command Register on the rising edge of Write Enable (WE#).
ALE	**Address Latch Enable.** This input activates the latching of the I/O inputs inside the Address Register on the rising edge of Write Enable (WE#).
CE#	**Chip Enable.** This input controls the selection of the device. When the device is not busy CE# low selects the memory.
WE#	**Write Enable.** This input latches Command, Address and Data. The I/O inputs are latched on the rising edge of WE#.
RE#	**Read Enable.** The RE# input is the serial data-out control, and when active drives the data onto the I/O bus. Data is valid t_{REA} after the falling edge of RE# which also increments the internal column address counter by one.
WP#	**Write Protect.** The WP# pin, when low, provides hardware protection against undesired data modification (program / erase).
R/B#	**Ready Busy**. The Ready/Busy output is an Open Drain pin that signals the state of the memory.
V_{CC}	**Supply Voltage**. The V_{CC} supplies the power for all the operations (Read, Program, Erase). An internal lock circuit prevents the insertion of Commands when V_{CC} is less than V_{LKO}.
V_{SS}	**Ground.**
NC	**Not Connected.**

Notes:

1. *A 0.1 µF capacitor should be connected between the V_{CC} Supply Voltage pin and the V_{SS} Ground pin to decouple the current surges from the power supply. The PCB track widths must be sufficient to carry the currents required during program and erase operations.*
2. *An internal voltage detector disables all functions whenever V_{CC} is below 1.8V to protect the device from any involuntary program/erase during power transitions.*

4. Block Diagrams

Figure 4.1 Functional Block Diagram

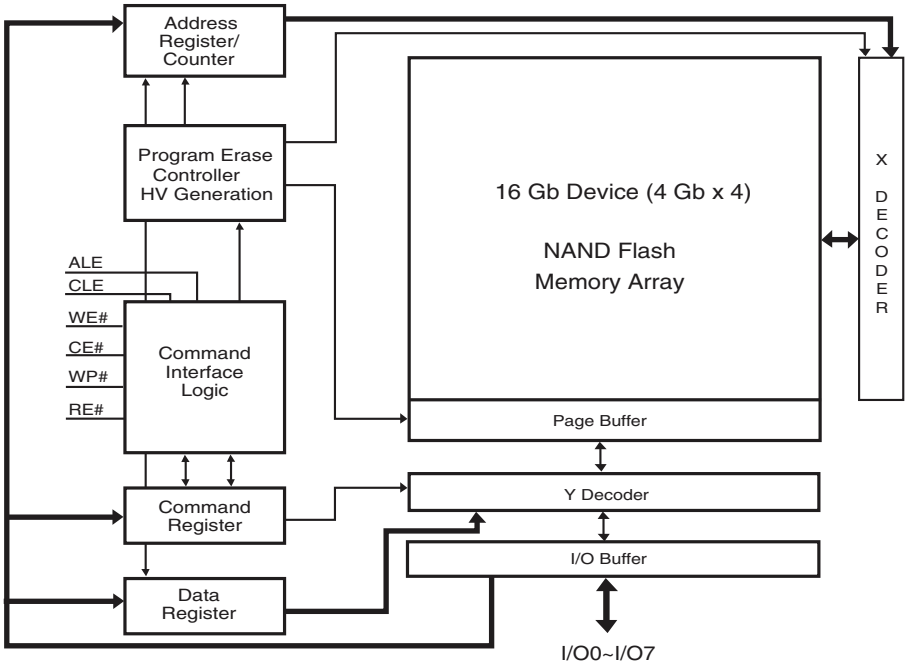
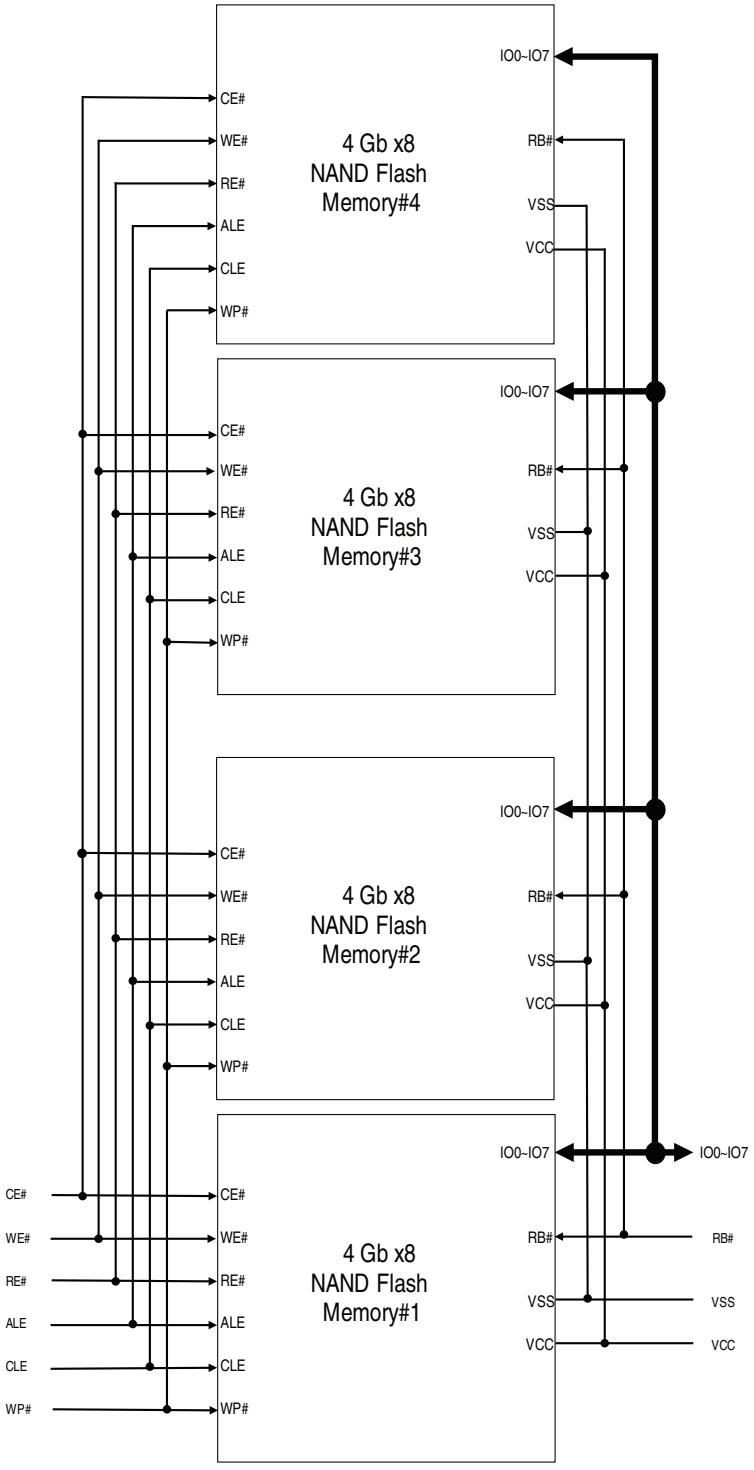


Figure 4.2 Block Diagram — 16 Gb (4 Gb x 4) 63-Ball BGA with 1 CE# (One Chip Enable Signal)



5. Addressing

Table 5.1 Address Cycle Map

Bus Cycle	I/O0	I/O1	I/O2	I/O3	I/O4	I/O5	I/O6	I/O7
1st / Col. Add. 1	A0 (CA0)	A1 (CA1)	A2 (CA2)	A3 (CA3)	A4 (CA4)	A5 (CA5)	A6 (CA6)	A7 (CA7)
2nd / Col. Add. 2	A8 (CA8)	A9 (CA9)	A10 (CA10)	A11 (CA11)	Low	Low	Low	Low
3rd / Row Add. 1	A12 (PA0)	A13 (PA1)	A14 (PA2)	A15 (PA3)	A16 (PA4)	A17 (PA5)	A18 (PLA0)	A19 (BA0)
4th / Row Add. 2	A20 (BA1)	A21 (BA2)	A22 (BA3)	A23 (BA4)	A24 (BA5)	A25 (BA6)	A26 (BA7)	A27 (BA8)
5th / Row Add. 3 (6)	A28 (BA9)	A29 (BA10)	A30 (BA11)	A31 (BA12)	Low	Low	Low	Low

Notes:

1. *CAx = Column Address bit.*
2. *PAx = Page Address bit.*
3. *PLA0 = Plane Address bit zero.*
4. *BAx = Block Address bit.*
5. *Block address concatenated with page address and plane address = actual page address, also known as the row address.*
6. *A31 for 16 Gb (4 Gb x 4 – QDP).*

For the address bits, the following rules apply:

- A0–A11: column address in the page
- A12–A17: page address in the block
- A18: plane address (for multiplane operations) / block address (for normal operations)
- A19–A31: block address

6. Read Status Enhanced

Read Status Enhanced is used to retrieve the status value for a previous operation in the following cases:

- In the case of concurrent operations on a multi-die stack.

When four dies are stacked to form a quad-die package (QDP), it is possible to run one operation on the first die, then activate a different operation on the second die, for example: Erase while Read, Read while Program, etc.

- In the case of multiplane operations in the same die.

7. Read ID

The device contains a product identification mode, initiated by writing 90h to the command register, followed by an address input of 00h.

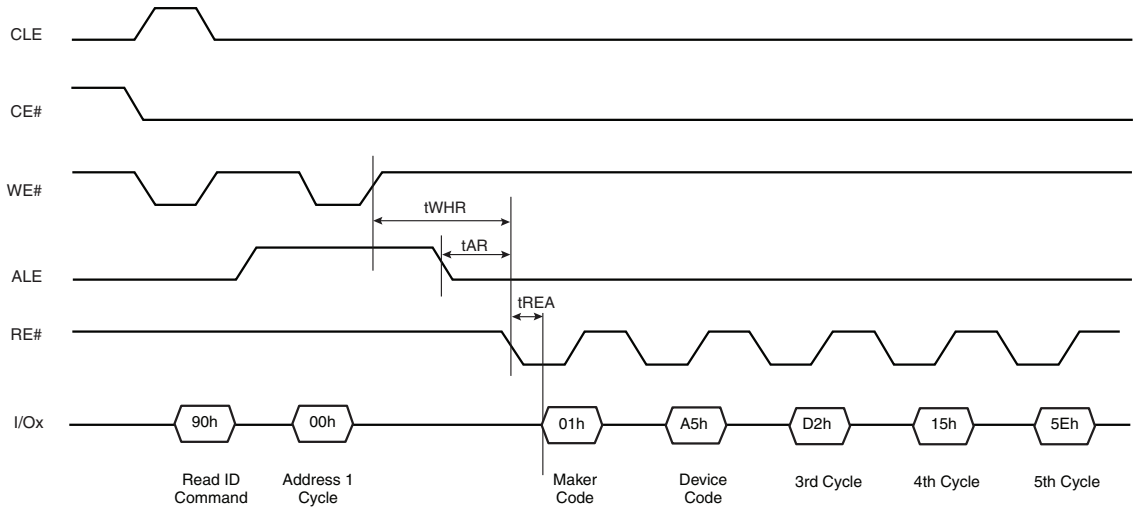
Note: If you want to execute Read Status command (0x70) after Read ID sequence, you should input dummy command (0x00) before Read Status command (0x70).

For the S34MS16G2 device, five read cycles sequentially output the manufacturer code (01h), and the device code and 3rd, 4th, and 5th cycle ID, respectively. The command register remains in Read ID mode until further commands are issued to it.

Table 7.1 Read ID for Supported Configurations

Density	Org	V_{CC}	1st	2nd	3rd	4th	5th
4 Gb	x8	1.8V	01h	ACh	90h	15h	56h
16 Gb (4 Gb x 4 – QDP with one CE#)	x8	1.8V	01h	A5h	D2h	15h	5Eh

Figure 7.1 Read ID Operation Timing



5th ID Data

Table 7.2 Read ID Byte 5 Description

	Description	I/O7	I/O6 I/O5 I/O4	I/O3 I/O2	I/O1 I/O0
ECC Level	1 bit / 512 bytes 2 bit / 512 bytes 4 bit / 512 bytes 8 bit / 512 bytes				0 0 0 1 1 0 1 1
Plane Number	1 2 4 8			0 0 0 1 1 0 1 1	
Plane Size (without spare area)	64 Mb 128 Mb 256 Mb 512 Mb 1 Gb 2 Gb 4 Gb		0 0 0 0 0 1 0 1 0 0 1 1 1 0 0 1 0 1 1 1 0		
Reserved		0			

7.1 Read Parameter Page

The device supports the ONFI Read Parameter Page operation, initiated by writing ECh to the command register, followed by an address input of 00h. The command register remains in Parameter Page mode until further commands are issued to it. Table 7.3 explains the parameter fields.

Note: For 32nm SkyHigh NAND, for a particular condition, the Read Parameter Page command does not give the correct values. Toovercome this issue, the host must issue a Reset command before the Read Parameter Page command. Issuance of Reset before the Read Parameter Page command will provide the correct values and will not output 00h values.

Table 7.3 Parameter Page Description

Byte	O/M	Description	Values
Revision Information and Features Block			
0-3	M	Parameter page signature Byte 0: 4Fh, “O” Byte 1: 4Eh, “N” Byte 2: 46h, “F” Byte 3: 49h, “I”	4Fh, 4Eh, 46h, 49h
4-5	M	Revision number 2-15 Reserved (0) 1 1 = supports ONFI version 1.0 0 Reserved (0)	02h, 00h
6-7	M	Features supported 5-15 Reserved (0) 4 1 = supports odd to even page Copyback 3 1 = supports interleaved operations 2 1 = supports non-sequential page programming 1 1 = supports multiple LUN operations 0 1 = supports 16-bit data bus width	1Eh, 00h
8-9	M	Optional commands supported 6-15 Reserved (0) 5 1 = supports Read Unique ID 4 1 = supports Copyback 3 1 = supports Read Status Enhanced 2 1 = supports Get Features and Set Features 1 1 = supports Read Cache commands 0 1 = supports Page Cache Program command	3Bh, 00h
10-31		Reserved (0)	00h
Manufacturer Information Block			
32-43	M	Device manufacturer (12 ASCII characters)	53h, 50h, 41h, 4Eh, 53h, 49h, 4Fh, 4Eh, 20h, 20h, 20h, 20h
44-63	M	Device model (20 ASCII characters)	53h, 33h, 34h, 4Dh, 53h, 31h, 36h, 47h, 32h, 20h, 20h, 20h, 20h, 20h, 20h, 20h, 20h, 20h, 20h, 20h
64	M	JEDEC manufacturer ID	01h
65-66	O	Date code	00h
67-79		Reserved (0)	00h
Memory Organization Block			
80-83	M	Number of data bytes per page	00h, 08h, 00h, 00h
84-85	M	Number of spare bytes per page	80h, 00h
86-89	M	Number of data bytes per partial page	00h, 00h, 00h, 00h
90-91	M	Number of spare bytes per partial page	00h, 00h

Table 7.3 Parameter Page Description (Continued)

Byte	O/M	Description	Values
92-95	M	Number of pages per block	40h, 00h, 00h, 00h
96-99	M	Number of blocks per logical unit (LUN)	00h, 40h, 00h, 00h (1 CE#)
100	M	Number of logical units (LUNs)	01h (1 CE#)
101	M	Number of address cycles 4-7 Column address cycles 0-3 Row address cycles	23h
102	M	Number of bits per cell	01h
103-104	M	Bad blocks maximum per LUN	47h, 01h (1 CE#)
105-106	M	Block endurance	01h, 05h
107	M	Guaranteed valid blocks at beginning of target	01h
108-109	M	Block endurance for guaranteed valid blocks	01h, 03h
110	M	Number of programs per page	04h
111	M	Partial programming attributes 5-7 Reserved 4 1 = partial page layout is partial page data followed by partial page spare 1-3 Reserved 0 1 = partial page programming has constraints	00h
112	M	Number of bits ECC correctability	04h
113	M	Number of interleaved address bits 4-7 Reserved (0) 0-3 Number of interleaved address bits	01h
114	O	Interleaved operation attributes 4-7 Reserved (0) 3 Address restrictions for program cache 2 1 = program cache supported 1 1 = no block address restrictions 0 Overlapped / concurrent interleaving support	04h
115-127		Reserved (0)	00h
Electrical Parameters Block			
128	M	I/O pin capacitance	0Ah
129-130	M	Timing mode support 6-15 Reserved (0) 5 1 = supports timing mode 5 4 1 = supports timing mode 4 3 1 = supports timing mode 3 2 1 = supports timing mode 2 1 1 = supports timing mode 1 0 1 = supports timing mode 0, shall be 1	03h, 00h
131-132	O	Program cache timing mode support 6-15 Reserved (0) 5 1 = supports timing mode 5 4 1 = supports timing mode 4 3 1 = supports timing mode 3 2 1 = supports timing mode 2 1 1 = supports timing mode 1 0 1 = supports timing mode 0	03h, 00h
133-134	M	t_{PROG} Maximum page program time (µs)	BCh, 02h

Table 7.3 Parameter Page Description (Continued)

Byte	O/M	Description	Values
135-136	M	t_{BERS} Maximum block erase time (µs)	10h, 27h
137-138	M	t_R Maximum page read time (µs)	1Eh, 00h
139-140	M	t_{CCS} Minimum Change Column setup time (ns)	C8h, 00h
141-163		Reserved (0)	00h
Vendor Block			
164-165	M	Vendor specific Revision number	00h
166-253		Vendor specific	00h
254-255	M	Integrity CRC	11h, F5h (1CE#)
Redundant Parameter Pages			
256-511	M	Value of bytes 0-255	Repeat Value of bytes 0-255
512-767	M	Value of bytes 0-255	Repeat Value of bytes 0-255
768+	O	Additional redundant parameter pages	FFh

Note:
1. "O" Stands for Optional, "M" for Mandatory.

8. Electrical Characteristics

8.1 Valid Blocks

Table 8.1 Valid Blocks

Device	Symbol	Min	Typ	Max	Unit
S34MS04G2	N_{VB}	4016	—	4096	Blocks
S34MS16G2	N_{VB}	16057 (1)	—	16384	Blocks

Note:

1. *Each 4 Gb can have a maximum 80 bad blocks.*

8.2 DC Characteristics

Table 8.2 DC Characteristics and Operating Conditions
(Values listed are for each 4 Gb NAND, 16 Gb (4 Gb x 4) will differ accordingly)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Units
Power On Current		I_{CC0}	FFh command input after power on	—	—	50 per device	mA
Operating Current	Sequential Read	I_{CC1}	$t_{RC} = t_{RC}$ (min) CE# = V_{IL}, Iout = 0 mA	—	15	30	mA
	Program	I_{CC2}	Normal	—	15	30	mA
			Cache	—	15	30	mA
	Erase	I_{CC3}	—	—	15	30	mA
Standby Current, (TTL)		I_{CC4}	CE# = V_{IH}, WP# = 0V/Vcc	—	—	1	mA
Standby Current, (CMOS)		I_{CC5}	CE# = V_{CC}-0.2, WP# = 0/V_{CC}	—	10	50	µA
Input Leakage Current		I_{LI}	V_{IN} = 0 to V_{CC}(max)	—	—	±10	µA
Output Leakage Current		I_{LO}	V_{OUT} = 0 to V_{CC}(max)	—	—	±10	µA
Input High Voltage		V_{IH}	—	V_{CC} x 0.8	—	V_{CC} + 0.3	V
Input Low Voltage		V_{IL}	—	-0.3	—	V_{CC} x 0.2	V
Output High Voltage		V_{OH}	I_{OH} = -100 µA	V_{CC} -0.1	—	—	V
Output Low Voltage		V_{OL}	I_{OL} = 100 µA	—	—	0.1	V
Output Low Current (R/B#)		$I_{OL(R/B\#)}$	V_{OL} = 0.1V	3	4	—	mA
Erase and Program Lockout Voltage		V_{LKO}	—	—	1.1	—	V

Notes:

1. *All V_{CC} pins, and V_{SS} pins respectively, are shorted together.*
2. *Values listed in this table refer to the complete voltage range for V_{CC} and to a single device in case of device stacking.*
3. *All current measurements are performed with a 0.1 µF capacitor connected between the V_{CC} Supply Voltage pin and the V_{SS} Ground pin.*
4. *Standby current measurement can be performed after the device has completed the initialization process at power up.*

8.3 Pin Capacitance

Table 8.3 Pin Capacitance (TA = 25°C, f=1.0 MHz)

Parameter	Symbol	Test Condition	Min	Max	Unit
Input	C_{IN}	V_{IN} = 0V	—	10	pF
Input / Output	C_{IO}	V_{IL} = 0V	—	10	pF

Note:
1. For the stacked devices version the Input is 10 pF x [number of stacked chips] and the Input/Output is 10 pF x [number of stacked chips].

8.4 Power Consumptions and Pin Capacitance for Allowed Stacking Configurations

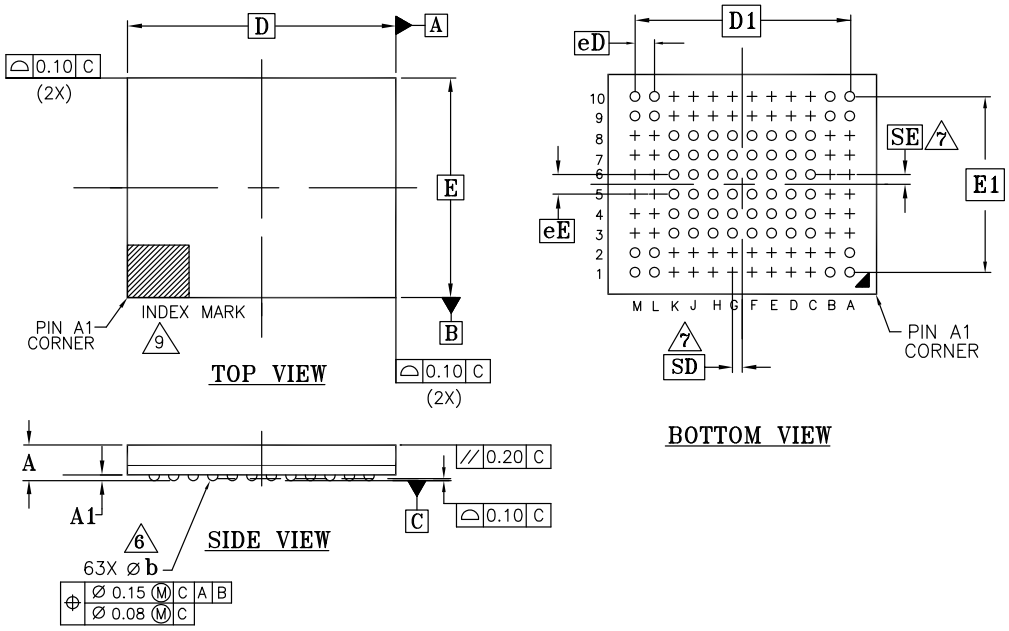
When multiple dies are stacked in the same package, the power consumption of the stack will increase according to the number of chips. As an example, the standby current is the sum of the standby currents of all the chips, while the active power consumption depends on the number of chips concurrently executing different operations.

When multiple dies are stacked in the same package the pin/ball capacitance for the single input and the single input/output of the combo package must be calculated based on the number of chips sharing that input or that pin/ball.

9. Physical Interface

9.1 63-Ball BGA Package

Figure 9.1 63-Ball BGA 9 x 11 x 1.2 mm



PACKAGE	TNA 063			NOTE
JEDEC	MO-207(N)			
D X E	11.00mm X 9.00mm PACKAGE			
SYMBOL	MIN.	NOM.	MAX.	
A	---	---	1.20	PROFILE
A1	0.25	---	---	BALL HEIGHT
D	11.00 BSC			BODY SIZE
E	9.00 BSC			BODY SIZE
D1	8.80 BSC			MATRIX FOOTPRINT
E1	7.20 BSC			MATRIX FOOTPRINT
MD	12			MATRIX SIZE D DIRECTION
ME	10			MATRIX SIZE E DIRECTION
n	63			BALL COUNT
Ø b	0.40	0.45	0.50	BALL DIAMETER
eE	0.80 BSC			BALL PITCH
eD	0.80 BSC			BALL PITCH
SD	0.40 BSC			SOLDER BALL PLACEMENT
SE	0.40 BSC			SOLDER BALL PLACEMENT
	A3-A8,B2-B8,C1,C2,C9,C10,D1, D2,D9,D10,E1,E2,E9,E10,F1,F2, F9,F10,G1,G2,G9,G10,H1,H2,H9, H10,J1,J2,J9,J10,K1,K2,K9,K10, L3-L8,M3-M8			DEPOPULATED SOLDER BALLS

NOTES:

1. DIMENSIONING AND TOLERANCING METHODS PER ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. BALL POSITION DESIGNATION PER JEP 95, SECTION 3, SPP-020.
4. e REPRESENTS THE SOLDER BALL GRID PITCH.
5. SYMBOL "MD" IS THE BALL MATRIX SIZE IN THE "D" DIRECTION. SYMBOL "ME" IS THE BALL MATRIX SIZE IN THE "E" DIRECTION. n IS THE NUMBER OF POPULATED SOLDER BALL POSITIONS FOR MATRIX SIZE MD X ME.
6. DIMENSION "b" IS MEASURED AT THE MAXIMUM BALL DIAMETER IN A PLANE PARALLEL TO DATUM C.
7. "SD" AND "SE" ARE MEASURED WITH RESPECT TO DATUMS A AND B AND DEFINE THE POSITION OF THE CENTER SOLDER BALL IN THE OUTER ROW. WHEN THERE IS AN ODD NUMBER OF SOLDER BALLS IN THE OUTER ROW "SD" OR "SE" = 0. WHEN THERE IS AN EVEN NUMBER OF SOLDER BALLS IN THE OUTER ROW "SD" = eD/2 AND "SE" = eE/2.
8. "+" INDICATES THE THEORETICAL CENTER OF DEPOPULATED BALLS.
9. A1 CORNER TO BE IDENTIFIED BY CHAMFER, LASER OR INK MARK, METALLIZED MARK INDENTATION OR OTHER MEANS.

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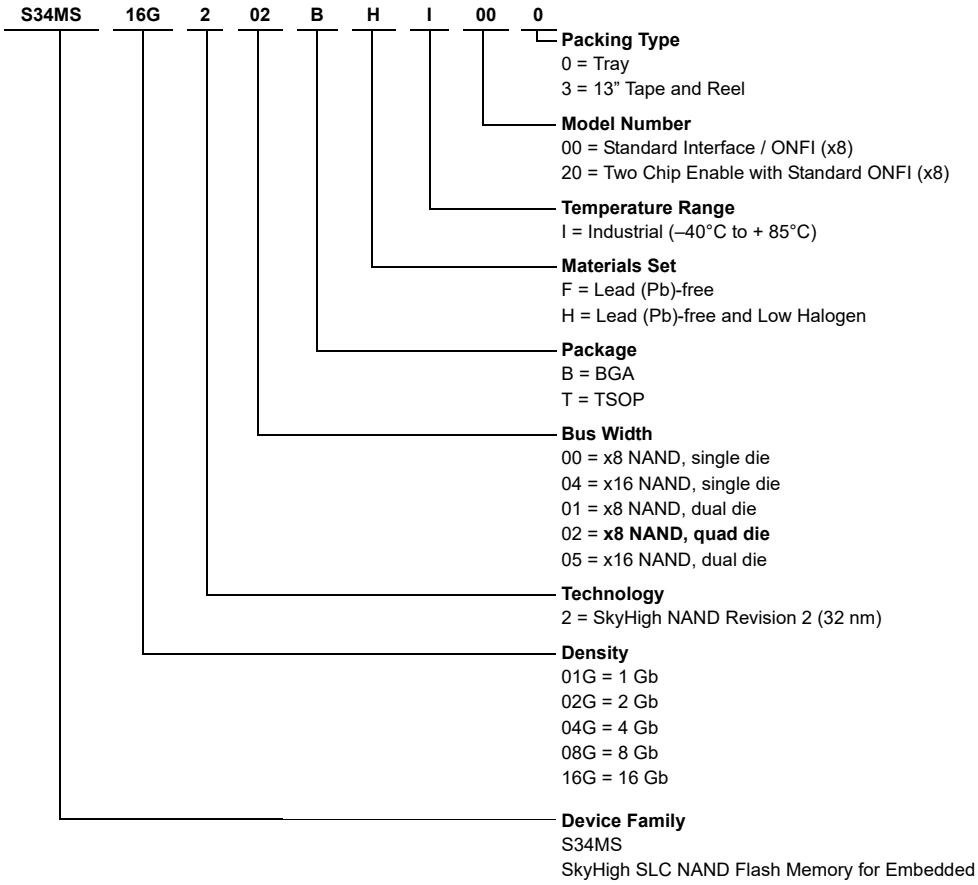
10. Ordering Information

The ordering part number is formed by a valid combination of the following:



Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult your local sales office to confirm availability of specific valid combinations and to check on newly released combinations.

Valid Combinations								
Device Family	**Density**	**Technology**	**Bus Width**	**Package Type**	**Temperature Range**	**Additional Ordering Options**	**Packing Type**	**Package Description**
S34MS	16G	2	02	BH	I	BH – 00	0, 3	BGA

11. Revision History

Document History Page

Document Title: S34MS16G2, 16 Gb, 4-Bit ECC, x8 I/O, and 1.8 V V_{CC} NAND Flash for Embedded Document Number: 002-00464				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	–	XILA	12/12/2014	Initial release
*A	–	XILA	04/24/2015	Performance: Corrected Package Options for 63-Ball BGA to 9 x 11 x 1.2 mm Physical Interface: Corrected figure title to '63-Ball BGA 9 x 11 x 1.2 mm' Ordering Information: Ordering Information table: corrected Model Number and Materials Set
*B	4962771	XILA	10/14/2015	Updated to Cypress template.
*C	5244672	XILA	04/28/2016	Changed status from Advance to Final. Updated Read ID: Updated Read Parameter Page: Updated description. Updated to new template.
*D	5497766	XILA	10/27/2016	Updated Electrical Characteristics: Updated DC Characteristics: Updated Table 8.2. Updated Notes 1 and 2. Updated to new template.
*E	5962114	AESATMP8	11/09/2017	Updated logo and Copyright.
*F	6100827	MNAD	03/16/2018	Updated to new template. Completing Sunset Review.
*G		MNAD	05/22/2019	Updated to SkyHigh format.

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