Multi-Purpose Flash + SRAM ComboMemory

SST32HF324 / SST32HF328
SST32HF324C / SST32HF328C

Preliminary Specifications

FEATURES:

- **ComboMemories organized as:**
  - SST32HF324x: 2M x16 Flash + 256K x16 SRAM
  - SST32HF328x: 2M x16 Flash + 512K x16 SRAM
- **Single 2.7-3.3V Read and Write Operations**
- **Concurrent Operation**
  - Read from or Write to SRAM while Erase/Program Flash
- **Superior Reliability**
  - Endurance: 100,000 Cycles (typical)
  - Greater than 100 years Data Retention
- **Low Power Consumption:**
  - Active Current: 15 mA (typical) for Flash or SRAM Read
  - Standby Current:
    - SST32HF32x: 80 µA (typical)
    - SST32HF32xC: 25 µA (typical)
- **Flexible Erase Capability**
  - Uniform 2 KWord sectors
  - Uniform 32 KWord size blocks
- **Fast Read Access Times:**
  - Flash: 70 ns and 90 ns
  - SRAM: 70 ns and 90 ns
- **Latched Address and Data for Flash**
- **Flash Fast Erase and Word-Program:**
  - Sector-Erase Time: 18 ms (typical)
  - Block-Erase Time: 18 ms (typical)
  - Chip-Erase Time: 40 ms (typical)
  - Word-Program Time: 7 µs (typical)
  - Chip Rewrite Time: SST32HF32x/32xC: 15 seconds (typical)
- **Flash Automatic Erase and Program Timing**
  - Internal V_{PP} Generation
- **Flash End-of-Write Detection**
  - Toggle Bit
  - Data# Polling
- **CMOS I/O Compatibility**
- **JEDEC Standard Command Set**
- **Package Available**
  - 63-ball TFBGA (8mm x 10mm x 1.2mm)
  - 63-ball LFBGA (8mm x 10mm x 1.4mm)
  - 62-ball LFBGA (8mm x 10mm x 1.4mm)

PRODUCT DESCRIPTION

The SST32HF32x/32xC ComboMemory devices integrate a 2M x16 CMOS flash memory bank with a 256K x16 or 512K x16 CMOS SRAM memory bank in a Multi-Chip Package (MCP), manufactured with SST's proprietary, high performance SuperFlash technology. The SST32HF32x devices use a Pseudo-SRAM. The SST32HF32xC devices use standard SRAM.

Featuring high performance Word-Program, the flash memory bank provides a maximum Word-Program time of 7 µsec. The entire flash memory bank can be erased and programmed word-by-word in typically 15 seconds for the SST32HF32x/32xC, when using interface features such as Toggle Bit or Data# Polling to indicate the completion of Program operation. To protect against inadvertent flash write, the SST32HF32x/32xC devices contain on-chip hardware and software data protection schemes. The SST32HF32x/32xC devices offer a guaranteed endurance of 10,000 cycles. Data retention is rated at greater than 100 years.

The SST32HF32x/32xC devices consist of two independent memory banks with respective bank enable signals. The Flash and SRAM memory banks are superimposed in the same memory address space. Both memory banks share common address lines, data lines, WE# and OE#. The memory bank selection is done by memory bank enable signals. The memory bank selection is done by two bank enable signals. The SRAM bank enable signals, BES1# and BES2, select the SRAM bank. The flash memory bank enable signal, BEF#, has to be used with Software Data Protection (SDP) command sequence when controlling the Erase and Program operations in the flash memory bank.

The SST32HF32x/32xC provide the added functionality of being able to simultaneously read from or write to the SRAM bank while erasing or programming in the flash memory bank. The SRAM memory bank can be read or written while the flash memory bank performs Sector-Erase, Bank-Erase, or Word-Program concurrently. All flash memory Erase and Program operations will automatically latch the input address and data signals and complete the operation in background without further input stimulus requirement. Once the internally controlled Erase or Program cycle in the flash bank has commenced, the SRAM bank can be accessed for Read or Write.

Preliminary Specifications

The SST32HF32x/32xC devices are suited for applications that use both flash memory and SRAM memory to store code or data. For systems requiring low power and small form factor, the SST32HF32x/32xC devices significantly improve performance and reliability, while lowering power consumption, when compared with multiple chip solutions. The SST32HF32x/32xC inherently use less energy during erase and program than alternative flash technologies. The total energy consumed is a function of the applied voltage, current, and time of application. Since for any given voltage range, the SuperFlash technology uses less current to program and has a shorter erase time, the total energy consumed during any Erase or Program operation is less than alternative flash technologies.

The SuperFlash technology provides fixed Erase and Program times, independent of the number of Erase/Program cycles that have occurred. Therefore the system software or hardware does not have to be modified or de-rated as is necessary with alternative flash technologies, whose Erase and Program times increase with accumulated Erase/Program cycles.

Device Operation

The SST32HF32x/32xC use BES1#, BES2 and BEF# to control operation of either the flash or the SRAM memory bank. When BEF# is low, the flash bank is activated for Read, Program or Erase operation. When BES1# is low, and BES2 is high the SRAM is activated for Read and Write operation. BEF# and BES1# cannot be at low level, and BES2 cannot be at high level at the same time. **If all bank enable signals are asserted, bus contention will result and the device may suffer permanent damage.** All address, data, and control lines are shared by flash and SRAM memory banks which minimizes power consumption and loading. The device goes into standby when BEF# and BES1# bank enables are raised to V_{IHC} (Logic High) or when BEF# is high and BES2 is low.

Concurrent Read/Write Operation

The SST32HF32x/32xC provide the unique benefit of being able to read from or write to SRAM, while simultaneously erasing or programming the flash. This allows data alteration code to be executed from SRAM, while altering the data in flash. See Figure 23 for a flowchart. The following table lists all valid states.

CONCURRENT READ/WRITE STATES

Flash	SRAM
Program/Erase	Read
Program/Erase	Write

The device will ignore all SDP commands when an Erase or Program operation is in progress. Note that Product Identification commands use SDP; therefore, these commands will also be ignored while an Erase or Program operation is in progress.

Flash Read

The Read operation of the SST32HF32x/32xC devices is controlled by BEF# and OE#. Both have to be low, with WE# high, for the system to obtain data from the outputs. BEF# is used for flash memory bank selection. When BEF# is high, the chip is deselected and only standby power is consumed. OE# is the output control and is used to gate data from the output pins. The data bus is in high impedance state when OE# is high. Refer to Figure 6 for further details.

Flash Word-Program Operation

The flash memory bank of the SST32HF32x/32xC devices is programmed on a word-by-word basis. Before Program operations, the memory must be erased first. The Program operation consists of three steps. The first step is the three-byte load sequence for Software Data Protection. The second step is to load word address and word data. During the Word-Program operation, the addresses are latched on the falling edge of either BEF# or WE#, whichever occurs last. The data is latched on the rising edge of either BEF# or WE#, whichever occurs first. The third step is the internal Program operation which is initiated after the rising edge of the fourth WE# or BEF#, whichever occurs first. The Program operation, once initiated, will be completed, within 10 µs. See Figures 7 and 8 for WE# and BEF# controlled Program operation timing diagrams and Figure 19 for flowcharts. During the Program operation, the only valid flash Read operations are Data# Polling and Toggle Bit. During the internal Program operation, the host is free to perform additional tasks. Any SDP commands loaded during the internal Program operation will be ignored.

Flash Sector/Block-Erase Operation

The Flash Sector/Block-Erase operation allows the system to erase the device on a sector-by-sector (or block-by-block) basis. The SST32HF32x/32xC offer both Sector-Erase and Block-Erase mode. The sector architecture is based on uniform sector size of 2 KWord. The Block-Erase mode is based on uniform block size of 32 KWord. The Sector-Erase operation is initiated by executing a six-byte command sequence with Sector-Erase command (30H) and sector address (SA) in the last bus cycle. The address lines A_{20}-A_{11} are used to determine the sector address. The Block-Erase operation is initiated by executing a six-byte command sequence with Block-Erase command (50H) and block address (BA) in the last bus cycle. The address lines A_{20}-A_{15} are used to determine the block address. The sector or block address is latched on the falling edge of the sixth WE# pulse, while the command (30H or 50H) is latched on the rising edge of the sixth WE# pulse. The internal Erase operation begins after the sixth WE# pulse. The End-of-Erase operation can be determined using either Data# Polling or Toggle Bit methods. See Figures 12 and 13 for timing waveforms. Any commands issued during the Sector- or Block-Erase operation are ignored.

Flash Chip-Erase Operation

The SST32HF32x/32xC provide a Chip-Erase operation, which allows the user to erase the entire memory array to the “1” state. This is useful when the entire device must be quickly erased.

The Chip-Erase operation is initiated by executing a six-byte command sequence with Chip-Erase command (10H) at address 5555H in the last byte sequence. The Erase operation begins with the rising edge of the sixth WE# or CE#, whichever occurs first. During the Erase operation, the only valid read is Toggle Bit or Data# Polling. See Table 4 for the command sequence, Figure 9 for timing diagram, and Figure 22 for the flowchart. Any commands issued during the Chip-Erase operation are ignored.

Flash Write Operation Status Detection

The SST32HF32x/32xC provide one hardware and two software means to detect the completion of a Write (Program or Erase) cycle, in order to optimize the system Write cycle time. The software detection includes two status bits: Data# Polling (DQ_7) and Toggle Bit (DQ_6). The End-of-Write detection mode is enabled after the rising edge of WE#, which initiates the internal Program or Erase operation.

The actual completion of the nonvolatile write is asynchronous with the system; therefore, either a Data# Polling (DQ_7) or Toggle Bit (DQ_6) Read may be simultaneous with the completion of the Write cycle. If this occurs, the system may possibly get an erroneous result, i.e., valid data may appear to conflict with either DQ_7 or DQ_6. In order to prevent spurious rejection, if an erroneous result occurs, the software routine should include a loop to read the accessed location an additional two (2) times. If both reads are valid, then the device has completed the Write cycle, otherwise the rejection is valid.

Flash Data# Polling (DQ_7)

When the SST32HF32x/32xC flash memory banks are in the internal Program operation, any attempt to read DQ_7 will produce the complement of the true data. Once the Program operation is completed, DQ_7 will produce true data. Note that even though DQ_7 may have valid data immediately following the completion of an internal Write operation, the remaining data outputs may still be invalid: valid data on the entire data bus will appear in subsequent successive Read cycles after an interval of 1 µs. During internal Erase operation, any attempt to read DQ_7 will produce a '0'. Once the internal Erase operation is completed, DQ_7 will produce a '1'. The Data# Polling is valid after the rising edge of the fourth WE# (or BEF#) pulse for Program operation. For Sector- or Block-Erase, the Data# Polling is valid after the rising edge of the sixth WE# (or BEF#) pulse. See Figure 9 for Data# Polling timing diagram and Figure 20 for a flowchart.

Flash Toggle Bit (DQ_6)

During the internal Program or Erase operation, any consecutive attempts to read DQ_6 will produce alternating 1s and 0s, i.e., toggling between 1 and 0. When the internal Program or Erase operation is completed, the toggling will stop. The flash memory bank is then ready for the next operation. The Toggle Bit is valid after the rising edge of the fourth WE# (or BEF#) pulse for Program operation. For Sector- or Bank-Erase, the Toggle Bit is valid after the rising edge of the sixth WE# (or BEF#) pulse. See Figure 10 for Toggle Bit timing diagram and Figure 20 for a flowchart.

Flash Memory Data Protection

The SST32HF32x/32xC flash memory bank provides both hardware and software features to protect nonvolatile data from inadvertent writes.

Flash Hardware Data Protection

Noise/Glitch Protection: A WE# or BEF# pulse of less than 5 ns will not initiate a Write cycle.

V_{DD} Power Up/Down Detection: The Write operation is inhibited when V_{DD} is less than 1.5V.

Write Inhibit Mode: Forcing OE# low, BEF# high, or WE# high will inhibit the flash Write operation. This prevents inadvertent writes during power-up or power-down.

Flash Software Data Protection (SDP)

The SST32HF32x/32xC provide the JEDEC approved software data protection scheme for all flash memory bank data alteration operations, i.e., Program and Erase. Any Program operation requires the inclusion of a series of three-byte sequence. The three byte-load sequence is used to initiate the Program operation, providing optimal protection from inadvertent Write operations, e.g., during the system power-up or power-down. Any Erase operation requires the inclusion of six-byte load sequence. The SST32HF32x/32xC devices are shipped with the software data protection permanently enabled. See Table 4 for the specific software command codes. During SDP command sequence, invalid commands will abort the device to Read mode, within T_{RC}. The contents of DQ_{15}-DQ_8 can be V_{IL} or V_{IH}, but no other value, during any SDP command sequence.

Concurrent Read and Write Operations

The SST32HF32x/32xC provide the unique benefit of being able to read from or write to SRAM, while simultaneously erasing or programming the flash. This allows data alteration code to be executed from SRAM, while altering the data in flash. The following table lists all valid states.

CONCURRENT READ/WRITE STATES

Flash	SRAM
Program/Erase	Read
Program/Erase	Write

The device will ignore all SDP commands when an Erase or Program operation is in progress. Note that Product Identification commands use SDP; therefore, these commands will also be ignored while an Erase or Program operation is in progress.

Product Identification

The Product Identification mode identifies the devices as the SST32HFxxx and manufacturer as SST. **This mode may be accessed by software operations only. The hardware device ID Read operation, which is typically used by programmers, cannot be used on this device because of the shared lines between flash and SRAM in the multi-chip package. Therefore, application of high voltage to pin A_9 may damage this device.** Users may use the software Product Identification operation to identify the part (i.e., using the device ID) when using multiple manufacturers in the same socket. For details, see Tables 3 and 4 for software operation, Figure 14 for the software ID entry and read timing diagram and Figure 21 for the ID entry command sequence flowchart.

TABLE 1: PRODUCT IDENTIFICATION

	Address	Data
Manufacturer's ID	0000H	00BFH
Device ID SST32HF32x/32xC	0001H	2783H

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Product Identification Mode Exit/Reset

In order to return to the standard read mode, the Software Product Identification mode must be exited. Exiting is accomplished by issuing the Exit ID command sequence, which returns the device to the Read operation. Please note that the software reset command is ignored during an internal Program or Erase operation. This command may also be used to reset the device to Read mode after any inadvertent transient condition that apparently causes the device to behave abnormally, e.g. not read correctly. See Table 4 for software command codes, Figure 15 for timing waveform, and Figure 21 for the Software ID Entry command sequence flowchart.

SRAM Operation

With BES1# low, BES2 and BEF# high, the SST32HF32x/32xC operate as either 256K x16 or 512K x16 CMOS SRAM, with fully static operation requiring no external clocks or timing strobes. The SST32HF32x/32xC SRAM is mapped into the first 512 KWord address space. When BES1#, BEF# are high and BES2 is low, all memory banks are deselected and the device enters standby. Read and Write cycle times are equal. The control signals UBS# and LBS# provide access to the upper data byte and lower data byte. See Table 3 for SRAM Read and Write data byte control modes of operation.

SRAM Read

The SRAM Read operation of the SST32HF32x/32xC is controlled by OE# and BES1#, both have to be low with WE# and BES2 high for the system to obtain data from the outputs. BES1# and BES2 are used for SRAM bank selection. OE# is the output control and is used to gate data from the output pins. The data bus is in high impedance state when OE# is high. Refer to the Read cycle timing diagram, Figure 3, for further details.

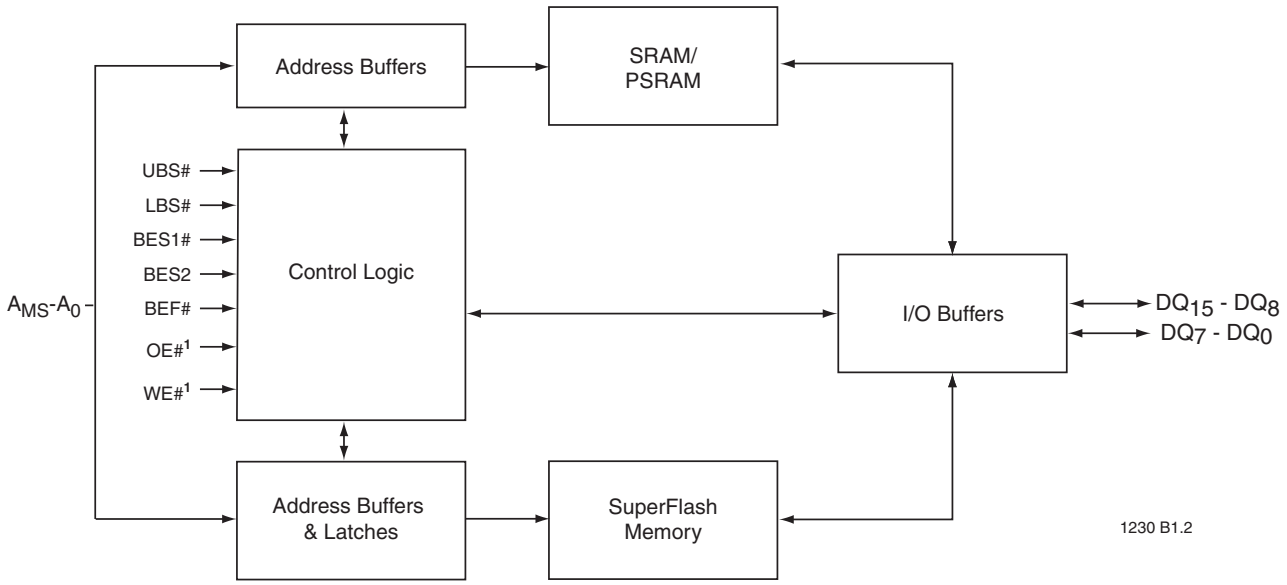
SRAM Write

The SRAM Write operation of the SST32HF32x/32xC is controlled by WE# and BES1#, both have to be low, BES2 must be high for the system to write to the SRAM. During the Word-Write operation, the addresses and data are referenced to the rising edge of either BES1#, WE#, or the falling edge of BES2 whichever occurs first. The write time is measured from the last falling edge of BES#1 or WE# or the rising edge of BES2 to the first rising edge of BES1#, or WE# or the falling edge of BES2. Refer to the Write cycle timing diagrams, Figures 4 and 5, for further details.

Design Considerations

SST recommends a high frequency 0.1 µF ceramic capacitor to be placed as close as possible between V_{DD} and V_{SS}, e.g., less than 1 cm away from the V_{DD} pin of the device. Additionally, a low frequency 4.7 µF electrolytic capacitor from V_{DD} to V_{SS} should be placed within 1 cm of the V_{DD} pin.

FUNCTIONAL BLOCK DIAGRAM



Notes: 1. For LS package only: WE# = WEF# and/or WES#
OE# = OEF# and/or OES#

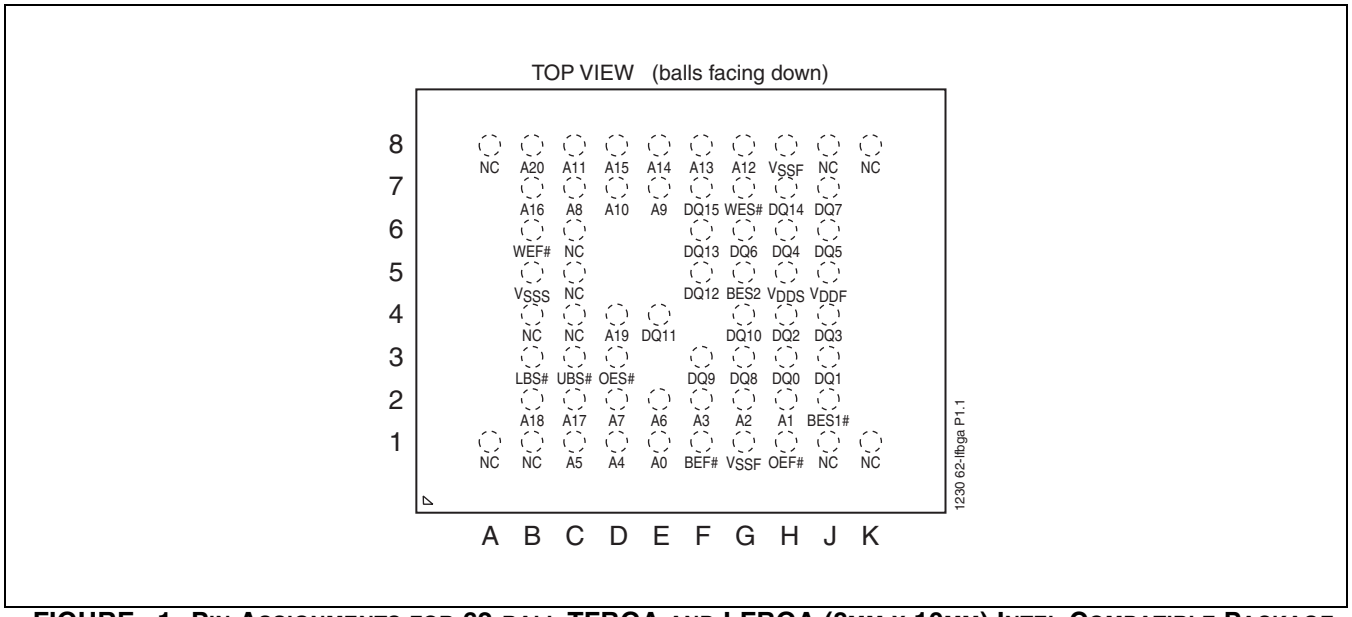


FIGURE 1: PIN ASSIGNMENTS FOR 62-BALL TFBGA AND LFBGA (8MM X 10MM) INTEL COMPATIBLE PACKAGE

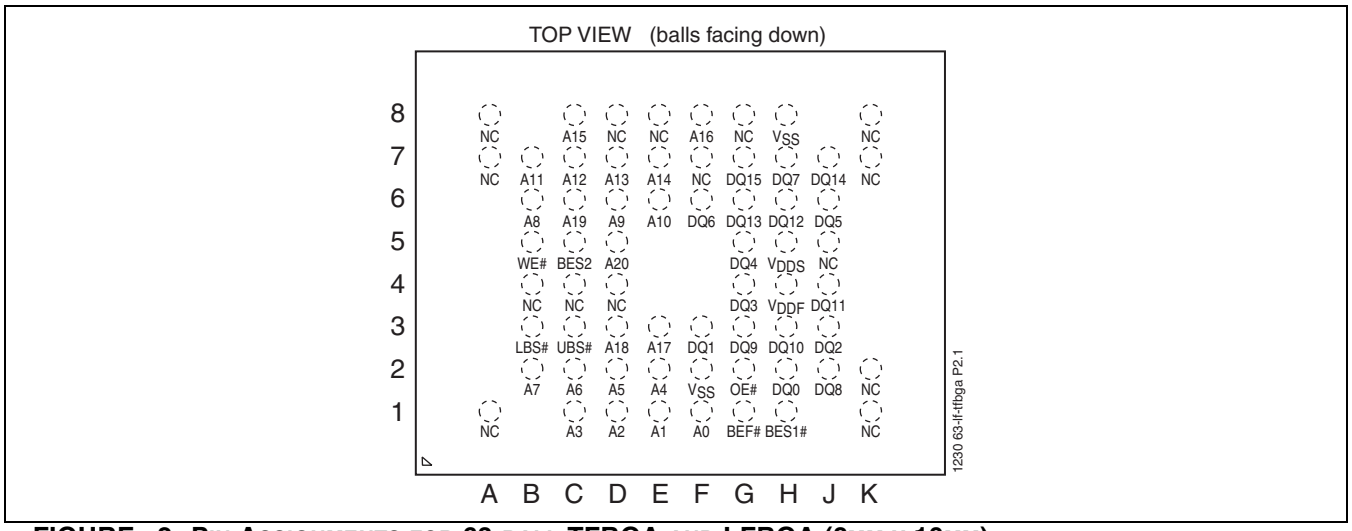


FIGURE 2: PIN ASSIGNMENTS FOR 63-BALL TFBGA AND LFBGA (8MM X 10MM)

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TABLE 2: PIN DESCRIPTION

Symbol	Pin Name	Functions
A_{MS}[1] to A_0	Address Inputs	To provide flash address, A_{MSF}-A_0. To provide SRAM address, A_{MSS}-A_0
DQ_{15}-DQ_0	Data Inputs/Outputs	To output data during Read cycles and receive input data during Write cycles. Data is internally latched during a flash Erase/Program cycle. The outputs are in tri-state when OE# is high or BES1# is high or BES2 is low and BEF# is high.
BEF#	Flash Memory Bank Enable	To activate the Flash memory bank when BEF# is low
BES1#	SRAM Memory Bank Enable	To activate the SRAM memory bank when BES1# is low
BES2	SRAM Memory Bank Enable	To activate the SRAM memory bank when BES2 is high
OEF#[2]	Output Enable	To gate the data output buffers for Flash[2] only
OES#[2]	Output Enable	To gate the data output buffers for SRAM[2] only
WEF#[2]	Write Enable	To control the Write operations for Flash[2] only
WES#[2]	Write Enable	To control the Write operations for SRAM[2] only
OE#	Output Enable	To gate the data output buffers
WE#	Write Enable	To control the Write operations
UBS#	Upper Byte Control (SRAM)	To enable DQ_{15}-DQ_8
LBS#	Lower Byte Control (SRAM)	To enable DQ_7-DQ_0
V_{SSF}[2]	Ground	Flash[2] only
V_{SSS}[2]	Ground	SRAM[2] only
V_{SS}	Ground	
V_{DDF}	Power Supply (Flash)	2.7-3.3V Power Supply to Flash only
V_{DDS}	Power Supply (SRAM)	2.7-3.3V Power Supply to SRAM only
NC	No Connection	Unconnected pins

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1. A_{MSF} = Most Significant Flash Address
   A_{MSF} = A_{20} for SST32HF32xx
   A_{MSS} = Most Significant SRAM Address
   A_{MSS} = A_{17} for SST32HF324x and A_{18} for SST32HF328x
2. LS package only

TABLE 3: OPERATIONAL MODES SELECTION[1]

Mode	BEF#	BES1#	BES2[2]	OE#[3]	WE#[3]	LBS#	UBS#	DQ_{0-7}	DQ_{8-15}
Full Standby	V_{IH}	V_{IH}	X	X	X	X	X	HIGH-Z	HIGH-Z
		X	V_{IL}	X	X	X	X		
Output Disable	V_{IH}	V_{IL}	V_{IH}	V_{IH}	V_{IH}	X	X	HIGH-Z	HIGH-Z
		V_{IL}	V_{IH}	X	X	V_{IH}	V_{IH}		
	V_{IL}	V_{IH}	X	V_{IH}	V_{IH}	X	X	HIGH-Z	HIGH-Z
		X	V_{IL}						
Flash Read	V_{IL}	V_{IH}	X	V_{IL}	V_{IH}	X	X	D_{OUT}	D_{OUT}
		X	V_{IL}						
Flash Write	V_{IL}	V_{IH}	X	V_{IH}	V_{IL}	X	X	D_{IN}	D_{IN}
		X	V_{IL}						
Flash Erase	V_{IL}	V_{IH}	X	V_{IH}	V_{IL}	X	X	X	X
		X	V_{IL}						
SRAM Read	V_{IH}	V_{IL}	V_{IH}	V_{IL}	V_{IH}	V_{IL}	V_{IL}	D_{OUT}	D_{OUT}
						V_{IH}	V_{IL}	HIGH-Z	D_{OUT}
						V_{IL}	V_{IH}	D_{OUT}	HIGH-Z
SRAM Write	V_{IH}	V_{IL}	V_{IH}	X	V_{IL}	V_{IL}	V_{IL}	D_{IN}	D_{IN}
						V_{IH}	V_{IL}	HIGH-Z	D_{IN}
						V_{IL}	V_{IH}	D_{IN}	HIGH-Z
Product Identification[4]	V_{IL}	V_{IH}	X	V_{IL}	V_{IH}	X	X	Manufacturer's ID[5] Device ID[5]	
		X	V_{IL}						

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1. X can be V_{IL} or V_{IH}, but no other value.
2. Do not apply BEF# = V_{IL}, BES1# = V_{IL} and BES2 = V_{IH} at the same time
3. OE# = OEF# and OES#
   WE# = WEF# and WES# for LS package only
4. Software mode only
5. With A_{MS}-A_1 = 0;SST Manufacturer's ID = 00BFH, is read with A_0=0,
   SST32HF32xx Device ID = 2783H, is read with A_0=1.

TABLE 4: SOFTWARE COMMAND SEQUENCE

Command Sequence	1st Bus Write Cycle		2nd Bus Write Cycle		3rd Bus Write Cycle		4th Bus Write Cycle		5th Bus Write Cycle		6th Bus Write Cycle	
	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]	Addr[1]	Data[2]
Word-Program	5555H	AAH	2AAAH	55H	5555H	A0H	WA[3]	Data				
Sector-Erase	5555H	AAH	2AAAH	55H	5555H	80H	5555H	AAH	2AAAH	55H	SA_X[4]	30H
Block-Erase	5555H	AAH	2AAAH	55H	5555H	80H	5555H	AAH	2AAAH	55H	BA_X[4]	50H
Chip-Erase	5555H	AAH	2AAAH	55H	5555H	80H	5555H	AAH	2AAAH	55H	5555H	10H
Software ID Entry[5,6]	5555H	AAH	2AAAH	55H	5555H	90H						
Software ID Exit	XXH	F0H										
Software ID Exit	5555H	AAH	2AAAH	55H	5555H	F0H						

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1. Address format A_{14}-A_0 (Hex),Address A_{15} can be V_{IL} or V_{IH}, but no other value, for the Command sequence.
2. DQ_{15}-DQ_8 can be V_{IL} or V_{IH}, but no other value, for the Command sequence.
3. WA = Program word address
4. SA_X for Sector-Erase; uses A_{MS}-A_{11} address lines
   BA_X for Block-Erase; uses A_{20}-A_{15} address lines
   A_{MS} = Most significant address
   A_{MS} = A_{20} for SST32HF32x/32xC
5. The device does not remain in Software Product ID mode if powered down.
6. With A_{MS}-A_1 = 0; SST Manufacturer's ID = 00BFH, is read with A_0=0,
   SST32HF32x/32xC Device ID = 2783H, is read with A_0=1.

Absolute Maximum Stress Ratings (Applied conditions greater than those listed under "Absolute Maximum Stress Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.)

Operating Temperature . . . . . -20°C to +85°C
Storage Temperature . . . . . -65°C to +150°C
D. C. Voltage on Any Pin to Ground Potential . . . . . -0.5V to V_{DD}[1]+0.3V
Transient Voltage (<20 ns) on Any Pin to Ground Potential . . . . . -1.0V to V_{DD}[1]+1.0V
Package Power Dissipation Capability (Ta = 25°C) 1.0W
Output Short Circuit Current[2] . . . . . 50 mA

1. $V_{DD} = V_{DDF}$ and V_{DDS}
2. Outputs shorted for no more than one second. No more than one output shorted at a time.

OPERATING RANGE

Range	Ambient Temp	V_{DD}
Commercial	0°C to +70°C	2.7-3.3V
Extended	-20°C to +85°C	2.7-3.3V

AC CONDITIONS OF TEST

Input Rise/Fall Time	5 ns
Output Load	C_L = 30 pF
See Figures 17 and 18	

TABLE 5: DC OPERATING CHARACTERISTICS (V_{DD} = V_{DDF} AND V_{DDS} = 2.7-3.3V)

Symbol	Parameter	Limits			Test Conditions
		Min	Max	Units	
I_{DD}	Active V_{DD} Current				Address input = V_{ILT}/V_{IHT}, at f=1/T_{RC} Min, V_{DD}=V_{DD} Max, all DQs open
	Read				OE#=V_{IL}, WE#=V_{IH}
	Flash		18	mA	BEF#=V_{IL}, BES1#=V_{IH}, or BES2=V_{IL}
	SRAM		30	mA	BEF#=V_{IH}, BES1#=V_{IL}, BES2=V_{IH}
	Concurrent Operation		40	mA	BEF#=V_{IH}, BES1#=V_{IL}, BES2=V_{IH}
	Write[1]				WE#=V_{IL}
	Flash		35	mA	BEF#=V_{IL}, BES1#=V_{IH}, or BES2=V_{IL}, OE#=V_{IH}
	SRAM		30	mA	BEF#=V_{IH}, BES1#=V_{IL}, BES2=V_{IH}
I_{SB}	Standby V_{DD} Current SST32HF32x SST32HF32xC		110 45	µA µA	V_{DD} = V_{DD} Max, BEF#=BES1#=V_{IHC}, BES2=V_{ILC}
I_{LI}	Input Leakage Current		1	µA	V_{IN}=GND to V_{DD}, V_{DD}=V_{DD} Max
I_{LO}	Output Leakage Current		10	µA	V_{OUT}=GND to V_{DD}, V_{DD}=V_{DD} Max
V_{IL}	Input Low Voltage		0.8	V	V_{DD}=V_{DD} Min
V_{ILC}	Input Low Voltage (CMOS)		0.3	V	V_{DD}=V_{DD} Max
V_{IH}	Input High Voltage	0.7 V_{DD}		V	V_{DD}=V_{DD} Max
V_{IHC}	Input High Voltage (CMOS)	V_{DD}-0.3		V	V_{DD}=V_{DD} Max
V_{OLF}	Flash Output Low Voltage		0.2	V	I_{OL}=100 µA, V_{DD}=V_{DD} Min
V_{OHF}	Flash Output High Voltage	V_{DD}-0.2		V	I_{OH}=-100 µA, V_{DD}=V_{DD} Min
V_{OLS}	SRAM Output Low Voltage		0.4	V	IOL =1 mA, V_{DD}=V_{DD} Min
V_{OHS}	SRAM Output High Voltage	2.2		V	IOH =-500 µA, V_{DD}=V_{DD} Min

T5.0 1230

1. I_{DD} active while Erase or Program is in progress.

TABLE 6: RECOMMENDED SYSTEM POWER-UP TIMINGS

Symbol	Parameter	Minimum	Units
$T_{PU-READ}$[1]	Power-up to Read Operation	100	µs
$T_{PU-WRITE}$[1]	Power-up to Program/Erase Operation	100	µs

T6.0 1230

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

TABLE 7: CAPACITANCE (Ta = 25°C, f=1 Mhz, other pins open)

Parameter	Description	Test Condition	Maximum
$C_{I/O}$[1]	I/O Pin Capacitance	$V_{I/O}$ = 0V	12 pF
C_{IN}[1]	Input Capacitance	V_{IN} = 0V	12 pF

T7.0 1230

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

TABLE 8: FLASH RELIABILITY CHARACTERISTICS

Symbol	Parameter	Minimum Specification	Units	Test Method
N_{END}[1]	Endurance	10,000	Cycles	JEDEC Standard A117
T_{DR}[1]	Data Retention	100	Years	JEDEC Standard A103
I_{LTH}[1]	Latch Up	100 + I_{DD}	mA	JEDEC Standard 78

T8.0 1230

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

AC CHARACTERISTICS

TABLE 9: SRAM READ CYCLE TIMING PARAMETERS

Symbol	Parameter	SST32HFx1/x1C-70		SST32HFx1/x1C-90		Units
		Min	Max	Min	Max	
T_{RCS}	Read Cycle Time	70		90		ns
T_{AAS}	Address Access Time		70		90	ns
T_{BES}	Bank Enable Access Time		70		90	ns
T_{OES}	Output Enable Access Time		35		45	ns
T_{BYES}	UBS#, LBS# Access Time		70		90	ns
T_{BLZS}[1]	BES# to Active Output	0		0		ns
T_{OLZS}[1]	Output Enable to Active Output	0		0		ns
T_{BYLZS}[1]	UBS#, LBS# to Active Output	0		0		ns
T_{BHZS}[1]	BES# to High-Z Output		25		35	ns
T_{OHZS}[1]	Output Disable to High-Z Output	0	25	0	35	ns
T_{BYHZS}[1]	UBS#, LBS# to High-Z Output		35		45	ns
T_{OHS}	Output Hold from Address Change	10		10		ns

T9.0 1230

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

TABLE 10: SRAM WRITE CYCLE TIMING PARAMETERS

Symbol	Parameter	SST32HFx1/x1C-70		SST32HFx1/x1C-90		Units
		Min	Max	Min	Max	
T_{WCS}	Write Cycle Time	70		90		ns
T_{BWS}	Bank Enable to End-of-Write	60		80		ns
T_{AWS}	Address Valid to End-of-Write	60		80		ns
T_{ASTS}	Address Set-up Time	0		0		ns
T_{WPS}	Write Pulse Width	60		80		ns
T_{WRS}	Write Recovery Time	0		0		ns
T_{BYWS}	UBS#, LBS# to End-of-Write	60		80		ns
T_{ODWS}	Output Disable from WE# Low		30		40	ns
T_{OEWS}	Output Enable from WE# High	0		0		ns
T_{DSS}	Data Set-up Time	30		40		ns
T_{DHS}	Data Hold from Write Time	0		0		ns

T10.0 1230

TABLE 11: FLASH READ CYCLE TIMING PARAMETERS V_{DD} = 2.7-3.6V

Symbol	Parameter	SST32HFx1/x1C-70		SST32HFx1/x1C-90		Units
		Min	Max	Min	Max	
T_{RC}	Read Cycle Time	70		90		ns
T_{CE}	Chip Enable Access Time		70		90	ns
T_{AA}	Address Access Time		70		90	ns
T_{OE}	Output Enable Access Time		35		45	ns
T_{BLZ}[1]	BEF# Low to Active Output	0		0		ns
T_{OLZ}[1]	OE# Low to Active Output	0		0		ns
T_{BHZ}[1]	BEF# High to High-Z Output		20		30	ns
T_{OHZ}[1]	OE# High to High-Z Output		20		30	ns
T_{OH}[1]	Output Hold from Address Change	0		0		ns

T11.0 1230

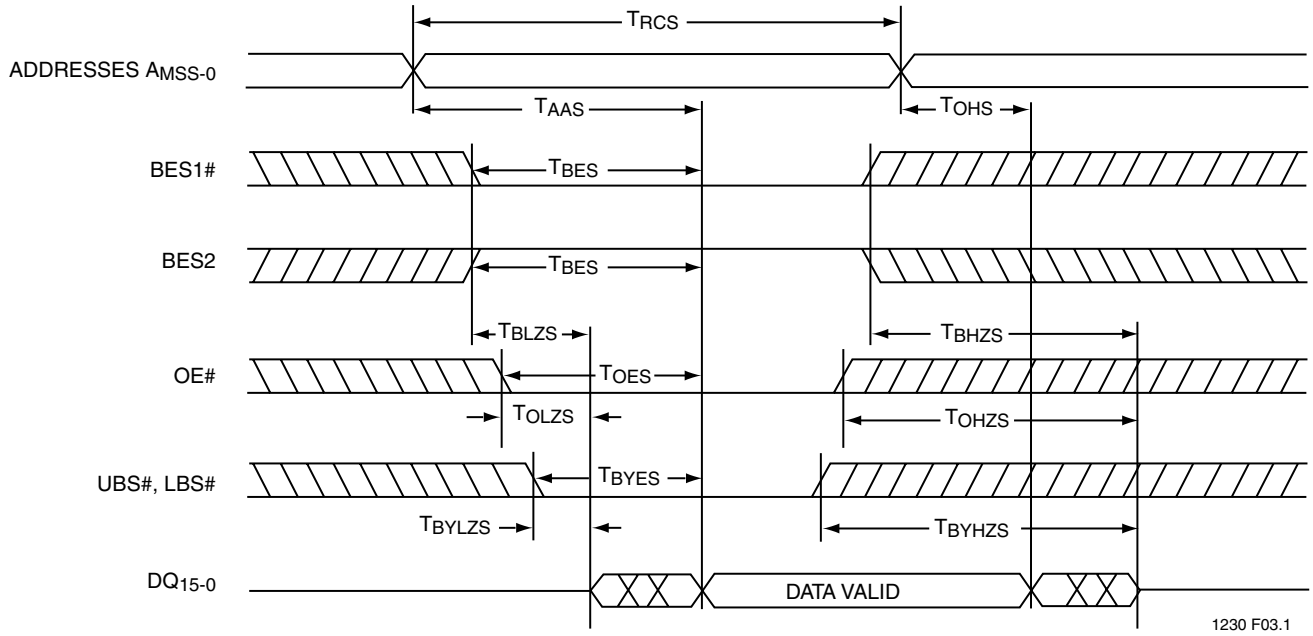
1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

TABLE 12: FLASH PROGRAM/ERASE CYCLE TIMING PARAMETERS

Symbol	Parameter	Min	Max	Units
T_{BP}	Word-Program Time		10	µs
T_{AS}	Address Setup Time	0		ns
T_{AH}	Address Hold Time	30		ns
T_{BS}	WE# and BEF# Setup Time	0		ns
T_{BH}	WE# and BEF# Hold Time	0		ns
T_{OES}	OE# High Setup Time	0		ns
T_{OEH}	OE# High Hold Time	10		ns
T_{BP}	BEF# Pulse Width	40		ns
T_{WP}	WE# Pulse Width	40		ns
T_{WPH}[1]	WE# Pulse Width High	30		ns
T_{BPH}[1]	BEF# Pulse Width High	30		ns
T_{DS}	Data Setup Time	30		ns
T_{DH}[1]	Data Hold Time	0		ns
T_{IDA}[1]	Software ID Access and Exit Time		150	ns
T_{SE}	Sector-Erase		25	ms
T_{BE}	Block-Erase		25	ms
T_{SCE}	Chip-Erase		50	ms

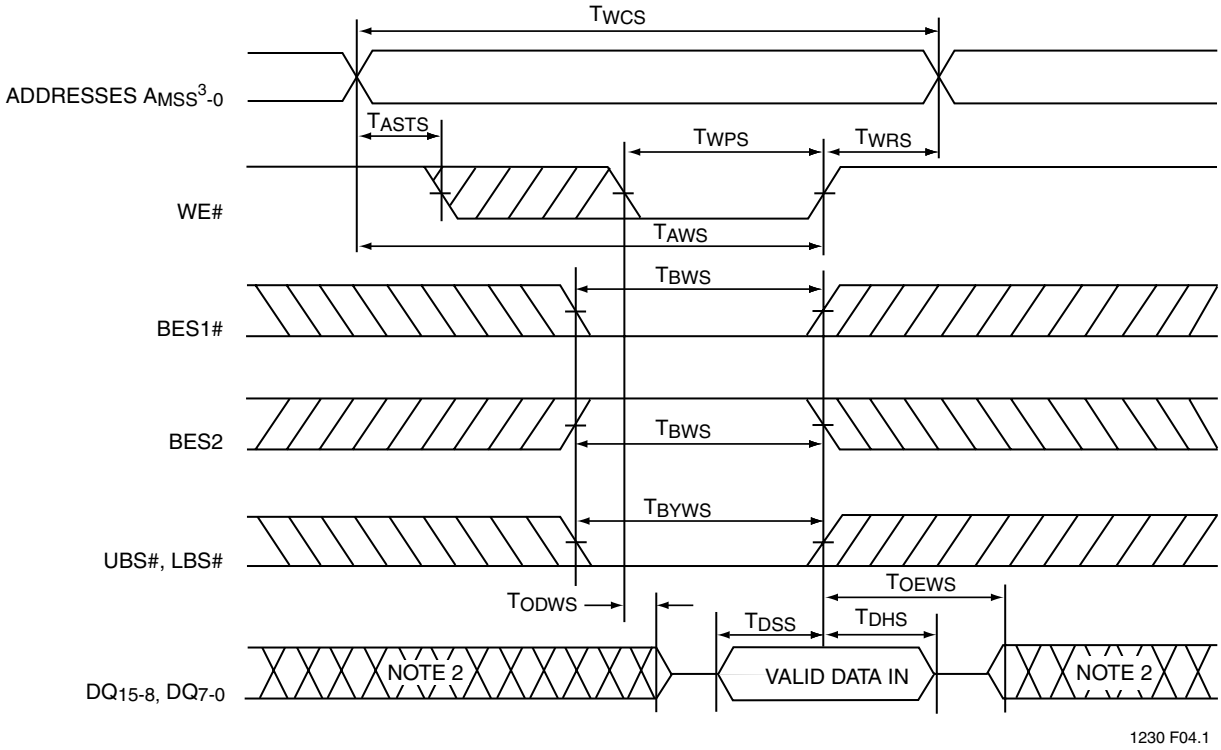
T12.0 1230

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.



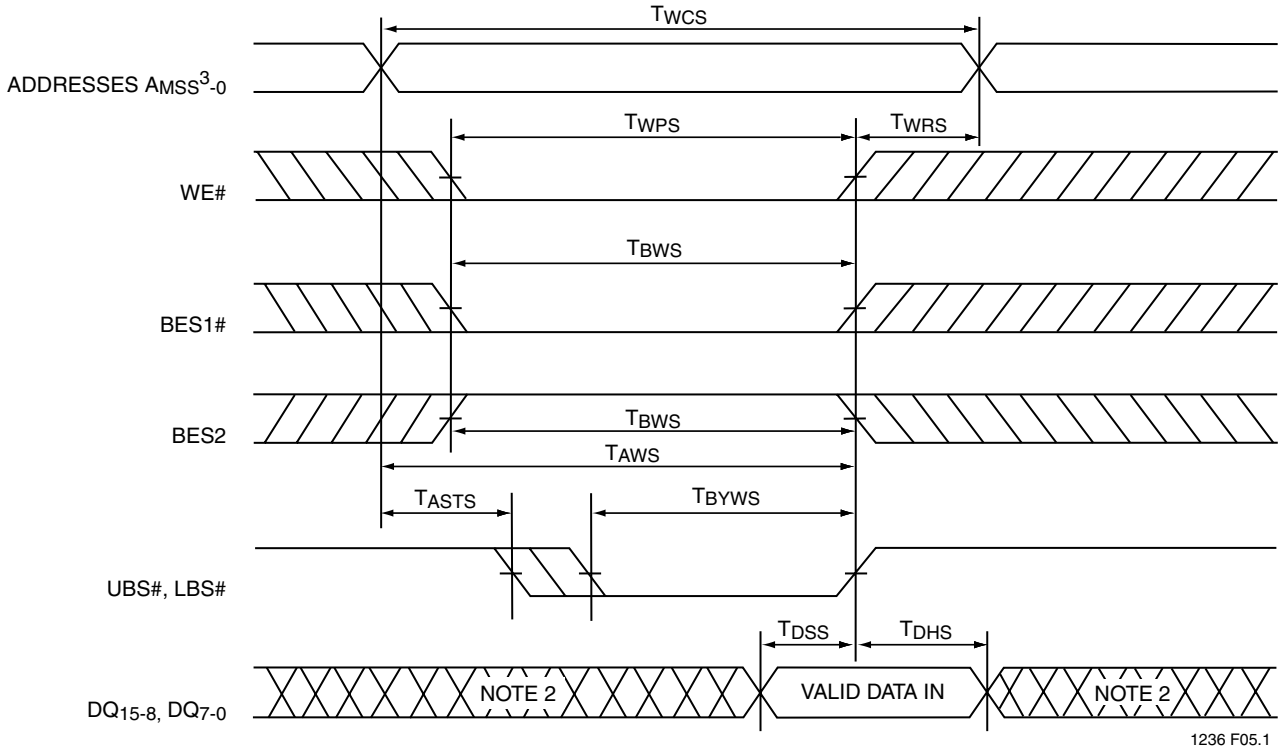
Note: A_{MSS} = Most Significant SRAM Address
$A_{MSS} = A_{17}$ for SST32HF324x and A_{18} for SST32HF328x

FIGURE 3: SRAM READ CYCLE TIMING DIAGRAM



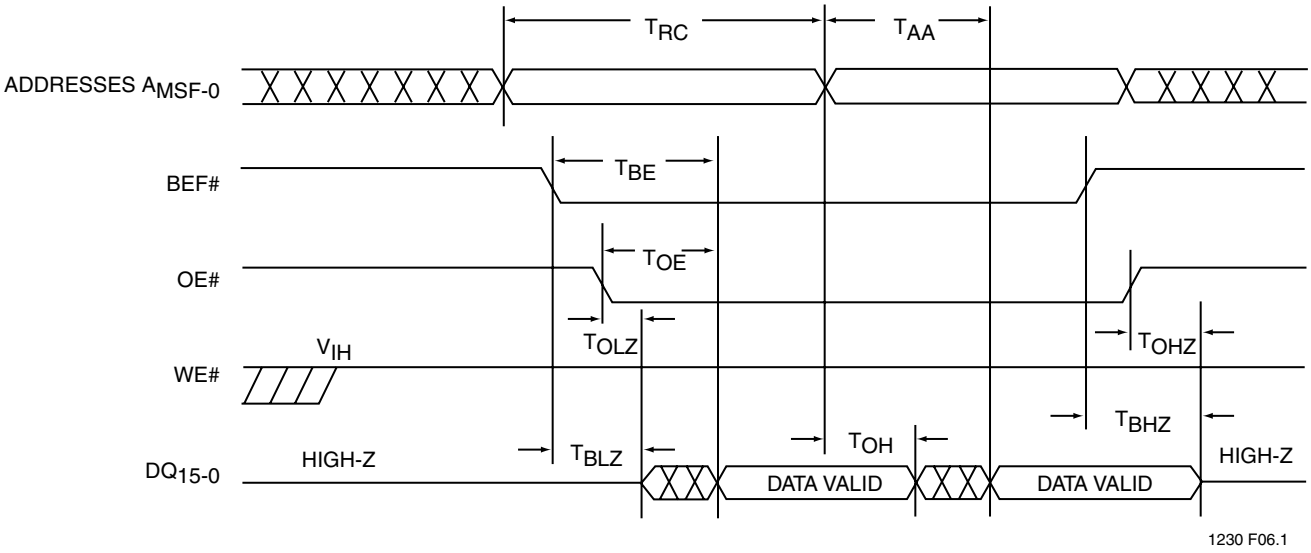
Note: 1. If OE# is High during the Write cycle, the outputs will remain at high impedance.
2. If BES1# goes Low or BES2 goes high coincident with or after WE# goes Low, the output will remain at high impedance. If BES1# goes High or BES2 goes low coincident with or before WE# goes High, the output will remain at high impedance. Because D_{IN} signals may be in the output state at this time, input signals of reverse polarity must not be applied.
3. A_{MSS} = Most Significant SRAM Address
$A_{MSS} = A_{17}$ for SST32HF324xx and A_{18} for SST32HF328x

FIGURE 4: SRAM WRITE CYCLE TIMING DIAGRAM (WE# CONTROLLED)[1]



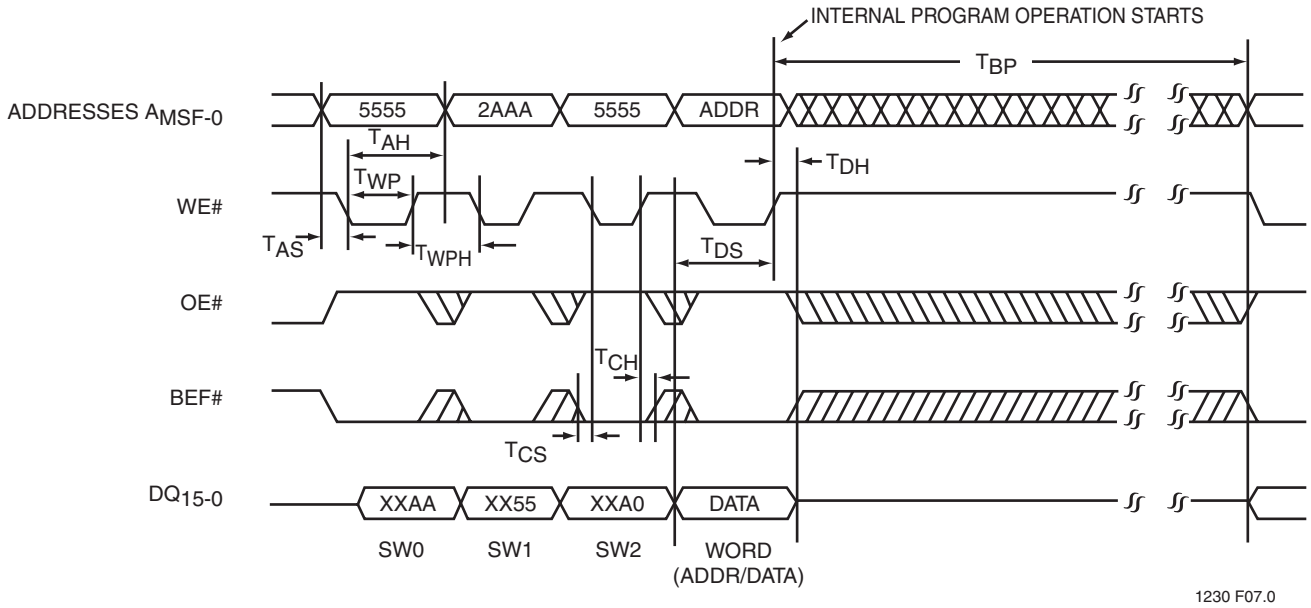
Note: 1. If OE# is High during the Write cycle, the outputs will remain at high impedance.
2. Because D_{IN} signals may be in the output state at this time, input signals of reverse polarity must not be applied.
3. A_{MSS} = Most Significant SRAM Address
$A_{MSS} = A_{17}$ for SST32HF324x and A_{18} for SST32HF328x

FIGURE 5: SRAM WRITE CYCLE TIMING DIAGRAM (UBS#, LBS# CONTROLLED)[1]



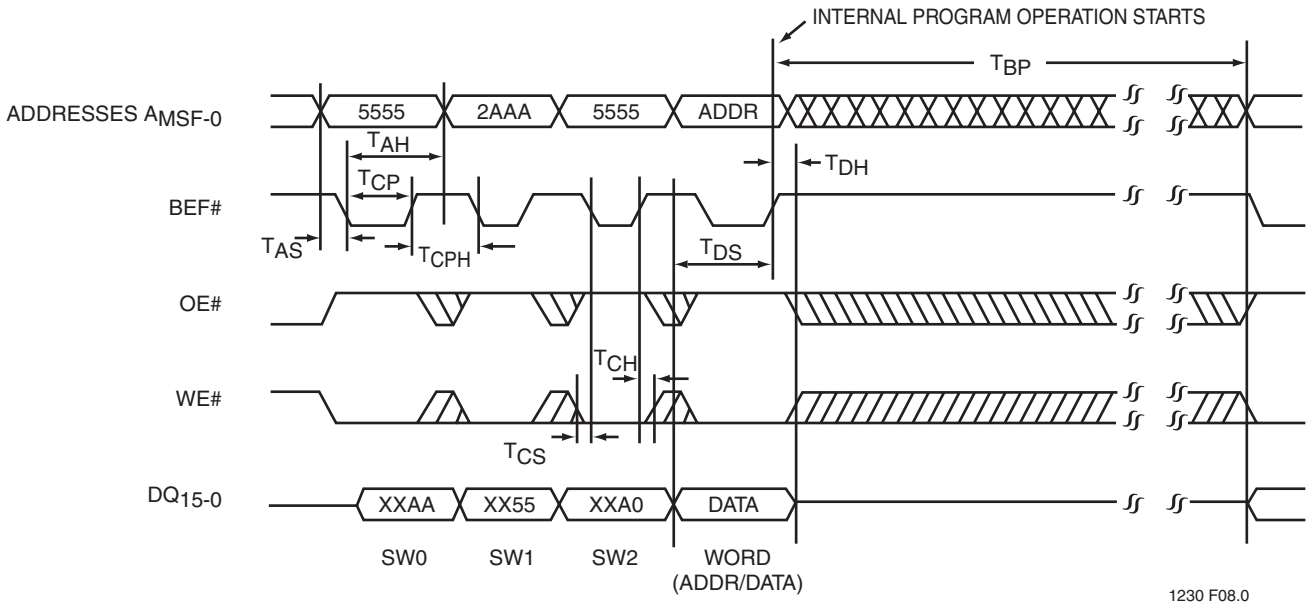
Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx

FIGURE 6: FLASH READ CYCLE TIMING DIAGRAM



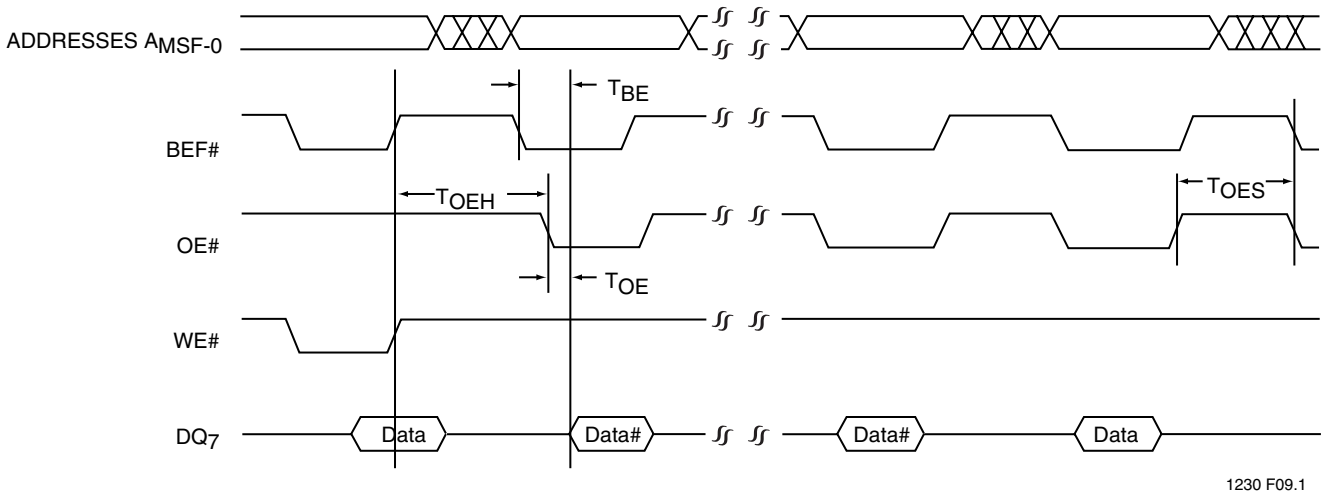
Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx

FIGURE 7: FLASH WE# CONTROLLED PROGRAM CYCLE TIMING DIAGRAM



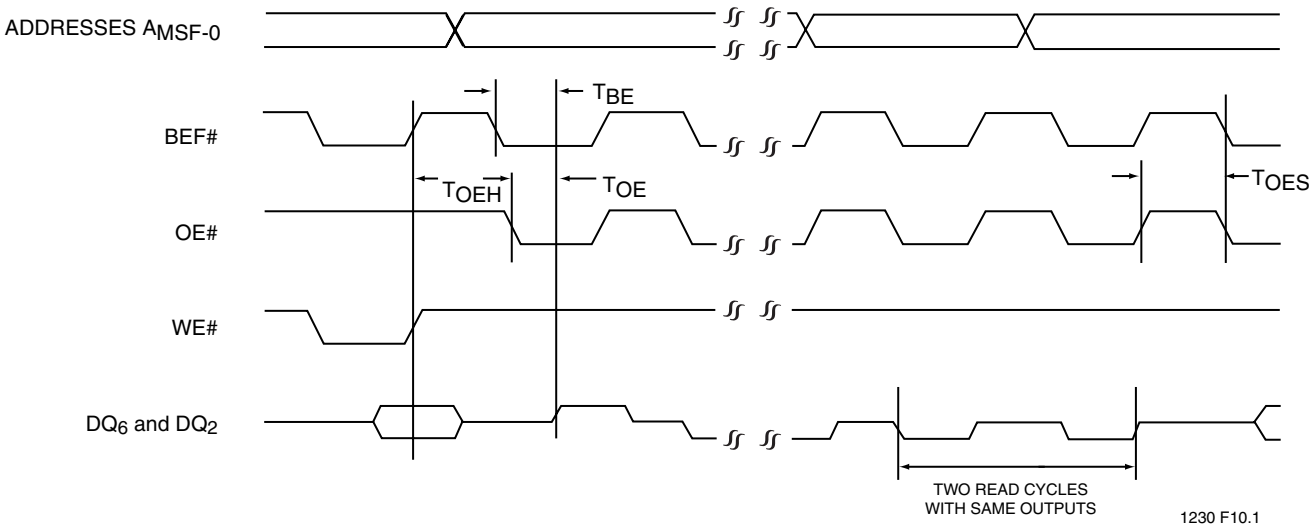
Note: A_{MSF} = Most Significant Flash Address
A_{MSF} = A_{20} for SST32HF32xx

FIGURE 8: BEF# CONTROLLED FLASH PROGRAM CYCLE TIMING DIAGRAM



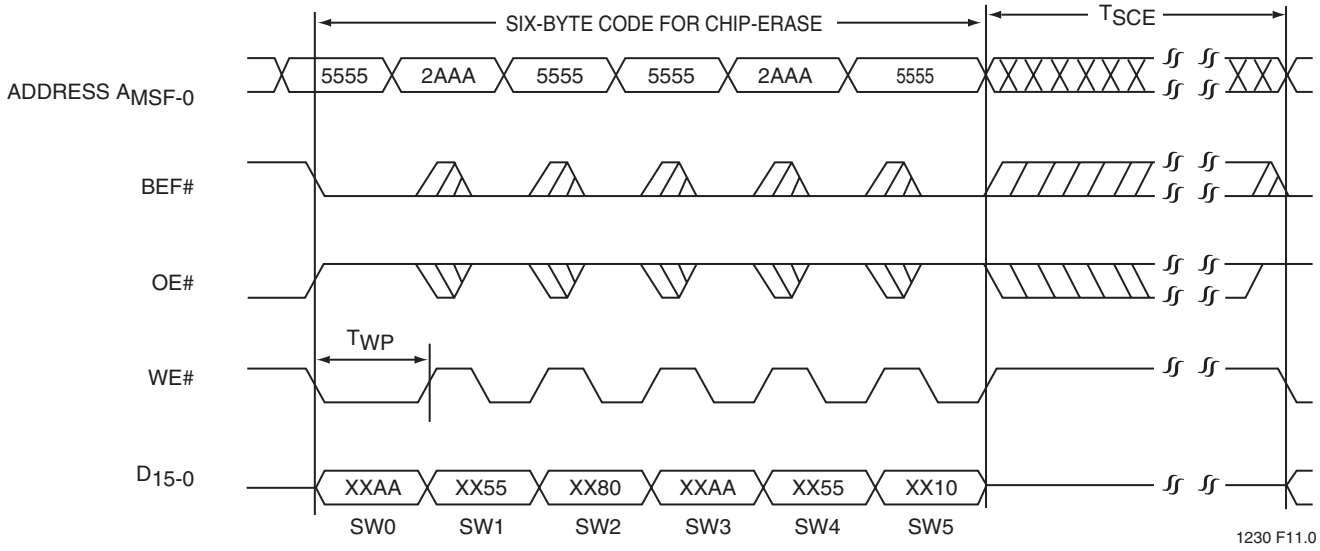
Note: A_{MSF} = Most Significant Flash Address
A_{MSF} = A_{20} for SST32HF32xx

FIGURE 9: FLASH DATA# POLLING TIMING DIAGRAM



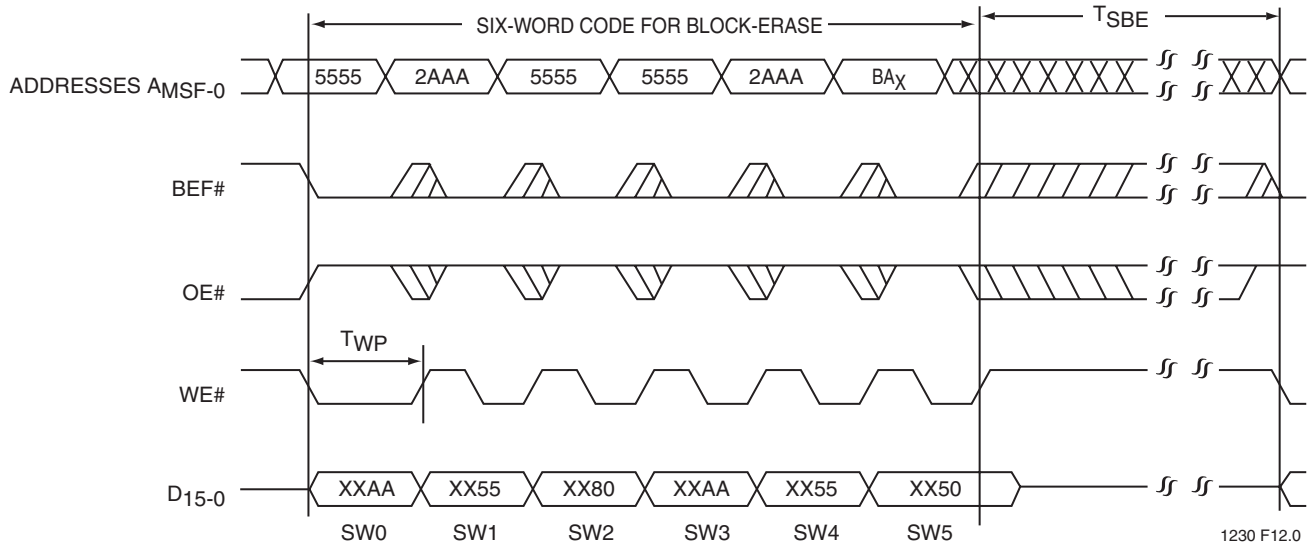
Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx

FIGURE 10: FLASH TOGGLE BIT TIMING DIAGRAM



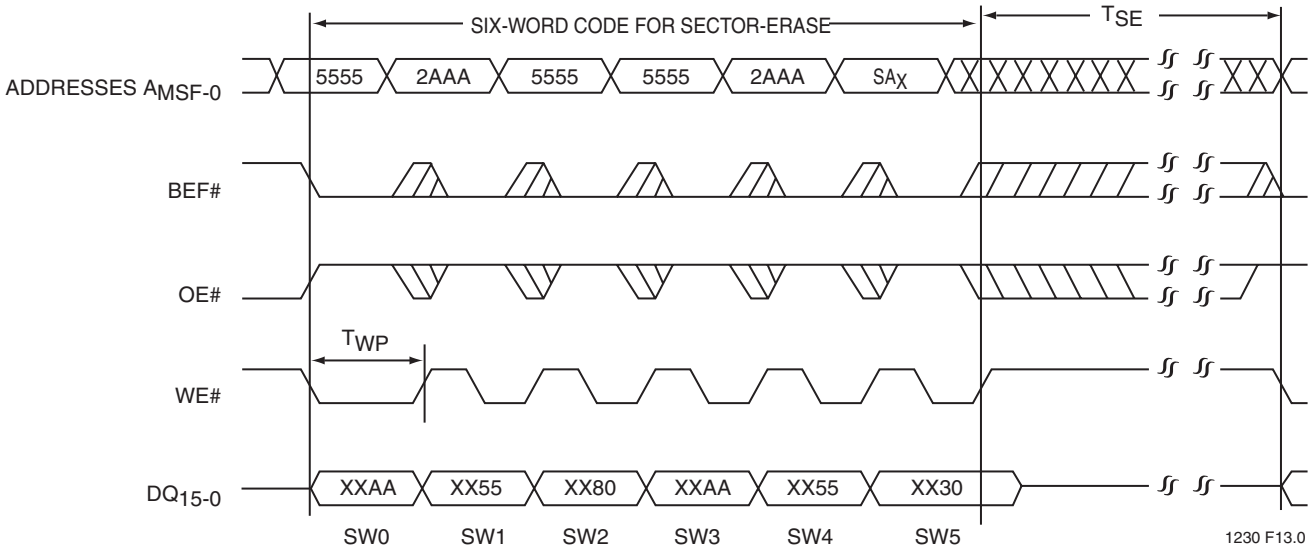
Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx
This device also supports BEF# controlled Chip-Erase operation.
The WE# and BEF# signals are interchangeable as long as minimum timings are meet. (See Table 12.)
X can be V_{IL} or $V_{IH,}$ but no other value.

FIGURE 11: WE# CONTROLLED FLASH CHIP-ERASE TIMING DIAGRAM



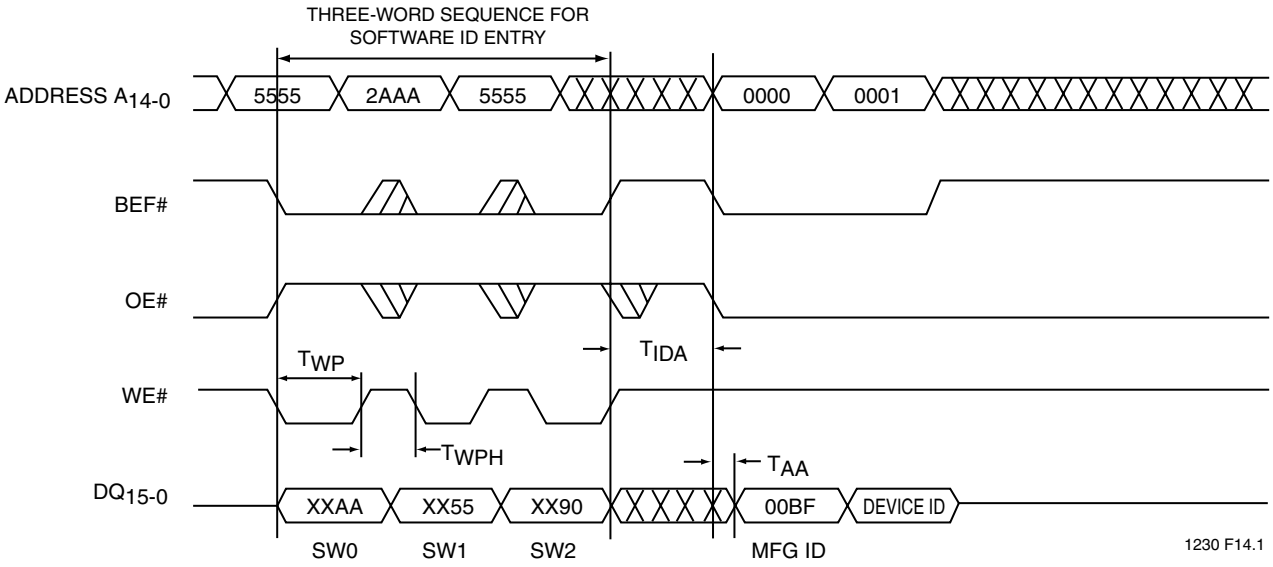
Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx
This device also supports BEF# controlled Block-Erase operation.
The WE# and BEF# signals are interchangeable as long as minimum timings are meet. (See Table 12.)
BA_X = Block Address
X can be V_{IL} or V_{IH}, but no other value.

FIGURE 12: WE# CONTROLLED FLASH BLOCK-ERASE TIMING DIAGRAM



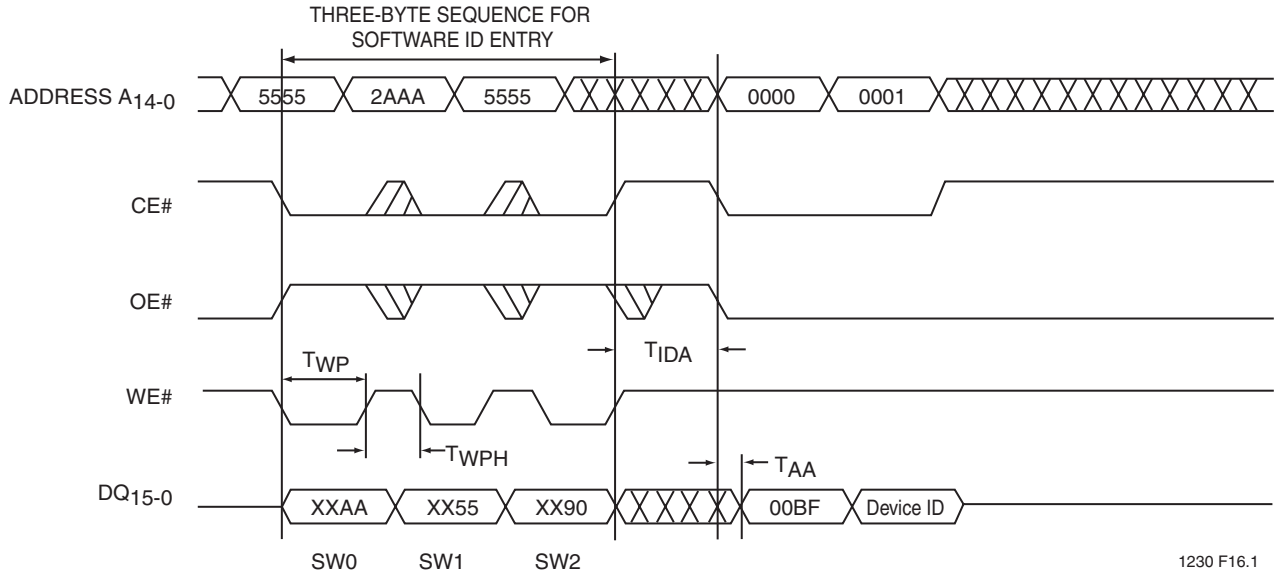
Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx
This device also supports BEF# controlled Sector-Erase operation.
The WE# and BEF# signals are interchangeable as long as minimum timings are meet. (See Table 12.)
SA_X = Sector Address
X can be V_{IL} or V_{IH}, but no other value.

FIGURE 13: WE# CONTROLLED FLASH SECTOR-ERASE TIMING DIAGRAM



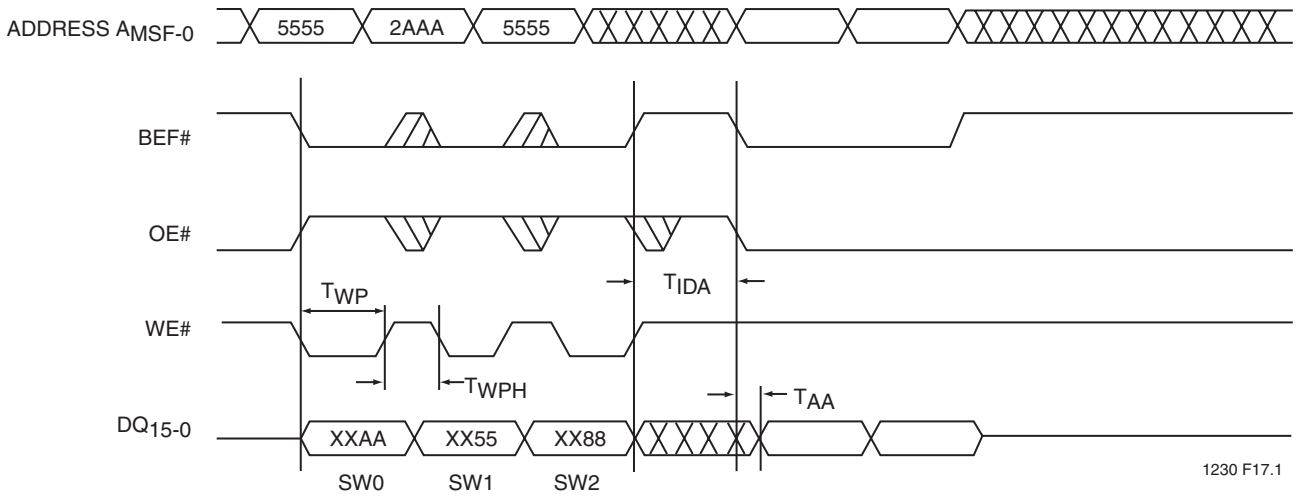
Note: X can be V_{IL} or V_{IH}, but no other value.
Device ID - See Table 1 on page 5

FIGURE 14: SOFTWARE ID ENTRY AND READ



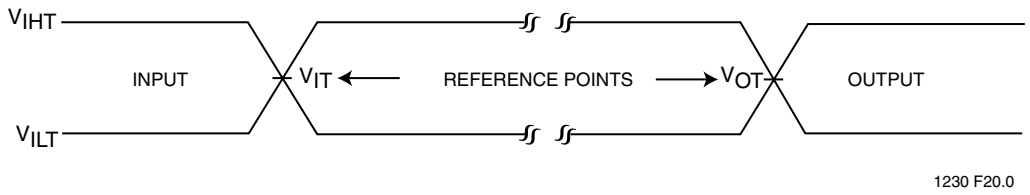
Note: X can be V_{IL} or V_{IH}, but no other value.
Device ID - See Table 1 on page 5

FIGURE 15: SOFTWARE ID



Note: A_{MSF} = Most Significant Flash Address
$A_{MSF} = A_{20}$ for SST32HF32xx
WP# must be held in proper logic state (V_{IL} or V_{IH}) 1 µs prior to and 1 µs after the command sequence.
X can be V_{IL} or $V_{IH,}$ but no other value.

FIGURE 16: FLASH SEC ID ENTRY



AC test inputs are driven at V_{IHT} (0.9 V_{DD}) for a logic "1" and V_{ILT} (0.1 V_{DD}) for a logic "0". Measurement reference points for inputs and outputs are V_{IT} (0.5 V_{DD}) and V_{OT} (0.5 V_{DD}). Input rise and fall times (10% ↔ 90%) are <5 ns.

Note: V_{IT} - V_{INPUT} Test
V_{OT} - V_{OUTPUT} Test
V_{IHT} - V_{INPUT} HIGH Test
V_{ILT} - V_{INPUT} LOW Test

FIGURE 17: AC INPUT/OUTPUT REFERENCE WAVEFORMS

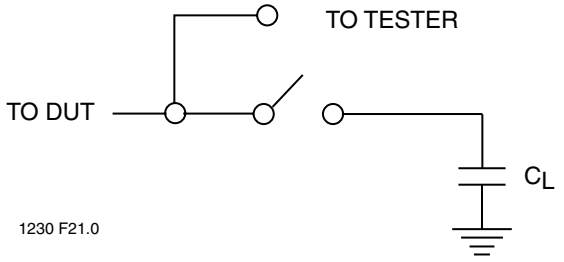
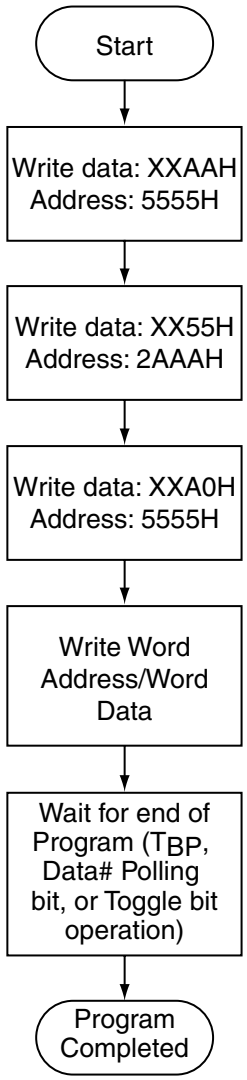


FIGURE 18: A TEST LOAD EXAMPLE



Note: X can be V_{IL} or V_{IH}, but no other value

FIGURE 19: WORD-PROGRAM ALGORITHM

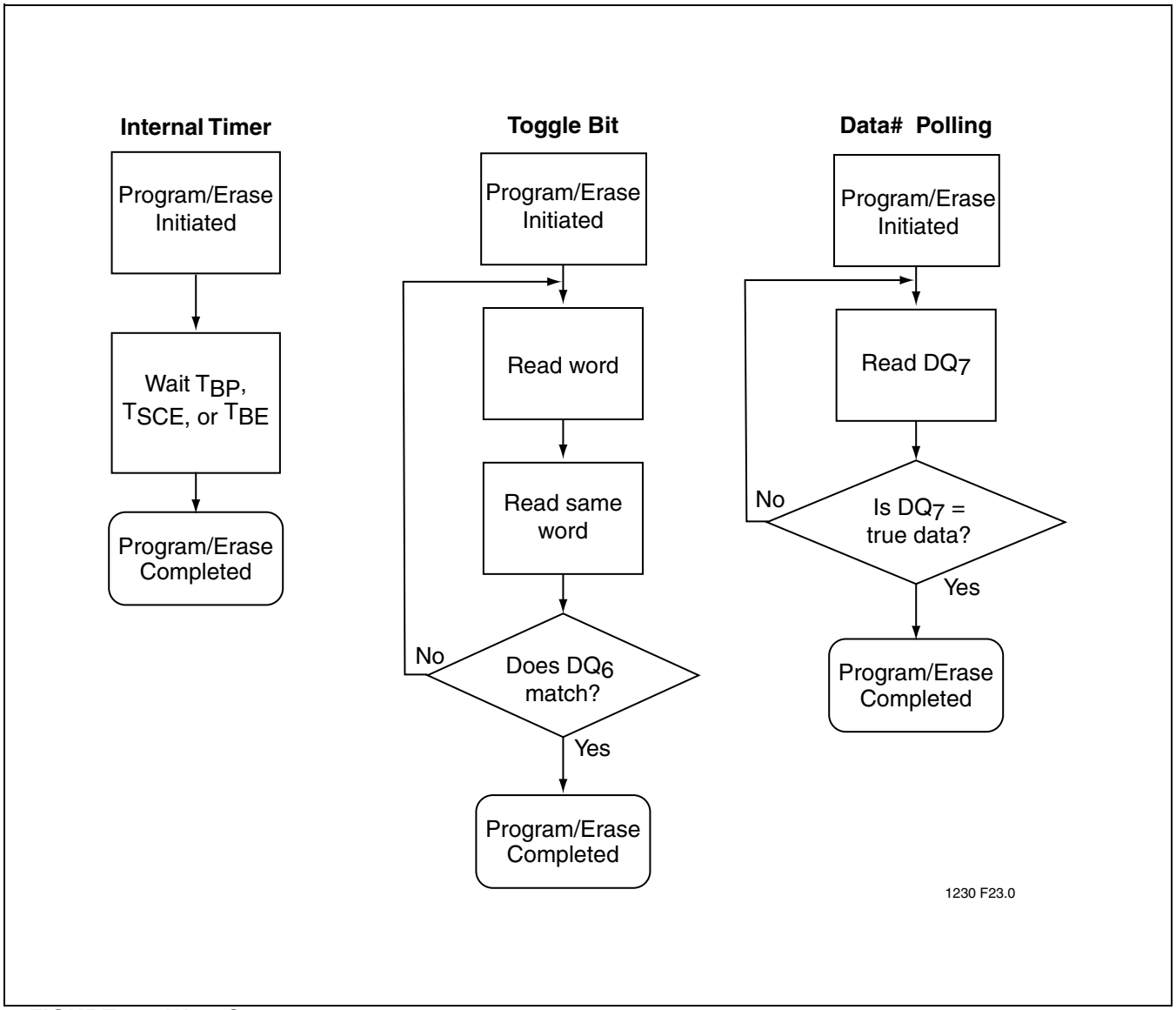


FIGURE 20: WAIT OPTIONS

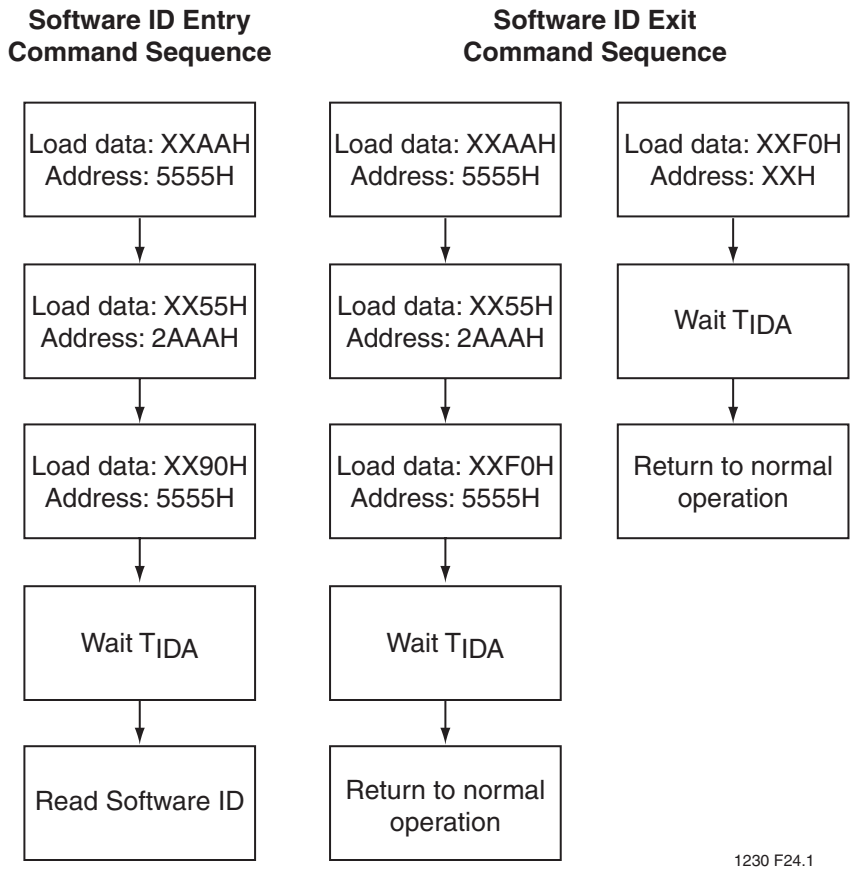
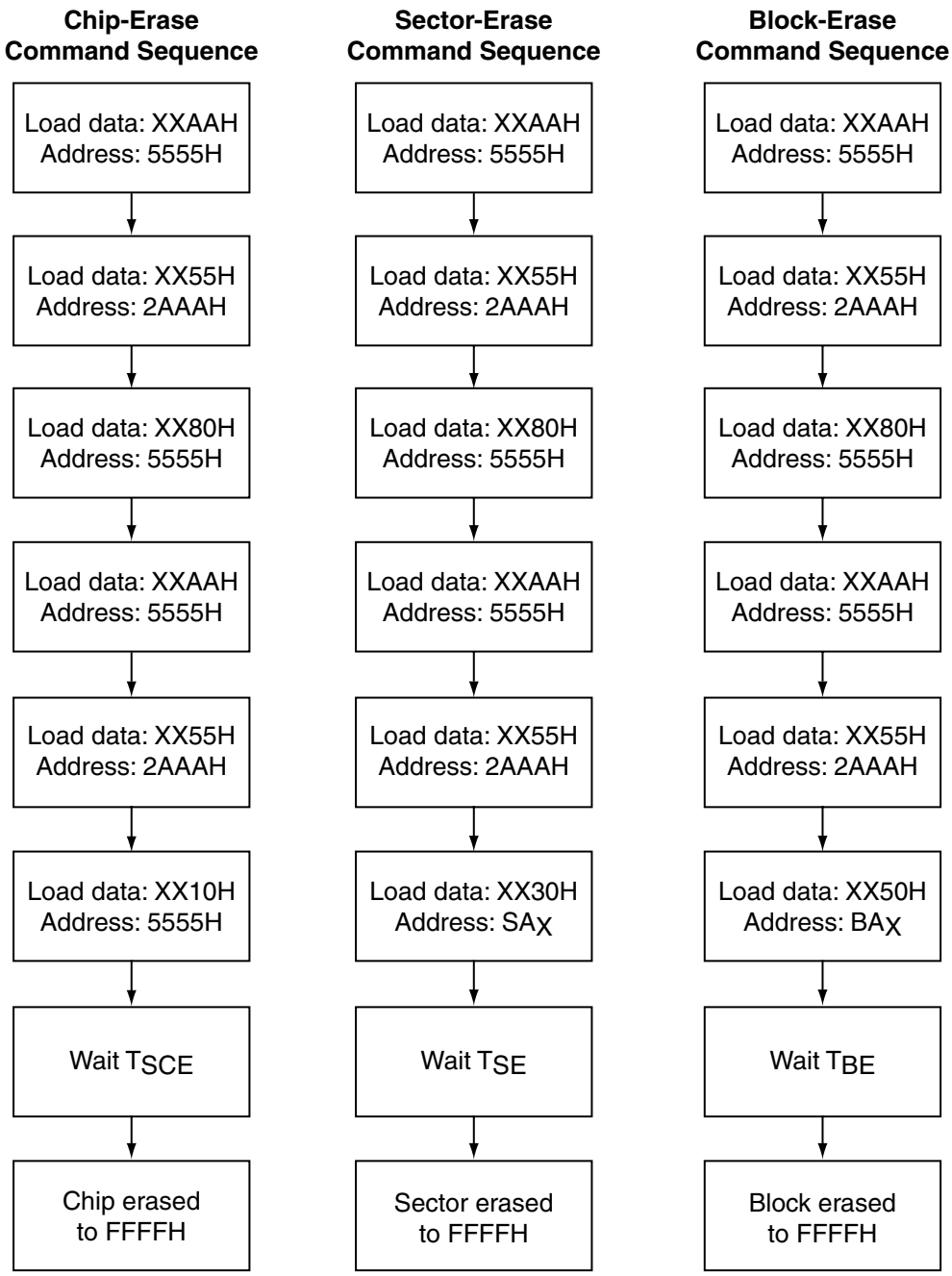


FIGURE 21: SOFTWARE ID COMMAND SEQUENCE



Note: X can be V_{IL} or V_{IH}, but no other value.

FIGURE 22: ERASE COMMAND SEQUENCE

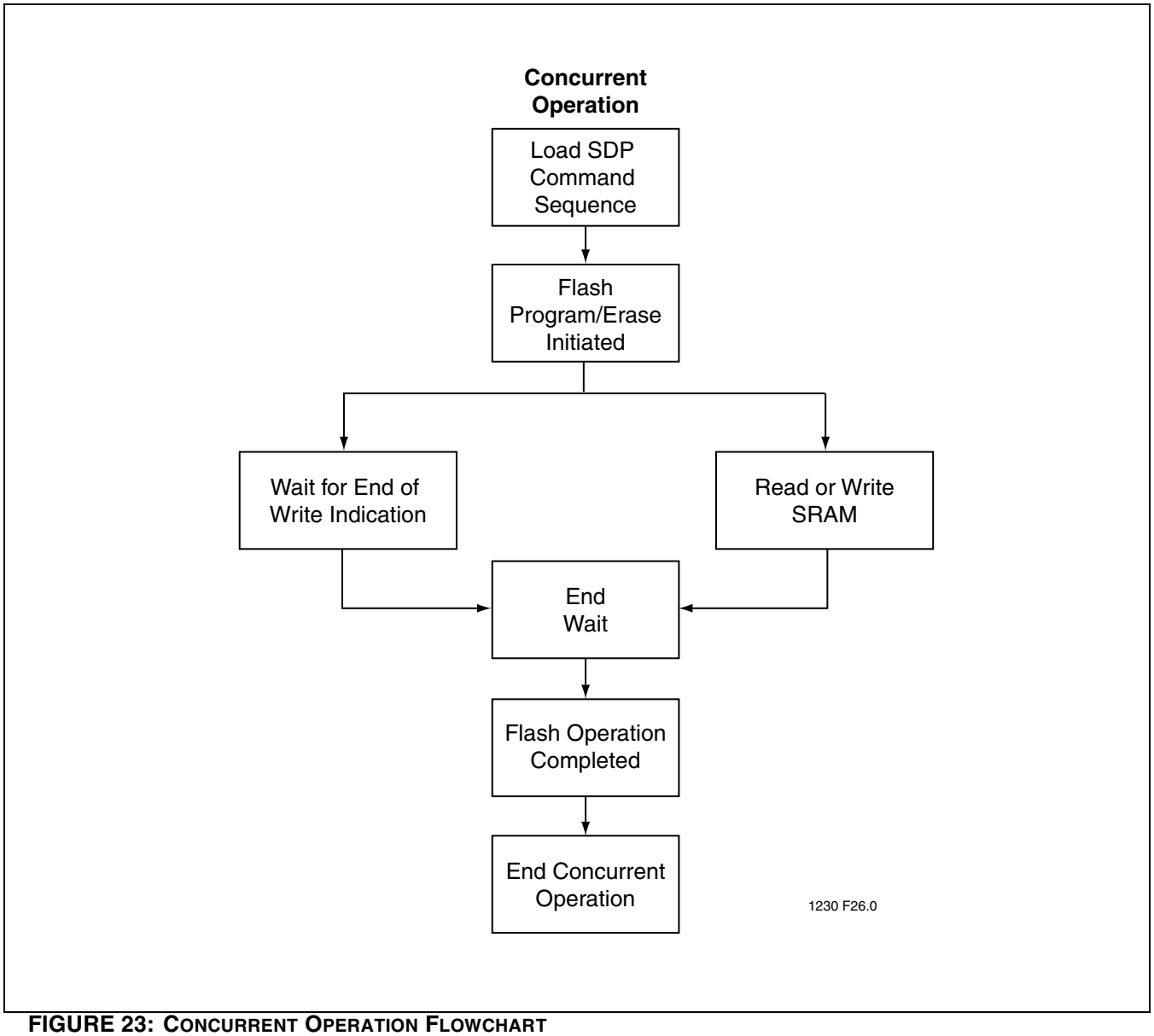


FIGURE 23: CONCURRENT OPERATION FLOWCHART

Preliminary Specifications

PRODUCT ORDERING INFORMATION

Device	Speed	Suffix1	Suffix2
SST32HFxxxC -	XXX -	XX -	XX

Package Modifier
FS = 63 balls
S = 62 balls

Package Type
B = TFBGA (8mm x 10mm x 1.2mm, 0.40mm ball size)
L = LFBGA (8mm x 10mm x 1.4mm, 0.40mm ball size)

Temperature Range
C = Commercial = 0°C to +70°C
E = Extended = -20°C to +85°C

Minimum Endurance
4 = 10,000 cycles

Read Access Speed
70 = 70 ns
90 = 90 ns

Device
Blank = Pseudo-SRAM
C = Standard SRAM

SRAM Density[1]
4 = 4 Mbit
8 = 8 Mbit

Flash Density
32 = 32 Mbit

Voltage
H = 2.7-3.3V

Device Family
32 = Multi-Purpose Flash + SRAM ComboMemory

1. No SRAM and 2 Mbit SRAM options not currently planned. However, if business conditions merit, these devices could go into production. Contact your SST sales representative for availability.

Valid combinations for SST32HF324

SST32HF324-70-4C-BFS	SST32HF324-70-4C-LS	SST32HF324-70-4C-LFS
SST32HF324-90-4C-BFS	SST32HF324-90-4C-LS	SST32HF324-90-4C-LFS
SST32HF324-70-4E-BFS	SST32HF324-70-4E-LS	SST32HF324-70-4E-LFS
SST32HF324-90-4E-BFS	SST32HF324-90-4E-LS	SST32HF324-90-4E-LFS

Valid combinations for SST32HF324C

SST32HF324C-70-4C-BFS	SST32HF324C-70-4C-LS	SST32HF324C-70-4C-LFS
SST32HF324C-90-4C-BFS	SST32HF324C-90-4C-LS	SST32HF324C-90-4C-LFS
SST32HF324C-70-4E-BFS	SST32HF324C-70-4E-LS	SST32HF324C-70-4E-LFS
SST32HF324C-90-4E-BFS	SST32HF324C-90-4E-LS	SST32HF324C-90-4E-LFS

Valid combinations for SST32HF328

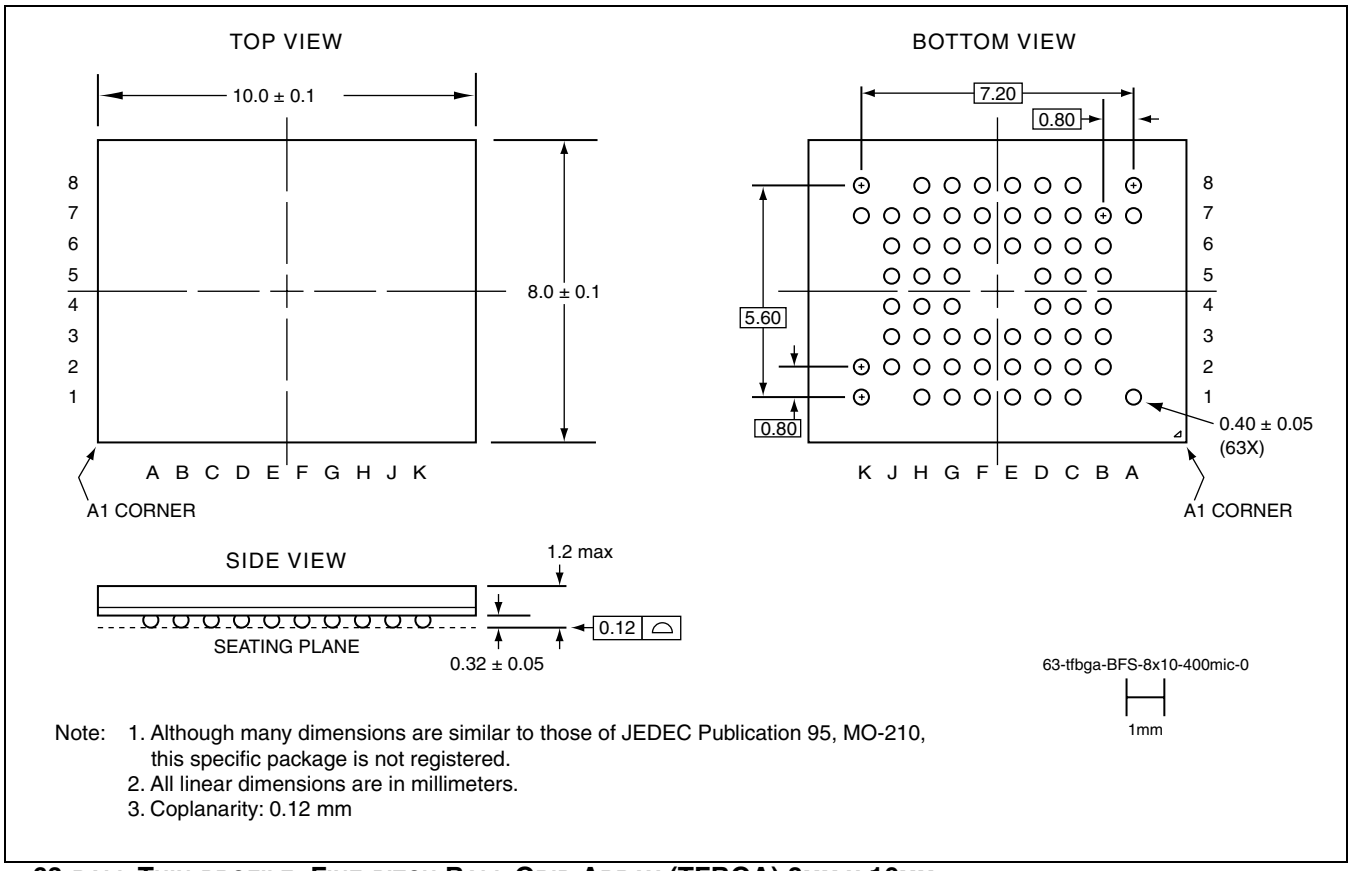
SST32HF328-70-4C-BFS	SST32HF328-70-4C-LS	SST32HF328-70-4C-LFS
SST32HF328-90-4C-BFS	SST32HF328-90-4C-LS	SST32HF328-90-4C-LFS
SST32HF328-70-4E-BFS	SST32HF328-70-4E-LS	SST32HF328-70-4E-LFS
SST32HF328-90-4E-BFS	SST32HF328-90-4E-LS	SST32HF328-90-4E-LFS

Valid combinations for SST32HF328C

SST32HF328C-70-4C-BFS	SST32HF328C-70-4C-LS	SST32HF328C-70-4C-LFS
SST32HF328C-90-4C-BFS	SST32HF328C-90-4C-LS	SST32HF328C-90-4C-LFS
SST32HF328C-70-4E-BFS	SST32HF328C-70-4E-LS	SST32HF328C-70-4E-LFS
SST32HF328C-90-4E-BFS	SST32HF328C-90-4E-LS	SST32HF328C-90-4E-LFS

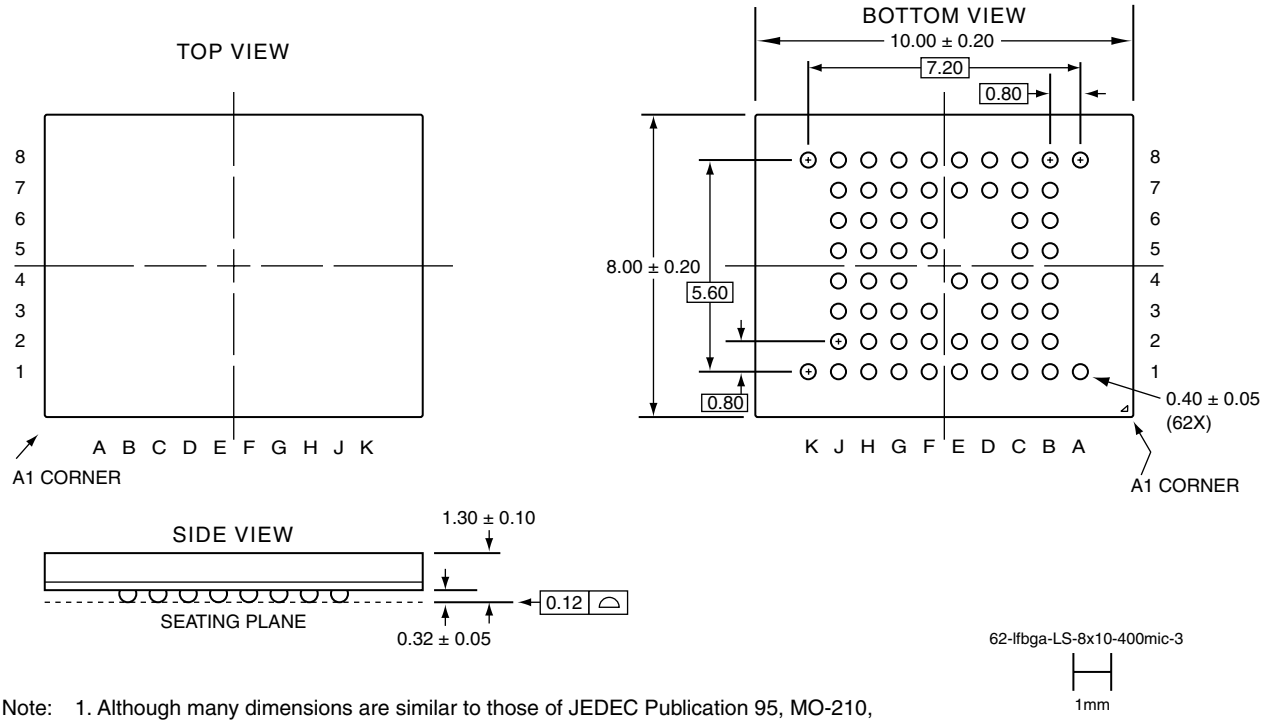
Note: Valid combinations are those products in mass production or will be in mass production.
A BGA package with a height of 1.2mm is not currently planned. However, if business conditions merit, these devices could go into production. Consult your SST sales representative to confirm availability of valid combinations and to determine availability of new combinations.

PACKAGING DIAGRAMS



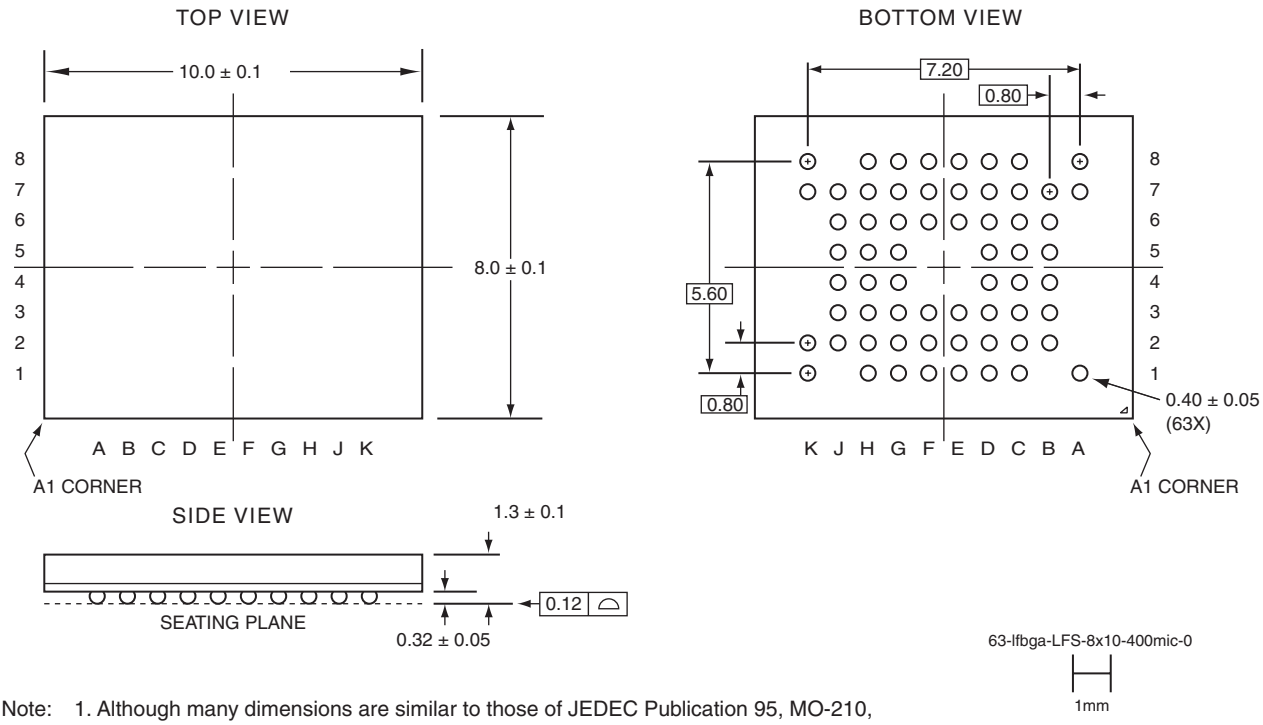
Note: 1. Although many dimensions are similar to those of JEDEC Publication 95, MO-210, this specific package is not registered.
2. All linear dimensions are in millimeters.
3. Coplanarity: 0.12 mm

63-BALL THIN-PROFILE, FINE-PITCH BALL GRID ARRAY (TFBGA) 8MM X 10MM
SST PACKAGE CODE: BFS



Note: 1. Although many dimensions are similar to those of JEDEC Publication 95, MO-210, this specific package is not registered.
2. All linear dimensions are in millimeters.
3. Coplanarity: 0.12 mm
4. The actual shape of the corners may be slightly different than as portrayed in the drawing.

62-BALL LOW-PROFILE, FINE-PITCH BALL GRID ARRAY (LFBGA) 8MM X 10MM
SST PACKAGE CODE: LS



Note: 1. Although many dimensions are similar to those of JEDEC Publication 95, MO-210, this specific package is not registered.
2. All linear dimensions are in millimeters.
3. Coplanarity: 0.12 mm
4. Ball opening size: 0.32 mm

63-BALL LOW-PROFILE, FINE-PITCH BALL GRID ARRAY (LFBGA) 8MM X 10MM
SST PACKAGE CODE: LFS

TABLE 13: REVISION HISTORY

Number	Description	Date
00	• Initial Release	Jul 2003