16 Mbit (x8/x16) Concurrent SuperFlash
GLS36VF1601G / GLS36VF1602G

Data Sheet

FEATURES:

- **Organized as 1M x16 or 2M x8**
- **Dual Bank Architecture for Concurrent Read/Write Operation**
  - 16 Mbit Bottom Sector Protection
    - GLS36VF1601G: 4 Mbit + 12 Mbit
  - 16 Mbit Top Sector Protection
    - GLS36VF1602G: 12 Mbit + 4 Mbit
- **Single 2.7-3.6V for Read and Write Operations**
- **Superior Reliability**
  - Endurance: 100,000 cycles (typical)
  - Greater than 100 years Data Retention
- **Low Power Consumption:**
  - Active Current: 6 mA typical
  - Standby Current: 4 µA typical
  - Auto Low Power Mode: 4 µA typical
- **Hardware Sector Protection/WP# Input Pin**
  - Protects the 4 outermost sectors (8 KWord) in the smaller bank by driving WP# low and unprotects by driving WP# high
- **Hardware Reset Pin (RST#)**
  - Resets the internal state machine to reading array data
- **Byte# Pin**
  - Selects 8-bit or 16-bit mode
- **Sector-Erase Capability**
  - Uniform 2 KWord sectors
- **Chip-Erase Capability**
- **Block-Erase Capability**
  - Uniform 32 KWord blocks
- **Erase-Suspend / Erase-Resume Capabilities**
- **Security ID Feature**
  - Greenliant: 128 bits
  - User: 256 Byte
- **Fast Read Access Time**
  - 70 ns
- **Latched Address and Data**
- **Fast Erase and Program (typical):**
  - Sector-Erase Time: 18 ms
  - Block-Erase Time: 18 ms
  - Chip-Erase Time: 35 ms
  - Program Time: 7 µs
- **Automatic Write Timing**
  - Internal V_{PP} Generation
- **End-of-Write Detection**
  - Toggle Bit
  - Data# Polling
  - Ready/Busy# pin
- **CMOS I/O Compatibility**
- **Conforms to Common Flash Memory Interface (CFI)**
- **JEDEC Standards**
  - Flash EEPROM Pinouts and command sets
- **Packages Available**
  - 48-ball TFBGA (6mm x 8mm)
  - 48-lead TSOP (12mm x 20mm)
  - 56-ball LFBGA (8mm x 10mm)
- **All non-Pb (lead-free) devices are RoHS compliant**

PRODUCT DESCRIPTION

The GLS36VF1601G and GLS36VF1602G are 1M x16 or 2M x8 CMOS Concurrent Read/Write Flash Memory manufactured with high performance SuperFlash memory technology. The split-gate cell design and thick oxide tunneling injector attain better reliability and manufacturability compared with alternate approaches. The devices write (Program or Erase) with a 2.7-3.6V power supply and conform to JEDEC standard pinouts for x8/x16 memories.

Featuring high performance Program, the GLS36VF160xG provide a typical Program time of 7 µsec and use Toggle Bit, Data# Polling, or RY/BY# to detect the completion of the Program or Erase operation. To protect against inadvertent write, the devices have on-chip hardware and Software Data Protection schemes. Designed, manufactured, and tested for a wide spectrum of applications, these devices are offered with a guaranteed endurance of 10,000 cycles. Data retention is rated at greater than 100 years.

These devices are suited for applications that require convenient and economical updating of program, configuration, or data memory. For all system applications, the GLS36VF160xG significantly improve performance and reliability, while lowering power consumption. These devices inherently use less energy during Erase and Program than alternative flash technologies, because the total energy consumed is a function of the applied voltage, current, and time of application. For any given voltage range,

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the SuperFlash technology uses less current to program and has a shorter erase time; therefore, the total energy consumed during any Erase or Program operation is less than alternative flash technologies.

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.

To meet high-density, surface-mount requirements, the GLS36VF1601G and GLS36VF1602G devices are offered in 48-ball TFBGA, 48-lead TSOP, and 56-ball LFBGA packages. See Figures 6, 7, and 8 for pin assignments.

Device Operation

Memory operation functions are initiated using standard microprocessor write sequences. A command is written by asserting WE# low while keeping CE# low. The address bus is latched on the falling edge of WE# or CE#, whichever occurs last. The data bus is latched on the rising edge of WE# or CE#, whichever occurs first.

Auto Low Power Mode

These devices also have the **Auto Lower Power** mode which puts them in a near-standby mode within 500 ns after data has been accessed with a valid Read operation. This reduces the typical I_{DD} active Read current to 4 µA. While CE# is low, the devices exit Auto Low Power mode with any address transition or control signal transition used to initiate another Read cycle, with no access time penalty.

Concurrent Read/Write Operation

The dual bank architecture of these devices allows the Concurrent Read/Write operation whereby the user can read from one bank while programming or erasing in the other bank. For example, reading system code in one bank while updating data in the other bank. See Table 1 below for more information.

TABLE 1: Concurrent Read/Write State

Bank 1	Bank 2
Read	No Operation
Read	Write
Write	Read
Write	No Operation

TABLE 1: Concurrent Read/Write State

Bank 1	Bank 2
No Operation	Read
No Operation	Write

Note: For the purposes of this table, write means to perform Block- or Sector-Erase or Program operations as applicable to the appropriate bank.

The Read operation of the GLS36VF160xG is controlled by CE# and OE#, both of which have to be low for the system to obtain data from the outputs. CE# is used for device selection. When CE# 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 a high impedance state when either CE# or OE# is high. Refer to Figure 9, the Read cycle timing diagram, for further details.

Program Operation

These devices are programmed on a word-by-word or byte-by-byte basis depending on the state of the BYTE# pin. Before programming, ensure that the sector which is being programmed is fully erased.

The Program operation is accomplished in three steps:

1. Initiate Software Data Protection using the three-byte load sequence.
2. Load address and data.

   During the Program operation, the addresses are latched on the falling edge of either CE# or WE#, whichever occurs last. The data is latched on the rising edge of either CE# or WE#, whichever occurs first.
3. Initiate the internal Program operation after the rising edge of the fourth WE# or CE#, whichever occurs first. The Program operation, once initiated, will be completed typically within 7 µs.

See Figures 10 and 11 for WE# and CE# controlled Program operation timing diagrams and Figure 25 for flowcharts. During the Program operation, the only valid reads are Data# Polling and Toggle Bit. During the internal Program operation, the host is free to perform additional tasks. Any commands issued during an internal Program operation are ignored.

Sector-Erase/Block-Erase Operation

The Sector- or Block- Erase operation allows the system to erase the device on a sector-by-sector (or block-by-block) basis. The GLS36VF160xG offer both Sector-Erase and Block-Erase operations.

The sector architecture is based on a uniform sector size of 2 KWord. The Sector-Erase operation is initiated by executing a six-byte command sequence with a Sector-Erase command (50H) and sector address (SA) in the last bus cycle.

The Block-Erase mode is based on a uniform block size of 32 KWord. Block-Erase is initiated by executing a six-byte command sequence with Block-Erase command (30H) and block address (BA) in the last bus cycle. The sector or block address is latched on the falling edge of the sixth WE# pulse, while the command (50H or 30H) is latched on the rising edge of the sixth WE# pulse. The internal Erase operation begins after the sixth WE# pulse.

Any commands issued during the Sector- or Block-Erase operation are ignored except Erase-Suspend and Erase-Resume. See Figures 15 and 16 for timing waveforms.

Chip-Erase Operation

The GLS36VF1601G and GLS36VF1602G provide a Chip-Erase operation, which erases the entire memory array to the '1' state. This operation 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 555H 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. Any commands issued during the Chip-Erase operation are ignored. See Table 6 for the command sequence, Figure 14 for timing diagram, and Figure 29 for the flowchart. When WP# is low, any attempt to Chip-Erase will be ignored.

Erase-Suspend/Erase-Resume Operations

The Erase-Suspend operation temporarily suspends a Sector- or Block-Erase operation thus allowing data to be read or programmed into any sector or block that is not engaged in an Erase operation. The operation is executed by issuing a one-byte command sequence with Erase-Suspend command (B0H). The device automatically enters read mode no more than 10 µs after the Erase-Suspend command had been issued. (T_{ES} maximum latency equals 10 µs.) Valid data can be read from any sector or block that is not suspended from an Erase operation. Reading at address location within erase-suspended sectors/blocks will output DQ_2 toggling and DQ_6 at '1'. While in Erase-Suspend mode, a Program operation is allowed except for the sector or block selected for Erase-Suspend.

To resume a suspended Sector-Erase or Block-Erase operation, the system must issue an Erase-Resume command. The operation is executed by issuing a one-byte command sequence with Erase Resume command (30H) at any address in the one-byte sequence.

Write Operation Status Detection

To optimize the system Write cycle time, the GLS36VF160xG provide two software means to detect the completion of a Write (Program or Erase) cycle 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, Data# Polling or Toggle Bit maybe be read concurrent with the completion of the write cycle. If this occurs, the system may possibly get an incorrect result from the status detection process. For example, valid data may appear to conflict with either DQ_7 or DQ_6. To prevent false results, upon detection of failures, the software routine should loop to read the accessed location an additional two times. If both reads are valid, then the device has completed the Write cycle, otherwise the failure is valid.

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Ready/Busy# (RY/BY#)

The GLS36VF160xG include a Ready/Busy# (RY/BY#) output signal. RY/BY# is an open drain output pin that indicates whether an Erase or Program operation is in progress. Since RY/BY# is an open drain output, it allows several devices to be tied in parallel to V_{DD} via an external pull-up resistor. After the rising edge of the final WE# pulse in the command sequence, the RY/BY# status is valid.

When RY/BY# is actively pulled low, it indicates that an Erase or Program operation is in progress. When RY/BY# is high (Ready), the devices may be read or left in standby mode.

Byte/Word (BYTE#)

The device includes a BYTE# pin to control whether the device data I/O pins operate x8 or x16. If the BYTE# pin is at logic "1" (V_{IH}) the device is in x16 data configuration: all data I/0 pins DQ_0-DQ_{15} are active and controlled by CE# and OE#.

If the BYTE# pin is at logic '0', the device is in x8 data configuration -- only data I/O pins DQ_0-DQ_7 are active and controlled by CE# and OE#. The remaining data pins DQ_8-DQ_{14} are at Hi-Z, while pin DQ_{15} is used as the address input A_{-1} for the Least Significant Bit of the address bus.

Data# Polling (DQ_7)

When the GLS36VF160xG are in an internal Program operation, any attempt to read DQ_7 will produce the complement of true data. Once the Program operation is completed, DQ_7 will produce valid data.

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 fourth WE# (or CE#) pulse for Program operation. For Sector-, Block-, or Chip-Erase, the Data# Polling is valid after the rising edge of sixth WE# (or CE#) pulse. See Figure 12 for Data# Polling (DQ_7) timing diagram and Figure 26 for a flowchart.

Toggle Bits (DQ_6 and DQ_2)

During the internal Program or Erase operation, any consecutive attempts to read DQ_6 will produce alternating '1's and '0's, i.e., toggling between '1' and '0'. When the internal Program or Erase operation is completed, the DQ_6 bit will stop toggling, and the device is then ready for the next operation. For Sector-, Block-, or Chip-Erase, the toggle bit (DQ_6) is valid after the rising edge of sixth WE# (or CE#) pulse. DQ_6 will be set to '1' if a Read operation is attempted on an Erase-Suspended Sector or Block. If Program operation is initiated in a sector/block not selected in Erase-Suspend mode, DQ_6 will toggle.

An additional Toggle Bit is available on DQ_2, which can be used in conjunction with DQ_6 to check whether a particular sector or block is being actively erased or erase-suspended. Table 2 shows detailed bit status information. The Toggle Bit (DQ_2) is valid after the rising edge of the last WE# (or CE#) pulse of Write operation. See Figure 13 for Toggle Bit timing diagram and Figure 26 for a flowchart.

TABLE 2: Write Operation Status

Status		DQ_7	DQ_6	DQ_2	RY/BY#
Normal Operation	Standard Program	DQ7#	Toggle	No Toggle	0
	Standard Erase	0	Toggle	Toggle	0
Erase-Suspend Mode	Read From Erase Suspended Sector/Block	1	1	Toggle	1
	Read From Non-Erase Suspended Sector/Block	Data	Data	Data	1
	Program	DQ7#	Toggle	N/A	0

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Note: DQ_7, DQ_6, and DQ_2 require a valid address when reading status information. The address must be in the bank where the operation is in progress in order to read the operation status. If the address is pointing to a different bank (not busy), the device will output array data.

Data Protection

The GLS36VF160xG provide both hardware and software features to protect nonvolatile data from inadvertent writes.

Hardware Data Protection

Noise/Glitch Protection: A WE# or CE# 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, CE# high, or WE# high will inhibit the Write operation. This prevents inadvertent writes during power-up or power-down.

Hardware Block Protection

The GLS36VF1601G and GLS36VF1602G provide hardware block protection which protects the outermost 8 KWord in the smaller bank. The block is protected when WP# is held low. See Figures 2, 3, 4, and 5 for Block-Protection location.

Block protection is disabled by driving WP# high. This allows data to be erased or programmed into the protected sectors. WP# must be held high prior to issuing the Write command and remain stable until after the entire Write operation has completed. If WP# is left floating, it is internally held high via a pull-up resistor, and the Boot Block is unprotected, enabling Program and Erase operations on that block.

Hardware Reset (RST#)

The RST# pin provides a hardware method of resetting the devices to read array data. When the RST# pin is held low for at least T_{RP}, any in-progress operation will terminate and return to Read mode (see). When no internal Program/Erase operation is in progress, a minimum period of T_{RHR} is required after RST# is driven high before a valid Read can take place. See Figures 22 and 21 for more information.

The interrupted Erase or Program operation must be re-initiated after the device resumes normal operation mode to ensure data integrity.

Software Data Protection (SDP)

The GLS36VF160xG devices implement the JEDEC approved Software Data Protection (SDP) scheme for all data alteration operations, such as Program and Erase. These devices are shipped with the Software Data Protection permanently enabled. See Table 6 for the specific software command codes.

All Program operations require the inclusion of the three-byte sequence. The three-byte load sequence is used to initiate the Program operation, providing optimal protection from inadvertent Write operations. SDP for Erase operations is similar to Program, but a six-byte load sequence is required for Erase operations.

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.

Common Flash Memory Interface (CFI)

These devices contain Common Flash Memory Interface (CFI) information that describes the characteristics of the device. In order to enter the CFI Query mode, the system must write a three-byte sequence, using the CFI Query command, to address BKx555H in the last byte sequence. The system can also use the one-byte sequence with address BKx55H and Data Bus 98H to enter this mode. See Figure 18 for CFI Entry and Read timing diagram. Once the device enters the CFI Query mode, the system can read CFI data at the addresses given in Tables 7 through 9.

The system must write the CFI Exit command to return to Read mode from the CFI Query mode.

Security ID

The GLS36VF160xG offer a 136-word Security ID space. The Secure ID space is divided into two segments — one 128-bit, factory-programmed, segment and one 256-Byte, user programmed segment. The first segment is programmed and locked at Greenliant and contains a 128 bit Unique ID which uniquely identifies the device. The user segment is left un-programmed for the customer to program as desired.

The user segment of the Security ID can be programmed using the Security ID Program command. End-of-Write status is checked by reading the toggle bits. Data# Polling is not used for Security ID End-of-Write detection.

Once the programming is complete, lock the Sec ID by issuing the User Sec ID Program Lock-Out command. Locking the Sec ID disables any corruption of this space. Note that regardless of whether or not the Sec ID is locked, the Sec ID segments can not be erased.

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The Secure ID space can be queried by executing a three-byte command sequence with Query Sec ID command (88H) at address 555H in the last byte sequence. See Figure 20 for timing diagram. To exit this mode, the Exit Sec ID command should be executed. Refer to Table 6 for more details.

Product Identification

The Product Identification mode identifies the devices as GLS36VF1601G or GLS36VF1602G and the manufacturer as Greenliant. For details, see Table 3 for software operation, Figure 17 for the Software ID Entry and Read timing diagram, and Figure 27 for the Software ID Entry command sequence flowchart.

The addresses A_{19} and A_{18} indicate a bank address. When the addressed bank is switched to Product Identification mode, it is possible to read another address from the same bank without issuing a new Software ID Entry command.

TABLE 3: Product Identification

	Address	Data
Manufacturer's ID	BK0000H	00BFH
Device ID		
GLS36VF1601G	BK0001H	7343H
GLS36VF1602G	BK0001H	7344H

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Note: BK = Bank Address (A_{19}-A_{18})

Product Identification Mode Exit/CFI Mode Exit

In order to return to the standard Read mode, the Software Product Identification mode must be exited. The exit is accomplished by issuing the Software ID Exit command sequence, which returns the device to the Read mode. This command may also be used to reset the device to the Read mode after any inadvertent transient condition that causes the device to behave abnormally. Please note that the Software ID Exit/CFI Exit command is ignored during an internal Program or Erase operation. See Table 6 for the software command code, Figure 19 for timing waveform and Figure 28 for a flowchart.

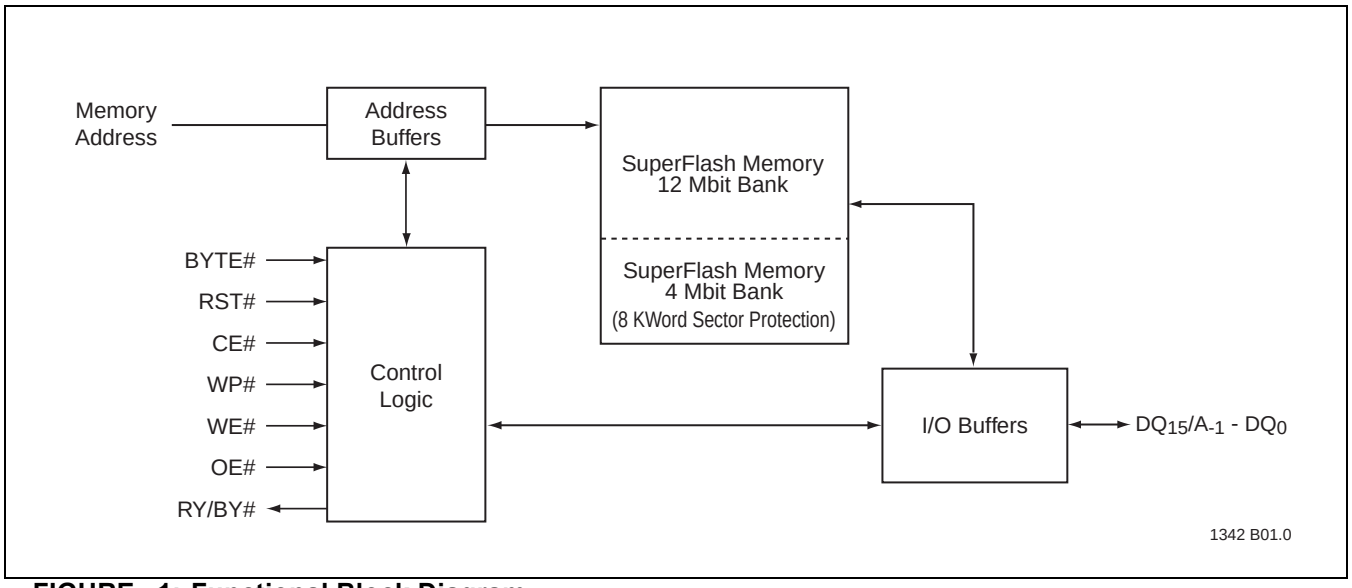
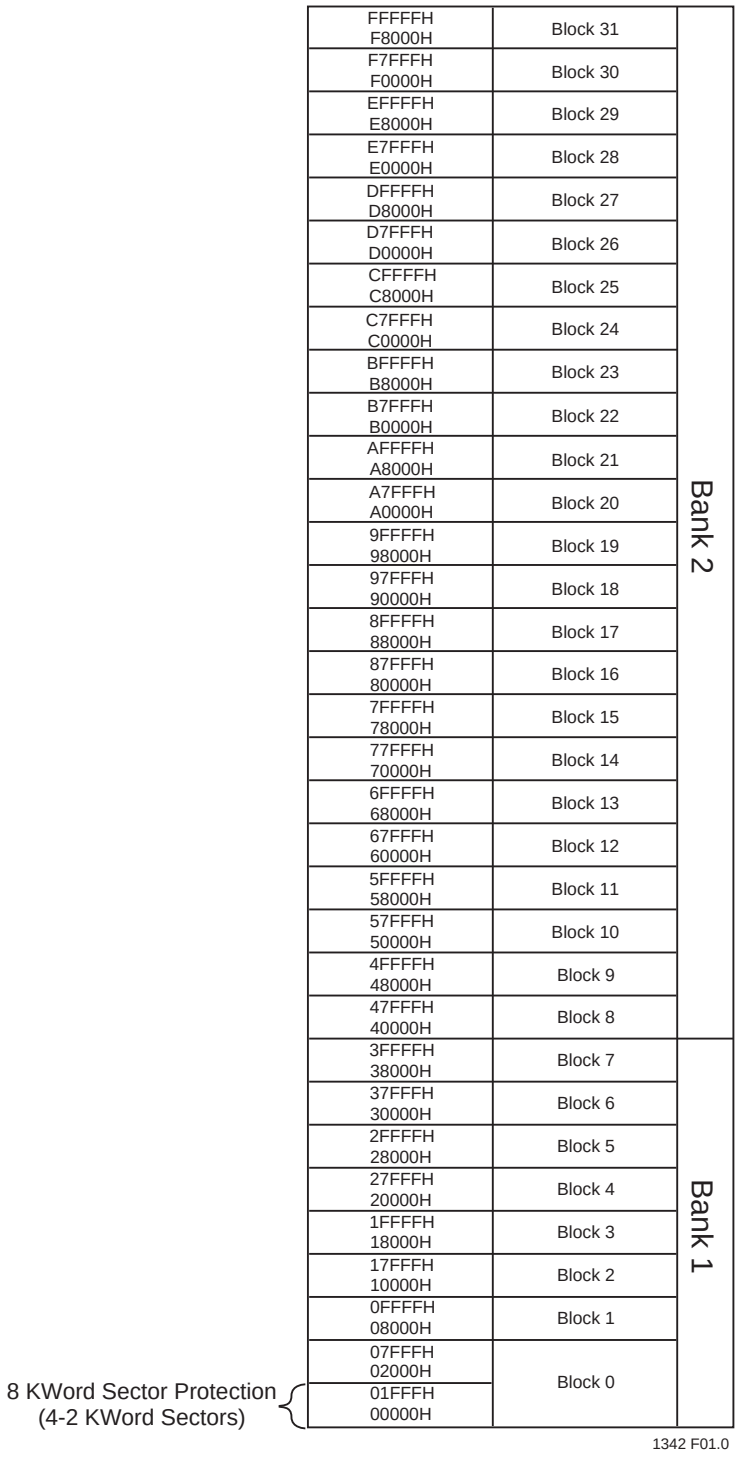


FIGURE 1: Functional Block Diagram

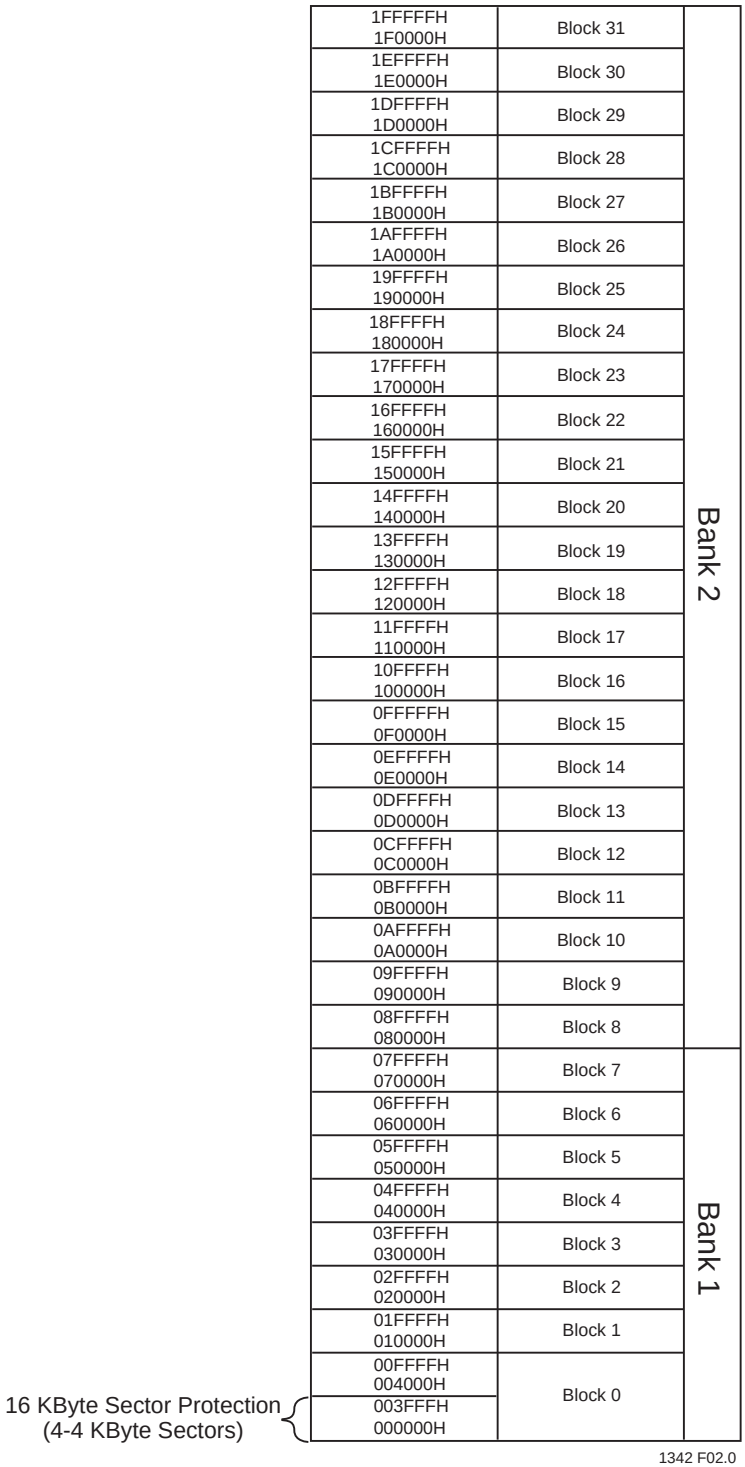
Bottom Sector Protection; 32 KWord Blocks; 2 KWord Sectors



Note: The address input range in x16 mode (BYTE#=V_{IH}) is A_{19}-

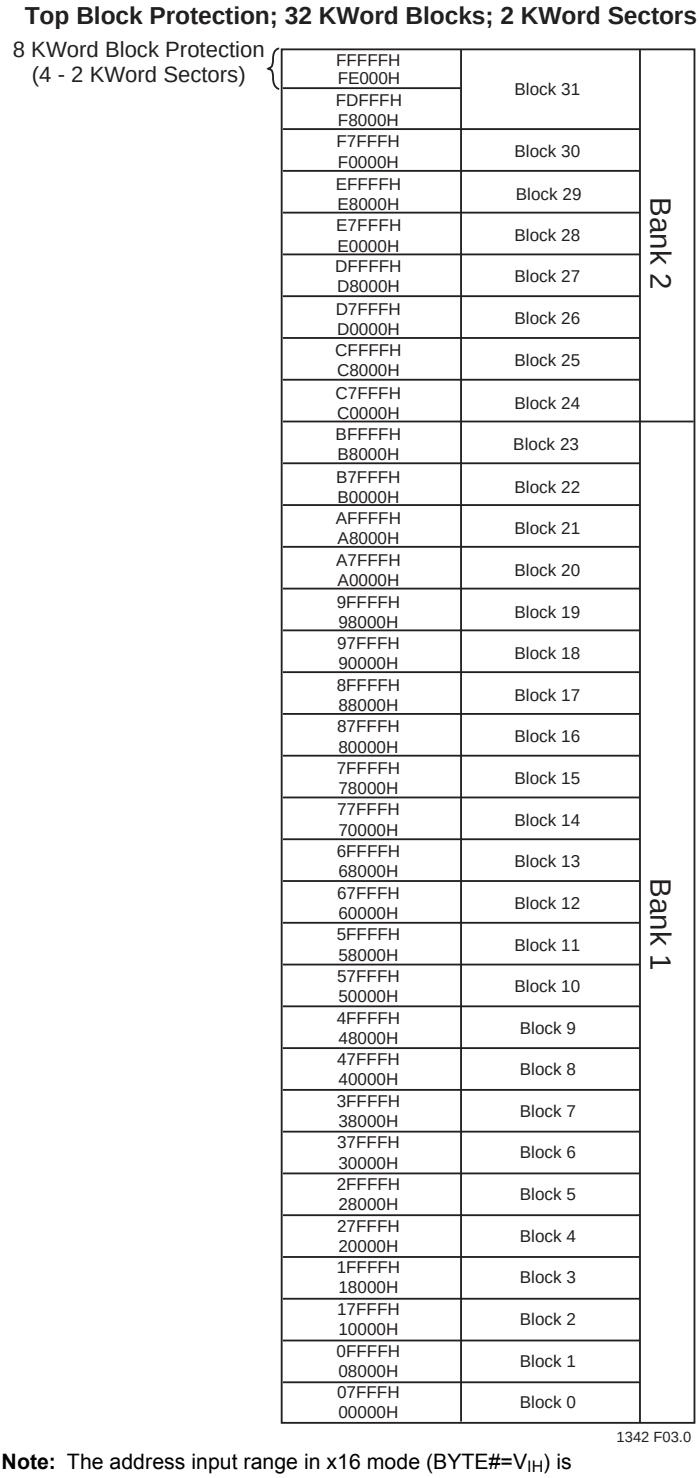
FIGURE 2: GLS36VF1601G, 1M x16 Concurrent SuperFlash Dual-Bank Memory Organization

Bottom Sector Protection; 64 KByte Blocks; 4 KByte Sectors



Note: The address input range in x8 mode (BYTE#=V_{IL})

FIGURE 3: GLS36VF1601G, 2M x8 Concurrent SuperFlash Dual-Bank Memory Organization



Note: The address input range in x16 mode (BYTE#=V_{IH}) is

FIGURE 4: GLS36VF1602G, 1M x16 Concurrent SuperFlash Dual-Bank Memory Organization

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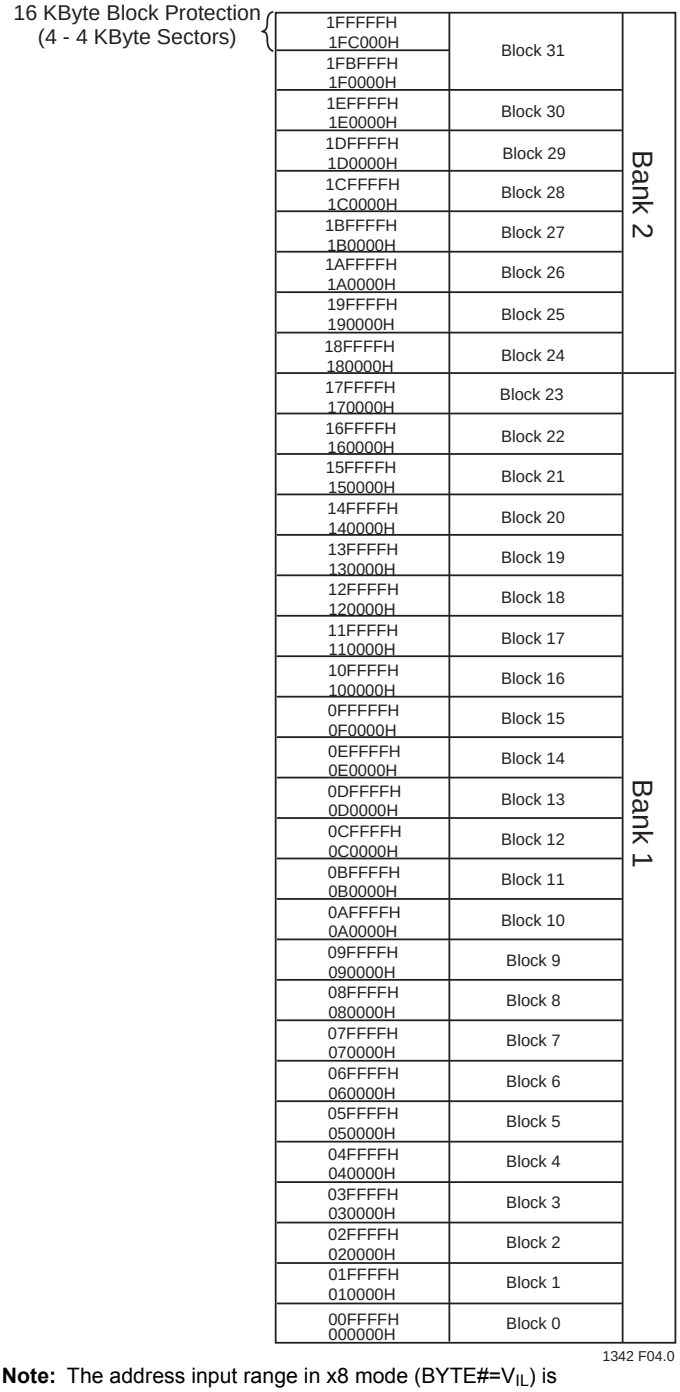
Top Block Protection; 64 KByte Blocks; 4 KByte Sectors



Note: The address input range in x8 mode (BYTE#=V_{IL}) is

FIGURE 5: GLS36VF1602G, 2M x8 Concurrent SuperFlash Dual-Bank Memory Organization

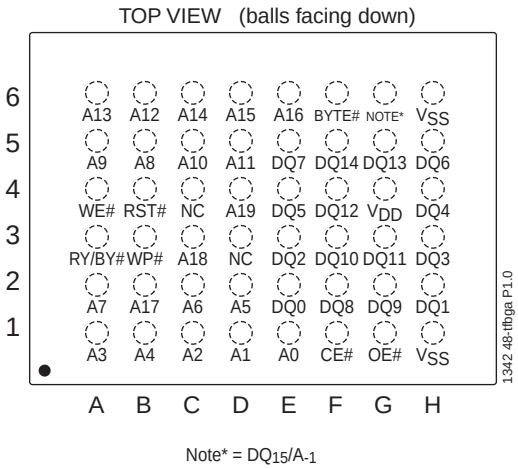


FIGURE 6: Pin Assignments for 48-ball TFBGA (6mm x 8mm)

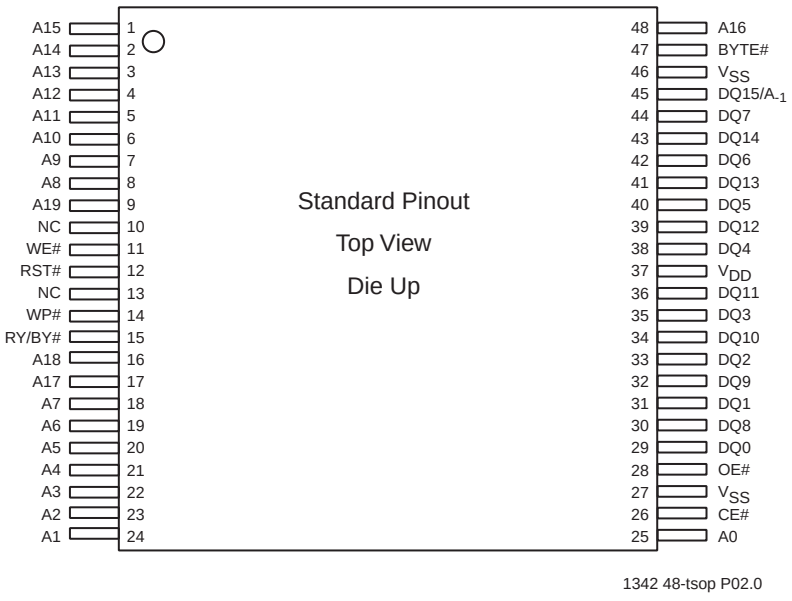


FIGURE 7: Pin Assignments for 48-lead TSOP (12mm x 20mm)

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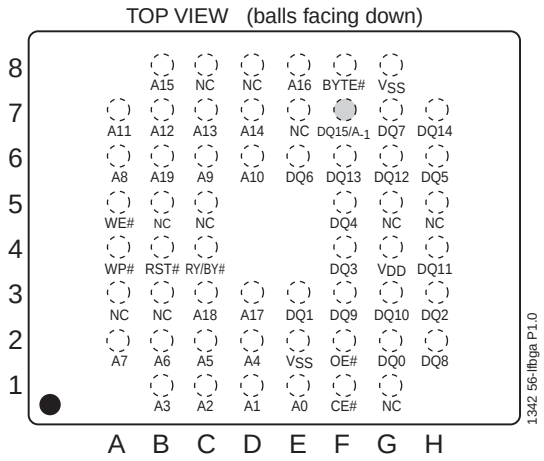

FIGURE 8: Pin Assignments for 56-lead LFBGA (8mm x 10mm)

TABLE 4: Pin Description

Symbol	Name	Functions
A_{19}-A_0	Address Inputs	To provide memory addresses. During Sector-Erase and Hardware Sector Protection, A_{19}-A_{11} address lines will select the sector. During Block-Erase A_{19}-A_{15} address lines will select the block.
DQ_{14}-DQ_0	Data Input/Output	To output data during Read cycles and receive input data during Write cycles Data is internally latched during a Write cycle. The outputs are in tri-state when OE# or CE# is high.
DQ_{15}/A_{-1}	Data Input/Output and LBS Address	DQ_{15} is used as data I/O pin when in x16 mode (BYTE# = "1") A_{-1} is used as the LSB address pin when in x8 mode (BYTE# = "0")
CE#	Chip Enable	To activate the device when CE# is low.
OE#	Output Enable	To gate the data output buffers
WE#	Write Enable	To control the Write operations
RST#	Hardware Reset	To reset and return the device to Read mode
RY/BY#	Ready/Busy#	To output the status of a Program or Erase operation RY/BY# is a open drain output, so a 10KΩ - 100KΩ pull-up resistor is required to allow RY/BY# to transition high indicating the device is ready to read.
WP#	Write Protect	To protect and unprotect top or bottom 8 KWord (4 outermost sectors) from Erase or Program operation.
BYTE#	Word/Byte Configuration	To select 8-bit or 16-bit mode.
V_{DD}	Power Supply	To provide 2.7-3.6V power supply voltage
V_{SS}	Ground	
NC	No Connection	Unconnected pins

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TABLE 5: Operation Modes Selection

Mode[1]	CE#	OE#	WE#	DQ_7-DQ_0	DQ_{15}-DQ_8		Address
					BYTE# = V_{IH}	BYTE# = V_{IL}	
Read	V_{IL}	V_{IL}	V_{IH}	D_{OUT}	D_{OUT}	DQ_{14}-DQ_8 = High Z	A_{IN}
Program	V_{IL}	V_{IH}	V_{IL}	D_{IN}	D_{IN}	DQ_{15} = A_{-1}	A_{IN}
Erase	V_{IL}	V_{IH}	V_{IL}	X[2]	X	High Z	Sector or Block address, 555H for Chip-Erase
Standby	V_{IHC}	X	X	High Z	High Z	High Z	X
Write Inhibit	X	V_{IL}	X	High Z / D_{OUT}	High Z / D_{OUT}	High Z	X
	X	X	V_{IH}	High Z / D_{OUT}	High Z / D_{OUT}	High Z	X
Product Identification							
Software Mode	V_{IL}	V_{IL}	V_{IH}	Manufacturer's ID (BFH)	Manufacturer's ID (00H)	High Z	See Table 6
				Device ID[3]	Device ID[3]	High Z	

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1. RST# = V_{IH} for all described operation modes
2. X can be V_{IL} or V_{IH}, but no other value.
3. Device ID = GLS36VF1601G = 7343H,
   GLS36VF1602G = 7344H

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TABLE 6: 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]
Program	555H	AAH	2AAH	55H	555H	A0H	WA[3]	Data				
Sector-Erase	555H	AAH	2AAH	55H	555H	80H	555H	AAH	2AAH	55H	SA_X[4]	50H
Block-Erase	555H	AAH	2AAH	55H	555H	80H	555H	AAH	2AAH	55H	BA_X[4]	30H
Chip-Erase	555H	AAH	2AAH	55H	555H	80H	555H	AAH	2AAH	55H	555H	10H
Erase-Suspend	XXXXH	B0H										
Erase-Resume	XXXXH	30H										
Query Sec ID[5]	555H	AAH	2AAH	55H	555H	88H						
User Security ID Program	555H	AAH	2AAH	55H	555H	A5H	SIWA[6]	Data				
User Security ID Program Lock-out[7]	555H	AAH	2AAH	55H	555H	85H	XXH	0000H				
Software ID Entry[8]	555H	AAH	2AAH	55H	BK_X[9] 555H	90H						
CFI Query Entry	555H	AAH	2AAH	55H	BK_X[9] 555H	98H						
CFI Query Entry	BK_X[9] 55H	98H										
Software ID Exit/ CFI Exit/ Sec ID Exit[10,11]	555H	AAH	2AAH	55H	555H	F0H						
Software ID Exit/ CFI Exit/ Sec ID Exit[10,11]	XXH	F0H										

T6.0 1342

1. Address format A_{10}-A_0 (Hex), Addresses A_{19}-A_{11} can be V_{IL} or V_{IH}, but no other value, for the command sequence when in x16 mode. When in x8 mode, Addresses A_{19}-A_{12}, Address A_{-1} and DQ_{14}-DQ_8 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/byte address
4. SA_X for Sector-Erase; uses A_{19}-A_{11} address lines
   BA_X for Block-Erase; uses A_{19}-A_{15} address lines
5. For GLS36VF1601G,
   Greenliant ID is read with A_3 = 0 (Address range = 00000H to 00007H),
   User ID is read with A_3 = 1 (Address range = = 00008H to 00087H).
   Lock Status is read with A_7-A_0 = 000FFH. Unlocked: DQ_3 = 1 / Locked: DQ_3 = 0.
   For GLS36VF1602G,
   Greenliant ID is read with A_3 = 0 (Address range = C0000H to C0007H),
   User ID is read with A_3 = 1 (Address range = = C0008H to C0087H).
   Lock Status is read with A_7-A_0 = C00FFH. Unlocked: DQ_3 = 1 / Locked: DQ_3 = 0.
6. SIWA = User Security ID Program word/byte address
   For GLS36VF1601G, valid Word-Addresses for User Sec ID are from 00008H to 00087H.
   For GLS36VF1602G, valid Word-Addresses for User Sec ID are from C0008H to C0087H.
   All 4 cycles of User Security ID Program and Program Lock-out must be completed before going back to Read-Array mode.
7. The User Security ID Program Lock-out command must be executed in x16 mode (BYTE#=V_{IH}).
8. The device does not remain in Software Product Identification mode if powered down.
9. A_{19} and A_{18} = BK_X (Bank Address): address of the bank that is switched to Software ID/CFI Mode
   With A_{17}-A_1 = 0;Greenliant Manufacturer's ID = 00BFH, is read with A_0 = 0
   GLS36VF1601G Device ID = 7343H, is read with A0 = 1
   GLS36VF1602G Device ID = 7344H, is read with A0 = 1
10. Both Software ID Exit operations are equivalent

11. If users never lock after programming, User Sec ID can be programmed over the previously unprogrammed bits (data=1) using the User Sec ID mode again (the programmed “0” bits cannot be reversed to “1”).
For GLS36VF1601G, valid Word-Addresses for User Sec ID are from 00008H to 00087H.
For GLS36VF1602G, valid Word-Addresses for User Sec ID are from C0008H to C0087H.

TABLE 7: CFI Query Identification String[1]

Address x16 Mode	Address x8 Mode	Data[2]	Description
10H	20H	0051H	Query Unique ASCII string “QRY”
11H	22H	0052H	
12H	24H	0059H	
13H	26H	0002H	Primary OEM command set
14H	28H	0000H	
15H	2AH	0000H	Address for Primary Extended Table
16H	2CH	0000H	
17H	2EH	0000H	Alternate OEM command set (00H = none exists)
18H	30H	0000H	
19H	32H	0000H	Address for Alternate OEM extended Table (00H = none exits)
1AH	34H	0000H	

T7.0 1342

1. Refer to CFI publication 100 for more details.
2. In x8 mode, only the lower byte of data is output.

TABLE 8: System Interface Information

Address x16 Mode	Address x8 Mode	Data[1]	Description
1BH	36H	0027H	V_{DD} Min (Program/Erase) DQ_7-DQ_4: Volts, DQ_3-DQ_0: 100 millivolts
1CH	38H	0036H	V_{DD} Max (Program/Erase) DQ_7-DQ_4: Volts, DQ_3-DQ_0: 100 millivolts
1DH	3AH	0000H	V_{PP} min (00H = no V_{PP} pin)
1EH	3CH	0000H	V_{PP} max (00H = no V_{PP} pin)
1FH	3EH	0004H	Typical time out for Program 2^N µs (2^4 = 16 µs)
20H	40H	0000H	Typical time out for min size buffer program 2^N µs (00H = not supported)
21H	42H	0004H	Typical time out for individual Sector/Block-Erase 2^N ms (2^4 = 16 ms)
22H	44H	0006H	Typical time out for Chip-Erase 2^N ms (2^6 = 64 ms)
23H	46H	0001H	Maximum time out for Program 2^N times typical (2^1 x 2^4 = 32 µs)
24H	48H	0000H	Maximum time out for buffer program 2^N times typical
25H	4AH	0001H	Maximum time out for individual Sector-/Block-Erase 2^N times typical (2^1 x 2^4 = 32 ms)
26H	4CH	0001H	Maximum time out for Chip-Erase 2^N times typical (2^1 x 2^6 = 128 ms)

T8.0 1342

1. In x8 mode, only the lower byte of data is output.

Data Sheet

TABLE 9: Device Geometry Information

Address x16 Mode	Address x8 Mode	Data[1]	Description
27H	4EH	0015H	Device size = 2^N Bytes (15H = 21; 2^{21} = 2 MByte)
28H	50H	0002H	Flash Device Interface description; 0002H = x8/x16 asynchronous interface
29H	52H	0000H	
2AH	54H	0000H	Maximum number of bytes in multi-byte write = 2^N (00H = not supported)
2BH	56H	0000H	
2CH	58H	0002H	Number of Erase Sector/Block sizes supported by device
2DH	5AH	00FFH	Sector Information (y + 1 = Number of sectors; z x 256B = sector size)
2EH	5CH	0001H	y = 511 + 1 = 512 sectors (01FFH = 512)
2FH	5EH	0010H	
30H	60H	0000H	z = 16 x 256 Bytes = 4 KByte/sector (0010H = 16)
31H	62H	001FH	Block Information (y + 1 = Number of blocks; z x 256B = block size)
32H	64H	0000H	y = 31 + 1 = 32 blocks (001FH = 31)
33H	66H	0000H	
34H	68H	0001H	z = 256 x 256 Bytes = 64 KByte/block (0100H = 256)

T9.1 1342

1. In x8 mode, only the lower byte of data is output.

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.)

Temperature Under Bias . . . . . -55°C to +125°C
Storage Temperature . . . . . -65°C to +150°C
D. C. Voltage on Any Pin to Ground Potential . . . . . -0.5V to V_{DD}+0.5V
Transient Voltage (<20 ns) on Any Pin to Ground Potential. . . . . -2.0V to V_{DD}+2.0V
Package Power Dissipation Capability (T_A = 25°C) 1.0W
Surface Mount Solder Reflow Temperature . . . . . 260°C for 10 seconds
Output Short Circuit Current . . . . . 50 mA

Operating Range:

Range	Ambient Temp	V_{DD}
Commercial	0°C to +70°C	2.7-3.6V
Industrial	-40°C to +85°C	2.7-3.6V

AC Conditions of Test

Input Rise/Fall Time	5 ns
Output Load	C_L = 30 pF
See Figures 23 and 24	

Data Sheet

TABLE 10: DC Operating Characteristics V_{DD} = 2.7-3.6V

Symbol	Parameter	Freq	Limits			Test Conditions
			Min	Max	Units	
I_{DD}[1]	Active V_{DD} Current					
	Read	5 MHz		15	mA	CE#=V_{IL}, WE#=OE#=V_{IH}
		1 MHz		4	mA	
	Program and Erase			30	mA	CE#=WE#=V_{IL}, OE#=V_{IH}
	Concurrent Read/Write	5 MHz		45	mA	CE#=V_{IL}, OE#=V_{IH}
		1 MHz		35	mA	
I_{SB}	Standby V_{DD} Current			20	µA	CE#, RST#=V_{DD}±0.3V
I_{ALP}	Auto Low Power V_{DD} Current			20	µA	CE#=0.1V, V_{DD}=V_{DD} Max WE#=V_{DD}-0.1V Address inputs=0.1V or V_{DD}-0.1V
I_{RT}	Reset V_{DD} Current			20	µA	RST#=GND
I_{LI}	Input Leakage Current			1	µA	V_{IN} =GND to V_{DD}, V_{DD}=V_{DD} Max
I_{LIW}	Input Leakage Current on WP# pin and RST# pin			10	µA	WP#=GND to V_{DD}, V_{DD}=V_{DD} Max RST#=GND to V_{DD}, V_{DD}=V_{DD} Max
I_{LO}	Output Leakage Current			1	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_{DD}+0.3	V	V_{DD}=V_{DD} Max
V_{IHC}	Input High Voltage (CMOS)		V_{DD}-0.3	V_{DD}+0.3	V	V_{DD}=V_{DD} Max
V_{OL}	Output Low Voltage			0.2	V	I_{OL}=100 µA, V_{DD}=V_{DD} Min
V_{OH}	Output High Voltage		V_{DD}-0.2		V	I_{OH}=-100 µA, V_{DD}=V_{DD} Min

T10.1 1342

1. Address input = V_{ILT}/V_{IHT}, V_{DD}=V_{DD} Max (See Figure 23)

TABLE 11: 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 Write Operation	100	µs

T11.0 1342

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

TABLE 12: Capacitance (T_A = 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	10 pF
C_{IN}[1]	Input Capacitance	V_{IN} = 0V	10 pF

T12.0 1342

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

TABLE 13: 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

T13.0 1342

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

AC CHARACTERISTICS

TABLE 14: Read Cycle Timing Parameters V_{DD} = 2.7-3.6V

Symbol	Parameter	Min	Max	Units
T_{RC}	Read Cycle Time	70		ns
T_{CE}	Chip Enable Access Time		70	ns
T_{AA}	Address Access Time		70	ns
T_{OE}	Output Enable Access Time		35	ns
T_{CLZ}[1]	CE# Low to Active Output	0		ns
T_{OLZ}[1]	OE# Low to Active Output	0		ns
T_{CHZ}[1]	CE# High to High-Z Output		16	ns
T_{OHZ}[1]	OE# High to High-Z Output		16	ns
T_{OH}[1]	Output Hold from Address Change	0		ns
T_{RP}[1]	RST# Pulse Width	500		ns
T_{RHR}[1]	RST# High before Read	50		ns
T_{RY}[1,2]	RST# Pin Low to Read Mode		20	µs

T14.1 1342

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.
2. This parameter applies to Sector-Erase, Block-Erase, and Program operations.
   This parameter does not apply to Chip-Erase operations.

TABLE 15: Program/Erase Cycle Timing Parameters

Symbol	Parameter	Min	Max	Units
T_{BP}	Program Time		10	µs
T_{AS}	Address Setup Time	0		ns
T_{AH}	Address Hold Time	40		ns
T_{CS}	WE# and CE# Setup Time	0		ns
T_{CH}	WE# and CE# Hold Time	0		ns
T_{OES}	OE# High Setup Time	0		ns
T_{OEH}	OE# High Hold Time	10		ns
T_{CP}	CE# Pulse Width	40		ns
T_{WP}	WE# Pulse Width	40		ns
T_{WPH}[1]	WE# Pulse Width High	30		ns
T_{CPH}[1]	CE# 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
T_{ES}	Erase-Suspend Latency		10	µs
T_{BY}[1,2]	RY/BY# Delay Time		90	ns
T_{BR}[1]	Bus Recovery Time		0	µs

T15.1 1342

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.
2. This parameter applies to Sector-Erase, Block-Erase, and Program operations.
   This parameter does not apply to Chip-Erase operations.

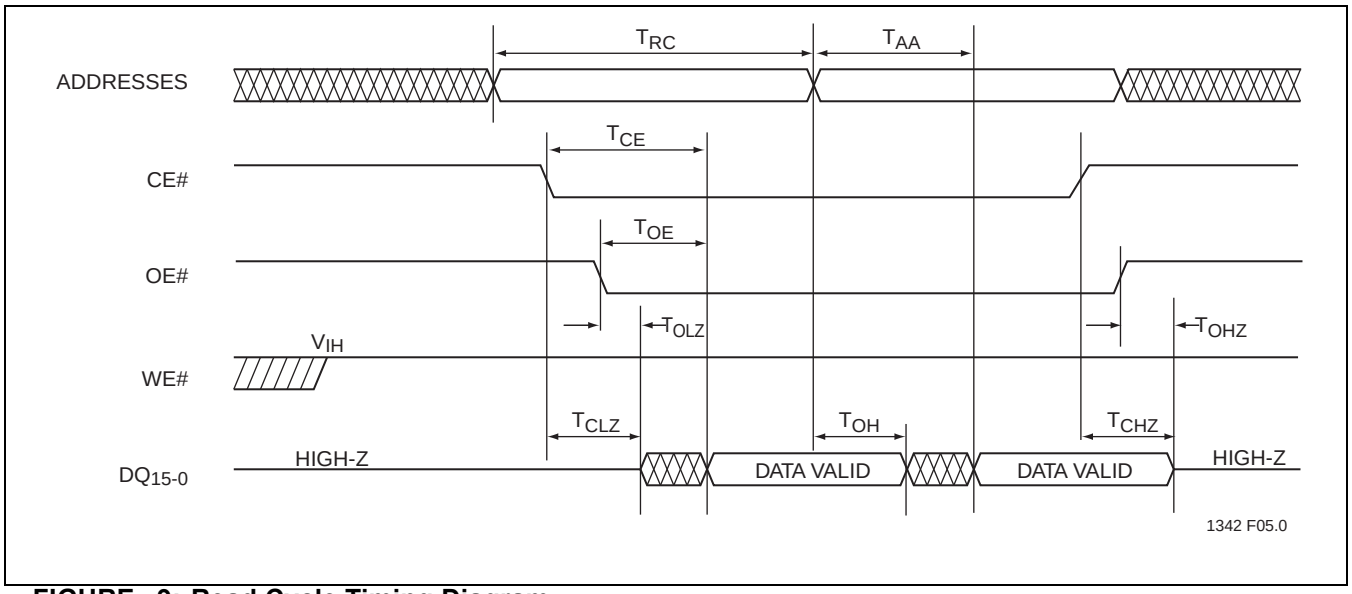
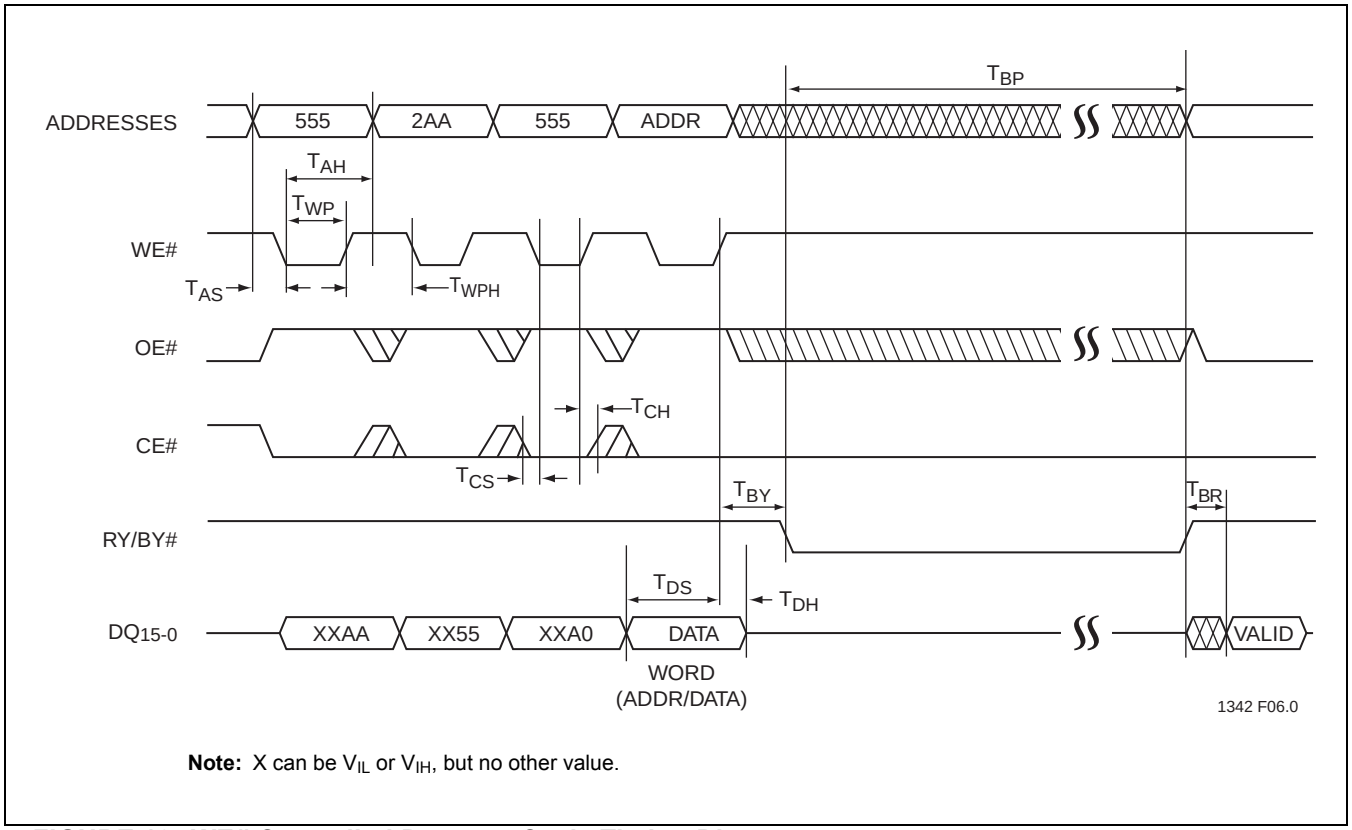
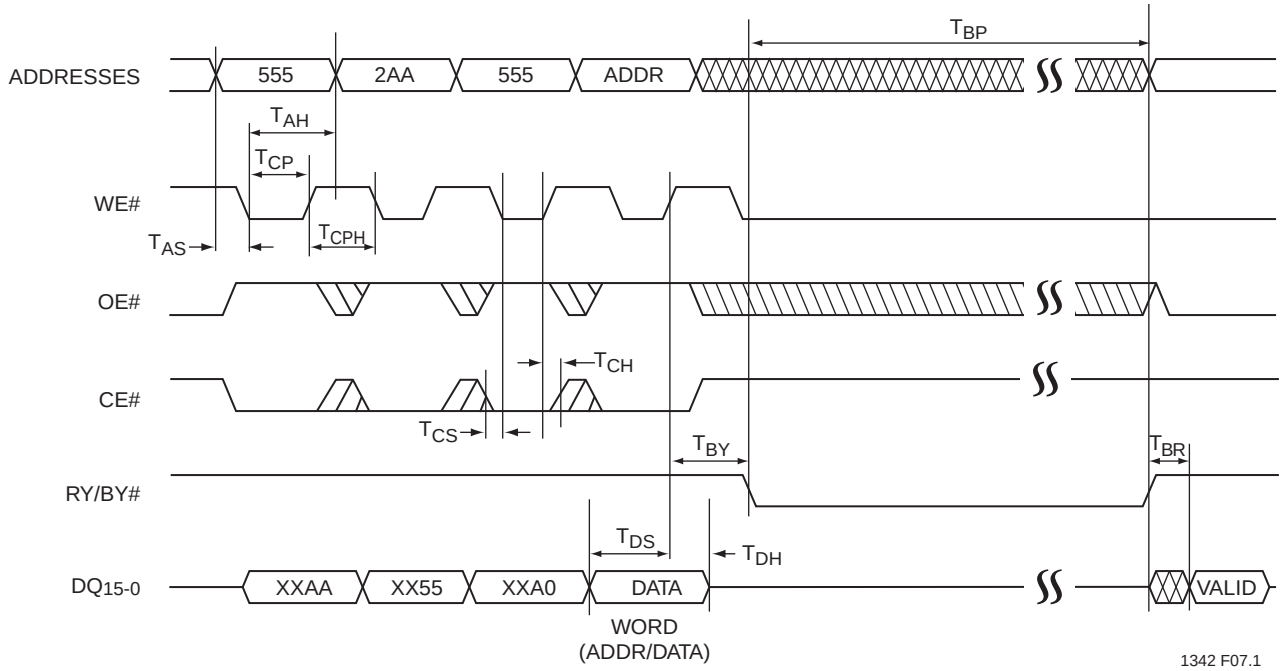


FIGURE 9: Read Cycle Timing Diagram



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

FIGURE 10: WE# Controlled Program Cycle Timing Diagram



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

FIGURE 11: CE# Controlled Program Cycle Timing Diagram

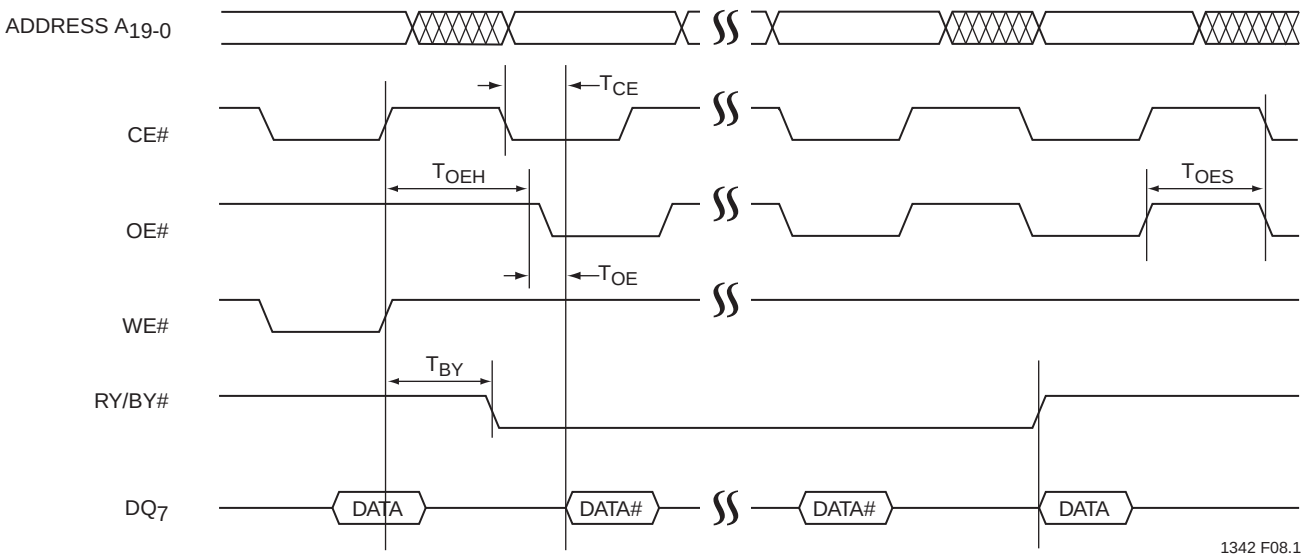


FIGURE 12: Data# Polling Timing Diagram

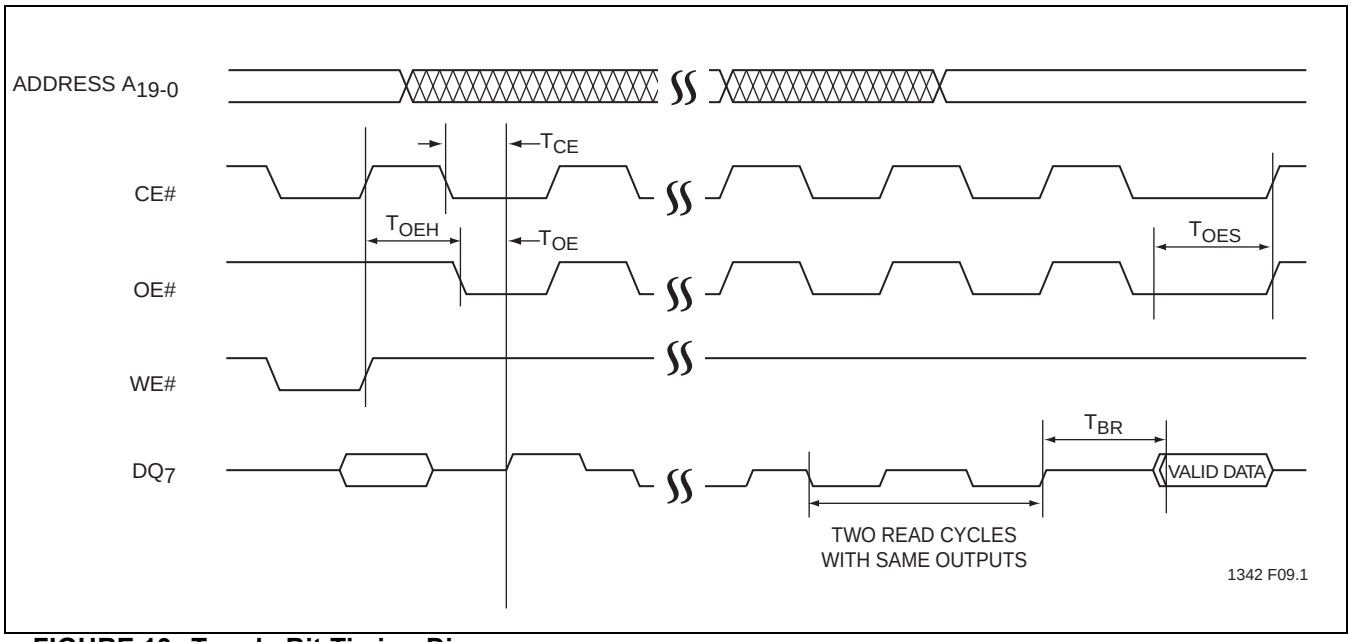
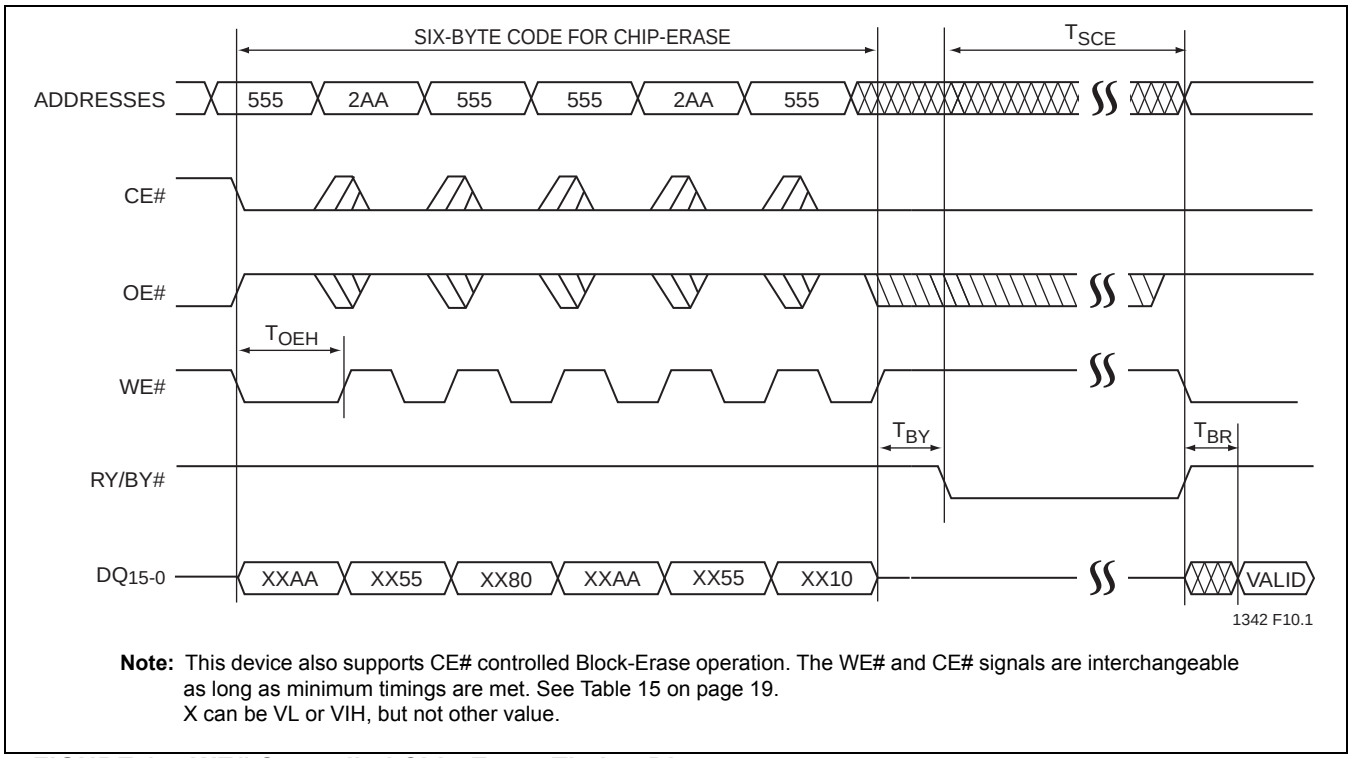
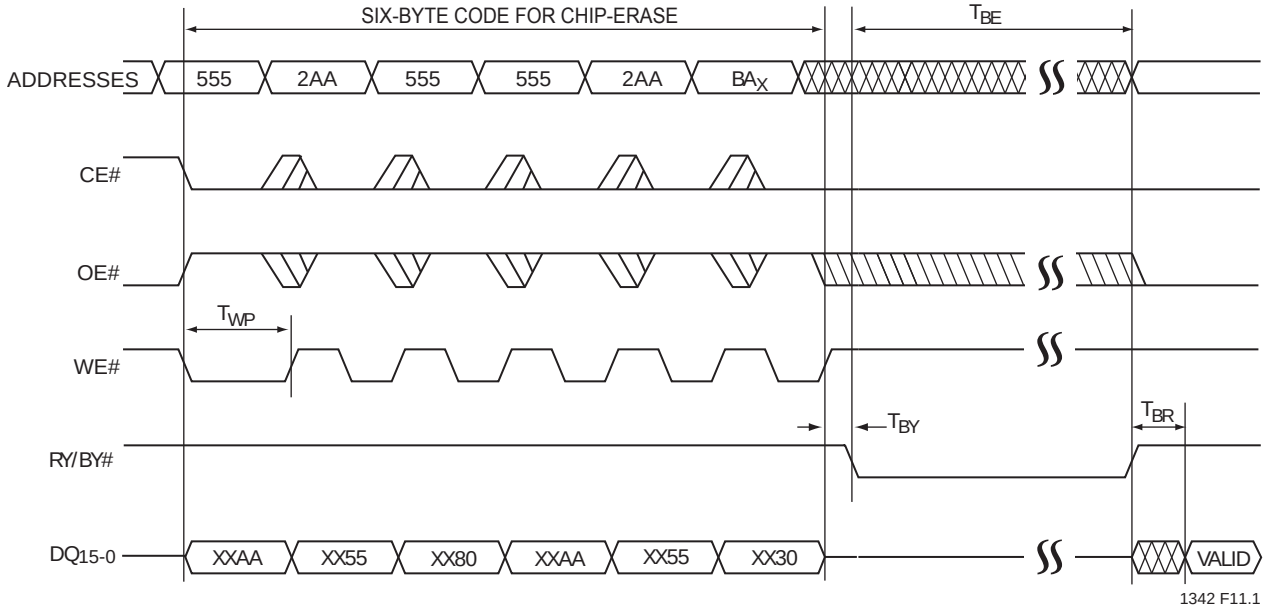


FIGURE 13: Toggle Bit Timing Diagram



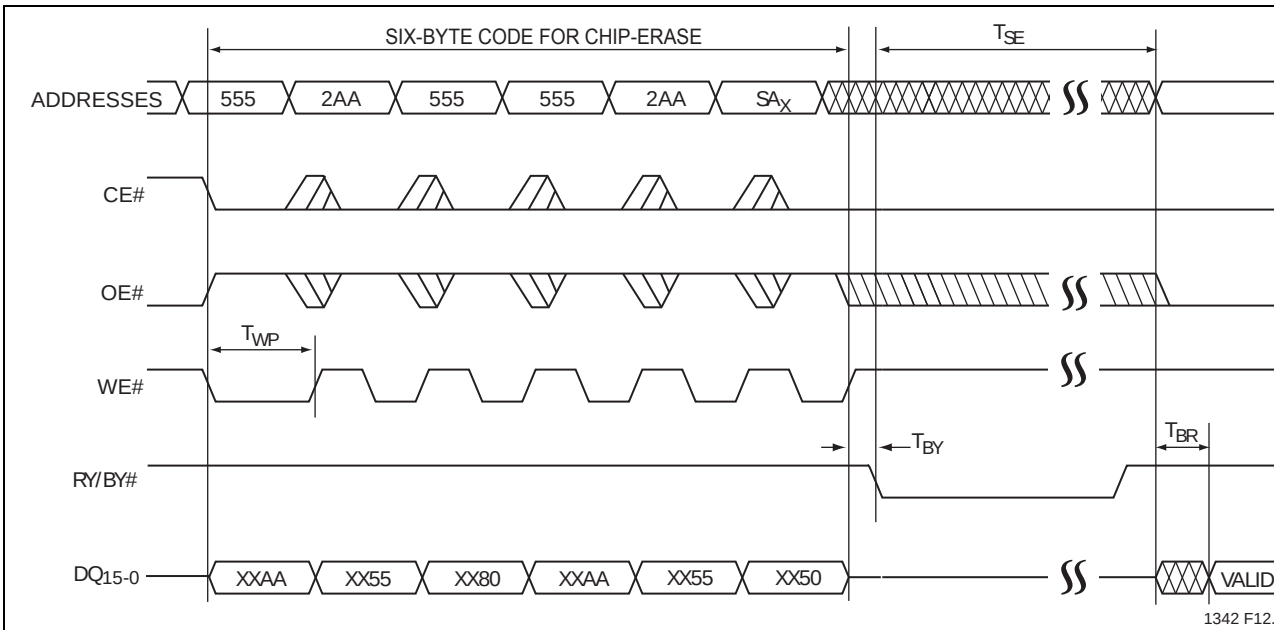
Note: This device also supports CE# controlled Block-Erase operation. The WE# and CE# signals are interchangeable as long as minimum timings are met. See Table 15 on page 19.
X can be VL or VIH, but not other value.

FIGURE 14: WE# Controlled Chip-Erase Timing Diagram



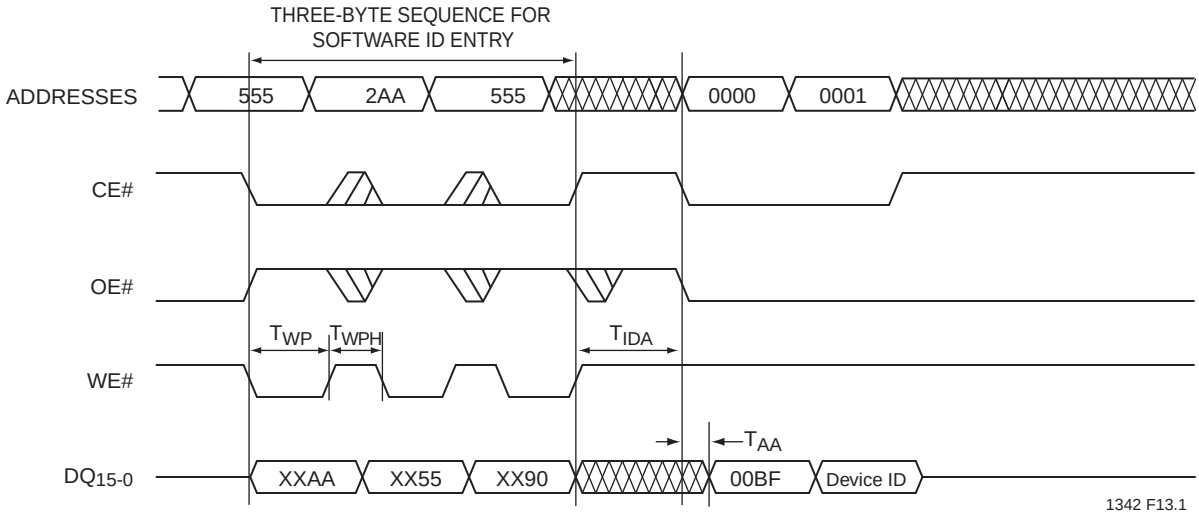
Note: This device also supports CE# controlled Block-Erase operation. The WE# and CE# signals are interchangeable as long as minimum timings are met. See Table 15 on page 19.
BAx = Block Address
X can be VL or VIH, but not other value.

FIGURE 15: WE# Controlled Block-Erase Timing Diagram



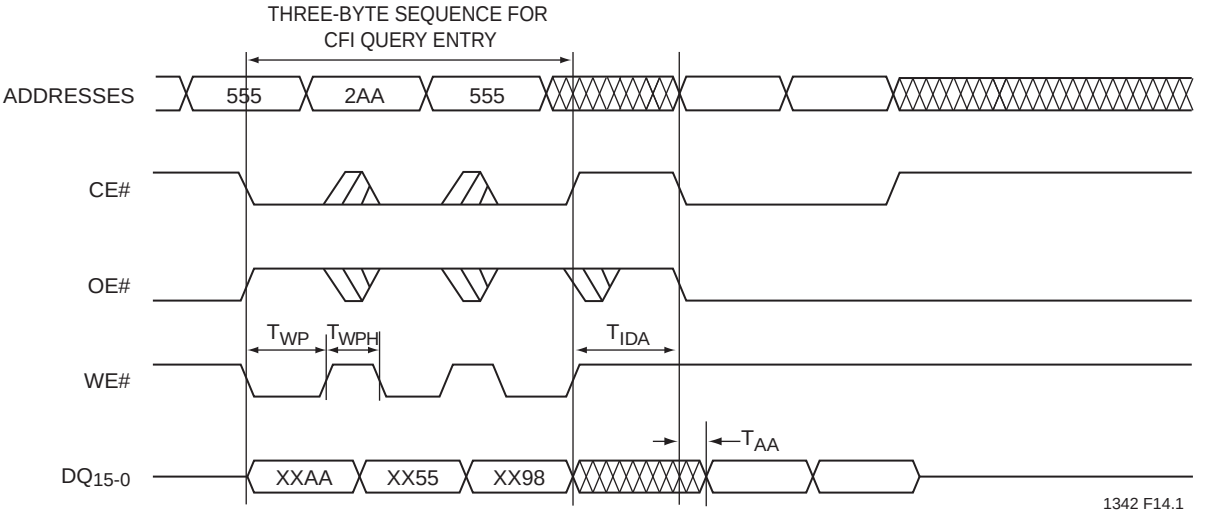
Note: This device also supports CD# controlled Sector-Erase operation. The WE# and CE# signals are interchangeable as long as minimum timings are met. See Table 15 on page 19.
BAx = Block Address
X can be VL or VIH, but no other value.

FIGURE 16: WE# Controlled Sector-Erase Timing Diagram



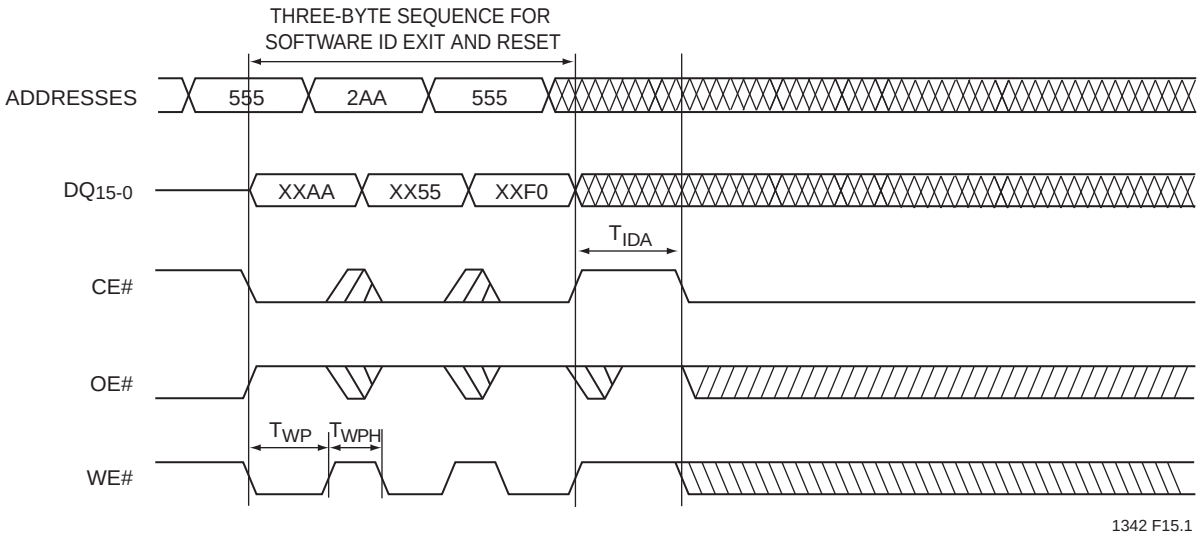
Note: Device ID = 7343H for GLS36VF1601G, and 7344H for GLS36VF1602G
X can be V_{IL} or V_{IH}, but no other value.

FIGURE 17: Software ID Entry and Read



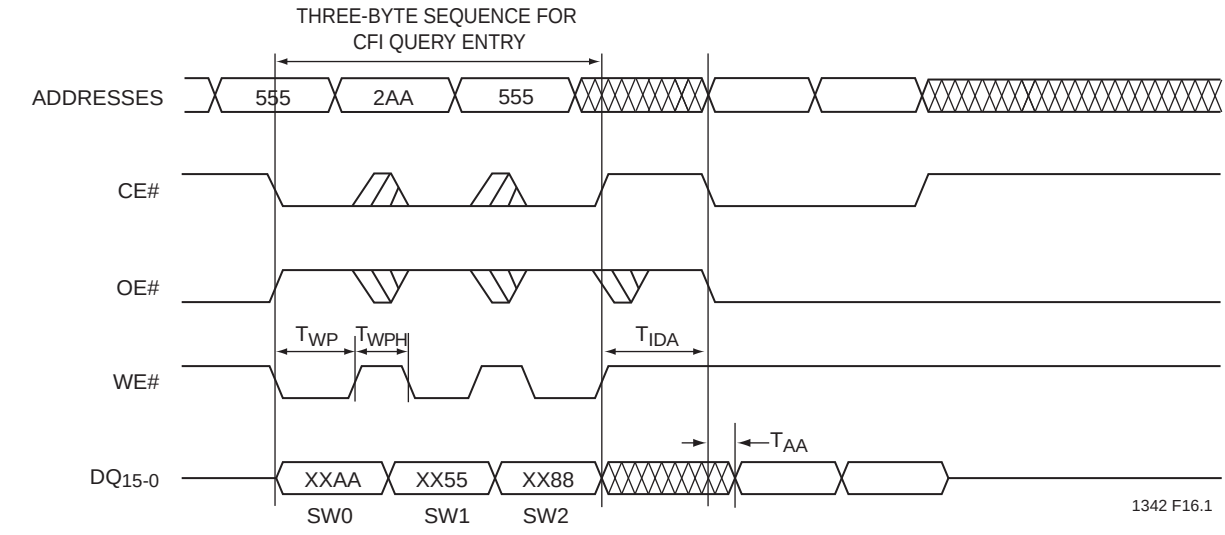
Note: X can be V_{IL} or V_{IH}, but no other value.

FIGURE 18: CFI Entry and Read



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

FIGURE 19: Software ID Exit/CFI Exit



Note: WP# must be held in proper logic state (V_{IL} or V_{IH}) 1µs prior to and 1 µs after the command sequence.
X can be V_{IL} or V_{IH}, but no other value.

FIGURE 20: Sec ID Entry

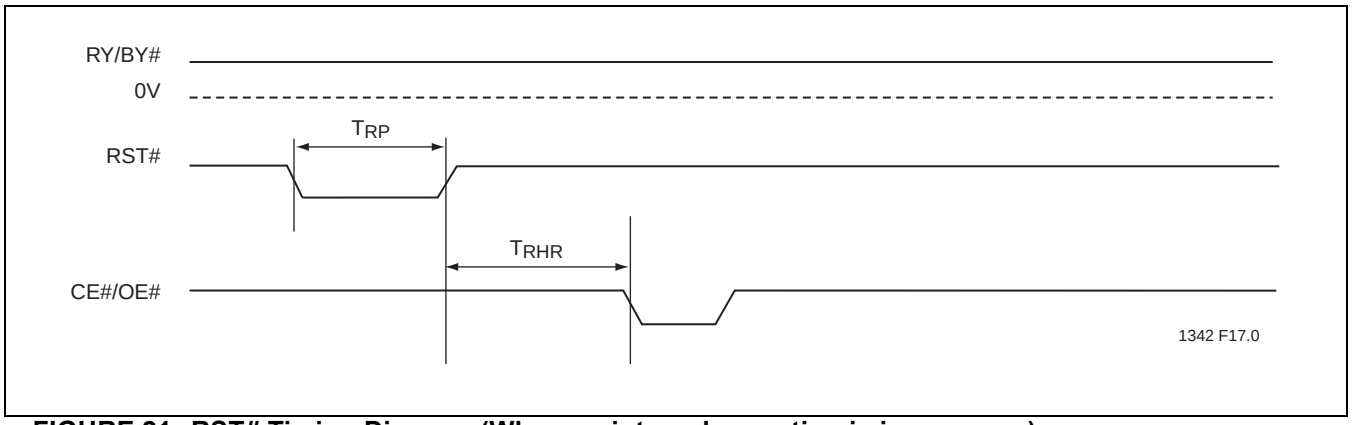


FIGURE 21: RST# Timing Diagram (When no internal operation is in progress)

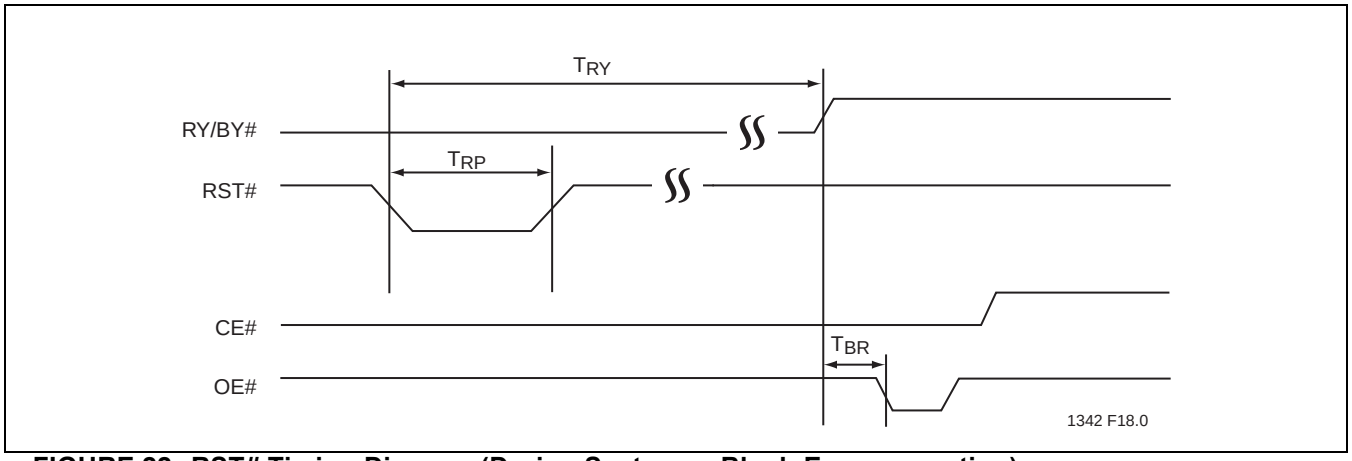
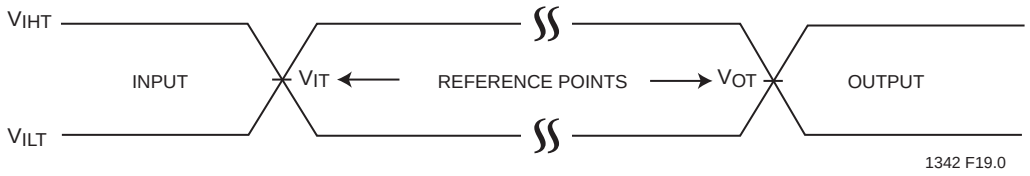


FIGURE 22: RST# Timing Diagram (During Sector- or Block-Erase operation)



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 23: AC Input/Output Reference Waveforms

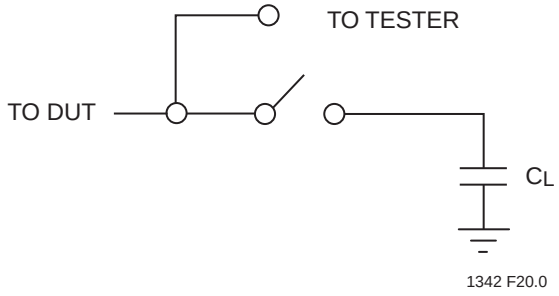
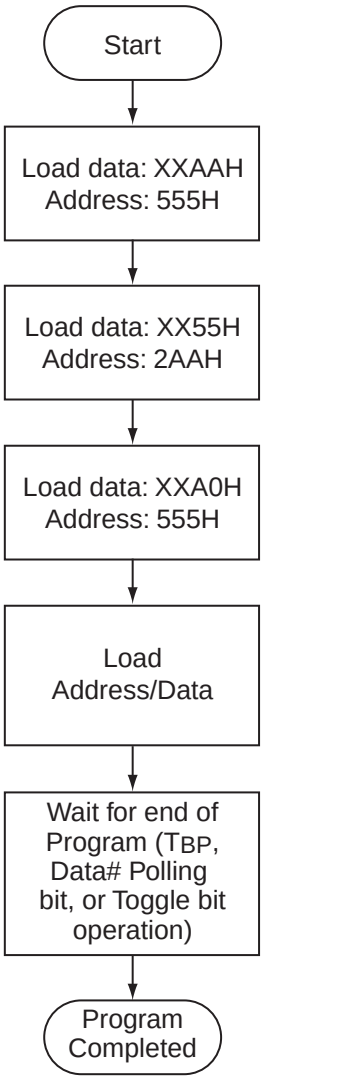


FIGURE 24: A Test Load Example



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

FIGURE 25: Program Algorithm

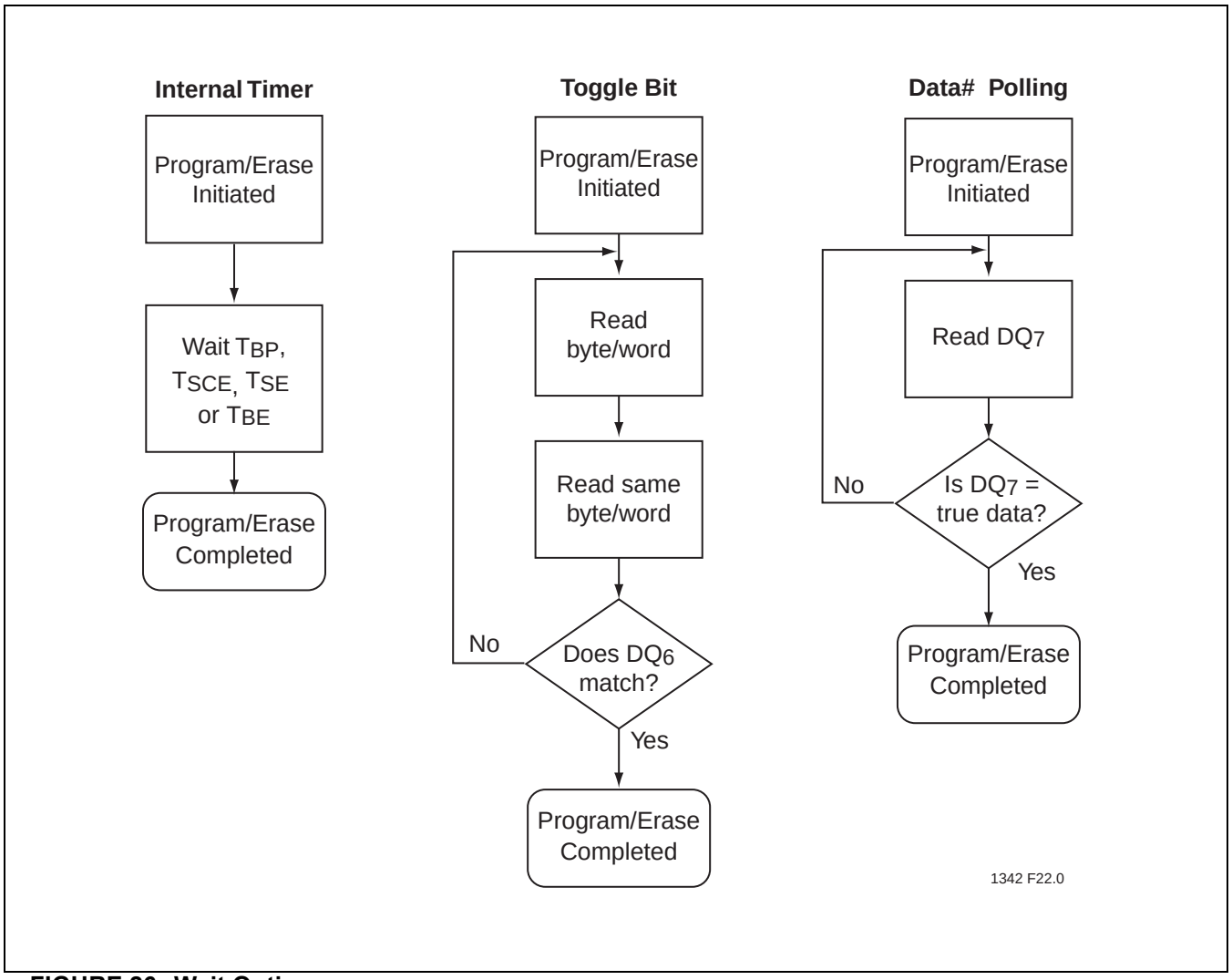


FIGURE 26: Wait Options

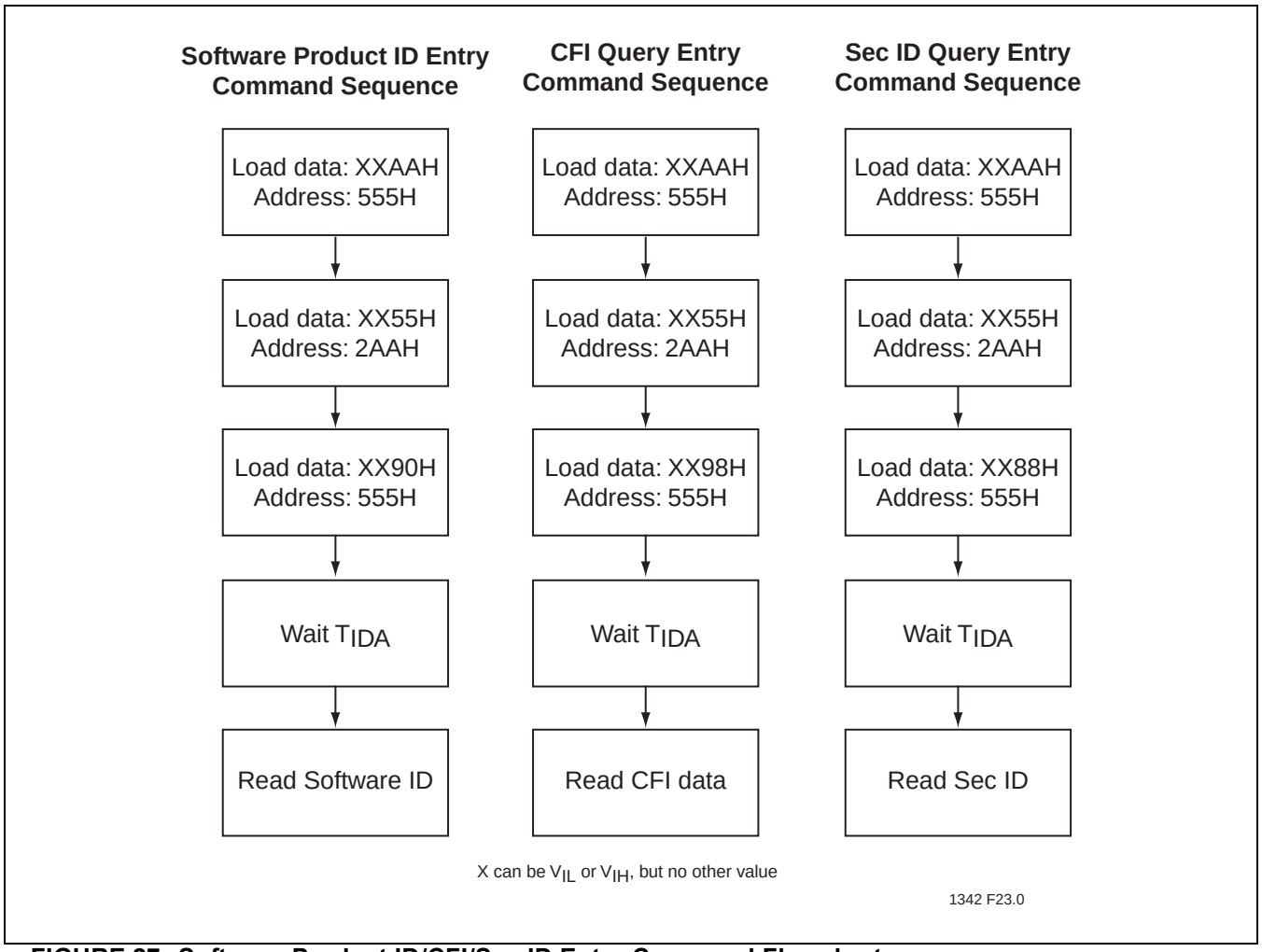


FIGURE 27: Software Product ID/CFI/Sec ID Entry Command Flowcharts

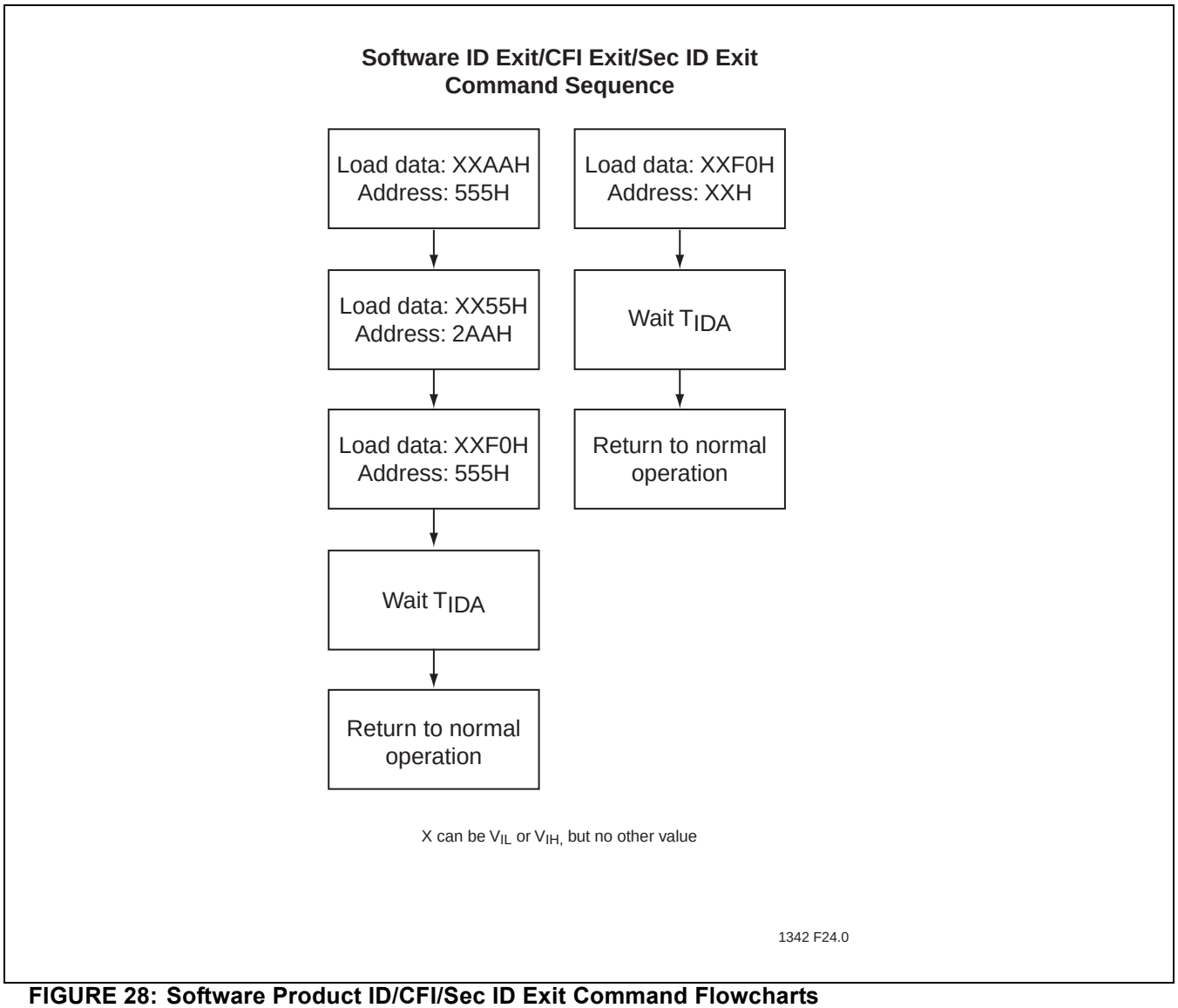
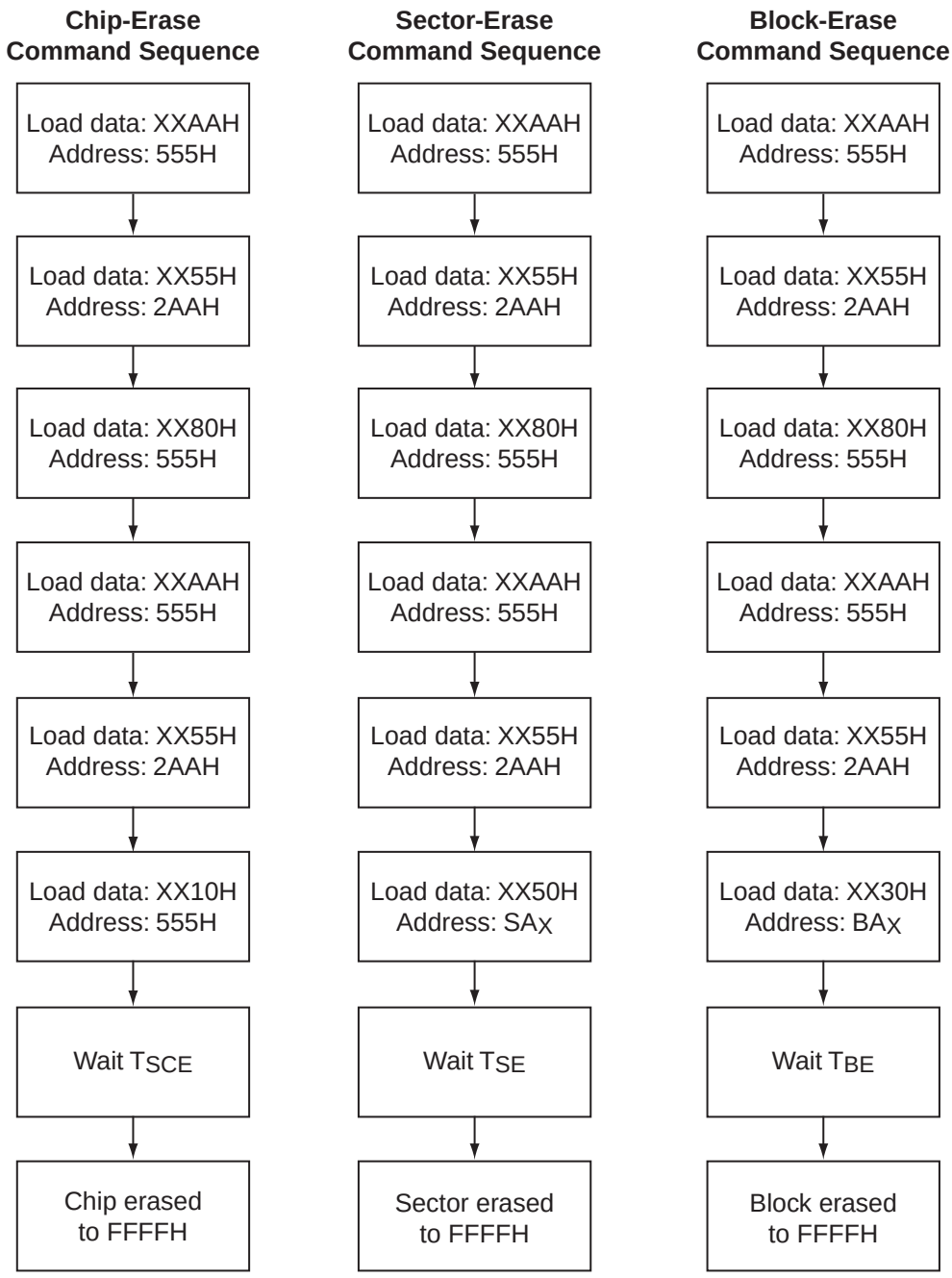


FIGURE 28: Software Product ID/CFI/Sec ID Exit Command Flowcharts

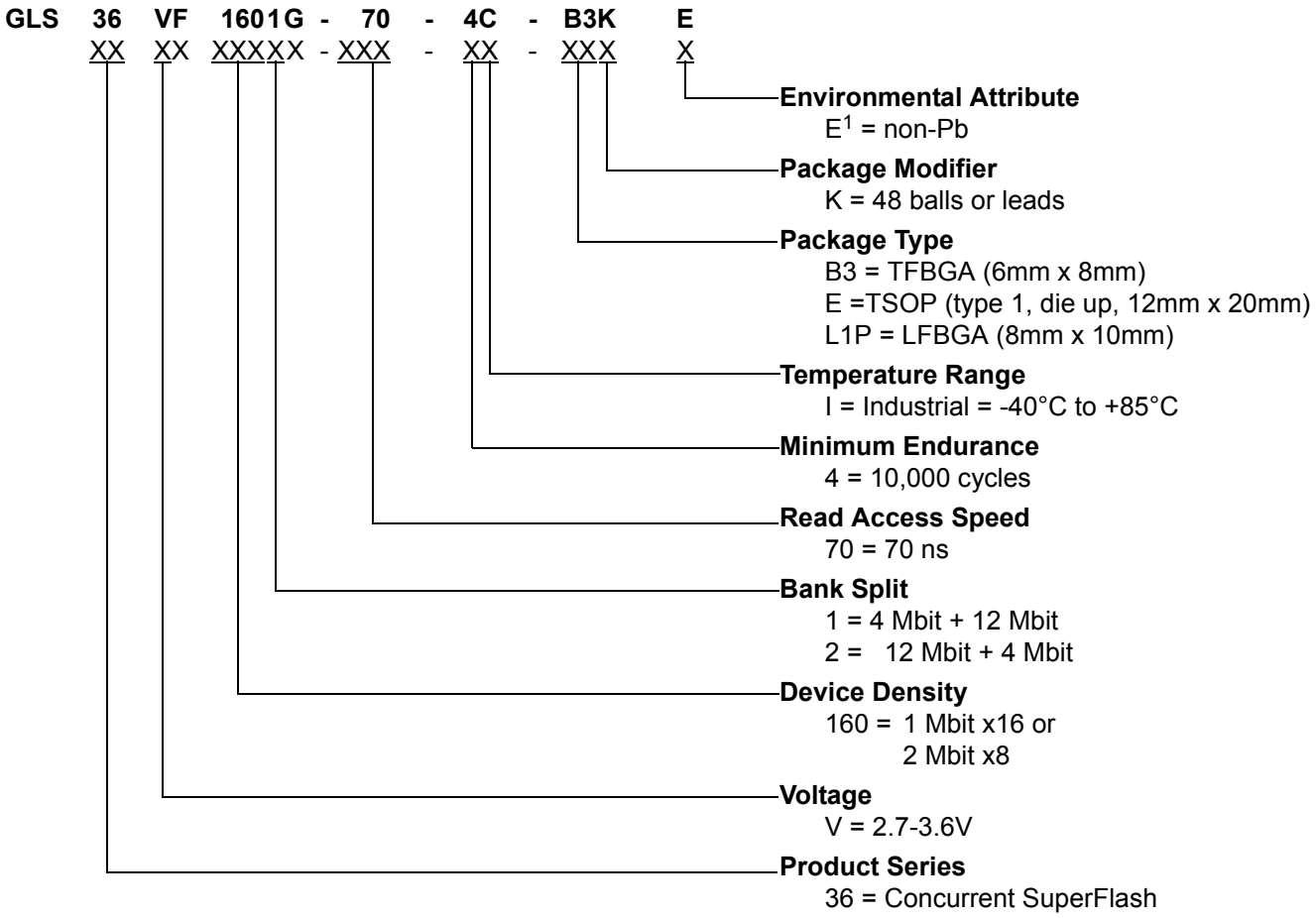


Note: X can be V_{IL} or V_{IH}, but no other value.

FIGURE 29: Erase Command Sequence

Data Sheet

PRODUCT ORDERING INFORMATION



1. Environmental suffix "E" denotes non-Pb solder. Greenliant non-Pb solder devices are "RoHS Compliant".

Valid combinations for GLS36VF1601G

GLS36VF1601G-70-4C-B3KE	GLS36VF1601G-70-4C-EKE	GLS36VF1601G-70-4C-L1PE
GLS36VF1601G-70-4I-B3KE	GLS36VF1601G-70-4I-EKE	GLS36VF1601G-70-4I-L1PE

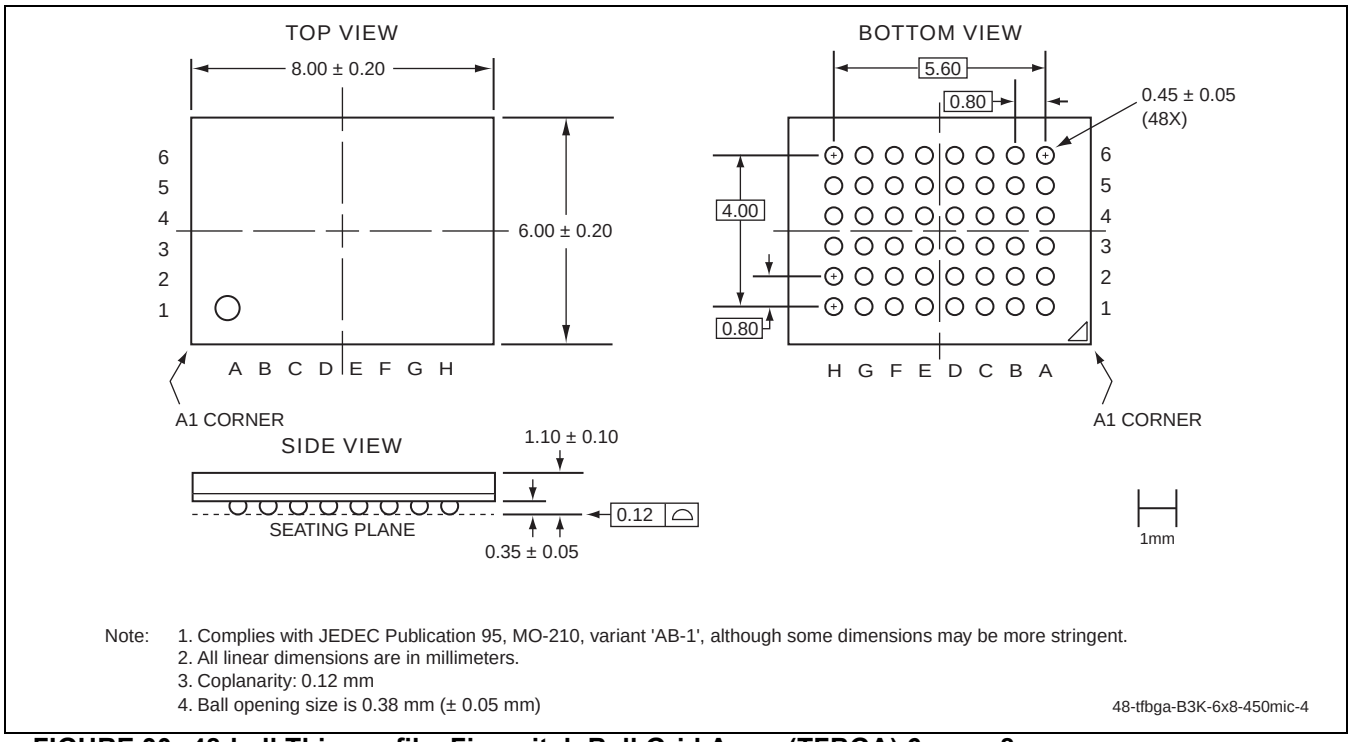
Valid combinations for GLS36VF1602G

GLS36VF1602G-70-4C-B3KE	GLS36VF1602G-70-4C-EKE	GLS36VF1602G-70-4C-L1PE
GLS36VF1602G-70-4I-B3KE	GLS36VF1602G-70-4I-EKE	GLS36VF1602G-70-4I-L1PE

Note: Valid combinations are those products in mass production or will be in mass production. Consult your Greenliant sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Data Sheet

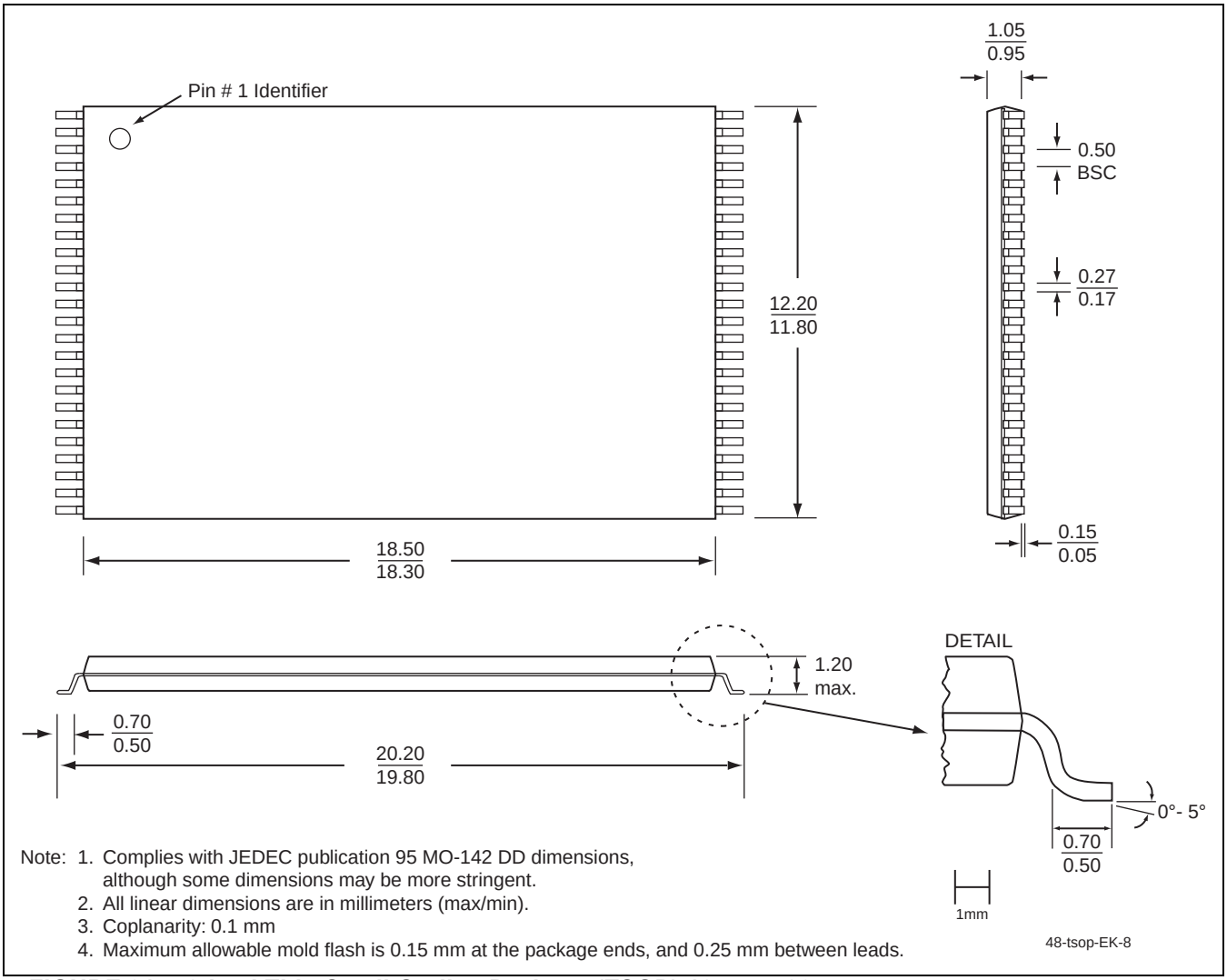
PACKAGING DIAGRAMS



Note: 1. Complies with JEDEC Publication 95, MO-210, variant 'AB-1', although some dimensions may be more stringent.
2. All linear dimensions are in millimeters.
3. Coplanarity: 0.12 mm
4. Ball opening size is 0.38 mm (± 0.05 mm)

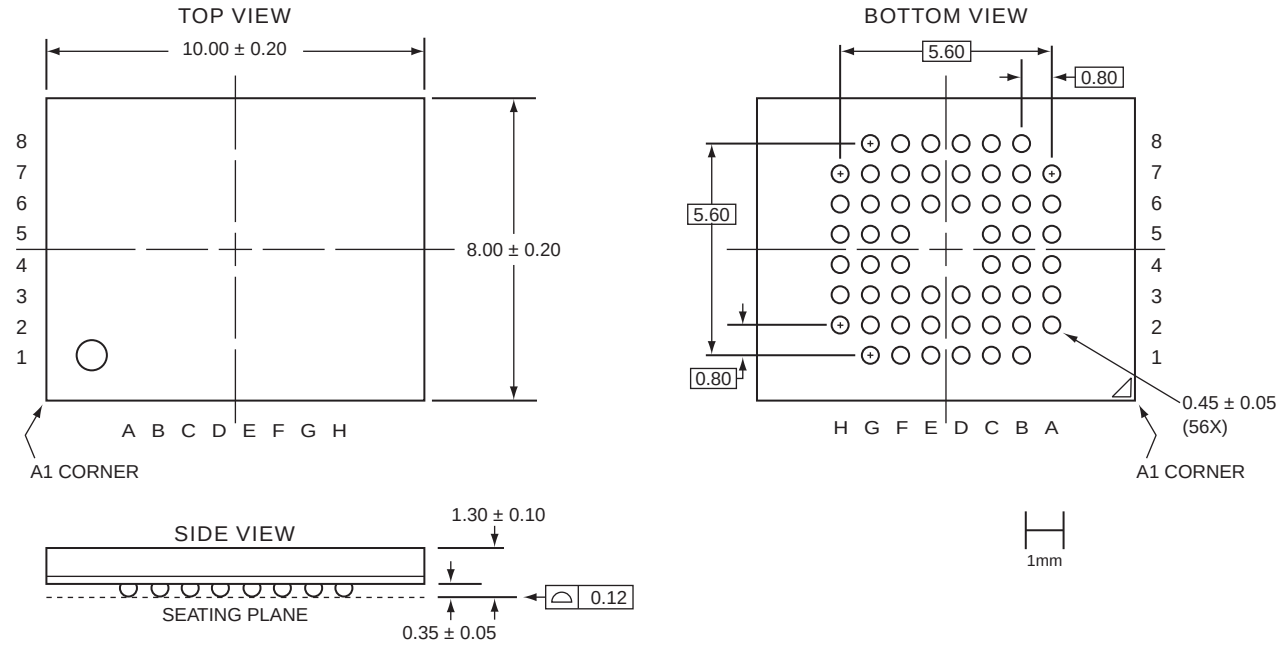
48-tfbga-B3K-6x8-450mic-4

FIGURE 30: 48-ball Thin-profile, Fine-pitch Ball Grid Array (TFBGA) 6mm x 8mm
Greenliant Package Code: B3K



Note: 1. Complies with JEDEC publication 95 MO-142 DD dimensions, although some dimensions may be more stringent.
2. All linear dimensions are in millimeters (max/min).
3. Coplanarity: 0.1 mm
4. Maximum allowable mold flash is 0.15 mm at the package ends, and 0.25 mm between leads.

FIGURE 31: 48-lead Thin Small Outline Package (TSOP) 12mm x 20mm
Greenliant Package Code: EK



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 is 0.38 mm (± 0.05 mm)

56-lfbga-L1P-8x10-450mic-4

FIGURE 32: 56-Ball, Low-Profile, Fine-Pitch Ball Grid Array (LFBGA) 8mm x 10mm
Greenliant Package Code: L1P

TABLE 16: Revision History

Number	Description	Date
00	• Initial release of data sheet	Dec 2006
01	• Edited Tby TY/BY# Delay Time in Table 15 on page 19 from 90ns Min to 90ns Max	Nov 2009
02	• Transferred from SST to Greenliant	May 2010
03	• Corrected XX50 and XX30 values in Figures 15 and 16 on page 23.	Nov 2010