



M29DW323DT M29DW323DB

32 Mbit (4Mb x8 or 2Mb x16, Dual Bank 8:24, Boot Block)
3V Supply Flash Memory

FEATURES SUMMARY

- SUPPLY VOLTAGE
 - V_{CC} = 2.7V to 3.6V for Program, Erase and Read
 - V_{PP} = 12V for Fast Program (optional)
- ACCESS TIME: 70, 90ns
- PROGRAMMING TIME
 - 10 μ s per Byte/Word typical
 - Double Word/ Quadruple Byte Program
- MEMORY BLOCKS
 - Dual Bank Memory Array: 8Mbit+24Mbit
 - Parameter Blocks (Top or Bottom Location)
- DUAL OPERATIONS
 - Read in one bank while Program or Erase in other
- ERASE SUSPEND and RESUME MODES
 - Read and Program another Block during Erase Suspend
- UNLOCK BYPASS PROGRAM COMMAND
 - Faster Production/Batch Programming
- V_{PP}/\overline{WP} PIN for FAST PROGRAM and WRITE PROTECT
- TEMPORARY BLOCK UNPROTECTION MODE
- COMMON FLASH INTERFACE
 - 64 bit Security Code
- EXTENDED MEMORY BLOCK
 - Extra block used as security block or to store additional information
- LOW POWER CONSUMPTION
 - Standby and Automatic Standby
- 100,000 PROGRAM/ERASE CYCLES per BLOCK
- ELECTRONIC SIGNATURE
 - Manufacturer Code: 0020h
 - Top Device Code M29DW323DT: 225Eh
 - Bottom Device Code M29DW323DB: 225Fh

Figure 1. Packages

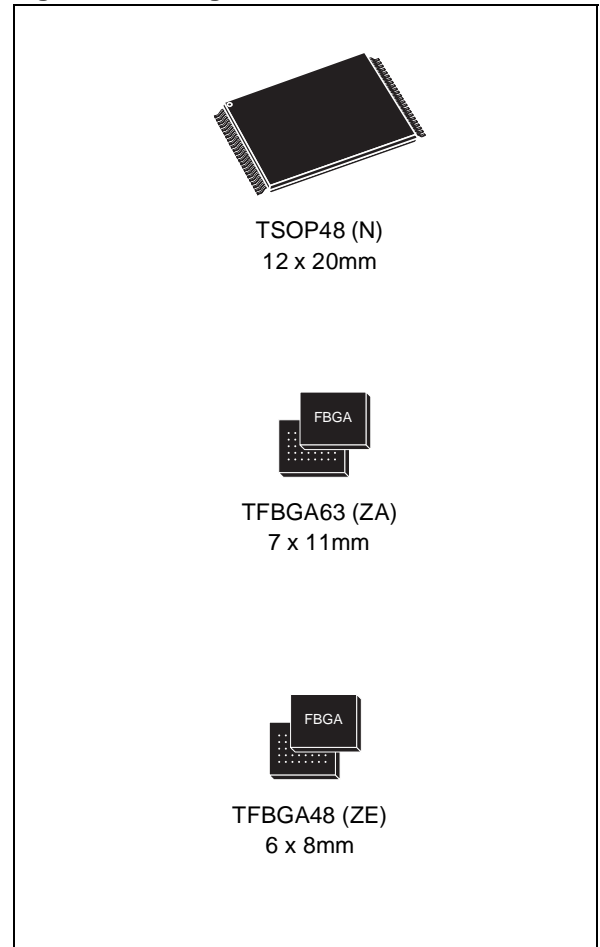


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SUMMARY DESCRIPTION

The M29DW323D is a 32 Mbit (4Mb x8 or 2Mb x16) non-volatile memory that can be read, erased and reprogrammed. These operations can be performed using a single low voltage (2.7 to 3.6V) supply. On power-up the memory defaults to its Read mode where it can be read in the same way as a ROM or EPROM.

The device features an asymmetrical block architecture. The M29DW323D has an array of 8 parameter and 63 main blocks and is divided into two Banks, A and B, providing Dual Bank operations. While programming or erasing in Bank A, read operations are possible in Bank B and vice versa. Only one bank at a time is allowed to be in program or erase mode. The bank architecture is summarized in Table 2. M29DW323DT locates the Parameter Blocks at the top of the memory address space while the M29DW323DB locates the Parameter Blocks starting from the bottom.

M29DW323D has an extra 32 KWord (x16 mode) or 64 KByte (x8 mode) block, the Extended Block, that can be accessed using a dedicated command. The Extended Block can be protected and so is useful for storing security information. How-

ever the protection is irreversible, once protected the protection cannot be undone.

Each block can be erased independently so it is possible to preserve valid data while old data is erased. The blocks can be protected to prevent accidental Program or Erase commands from modifying the memory. Program and Erase commands are written to the Command Interface of the memory. An on-chip Program/Erase Controller simplifies the process of programming or erasing the memory by taking care of all of the special operations that are required to update the memory contents. The end of a program or erase operation can be detected and any error conditions identified. The command set required to control the memory is consistent with JEDEC standards.

Chip Enable, Output Enable and Write Enable signals control the bus operation of the memory. They allow simple connection to most microprocessors, often without additional logic.

The memory is offered in TSOP48 (12x20mm), TFBGA63 (7x11mm, 0.8mm pitch) and TFBGA48 (6x8mm, 0.8mm pitch) packages. The memory is supplied with all the bits erased (set to '1').

Figure 2. Logic Diagram

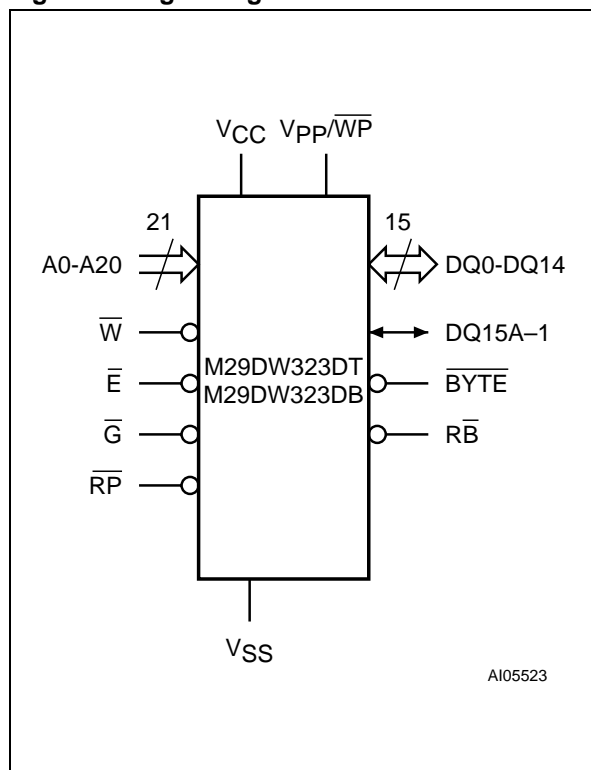
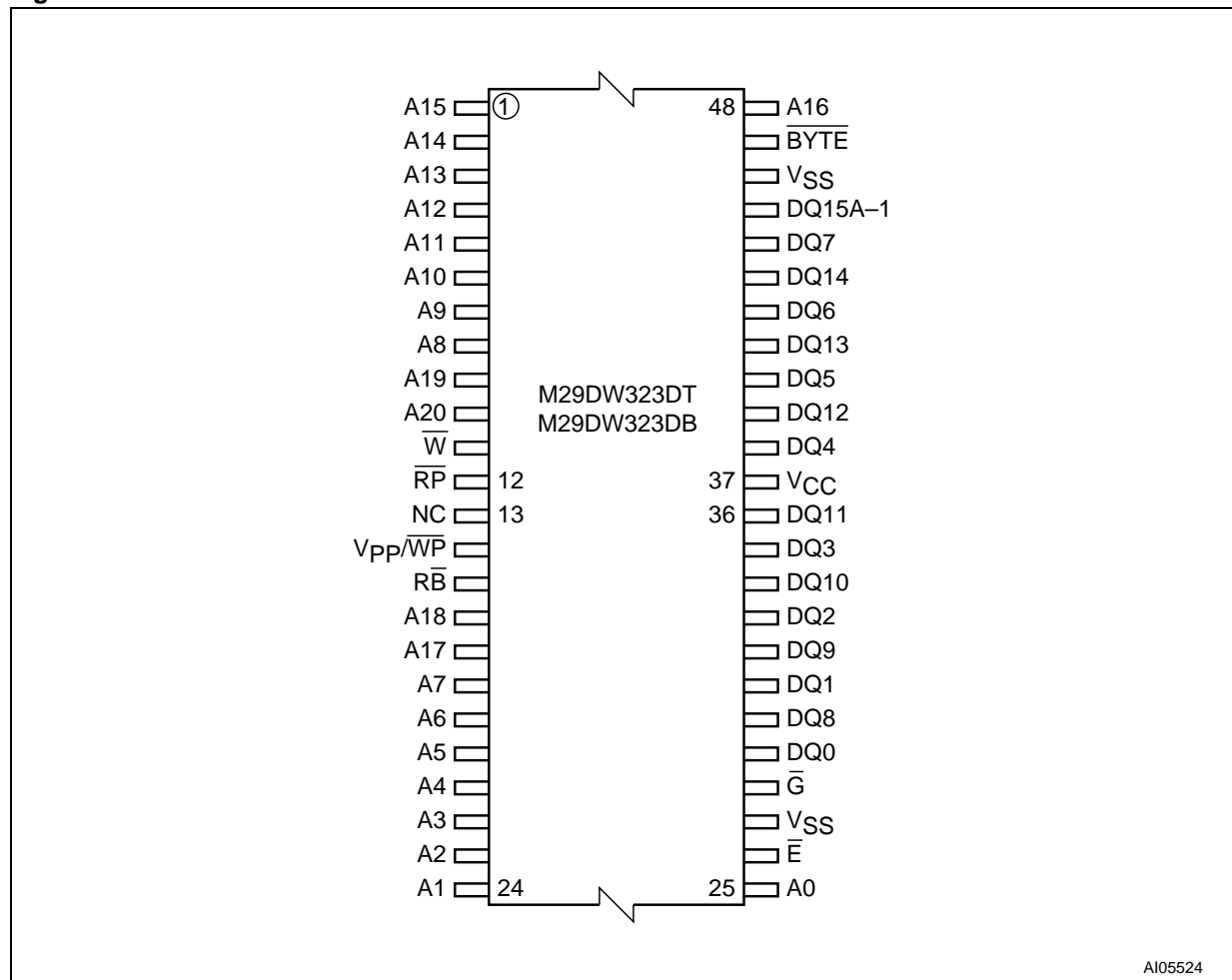


Table 1. Signal Names

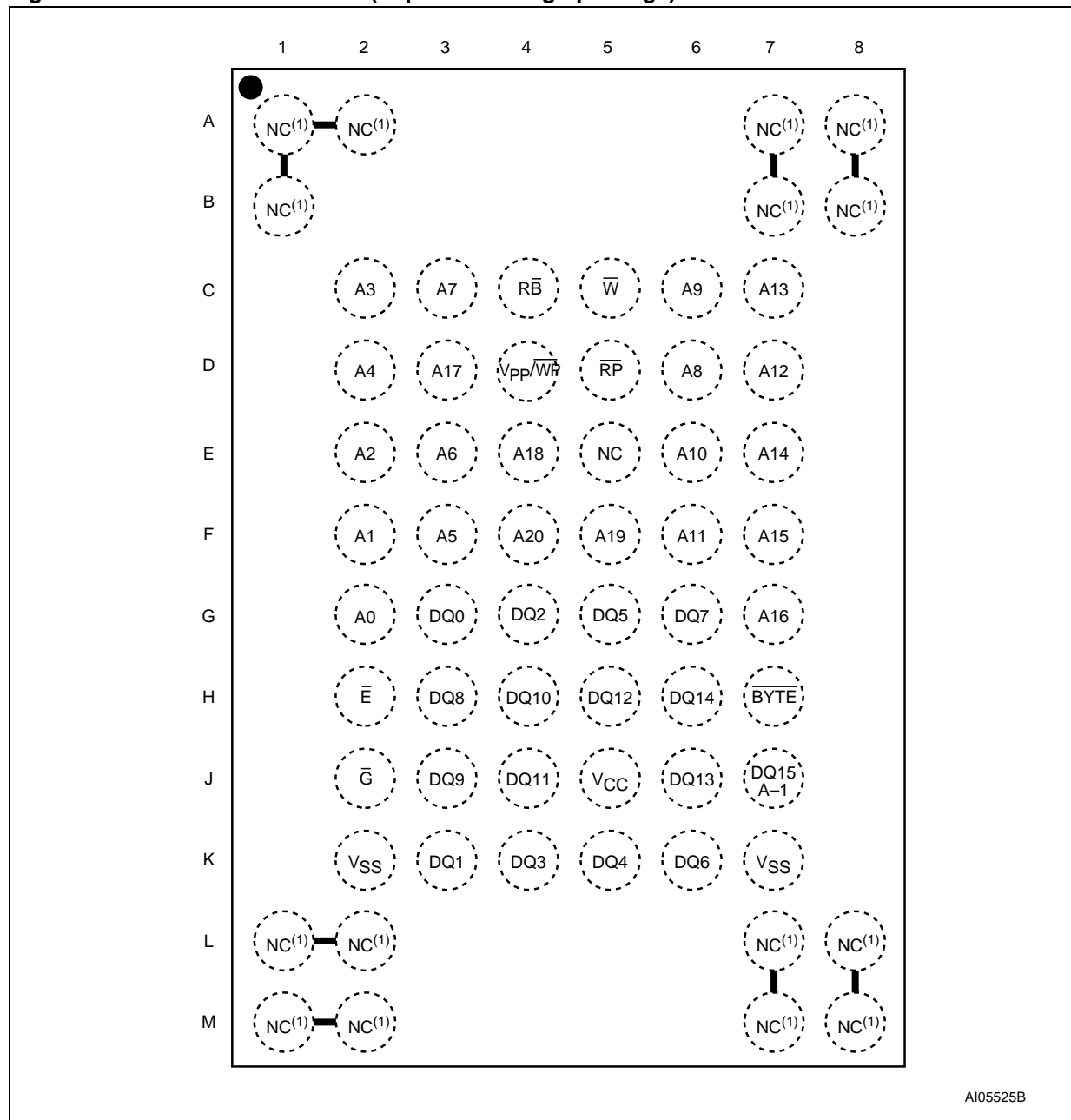
| | |
|-------------------|------------------------------------|
| A0-A20 | Address Inputs |
| DQ0-DQ7 | Data Inputs/Outputs |
| DQ8-DQ14 | Data Inputs/Outputs |
| DQ15A-1 | Data Input/Output or Address Input |
| \bar{E} | Chip Enable |
| \bar{G} | Output Enable |
| \bar{W} | Write Enable |
| \bar{RP} | Reset/Block Temporary Unprotect |
| \bar{RB} | Ready/Busy Output |
| \bar{BYTE} | Byte/Word Organization Select |
| VCC | Supply Voltage |
| V_{PP}/\bar{WP} | V_{PP} /Write Protect |
| VSS | Ground |
| NC | Not Connected Internally |

Figure 3. TSOP Connections



AI05524

Figure 4. TFBGA63 Connections (Top view through package)



AI05525B

Note: 1. Balls are shorted together via the substrate but not connected to the die.

Figure 5. TFBGA48 Connections (Top view through package)

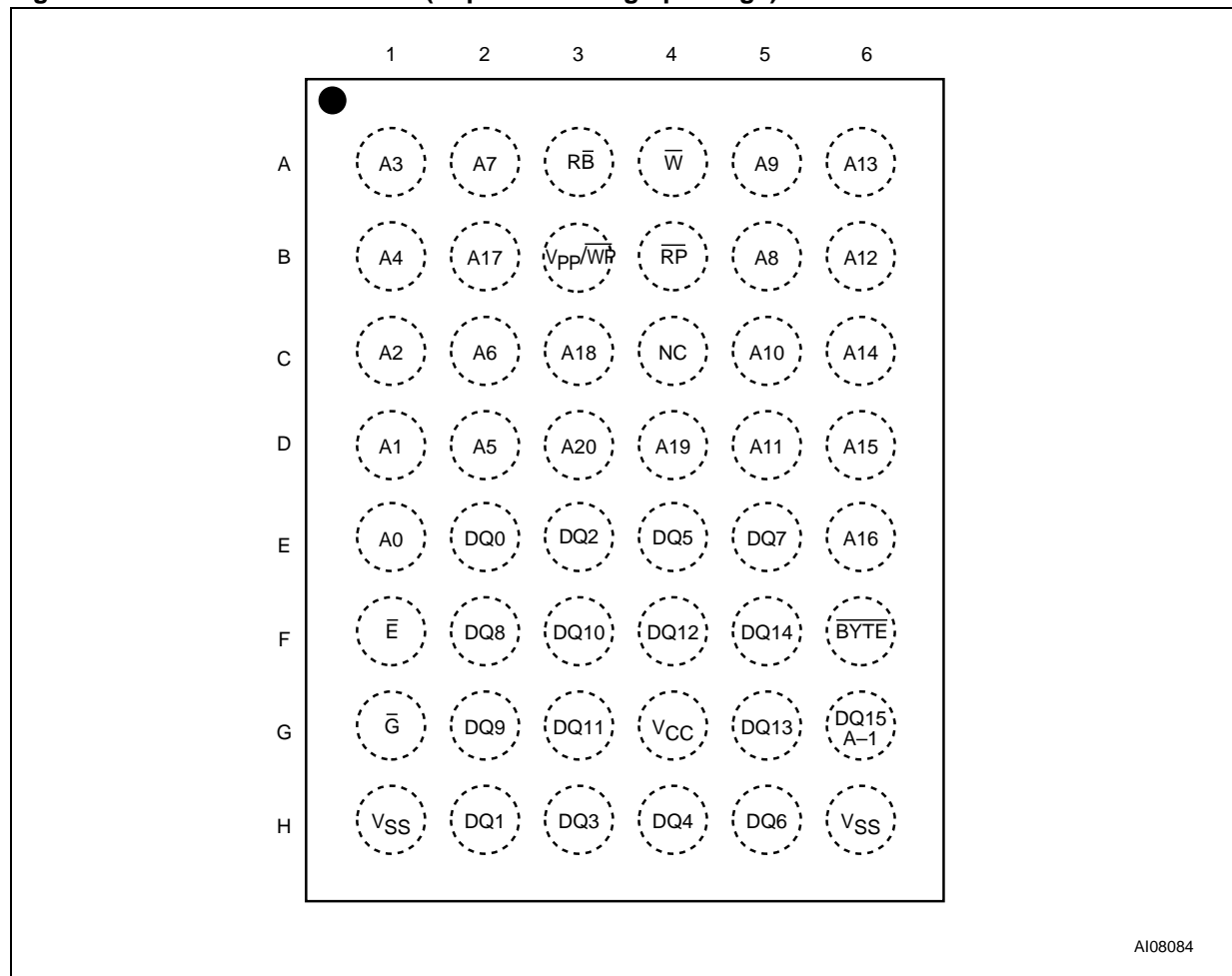
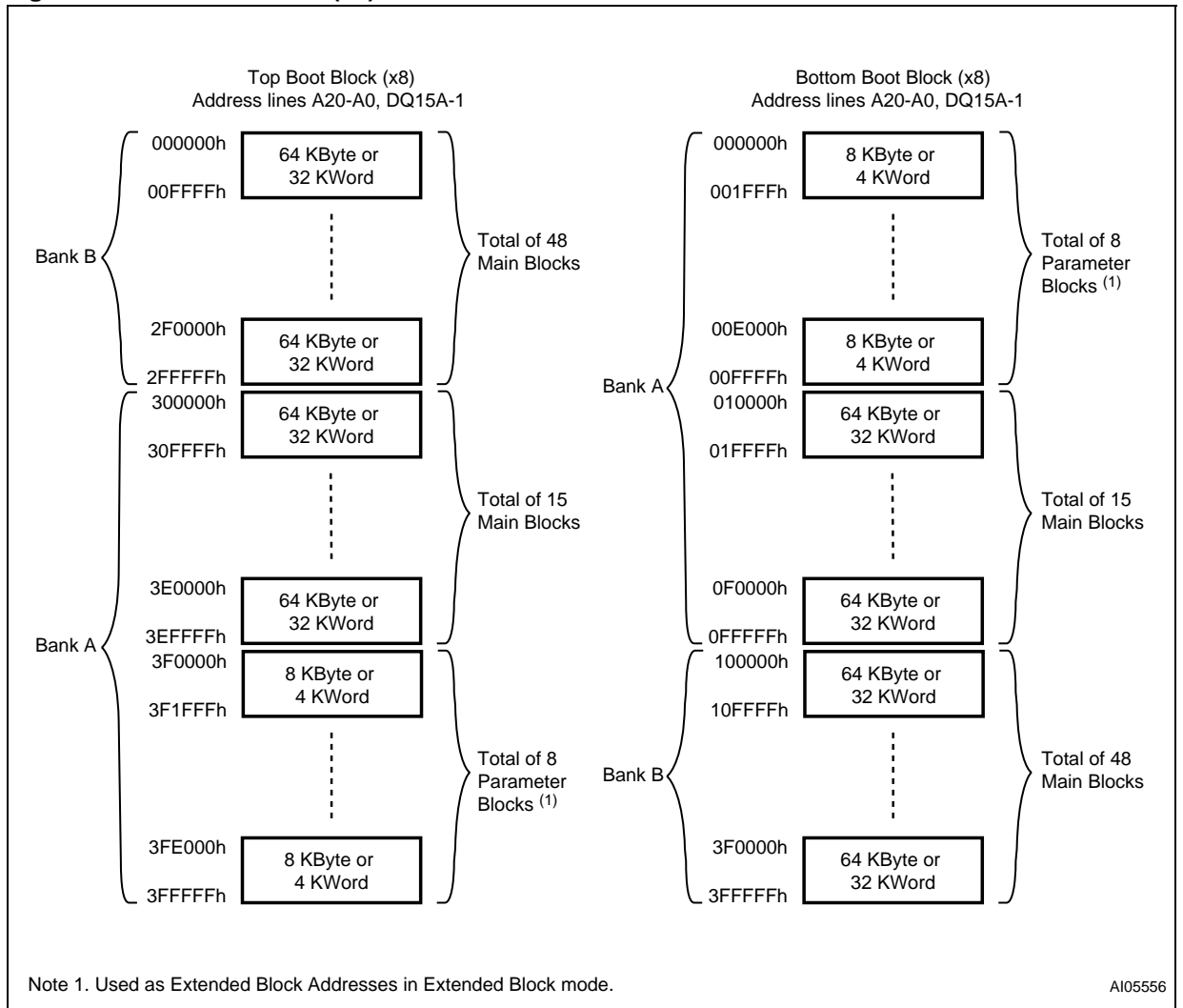


Table 2. Bank Architecture

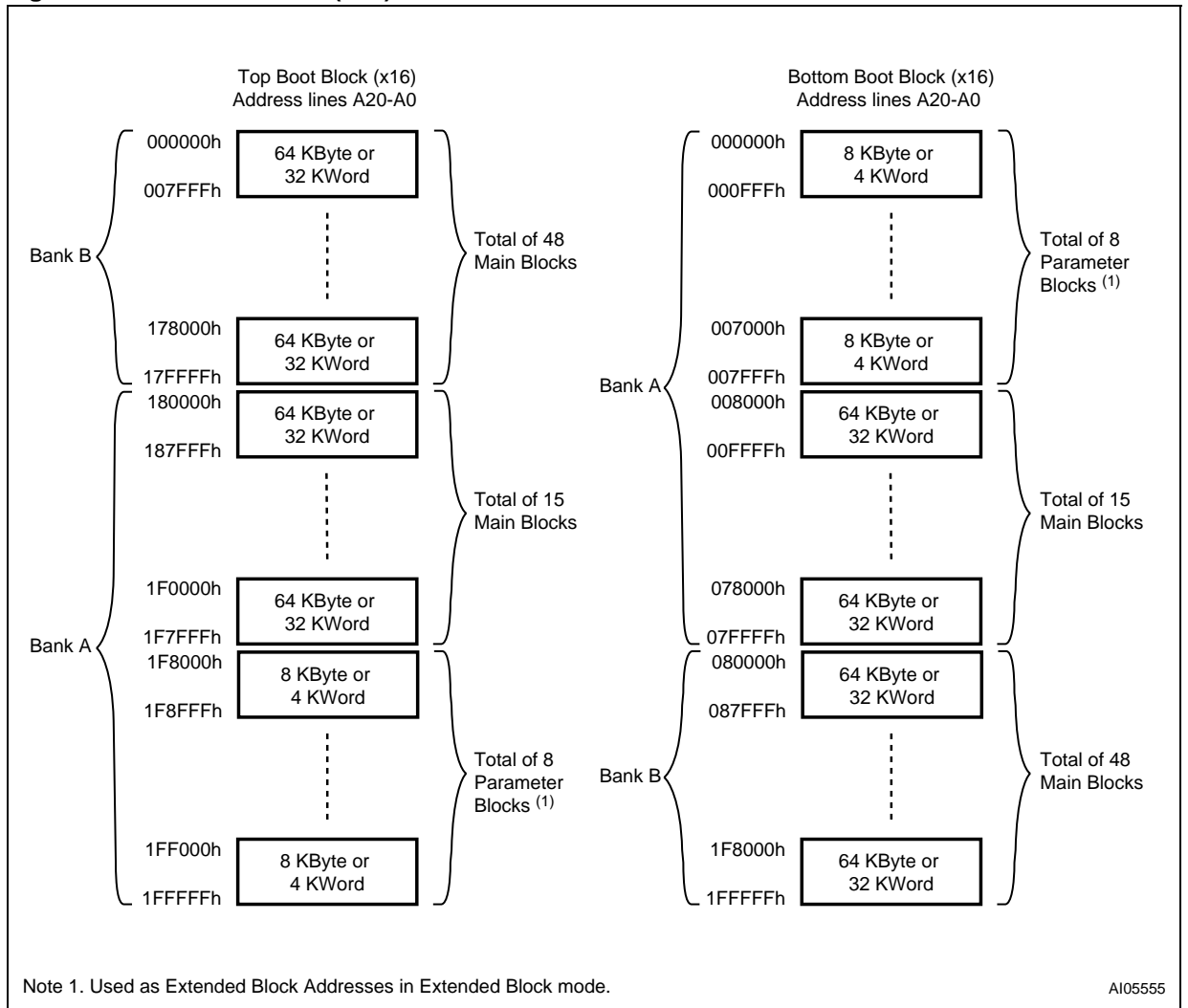
| Bank | Bank Size | Parameter Blocks | | Main Blocks | |
|------|-----------|------------------|-----------------|---------------|-------------------|
| | | No. of Blocks | Block Size | No. of Blocks | Block Size |
| A | 8 Mbit | 8 | 8KByte/ 4 KWord | 15 | 64KByte/ 32 KWord |
| B | 24 Mbit | - | | 48 | 64KByte/ 32 KWord |

Figure 6. Block Addresses (x8)



Note: Also see Appendix A, Tables 21 and 22 for a full listing of the Block Addresses.

Figure 7. Block Addresses (x16)



Note: Also see Appendix A, Tables 21 and 22 for a full listing of the Block Addresses.

SIGNAL DESCRIPTIONS

See Figure 2, Logic Diagram, and Table 1, Signal Names, for a brief overview of the signals connected to this device.

Address Inputs (A0-A20). The Address Inputs select the cells in the memory array to access during Bus Read operations. During Bus Write operations they control the commands sent to the Command Interface of the Program/Erase Controller.

Data Inputs/Outputs (DQ0-DQ7). The Data I/O outputs the data stored at the selected address during a Bus Read operation. During Bus Write operations they represent the commands sent to the Command Interface of the Program/Erase Controller.

Data Inputs/Outputs (DQ8-DQ14). The Data I/O outputs the data stored at the selected address during a Bus Read operation when $\overline{\text{BYTE}}$ is High, V_{IH} . When $\overline{\text{BYTE}}$ is Low, V_{IL} , these pins are not used and are high impedance. During Bus Write operations the Command Register does not use these bits. When reading the Status Register these bits should be ignored.

Data Input/Output or Address Input (DQ15A-1). When $\overline{\text{BYTE}}$ is High, V_{IH} , this pin behaves as a Data Input/Output pin (as DQ8-DQ14). When $\overline{\text{BYTE}}$ is Low, V_{IL} , this pin behaves as an address pin; DQ15A-1 Low will select the LSB of the addressed Word, DQ15A-1 High will select the MSB. Throughout the text consider references to the Data Input/Output to include this pin when $\overline{\text{BYTE}}$ is High and references to the Address Inputs to include this pin when $\overline{\text{BYTE}}$ is Low except when stated explicitly otherwise.

Chip Enable ($\overline{\text{E}}$). The Chip Enable, $\overline{\text{E}}$, activates the memory, allowing Bus Read and Bus Write operations to be performed. When Chip Enable is High, V_{IH} , all other pins are ignored.

Output Enable ($\overline{\text{G}}$). The Output Enable, $\overline{\text{G}}$, controls the Bus Read operation of the memory.

Write Enable ($\overline{\text{W}}$). The Write Enable, $\overline{\text{W}}$, controls the Bus Write operation of the memory's Command Interface.

V_{PP} /Write Protect ($V_{PP}/\overline{\text{WP}}$). The V_{PP} /Write Protect pin provides two functions. The V_{PP} function allows the memory to use an external high voltage power supply to reduce the time required for Program operations. This is achieved by bypassing the unlock cycles and/or using the Double Word or Quadruple Byte Program commands. The Write Protect function provides a hardware method of protecting the two outermost boot blocks.

When V_{PP} /Write Protect is Low, V_{IL} , the memory protects the two outermost boot blocks; Program

and Erase operations in these blocks are ignored while V_{PP} /Write Protect is Low, even when $\overline{\text{RP}}$ is at V_{ID} .

When V_{PP} /Write Protect is High, V_{IH} , the memory reverts to the previous protection status of the two outermost boot blocks. Program and Erase operations can now modify the data in these blocks unless the blocks are protected using Block Protection.

When V_{PP} /Write Protect is raised to V_{PP} the memory automatically enters the Unlock Bypass mode. When V_{PP} /Write Protect returns to V_{IH} or V_{IL} normal operation resumes. During Unlock Bypass Program operations the memory draws I_{PP} from the pin to supply the programming circuits. See the description of the Unlock Bypass command in the Command Interface section. The transitions from V_{IH} to V_{PP} and from V_{PP} to V_{IH} must be slower than t_{VHVPP} , see Figure 16.

Never raise V_{PP} /Write Protect to V_{PP} from any mode except Read mode, otherwise the memory may be left in an indeterminate state.

The V_{PP} /Write Protect pin must not be left floating or unconnected or the device may become unreliable. A 0.1 μF capacitor should be connected between the V_{PP} /Write Protect pin and the V_{SS} Ground pin to decouple the current surges from the power supply. The PCB track widths must be sufficient to carry the currents required during Unlock Bypass Program, I_{PP} .

Reset/Block Temporary Unprotect ($\overline{\text{RP}}$). The Reset/Block Temporary Unprotect pin can be used to apply a Hardware Reset to the memory or to temporarily unprotect all Blocks that have been protected.

Note that if $V_{PP}/\overline{\text{WP}}$ is at V_{IL} , then the two outermost boot blocks will remain protected even if $\overline{\text{RP}}$ is at V_{ID} .

A Hardware Reset is achieved by holding Reset/Block Temporary Unprotect Low, V_{IL} , for at least t_{PLPX} . After Reset/Block Temporary Unprotect goes High, V_{IH} , the memory will be ready for Bus Read and Bus Write operations after t_{PHEL} or t_{RHEL} , whichever occurs last. See the Ready/Busy Output section, Table 16 and Figure 15, Reset/Temporary Unprotect AC Characteristics for more details.

Holding $\overline{\text{RP}}$ at V_{ID} will temporarily unprotect the protected Blocks in the memory. Program and Erase operations on all blocks will be possible. The transition from V_{IH} to V_{ID} must be slower than t_{PHPHH} .

Ready/Busy Output ($\overline{\text{RB}}$). The Ready/Busy pin is an open-drain output that can be used to identify when the device is performing a Program or Erase operation. During Program or Erase operations

Ready/Busy is Low, V_{OL} . Ready/Busy is high-impedance during Read mode, Auto Select mode and Erase Suspend mode.

After a Hardware Reset, Bus Read and Bus Write operations cannot begin until Ready/Busy becomes high-impedance. See Table 16 and Figure 15, Reset/Temporary Unprotect AC Characteristics.

The use of an open-drain output allows the Ready/Busy pins from several memories to be connected to a single pull-up resistor. A Low will then indicate that one, or more, of the memories is busy.

Byte/Word Organization Select ($\overline{\text{BYTE}}$). The Byte/Word Organization Select pin is used to switch between the x8 and x16 Bus modes of the memory. When Byte/Word Organization Select is Low, V_{IL} , the memory is in x8 mode, when it is High, V_{IH} , the memory is in x16 mode.

V_{CC} Supply Voltage (2.7V to 3.6V). V_{CC} provides the power supply for all operations (Read, Program and Erase).

The Command Interface is disabled when the V_{CC} Supply Voltage is less than the Lockout Voltage, V_{LKO} . This prevents Bus Write operations from accidentally damaging the data during power up, power down and power surges. If the Program/Erase Controller is programming or erasing during this time then the operation aborts and the memory contents being altered will be invalid.

A 0.1 μ F capacitor should be connected between the V_{CC} Supply Voltage pin and the V_{SS} Ground pin to decouple the current surges from the power supply. The PCB track widths must be sufficient to carry the currents required during Program and Erase operations, I_{CC3} .

V_{SS} Ground. V_{SS} is the reference for all voltage measurements. The device features two V_{SS} pins which must be both connected to the system ground.

BUS OPERATIONS

There are five standard bus operations that control the device. These are Bus Read, Bus Write, Output Disable, Standby and Automatic Standby.

The Dual Bank architecture of the M29DW323 allows read/write operations in Bank A, while read operations are being executed in Bank B or vice versa. Write operations are only allowed in one bank at a time.

See Tables 3 and 4, Bus Operations, for a summary. Typically glitches of less than 5ns on Chip Enable or Write Enable are ignored by the memory and do not affect bus operations.

Bus Read. Bus Read operations read from the memory cells, or specific registers in the Command Interface. A valid Bus Read operation involves setting the desired address on the Address Inputs, applying a Low signal, V_{IL} , to Chip Enable and Output Enable and keeping Write Enable High, V_{IH} . The Data Inputs/Outputs will output the value, see Figure 12, Read Mode AC Waveforms, and Table 13, Read AC Characteristics, for details of when the output becomes valid.

Bus Write. Bus Write operations write to the Command Interface. A valid Bus Write operation begins by setting the desired address on the Address Inputs. The Address Inputs are latched by the Command Interface on the falling edge of Chip Enable or Write Enable, whichever occurs last. The Data Inputs/Outputs are latched by the Command Interface on the rising edge of Chip Enable or Write Enable, whichever occurs first. Output Enable must remain High, V_{IH} , during the whole Bus Write operation. See Figures 13 and 14, Write AC Waveforms, and Tables 14 and 15, Write AC Characteristics, for details of the timing requirements.

Output Disable. The Data Inputs/Outputs are in the high impedance state when Output Enable is High, V_{IH} .

Standby. When Chip Enable is High, V_{IH} , the memory enters Standby mode and the Data Inputs/Outputs pins are placed in the high-imped-

ance state. To reduce the Supply Current to the Standby Supply Current, I_{CC2} , Chip Enable should be held within $V_{CC} \pm 0.2V$. For the Standby current level see Table 12, DC Characteristics.

During program or erase operations the memory will continue to use the Program/Erase Supply Current, I_{CC3} , for Program or Erase operations until the operation completes.

Automatic Standby. If CMOS levels ($V_{CC} \pm 0.2V$) are used to drive the bus and the bus is inactive for 300ns or more the memory enters Automatic Standby where the internal Supply Current is reduced to the Standby Supply Current, I_{CC2} . The Data Inputs/Outputs will still output data if a Bus Read operation is in progress.

Special Bus Operations

Additional bus operations can be performed to read the Electronic Signature and also to apply and remove Block Protection. These bus operations are intended for use by programming equipment and are not usually used in applications. They require V_{ID} to be applied to some pins.

Electronic Signature. The memory has two codes, the manufacturer code and the device code, that can be read to identify the memory. These codes can be read by applying the signals listed in Tables 3 and 4, Bus Operations.

Block Protect and Chip Unprotect. Groups of blocks can be protected against accidental Program or Erase. The Protection Groups are shown in Appendix A, Tables 21 and 22, Block Addresses. The whole chip can be unprotected to allow the data inside the blocks to be changed.

The V_{PP} /Write Protect pin can be used to protect the two outermost boot blocks. When V_{PP} /Write Protect is at V_{IL} the two outermost boot blocks are protected and remain protected regardless of the Block Protection Status or the Reset/Block Temporary Unprotect pin status.

Block Protect and Chip Unprotect operations are described in Appendix D.

Table 3. Bus Operations, $\overline{\text{BYTE}} = V_{\text{IL}}$

| Operation | $\overline{\text{E}}$ | $\overline{\text{G}}$ | $\overline{\text{W}}$ | Address Inputs DQ15A-1, A0-A20 | Data Inputs/Outputs | |
|-----------------------------------|-----------------------|-----------------------|-----------------------|--|---------------------|--|
| | | | | | DQ14-DQ8 | DQ7-DQ0 |
| Bus Read | V_{IL} | V_{IL} | V_{IH} | Cell Address | Hi-Z | Data Output |
| Bus Write | V_{IL} | V_{IH} | V_{IL} | Command Address | Hi-Z | Data Input |
| Output Disable | X | V_{IH} | V_{IH} | X | Hi-Z | Hi-Z |
| Standby | V_{IH} | X | X | X | Hi-Z | Hi-Z |
| Read Manufacturer Code | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IL} , A1 = V_{IL} , A9 = V_{ID} , Others V_{IL} or V_{IH} | Hi-Z | 20h |
| Read Device Code | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IH} , A1 = V_{IL} , A9 = V_{ID} , Others V_{IL} or V_{IH} | Hi-Z | 5Eh (M29DW323DT) 5Fh (M29DW323DB) |
| Extended Memory Block Verify Code | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IH} , A1 = V_{IH} , A6 = V_{IL} , A9 = V_{ID} , Others V_{IL} or V_{IH} | Hi-Z | 81h (factory locked) 01h (not factory locked) |

 Note: X = V_{IL} or V_{IH} .

Table 4. Bus Operations, $\overline{\text{BYTE}} = V_{\text{IH}}$

| Operation | $\overline{\text{E}}$ | $\overline{\text{G}}$ | $\overline{\text{W}}$ | Address Inputs A0-A20 | Data Inputs/Outputs |
|-----------------------------------|-----------------------|-----------------------|-----------------------|--|--|
| | | | | | DQ15A-1, DQ14-DQ0 |
| Bus Read | V_{IL} | V_{IL} | V_{IH} | Cell Address | Data Output |
| Bus Write | V_{IL} | V_{IH} | V_{IL} | Command Address | Data Input |
| Output Disable | X | V_{IH} | V_{IH} | X | Hi-Z |
| Standby | V_{IH} | X | X | X | Hi-Z |
| Read Manufacturer Code | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IL} , A1 = V_{IL} , A9 = V_{ID} , Others V_{IL} or V_{IH} | 0020h |
| Read Device Code | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IH} , A1 = V_{IL} , A9 = V_{ID} , Others V_{IL} or V_{IH} | 225Eh (M29DW323DT) 225Fh (M29DW323DB) |
| Extended Memory Block Verify Code | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IH} , A1 = V_{IH} , A6 = V_{IL} , A9 = V_{ID} , Others V_{IL} or V_{IH} | 81h (factory locked) 01h (not factory locked) |

 Note: X = V_{IL} or V_{IH} .

COMMAND INTERFACE

All Bus Write operations to the memory are interpreted by the Command Interface. Commands consist of one or more sequential Bus Write operations. Failure to observe a valid sequence of Bus Write operations will result in the memory returning to Read mode. The long command sequences are imposed to maximize data security.

The address used for the commands changes depending on whether the memory is in 16-bit or 8-bit mode. See either Table 5, or 6, depending on the configuration that is being used, for a summary of the commands.

Read/Reset Command

The Read/Reset command returns the memory to its Read mode where it behaves like a ROM or EPROM. It also resets the errors in the Status Register. Either one or three Bus Write operations can be used to issue the Read/Reset command.

The Read/Reset command can be issued, between Bus Write cycles before the start of a program or erase operation, to return the device to read mode. If the Read/Reset command is issued during the timeout of a Block erase operation then the memory will take up to 10 μ s to abort. During the abort period no valid data can be read from the memory. The Read/Reset command will not abort an Erase operation when issued while in Erase Suspend.

Auto Select Command

The Auto Select command is used to read the Manufacturer Code, the Device Code, the Block Protection Status and the Extended Memory Block Verify Code. It can be addressed to either Bank. Three consecutive Bus Write operations are required to issue the Auto Select command. The final Write cycle must be addressed to one of the Banks. Once the Auto Select command is issued Bus Read operations to the Bank where the command was issued output the Auto Select data. Bus Read operations to the other Bank will output the contents of the memory array. The memory remains in Auto Select mode until a Read/Reset or CFI Query command is issued.

In Auto Select mode the Manufacturer Code can be read using a Bus Read operation with $A0 = V_{IL}$ and $A1 = V_{IL}$ and $A19-A20 =$ Bank Address. The other address bits may be set to either V_{IL} or V_{IH} .

The Device Code can be read using a Bus Read operation with $A0 = V_{IH}$ and $A1 = V_{IL}$ and $A19-A20 =$ Bank Address. The other address bits may be set to either V_{IL} or V_{IH} .

The Block Protection Status of each block can be read using a Bus Read operation with $A0 = V_{IL}$, $A1 = V_{IH}$, $A19-A20 =$ Bank Address and $A12-A17$ specifying the address of the block inside the Bank. The other address bits may be set to either

V_{IL} or V_{IH} . If the addressed block is protected then 01h is output on Data Inputs/Outputs DQ0-DQ7, otherwise 00h is output.

Read CFI Query Command

The Read CFI Query Command is used to read data from the Common Flash Interface (CFI) Memory Area. This command is valid when the device is in the Read Array mode, or when the device is in Autoselected mode.

One Bus Write cycle is required to issue the Read CFI Query Command. Once the command is issued subsequent Bus Read operations read from the Common Flash Interface Memory Area.

The Read/Reset command must be issued to return the device to the previous mode (the Read Array mode or Autoselected mode). A second Read/Reset command would be needed if the device is to be put in the Read Array mode from Autoselected mode.

See Appendix B, Tables 23, 24, 25, 26, 27 and 28 for details on the information contained in the Common Flash Interface (CFI) memory area.

Program Command

The Program command can be used to program a value to one address in the memory array at a time. The command requires four Bus Write operations, the final write operation latches the address and data, and starts the Program/Erase Controller.

If the address falls in a protected block then the Program command is ignored, the data remains unchanged. The Status Register is never read and no error condition is given.

During the program operation the memory will ignore all commands. It is not possible to issue any command to abort or pause the operation. After programming has started, Bus Read operations in the Bank being programmed output the Status Register content, while Bus Read operations to the other Bank output the contents of the memory array. See the section on the Status Register for more details. Typical program times are given in Table 7.

After the program operation has completed the memory will return to the Read mode, unless an error has occurred. When an error occurs Bus Read operations to the Bank where the command was issued will continue to output the Status Register. A Read/Reset command must be issued to reset the error condition and return to Read mode.

Note that the Program command cannot change a bit set at '0' back to '1'. One of the Erase Commands must be used to set all the bits in a block or in the whole memory from '0' to '1'.

Fast Program Commands

There are two Fast Program commands available to improve the programming throughput, by writing several adjacent words or bytes in parallel. The Quadruple Byte Program command is available for x8 operations, while the Double Word Program command is available for x16 operations.

Quadruple Byte Program Command. The Quadruple Byte Program command is used to write a page of four adjacent Bytes in parallel. The four bytes must differ only for addresses A0, DQ15A-1. Five bus write cycles are necessary to issue the Quadruple Byte Program command.

- The first bus cycle sets up the Quadruple Byte Program Command.
- The second bus cycle latches the Address and the Data of the first byte to be written.
- The third bus cycle latches the Address and the Data of the second byte to be written.
- The fourth bus cycle latches the Address and the Data of the third byte to be written.
- The fifth bus cycle latches the Address and the Data of the fourth byte to be written and starts the Program/Erase Controller.

Double Word Program Command. The Double Word Program command is used to write a page of two adjacent words in parallel. The two words must differ only for the address A0.

Three bus write cycles are necessary to issue the Double Word Program command.

- The first bus cycle sets up the Double Word Program Command.
- The second bus cycle latches the Address and the Data of the first word to be written.
- The third bus cycle latches the Address and the Data of the second word to be written and starts the Program/Erase Controller.

Only one bank can be programmed at any one time. The other bank must be in Read mode or Erase Suspend.

Programming should not be attempted when V_{PP} is not at V_{PPH} .

After programming has started, Bus Read operations in the Bank being programmed output the Status Register content, while Bus Read operations to the other Bank output the contents of the memory array.

After the program operation has completed the memory will return to the Read mode, unless an error has occurred. When an error occurs Bus Read operations to the Bank where the command was issued will continue to output the Status Register. A Read/Reset command must be issued to reset the error condition and return to Read mode.

Note that the Fast Program commands cannot change a bit set at '0' back to '1'. One of the Erase Commands must be used to set all the bits in a block or in the whole memory from '0' to '1'.

Typical Program times are given in Table 7, Program, Erase Times and Program/Erase Endurance Cycles.

Unlock Bypass Command

The Unlock Bypass command is used in conjunction with the Unlock Bypass Program command to program the memory faster than with the standard program commands. When the cycle time to the device is long (as with some EPROM programmers) considerable time saving can be made by using these commands. Three Bus Write operations are required to issue the Unlock Bypass command.

Once the Unlock Bypass command has been issued the bank enters Unlock Bypass mode. The Unlock Bypass Program command can then be issued to program addresses within the bank, or the Unlock Bypass Reset command can be issued to return the bank to Read mode. In Unlock Bypass mode the memory can be read as if in Read mode.

When V_{PP} is applied to the $V_{PP}/$ Write Protect pin the memory automatically enters the Unlock Bypass mode and the Unlock Bypass Program command can be issued immediately.

Unlock Bypass Program Command

The Unlock Bypass Program command can be used to program one address in the memory array at a time. The command requires two Bus Write operations, the final write operation latches the address and data, and starts the Program/Erase Controller.

The Program operation using the Unlock Bypass Program command behaves identically to the Program operation using the Program command. The operation cannot be aborted, a Bus Read operation to the Bank where the command was issued outputs the Status Register. See the Program command for details on the behavior.

Unlock Bypass Reset Command

The Unlock Bypass Reset command can be used to return to Read/Reset mode from Unlock Bypass Mode. Two Bus Write operations are required to issue the Unlock Bypass Reset command. Read/Reset command does not exit from Unlock Bypass Mode.

Chip Erase Command

The Chip Erase command can be used to erase the entire chip. Six Bus Write operations are required to issue the Chip Erase Command and start the Program/Erase Controller.

If any blocks are protected then these are ignored and all the other blocks are erased. If all of the

blocks are protected the Chip Erase operation appears to start but will terminate within about 100 μ s, leaving the data unchanged. No error condition is given when protected blocks are ignored.

During the erase operation the memory will ignore all commands, including the Erase Suspend command. It is not possible to issue any command to abort the operation. Typical chip erase times are given in Table 7. All Bus Read operations during the Chip Erase operation will output the Status Register on the Data Inputs/Outputs. See the section on the Status Register for more details.

After the Chip Erase operation has completed the memory will return to the Read Mode, unless an error has occurred. When an error occurs the memory will continue to output the Status Register. A Read/Reset command must be issued to reset the error condition and return to Read Mode.

The Chip Erase Command sets all of the bits in unprotected blocks of the memory to '1'. All previous data is lost.

Block Erase Command

The Block Erase command can be used to erase a list of one or more blocks in a Bank. It sets all of the bits in the unprotected selected blocks to '1'. All previous data in the selected blocks is lost.

Six Bus Write operations are required to select the first block in the list. Each additional block in the list can be selected by repeating the sixth Bus Write operation using the address of the additional block. All blocks must belong to the same Bank; if a block belonging to the other Bank is given it will not be erased. The Block Erase operation starts the Program/Erase Controller after a time-out period of 50 μ s after the last Bus Write operation. Once the Program/Erase Controller starts it is not possible to select any more blocks. Each additional block must therefore be selected within 50 μ s of the last block. The 50 μ s timer restarts when an additional block is selected. After the sixth Bus Write operation a Bus Read operation within the same Bank will output the Status Register. See the Status Register section for details on how to identify if the Program/Erase Controller has started the Block Erase operation.

If any selected blocks are protected then these are ignored and all the other selected blocks are erased. If all of the selected blocks are protected the Block Erase operation appears to start but will terminate within about 100 μ s, leaving the data unchanged. No error condition is given when protected blocks are ignored.

During the Block Erase operation the memory will ignore all commands except the Erase Suspend command and the Read/Reset command which is only accepted during the 50 μ s time-out period. Typical block erase times are given in Table 7.

After the Erase operation has started all Bus Read operations to the Bank being erased will output the Status Register on the Data Inputs/Outputs. See the section on the Status Register for more details.

After the Block Erase operation has completed the memory will return to the Read Mode, unless an error has occurred. When an error occurs Bus Read operations to the Bank where the command was issued will continue to output the Status Register. A Read/Reset command must be issued to reset the error condition and return to Read mode.

Erase Suspend Command

The Erase Suspend Command may be used to temporarily suspend a Block Erase operation and return the memory to Read mode. The command requires one Bus Write operation.

The Program/Erase Controller will suspend within the Erase Suspend Latency time of the Erase Suspend Command being issued. Once the Program/Erase Controller has stopped the memory will be set to Read mode and the Erase will be suspended. If the Erase Suspend command is issued during the period when the memory is waiting for an additional block (before the Program/Erase Controller starts) then the Erase is suspended immediately and will start immediately when the Erase Resume Command is issued. It is not possible to select any further blocks to erase after the Erase Resume.

During Erase Suspend it is possible to Read and Program cells in blocks that are not being erased; both Read and Program operations behave as normal on these blocks. If any attempt is made to program in a protected block or in the suspended block then the Program command is ignored and the data remains unchanged. The Status Register is not read and no error condition is given. Reading from blocks that are being erased will output the Status Register.

It is also possible to issue the Auto Select, Read CFI Query and Unlock Bypass commands during an Erase Suspend. The Read/Reset command must be issued to return the device to Read Array mode before the Resume command will be accepted.

During Erase Suspend a Bus Read operation to the Extended Block will output the Extended Block data.

Erase Resume Command

The Erase Resume command must be used to restart the Program/Erase Controller after an Erase Suspend. The device must be in Read Array mode before the Resume command will be accepted. An erase can be suspended and resumed more than once.

Enter Extended Block Command

The M29DW323D has an extra 64KByte block (Extended Block) that can only be accessed using the Enter Extended Block command. Three Bus write cycles are required to issue the Extended Block command. Once the command has been issued the device enters Extended Block mode where all Bus Read or Program operations to the Boot Block addresses access the Extended Block. The Extended Block (with the same address as the boot block) cannot be erased, and can be treated as one-time programmable (OTP) memory. In Extended Block mode the Boot Blocks are not accessible. In Extended Block mode dual operations are possible, with the Extended Block mapped in Bank A. When in Extended Block mode, Erase Commands in Bank A are not allowed.

To exit from the Extended Block mode the Exit Extended Block command must be issued.

The Extended Block can be protected, however once protected the protection cannot be undone.

Exit Extended Block Command

The Exit Extended Block command is used to exit from the Extended Block mode and return the device to Read mode. Four Bus Write operations are required to issue the command.

Block Protect and Chip Unprotect Commands

Groups of blocks can be protected against accidental Program or Erase. The Protection Groups are shown in Appendix A, Tables 21 and 22, Block Addresses. The whole chip can be unprotected to allow the data inside the blocks to be changed.

Block Protect and Chip Unprotect operations are described in Appendix D.

Table 5. Commands, 16-bit mode, $\overline{\text{BYTE}} = V_{IH}$

| Command | Length | Bus Write Operations | | | | | | | | | | | |
|-----------------------|--------|----------------------|------|------|------|--------------|------|------|------|------|------|------|------|
| | | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | |
| | | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data |
| Read/Reset | 1 | X | F0 | | | | | | | | | | |
| | 3 | 555 | AA | 2AA | 55 | X | F0 | | | | | | |
| Auto Select | 3 | 555 | AA | 2AA | 55 | (BKA) 555 | 90 | | | | | | |
| Program | 4 | 555 | AA | 2AA | 55 | 555 | A0 | PA | PD | | | | |
| Double Word Program | 3 | 555 | 50 | PA0 | PD0 | PA1 | PD1 | | | | | | |
| Unlock Bypass | 3 | 555 | AA | 2AA | 55 | 555 | 20 | | | | | | |
| Unlock Bypass Program | 2 | X | A0 | PA | PD | | | | | | | | |
| Unlock Bypass Reset | 2 | X | 90 | X | 00 | | | | | | | | |
| Chip Erase | 6 | 555 | AA | 2AA | 55 | 555 | 80 | 555 | AA | 2AA | 55 | 555 | 10 |
| Block Erase | 6+ | 555 | AA | 2AA | 55 | 555 | 80 | 555 | AA | 2AA | 55 | BA | 30 |
| Erase Suspend | 1 | BKA | B0 | | | | | | | | | | |
| Erase Resume | 1 | BKA | 30 | | | | | | | | | | |
| Read CFI Query | 1 | 55 | 98 | | | | | | | | | | |
| Enter Extended Block | 3 | 555 | AA | 2AA | 55 | 555 | 88 | | | | | | |
| Exit Extended Block | 4 | 555 | AA | 2AA | 55 | 555 | 90 | X | 00 | | | | |

Note: X Don't Care, PA Program Address, PD Program Data, BA Any address in the Block, BKA Bank Address. All values in the table are in hexadecimal.

The Command Interface only uses A-1, A0-A10 and DQ0-DQ7 to verify the commands; A11-A20, DQ8-DQ14 and DQ15 are Don't Care. DQ15A-1 is A-1 when $\overline{\text{BYTE}}$ is V_{IL} or DQ15 when $\overline{\text{BYTE}}$ is V_{IH} .

Table 6. Commands, 8-bit mode, $\overline{\text{BYTE}} = V_{\text{IL}}$

| Command | Length | Bus Write Operations | | | | | | | | | | | |
|------------------------|--------|----------------------|------|-----|------|--------------|------|-----|------|-----|------|-----|------|
| | | 1st | | 2nd | | 3rd | | 4th | | 5th | | 6th | |
| | | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data | Add | Data |
| Read/Reset | 1 | X | F0 | | | | | | | | | | |
| | 3 | AAA | AA | 555 | 55 | X | F0 | | | | | | |
| Auto Select | 3 | AAA | AA | 555 | 55 | (BKA) AAA | 90 | | | | | | |
| Program | 4 | AAA | AA | 555 | 55 | AAA | A0 | PA | PD | | | | |
| Quadruple Byte Program | 5 | AAA | 55 | PA0 | PD0 | PA1 | PD1 | PA2 | PD2 | PA3 | PD3 | | |
| Unlock Bypass | 3 | AAA | AA | 555 | 55 | AAA | 20 | | | | | | |
| Unlock Bypass Program | 2 | X | A0 | PA | PD | | | | | | | | |
| Unlock Bypass Reset | 2 | X | 90 | X | 00 | | | | | | | | |
| Chip Erase | 6 | AAA | AA | 555 | 55 | AAA | 80 | AAA | AA | 555 | 55 | AAA | 10 |
| Block Erase | 6+ | AAA | AA | 555 | 55 | AAA | 80 | AAA | AA | 555 | 55 | BA | 30 |
| Erase Suspend | 1 | BKA | B0 | | | | | | | | | | |
| Erase Resume | 1 | BKA | 30 | | | | | | | | | | |
| Read CFI Query | 1 | AA | 98 | | | | | | | | | | |
| Enter Extended Block | 3 | AAA | AA | 555 | 55 | AAA | 88 | | | | | | |
| Exit Extended Block | 4 | AAA | AA | 555 | 55 | AAA | 90 | X | 00 | | | | |

Note: X Don't Care, PA Program Address, PD Program Data, BA Any address in the Block. All values in the table are in hexadecimal.

The Command Interface only uses A-1, A0-A10 and DQ0-DQ7 to verify the commands; A11-A20, DQ8-DQ14 and DQ15 are Don't Care. DQ15A-1 is A-1 when $\overline{\text{BYTE}}$ is V_{IL} or DQ15 when $\overline{\text{BYTE}}$ is V_{IH} .

Table 7. Program, Erase Times and Program, Erase Endurance Cycles

| Parameter | Min | Typ ^(1, 2) | Max ⁽²⁾ | Unit |
|--|---------|-----------------------|--------------------|---------------|
| Chip Erase | | 40 | 200 ⁽³⁾ | s |
| Block Erase (64 KBytes) | | 0.8 | 6 ⁽³⁾ | s |
| Erase Suspend Latency Time | | | 50 ⁽⁴⁾ | μs |
| Program (Byte or Word) | | 10 | 200 ⁽⁴⁾ | μs |
| Double Word Program (Byte or Word) | | 10 | 200 ⁽³⁾ | μs |
| Chip Program (Byte by Byte) | | 40 | 200 ⁽³⁾ | s |
| Chip Program (Word by Word) | | 20 | 100 ⁽³⁾ | s |
| Chip Program (Quadruple Byte or Double Word) | | 10 | 100 ⁽³⁾ | s |
| Program/Erase Cycles (per Block) | 100,000 | | | cycles |
| Data Retention | 20 | | | years |

Note: 1. Typical values measured at room temperature and nominal voltages.

2. Sampled, but not 100% tested.

3. Maximum value measured at worst case conditions for both temperature and V_{CC} after 100,00 program/erase cycles.

4. Maximum value measured at worst case conditions for both temperature and V_{CC} .

STATUS REGISTER

The M29DW323D has two Status Registers, one for each bank. The Status Registers provide information on the current or previous Program or Erase operations executed in each bank. The various bits convey information and errors on the operation. Bus Read operations from any address within the Bank, always read the Status Register during Program and Erase operations. It is also read during Erase Suspend when an address within a block being erased is accessed.

The bits in the Status Register are summarized in Table 8, Status Register Bits.

Data Polling Bit (DQ7). The Data Polling Bit can be used to identify whether the Program/Erase Controller has successfully completed its operation or if it has responded to an Erase Suspend. The Data Polling Bit is output on DQ7 when the Status Register is read.

During Program operations the Data Polling Bit outputs the complement of the bit being programmed to DQ7. After successful completion of the Program operation the memory returns to Read mode and Bus Read operations from the address just programmed output DQ7, not its complement.

During Erase operations the Data Polling Bit outputs '0', the complement of the erased state of DQ7. After successful completion of the Erase operation the memory returns to Read Mode.

In Erase Suspend mode the Data Polling Bit will output a '1' during a Bus Read operation within a block being erased. The Data Polling Bit will change from a '0' to a '1' when the Program/Erase Controller has suspended the Erase operation.

Figure 8, Data Polling Flowchart, gives an example of how to use the Data Polling Bit. A Valid Address is the address being programmed or an address within the block being erased.

Toggle Bit (DQ6). The Toggle Bit can be used to identify whether the Program/Erase Controller has successfully completed its operation or if it has responded to an Erase Suspend. The Toggle Bit is output on DQ6 when the Status Register is read.

During Program and Erase operations the Toggle Bit changes from '0' to '1' to '0', etc., with successive Bus Read operations at any address. After successful completion of the operation the memory returns to Read mode.

During Erase Suspend mode the Toggle Bit will output when addressing a cell within a block being erased. The Toggle Bit will stop toggling when the Program/Erase Controller has suspended the Erase operation.

Figure 9, Data Toggle Flowchart, gives an example of how to use the Data Toggle Bit.

Error Bit (DQ5). The Error Bit can be used to identify errors detected by the Program/Erase Controller. The Error Bit is set to '1' when a Program, Block Erase or Chip Erase operation fails to write the correct data to the memory. If the Error Bit is set a Read/Reset command must be issued before other commands are issued. The Error bit is output on DQ5 when the Status Register is read.

Note that the Program command cannot change a bit set to '0' back to '1' and attempting to do so will set DQ5 to '1'. A Bus Read operation to that address will show the bit is still '0'. One of the Erase commands must be used to set all the bits in a block or in the whole memory from '0' to '1'.

Erase Timer Bit (DQ3). The Erase Timer Bit can be used to identify the start of Program/Erase Controller operation during a Block Erase command. Once the Program/Erase Controller starts erasing the Erase Timer Bit is set to '1'. Before the Program/Erase Controller starts the Erase Timer Bit is set to '0' and additional blocks to be erased may be written to the Command Interface. The Erase Timer Bit is output on DQ3 when the Status Register is read.

Alternative Toggle Bit (DQ2). The Alternative Toggle Bit can be used to monitor the Program/Erase controller during Erase operations. The Alternative Toggle Bit is output on DQ2 when the Status Register is read.

During Chip Erase and Block Erase operations the Toggle Bit changes from '0' to '1' to '0', etc., with successive Bus Read operations from addresses within the blocks being erased. A protected block is treated the same as a block not being erased. Once the operation completes the memory returns to Read mode.

During Erase Suspend the Alternative Toggle Bit changes from '0' to '1' to '0', etc. with successive Bus Read operations from addresses within the blocks being erased. Bus Read operations to addresses within blocks not being erased will output the memory cell data as if in Read mode.

After an Erase operation that causes the Error Bit to be set the Alternative Toggle Bit can be used to identify which block or blocks have caused the error. The Alternative Toggle Bit changes from '0' to '1' to '0', etc. with successive Bus Read Operations from addresses within blocks that have not erased correctly. The Alternative Toggle Bit does not change if the addressed block has erased correctly.

Table 8. Status Register Bits

| Operation | Address | DQ7 | DQ6 | DQ5 | DQ3 | DQ2 | R \bar{B} |
|------------------------------|----------------------|---------------------|-----------|-----|-----|-----------|-------------|
| Program | Bank Address | $\overline{DQ7}$ | Toggle | 0 | – | – | 0 |
| Program During Erase Suspend | Bank Address | $\overline{DQ7}$ | Toggle | 0 | – | – | 0 |
| Program Error | Bank Address | $\overline{DQ7}$ | Toggle | 1 | – | – | 0 |
| Chip Erase | Any Address | 0 | Toggle | 0 | 1 | Toggle | 0 |
| Block Erase before timeout | Erasing Block | 0 | Toggle | 0 | 0 | Toggle | 0 |
| | Non-Erasing Block | 0 | Toggle | 0 | 0 | No Toggle | 0 |
| Block Erase | Erasing Block | 0 | Toggle | 0 | 1 | Toggle | 0 |
| | Non-Erasing Block | 0 | Toggle | 0 | 1 | No Toggle | 0 |
| Erase Suspend | Erasing Block | 1 | No Toggle | 0 | – | Toggle | 1 |
| | Non-Erasing Block | Data read as normal | | | | | |
| Erase Error | Good Block Address | 0 | Toggle | 1 | 1 | No Toggle | 0 |
| | Faulty Block Address | 0 | Toggle | 1 | 1 | Toggle | 0 |

Note: Unspecified data bits should be ignored.

Figure 8. Data Polling Flowchart

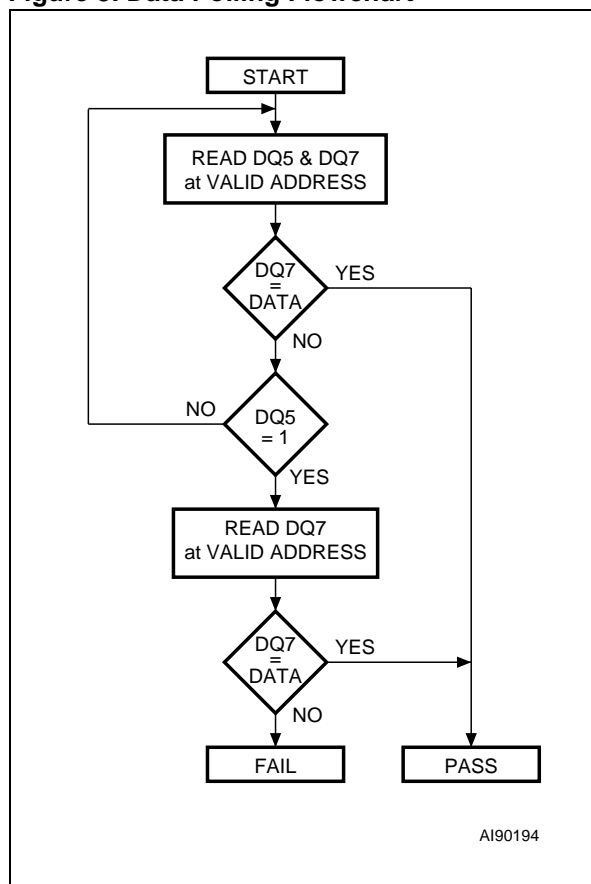
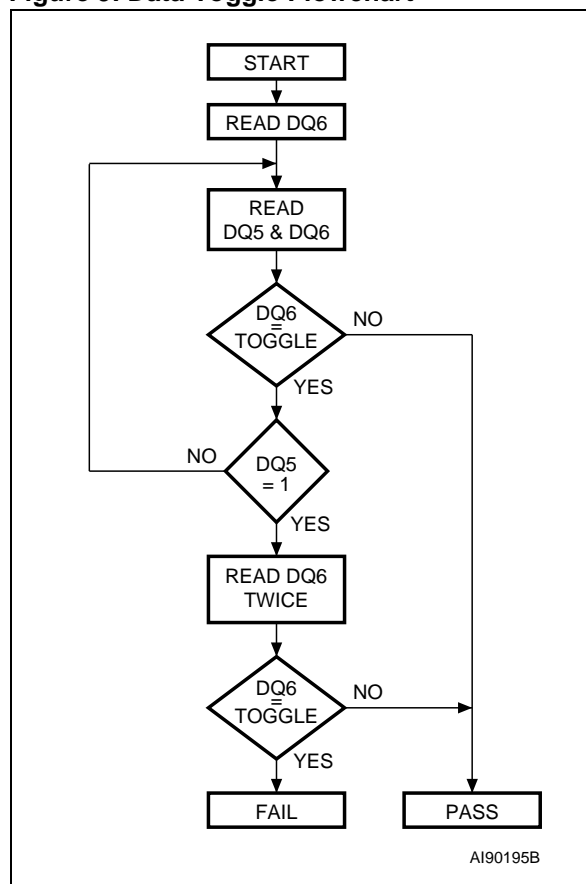


Figure 9. Data Toggle Flowchart



MAXIMUM RATING

Stressing the device above the rating listed in the Absolute Maximum Ratings table may cause permanent damage to the device. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. These are stress ratings only and operation of the device at

these or any other conditions above those indicated in the Operating sections of this specification is not implied. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

Table 9. Absolute Maximum Ratings

| Symbol | Parameter | Min | Max | Unit |
|----------------|--|------|----------------|------|
| T_{BIAS} | Temperature Under Bias | -50 | 125 | °C |
| T_{STG} | Storage Temperature | -65 | 150 | °C |
| V_{IO} | Input or Output Voltage ^(1,2) | -0.6 | $V_{CC} + 0.6$ | V |
| V_{CC} | Supply Voltage | -0.6 | 4 | V |
| V_{ID} | Identification Voltage | -0.6 | 13.5 | V |
| $V_{PP}^{(3)}$ | Program Voltage | -0.6 | 13.5 | V |

Note: 1. Minimum voltage may undershoot to -2V during transition and for less than 20ns during transitions.
2. Maximum voltage may overshoot to $V_{CC} + 2V$ during transition and for less than 20ns during transitions.
3. V_{PP} must not remain at 12V for more than a total of 80hrs.

DC AND AC PARAMETERS

This section summarizes the operating measurement conditions, and the DC and AC characteristics of the device. The parameters in the DC and AC characteristics Tables that follow, are derived from tests performed under the Measurement

Conditions summarized in Table 10, Operating and AC Measurement Conditions. Designers should check that the operating conditions in their circuit match the operating conditions when relying on the quoted parameters.

Table 10. Operating and AC Measurement Conditions

| Parameter | M29DW323D | | | | Unit |
|---------------------------------------|----------------------|-----|----------------------|-----|------|
| | 70 | | 90 | | |
| | Min | Max | Min | Max | |
| V _{CC} Supply Voltage | 3.0 | 3.6 | 2.7 | 3.6 | V |
| Ambient Operating Temperature | -40 | 85 | -40 | 85 | °C |
| Load Capacitance (C _L) | 30 | | 30 | | pF |
| Input Rise and Fall Times | | 10 | | 10 | ns |
| Input Pulse Voltages | 0 to V _{CC} | | 0 to V _{CC} | | V |
| Input and Output Timing Ref. Voltages | V _{CC} /2 | | V _{CC} /2 | | V |

Figure 10. AC Measurement I/O Waveform

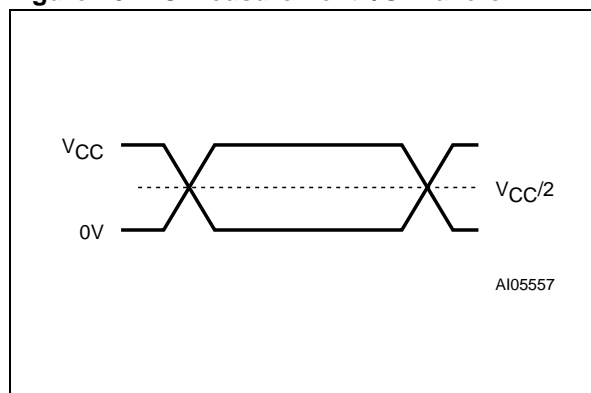


Figure 11. AC Measurement Load Circuit

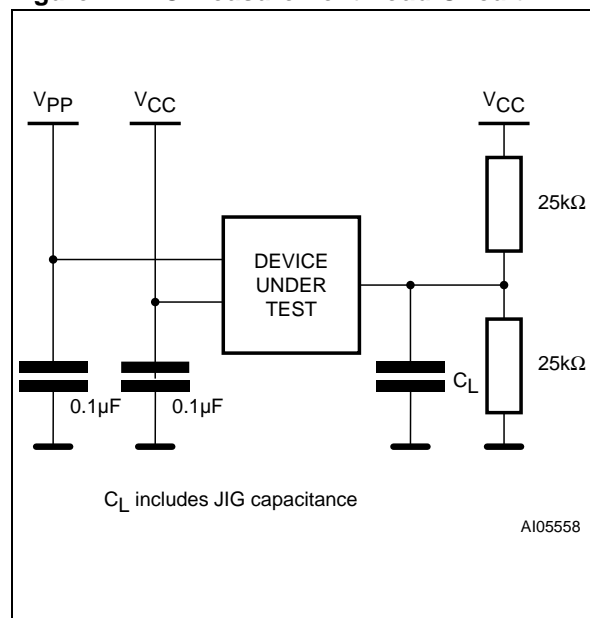


Table 11. Device Capacitance

| Symbol | Parameter | Test Condition | Min | Max | Unit |
|------------------|--------------------|-----------------------|-----|-----|------|
| C _{IN} | Input Capacitance | V _{IN} = 0V | | 6 | pF |
| C _{OUT} | Output Capacitance | V _{OUT} = 0V | | 12 | pF |

Note: Sampled only, not 100% tested.

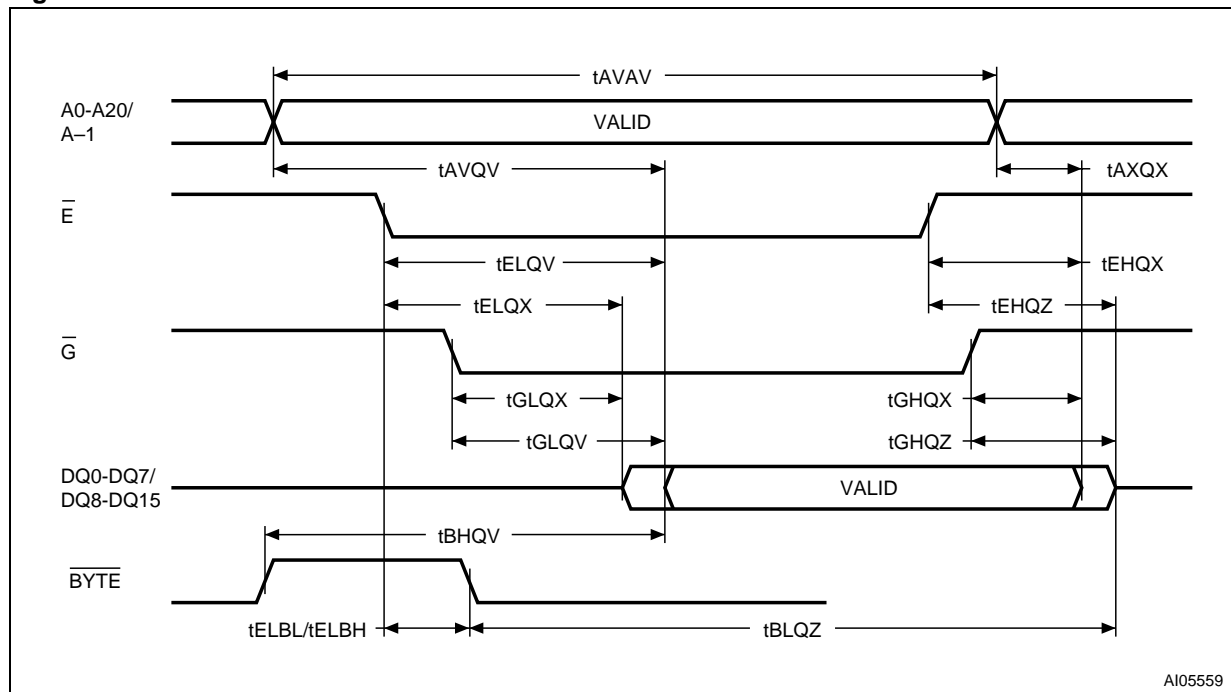
Table 12. DC Characteristics

| Symbol | Parameter | Test Condition | Min | Max | Unit |
|-------------------|---|--|--|----------------|---------|
| I_{LI} | Input Leakage Current | $0V \leq V_{IN} \leq V_{CC}$ | | ± 1 | μA |
| I_{LO} | Output Leakage Current | $0V \leq V_{OUT} \leq V_{CC}$ | | ± 1 | μA |
| $I_{CC1}^{(2)}$ | Supply Current (Read) | $\bar{E} = V_{IL}, \bar{G} = V_{IH},$ $f = 6MHz$ | | 10 | mA |
| I_{CC2} | Supply Current (Standby) | $\bar{E} = V_{CC} \pm 0.2V,$ $RP = V_{CC} \pm 0.2V$ | | 100 | μA |
| $I_{CC3}^{(1,2)}$ | Supply Current (Program/ Erase) | Program/Erase Controller active | $V_{PP}/\bar{WP} =$ $V_{IL} \text{ or } V_{IH}$ | 20 | mA |
| | | | $V_{PP}/\bar{WP} = V_{PP}$ | 20 | mA |
| V_{IL} | Input Low Voltage | | -0.5 | 0.8 | V |
| V_{IH} | Input High Voltage | | $0.7V_{CC}$ | $V_{CC} + 0.3$ | V |
| V_{PP} | Voltage for V_{PP}/\bar{WP} Program Acceleration | $V_{CC} = 3.0V \pm 10\%$ | 11.5 | 12.5 | V |
| I_{PP} | Current for V_{PP}/\bar{WP} Program Acceleration | $V_{CC} = 3.0V \pm 10\%$ | | 15 | mA |
| V_{OL} | Output Low Voltage | $I_{OL} = 1.8mA$ | | 0.45 | V |
| V_{OH} | Output High Voltage | $I_{OH} = -100\mu A$ | $V_{CC} - 0.4$ | | V |
| V_{ID} | Identification Voltage | | 11.5 | 12.5 | V |
| V_{LKO} | Program/Erase Lockout Supply Voltage | | 1.8 | 2.3 | V |

Note: 1. Sampled only, not 100% tested.

2. In Dual operations the Supply Current will be the sum of I_{CC1} (read) and I_{CC3} (program/erase).

Figure 12. Read Mode AC Waveforms



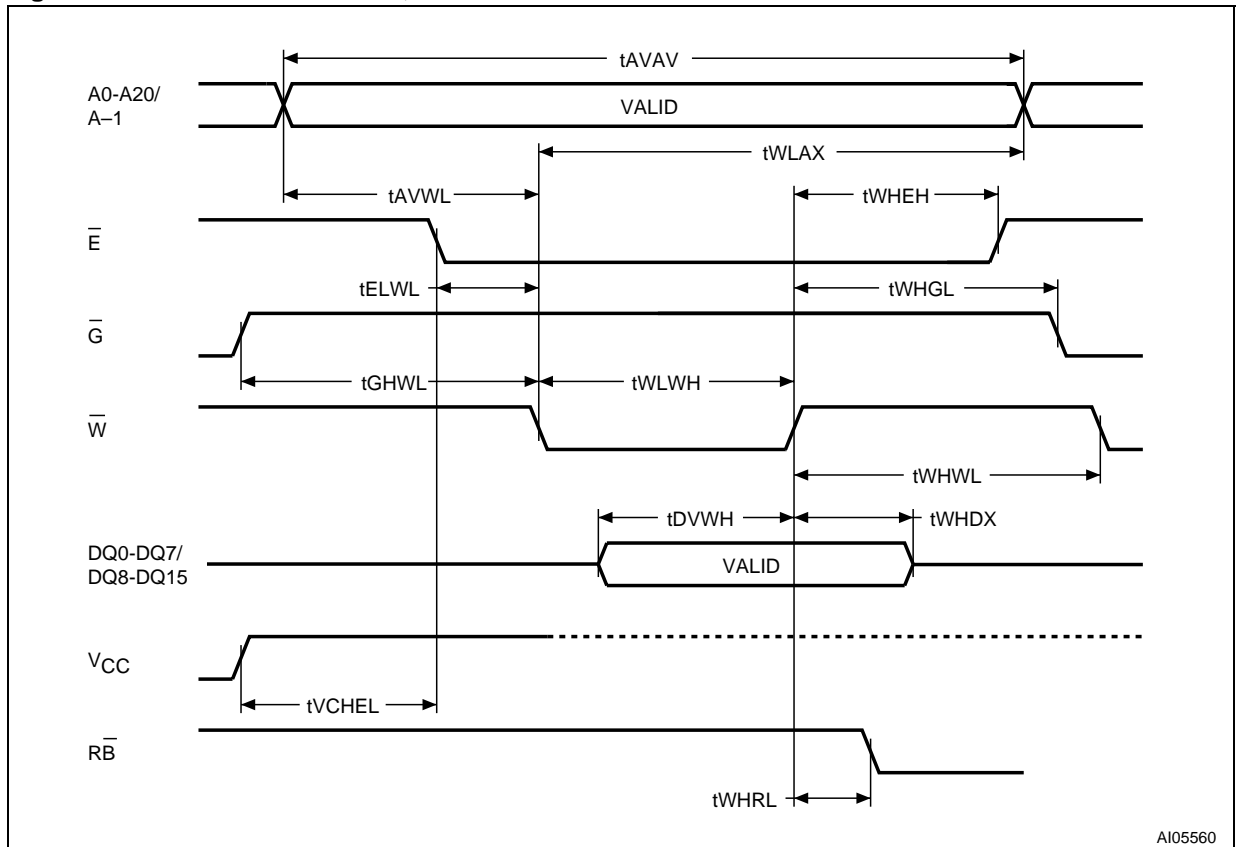
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Table 13. Read AC Characteristics

| Symbol | Alt | Parameter | Test Condition | | M29DW323D | | Unit |
|--|--------------------------|---|--|-----|-----------|----|------|
| | | | | | 70 | 90 | |
| t_{AVAV} | t_{RC} | Address Valid to Next Address Valid | $\bar{E} = V_{IL}$, $\bar{G} = V_{IL}$ | Min | 70 | 90 | ns |
| t_{AVQV} | t_{ACC} | Address Valid to Output Valid | $\bar{E} = V_{IL}$, $\bar{G} = V_{IL}$ | Max | 70 | 90 | ns |
| $t_{ELQX}^{(1)}$ | t_{LZ} | Chip Enable Low to Output Transition | $\bar{G} = V_{IL}$ | Min | 0 | 0 | ns |
| t_{ELQV} | t_{CE} | Chip Enable Low to Output Valid | $\bar{G} = V_{IL}$ | Max | 70 | 90 | ns |
| $t_{GLQX}^{(1)}$ | t_{OLZ} | Output Enable Low to Output Transition | $\bar{E} = V_{IL}$ | Min | 0 | 0 | ns |
| t_{GLQV} | t_{OE} | Output Enable Low to Output Valid | $\bar{E} = V_{IL}$ | Max | 30 | 35 | ns |
| $t_{EHQZ}^{(1)}$ | t_{HZ} | Chip Enable High to Output Hi-Z | $\bar{G} = V_{IL}$ | Max | 25 | 30 | ns |
| $t_{GHQZ}^{(1)}$ | t_{DF} | Output Enable High to Output Hi-Z | $\bar{E} = V_{IL}$ | Max | 25 | 30 | ns |
| t_{EHQX} t_{GHQX} t_{AXQX} | t_{OH} | Chip Enable, Output Enable or Address Transition to Output Transition | | Min | 0 | 0 | ns |
| t_{ELBL} t_{ELBH} | t_{ELFL} t_{ELFH} | Chip Enable to \bar{BYTE} Low or High | | Max | 5 | 5 | ns |
| t_{BLQZ} | t_{FLQZ} | \bar{BYTE} Low to Output Hi-Z | | Max | 25 | 30 | ns |
| t_{BHQV} | t_{FHQV} | \bar{BYTE} High to Output Valid | | Max | 30 | 40 | ns |

Note: 1. Sampled only, not 100% tested.

Figure 13. Write AC Waveforms, Write Enable Controlled



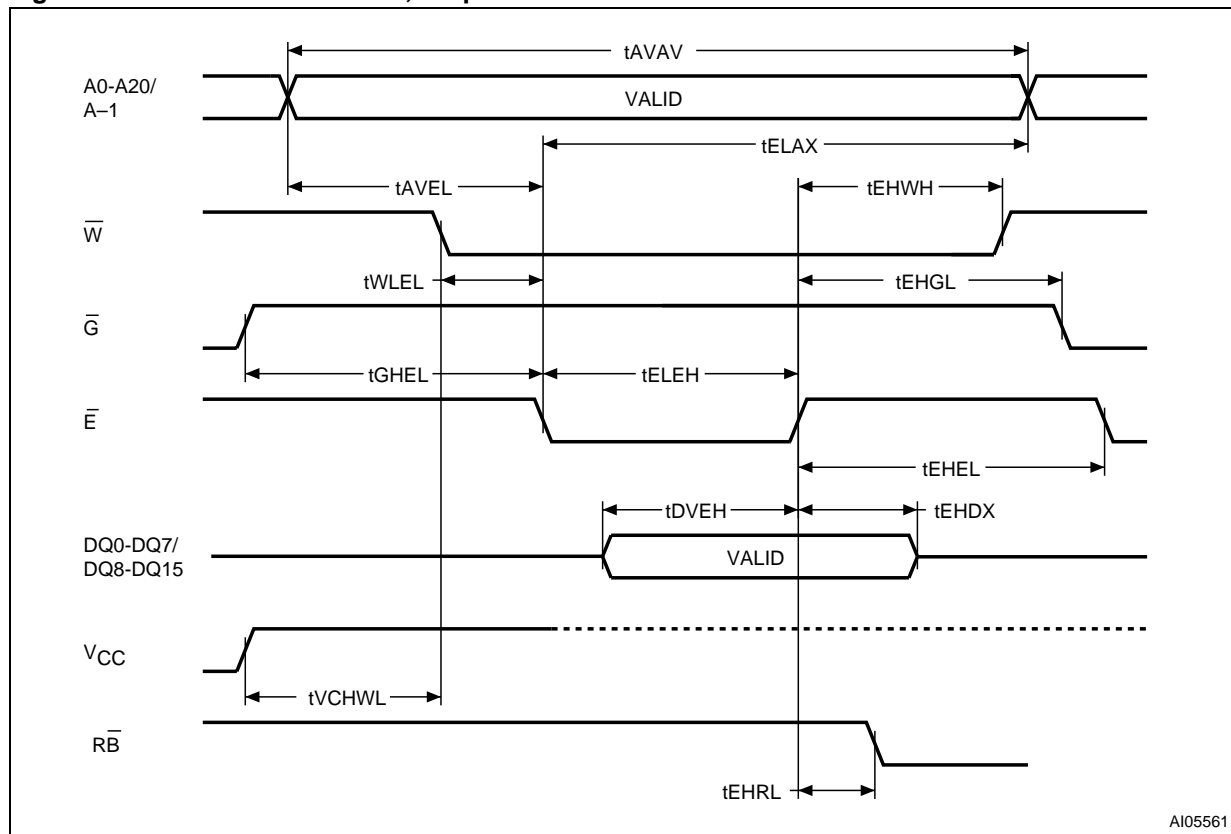
AI05560

Table 14. Write AC Characteristics, Write Enable Controlled

| Symbol | Alt | Parameter | | M29DW323D | | Unit |
|----------------------|-------|--|-----|-----------|----|------|
| | | | | 70 | 90 | |
| tAVAV | tWC | Address Valid to Next Address Valid | Min | 70 | 90 | ns |
| tELWL | tCS | Chip Enable Low to Write Enable Low | Min | 0 | 0 | ns |
| tWLWH | tWP | Write Enable Low to Write Enable High | Min | 45 | 50 | ns |
| tDVWH | tDS | Input Valid to Write Enable High | Min | 45 | 50 | ns |
| tWHDX | tDH | Write Enable High to Input Transition | Min | 0 | 0 | ns |
| tWHEH | tCH | Write Enable High to Chip Enable High | Min | 0 | 0 | ns |
| tWHWL | tWPH | Write Enable High to Write Enable Low | Min | 30 | 30 | ns |
| tAVWL | tAS | Address Valid to Write Enable Low | Min | 0 | 0 | ns |
| tWLAX | tAH | Write Enable Low to Address Transition | Min | 45 | 50 | ns |
| tGHWL | | Output Enable High to Write Enable Low | Min | 0 | 0 | ns |
| tWHGL | tOEH | Write Enable High to Output Enable Low | Min | 0 | 0 | ns |
| tWHRL ⁽¹⁾ | tBUSY | Program/Erase Valid to RB-bar Low | Max | 30 | 35 | ns |
| tVCHL | tVCS | VCC High to Chip Enable Low | Min | 50 | 50 | µs |

Note: 1. Sampled only, not 100% tested.

Figure 14. Write AC Waveforms, Chip Enable Controlled



AI05561

Table 15. Write AC Characteristics, Chip Enable Controlled

| Symbol | Alt | Parameter | | M29DW323D | | Unit |
|-----------------|------------|--|-----|-----------|----|---------|
| | | | | 70 | 90 | |
| t_{AVAV} | t_{WC} | Address Valid to Next Address Valid | Min | 70 | 90 | ns |
| t_{WLEL} | t_{WS} | Write Enable Low to Chip Enable Low | Min | 0 | 0 | ns |
| t_{ELEH} | t_{CP} | Chip Enable Low to Chip Enable High | Min | 45 | 50 | ns |
| t_{DVEH} | t_{DS} | Input Valid to Chip Enable High | Min | 45 | 50 | ns |
| t_{EHDX} | t_{DH} | Chip Enable High to Input Transition | Min | 0 | 0 | ns |
| t_{EHWH} | t_{WH} | Chip Enable High to Write Enable High | Min | 0 | 0 | ns |
| t_{EHEL} | t_{CPH} | Chip Enable High to Chip Enable Low | Min | 30 | 30 | ns |
| t_{AVEL} | t_{AS} | Address Valid to Chip Enable Low | Min | 0 | 0 | ns |
| t_{ELAX} | t_{AH} | Chip Enable Low to Address Transition | Min | 45 | 50 | ns |
| t_{GHEL} | | Output Enable High Chip Enable Low | Min | 0 | 0 | ns |
| t_{EHGL} | t_{OEHL} | Chip Enable High to Output Enable Low | Min | 0 | 0 | ns |
| $t_{EHL}^{(1)}$ | t_{BUSY} | Program/Erase Valid to \overline{RB} Low | Max | 30 | 35 | ns |
| t_{VCHWL} | t_{VCS} | V_{CC} High to Write Enable Low | Min | 50 | 50 | μ s |

Note: 1. Sampled only, not 100% tested.

Figure 15. Reset/Block Temporary Unprotect AC Waveforms

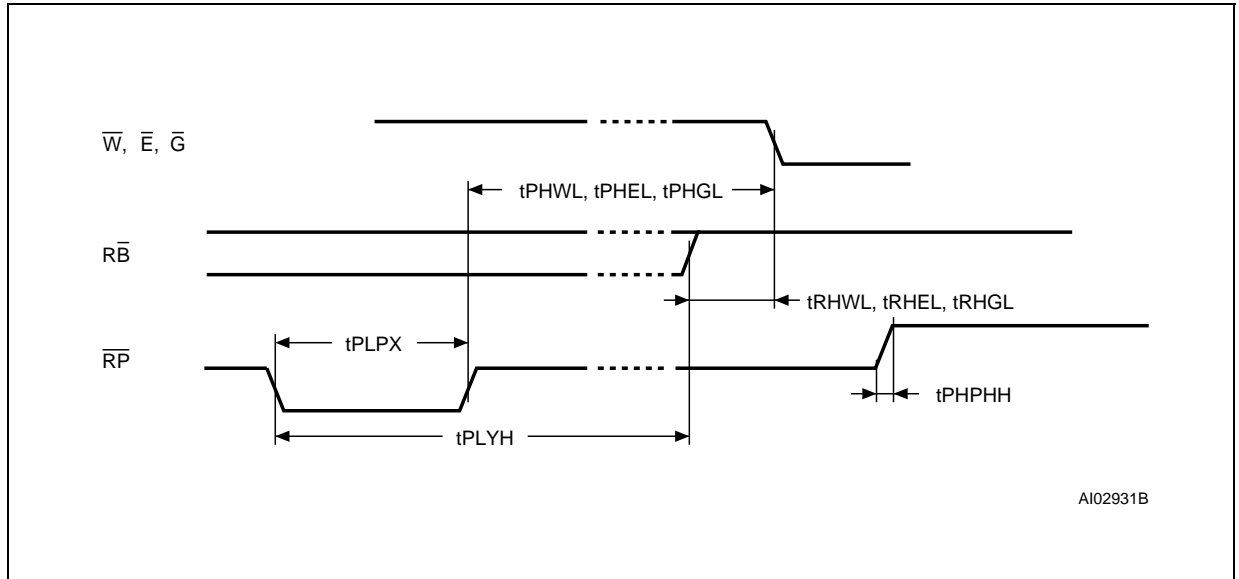
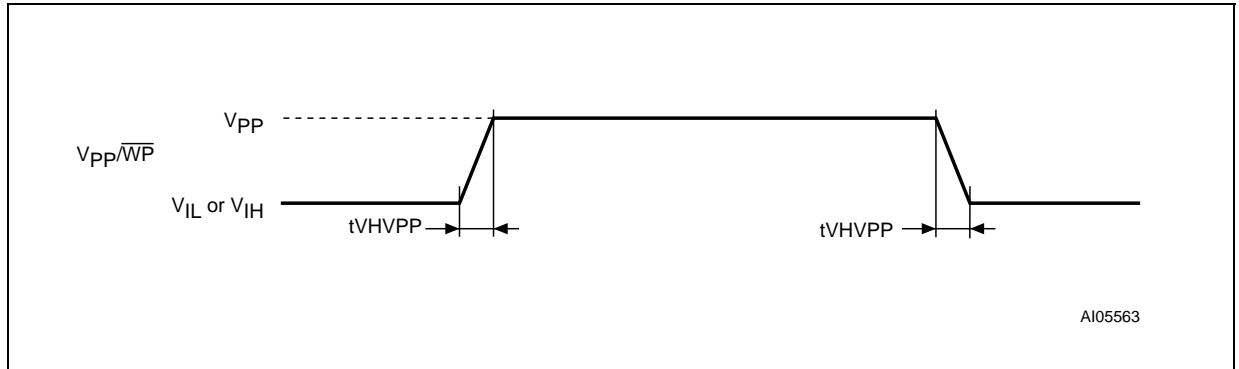


Table 16. Reset/Block Temporary Unprotect AC Characteristics

| Symbol | Alt | Parameter | M29DW323D | | Unit | |
|--|-------------|--|-----------|-----|------|---------|
| | | | 70 | 90 | | |
| $t_{PHWL}^{(1)}$ $t_{PHEL}^{(1)}$ $t_{PHGL}^{(1)}$ | t_{RH} | \overline{RP} High to Write Enable Low, Chip Enable Low, Output Enable Low | Min | 50 | 50 | ns |
| $t_{RHHL}^{(1)}$ $t_{RHEL}^{(1)}$ $t_{RHGL}^{(1)}$ | t_{RB} | \overline{RB} High to Write Enable Low, Chip Enable Low, Output Enable Low | Min | 0 | 0 | ns |
| t_{PLPX} | t_{RP} | \overline{RP} Pulse Width | Min | 500 | 500 | ns |
| t_{PLYH} | t_{READY} | \overline{RP} Low to Read Mode | Max | 50 | 50 | μ s |
| $t_{PHPHH}^{(1)}$ | t_{VIDR} | \overline{RP} Rise Time to V_{ID} | Min | 500 | 500 | ns |
| $t_{VHVPP}^{(1)}$ | | V_{PP} Rise and Fall Time | Min | 250 | 250 | ns |

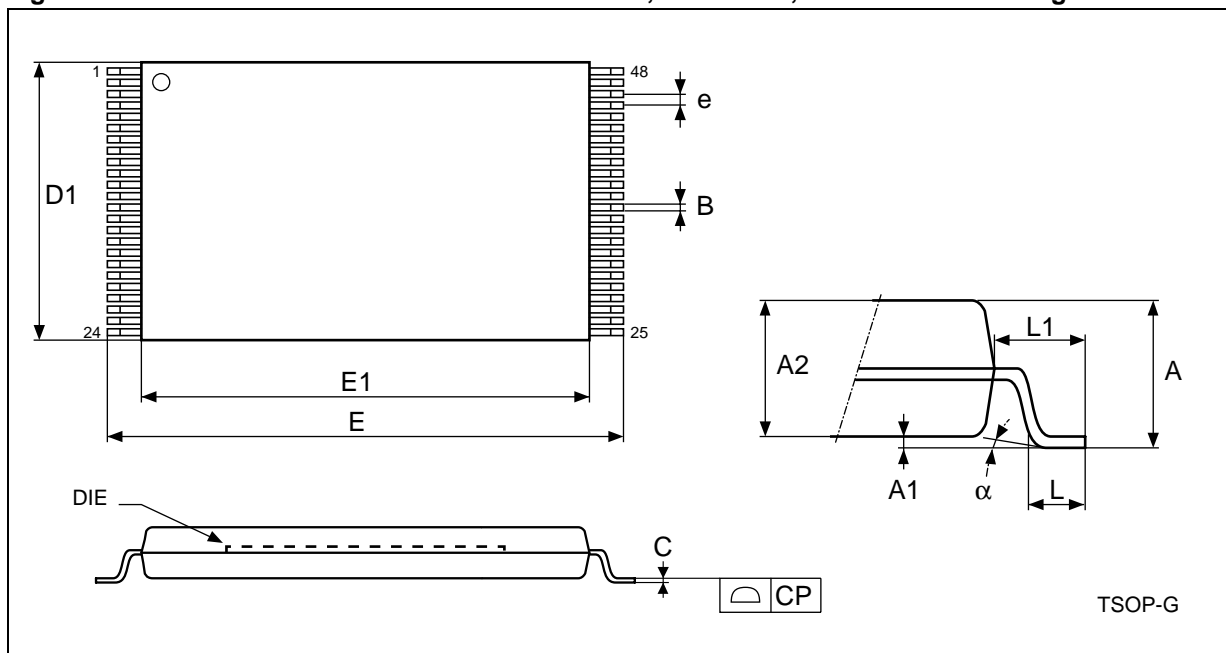
Note: 1. Sampled only, not 100% tested.

Figure 16. Accelerated Program Timing Waveforms



PACKAGE MECHANICAL

Figure 17. TSOP48 Lead Plastic Thin Small Outline, 12x20 mm, Bottom View Package Outline

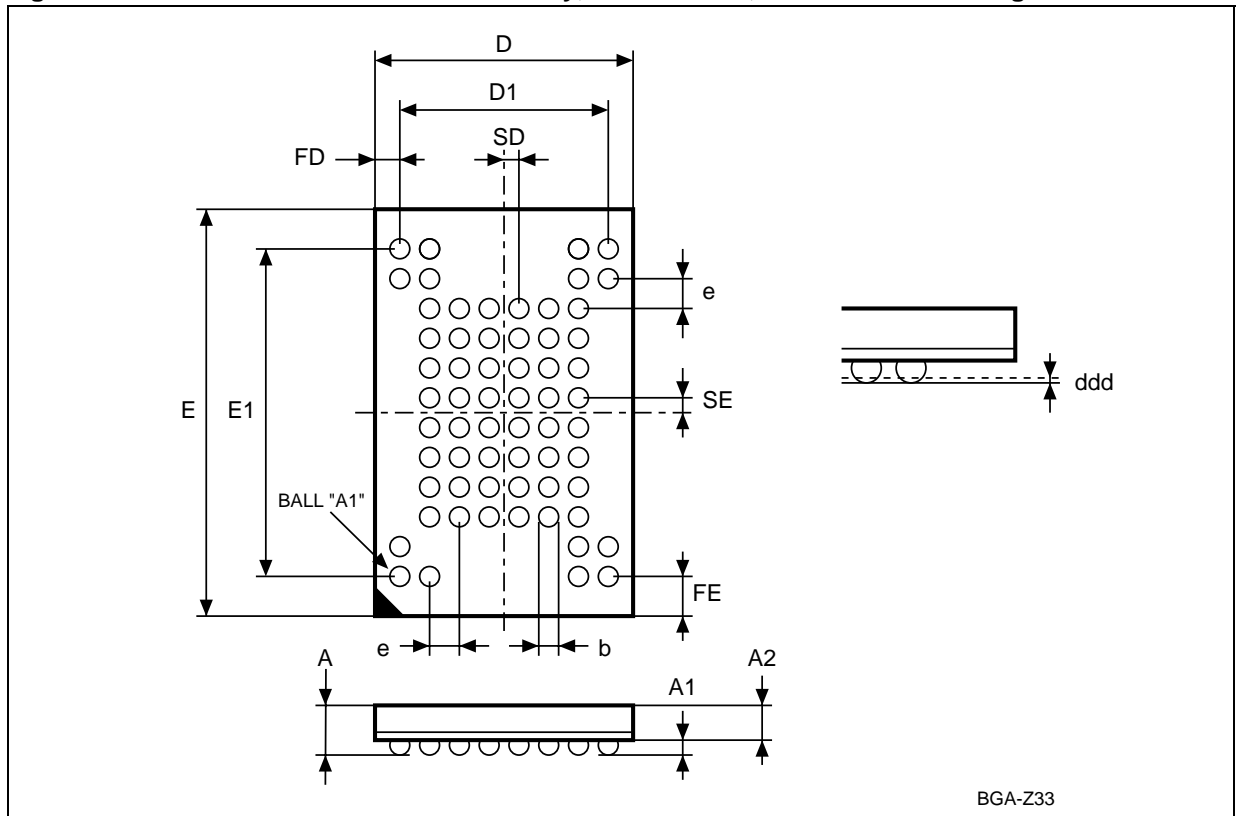


Note: Drawing not to scale.

Table 17. TSOP48 Lead Plastic Thin Small Outline, 12x20 mm, Package Mechanical Data

| Symbol | millimeters | | | inches | | |
|----------|-------------|--------|--------|--------|--------|--------|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 1.200 | | | 0.0472 |
| A1 | 0.100 | 0.050 | 0.150 | 0.0039 | 0.0020 | 0.0059 |
| A2 | 1.000 | 0.950 | 1.050 | 0.0394 | 0.0374 | 0.0413 |
| B | 0.220 | 0.170 | 0.270 | 0.0087 | 0.0067 | 0.0106 |
| C | | 0.100 | 0.210 | | 0.0039 | 0.0083 |
| CP | | | 0.080 | | | 0.0031 |
| D1 | 12.000 | 11.900 | 12.100 | 0.4724 | 0.4685 | 0.4764 |
| E | 20.000 | 19.800 | 20.200 | 0.7874 | 0.7795 | 0.7953 |
| E1 | 18.400 | 18.300 | 18.500 | 0.7244 | 0.7205 | 0.7283 |
| e | 0.500 | – | – | 0.0197 | – | – |
| L | 0.600 | 0.500 | 0.700 | 0.0236 | 0.0197 | 0.0276 |
| L1 | 0.800 | | | 0.0315 | | |
| α | 3 | 0 | 5 | 3 | 0 | 5 |

Figure 18. TFBGA63 7x11mm - 6x8 Ball Array, 0.8mm Pitch, Bottom View Package Outline

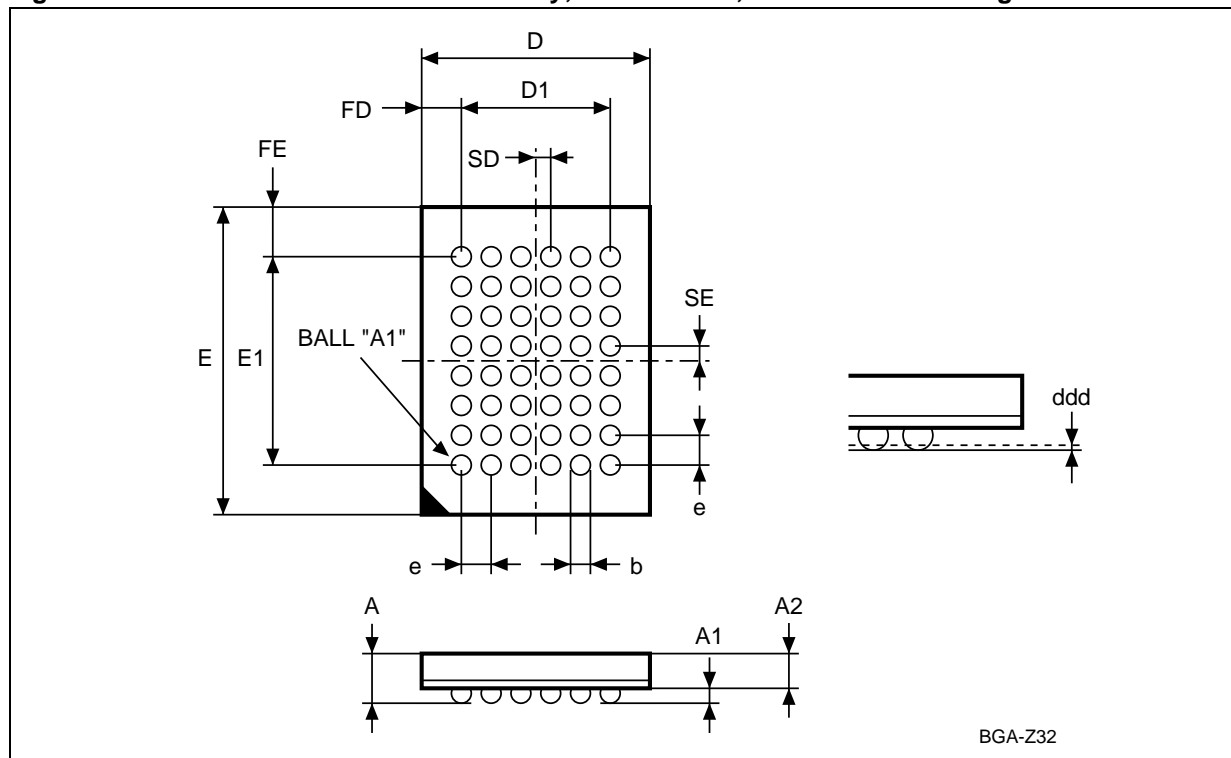


Note: Drawing not to scale.

Table 18. TFBGA63 7x11mm - 6x8 Ball Array, 0.8mm Pitch, Package Mechanical Data

| Symbol | millimeters | | | inches | | |
|--------|-------------|--------|--------|--------|--------|--------|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 1.200 | | | 0.0472 |
| A1 | | 0.250 | | | 0.0098 | |
| A2 | | | 0.900 | | | 0.0354 |
| b | | 0.350 | 0.450 | | 0.0138 | 0.0177 |
| D | 7.000 | 6.900 | 7.100 | 0.2756 | 0.2717 | 0.2795 |
| D1 | 5.600 | - | - | 0.2205 | - | - |
| ddd | - | - | 0.100 | - | - | 0.0039 |
| E | 11.000 | 10.900 | 11.100 | 0.4331 | 0.4291 | 0.4370 |
| E1 | 8.800 | - | - | 0.3465 | - | - |
| e | 0.800 | - | - | 0.0315 | - | - |
| FD | 0.700 | - | - | 0.0276 | - | - |
| FE | 1.100 | - | - | 0.0433 | - | - |
| SD | 0.400 | - | - | 0.0157 | - | - |
| SE | 0.400 | - | - | 0.0157 | - | - |

Figure 19. TFBGA48 6x8mm - 6x8 Ball Array, 0.8mm Pitch, Bottom View Package Outline



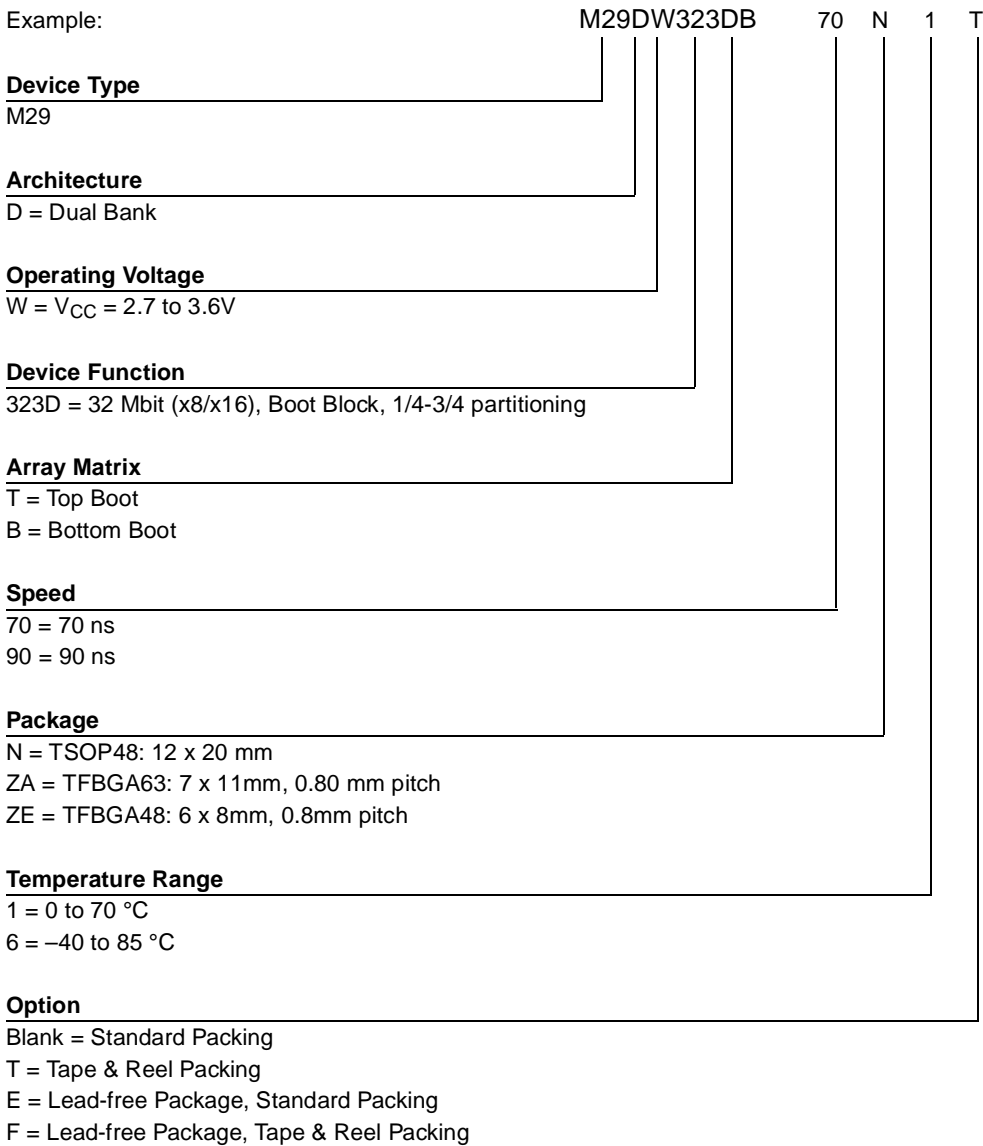
Note: Drawing not to scale.

Table 19. TFBGA48 6x8mm - 6x8 Ball Array, 0.8mm Pitch, Package Mechanical Data

| Symbol | millimeters | | | inches | | |
|--------|-------------|-------|-------|--------|--------|--------|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 1.200 | | | 0.0472 |
| A1 | | 0.260 | | | 0.0102 | |
| A2 | | | 0.900 | | | 0.0354 |
| b | | 0.350 | 0.450 | | 0.0138 | 0.0177 |
| D | 6.000 | 5.900 | 6.100 | 0.2362 | 0.2323 | 0.2402 |
| D1 | 4.000 | – | – | 0.1575 | – | – |
| ddd | | | 0.100 | | | 0.0039 |
| E | 8.000 | 7.900 | 8.100 | 0.3150 | 0.3110 | 0.3189 |
| E1 | 5.600 | – | – | 0.2205 | – | – |
| e | 0.800 | – | – | 0.0315 | – | – |
| FD | 1.000 | – | – | 0.0394 | – | – |
| FE | 1.200 | – | – | 0.0472 | – | – |
| SD | 0.400 | – | – | 0.0157 | – | – |
| SE | 0.400 | – | – | 0.0157 | – | – |

PART NUMBERING

Table 20. Ordering Information Scheme



Note: This product is also available with the Extended Block factory locked. For further details and ordering information contact your nearest ST sales office.

Devices are shipped from the factory with the memory content bits erased to '1'. For a list of available options (Speed, Package, etc...) or for further information on any aspect of this device, please contact the ST Sales Office nearest to you.

APPENDIX A. BLOCK ADDRESSES

Table 21. Top Boot Block Addresses, M29DW323DT

| Bank | Block | (Kbytes/ Kwords) | Protection Block Group | (x8) | (x16) |
|--------|-------|---------------------|---------------------------|-----------------|-----------------|
| Bank B | 0 | 64/32 | Protection Group | 000000h–00FFFFh | 000000h–07FFFh |
| | 1 | 64/32 | Protection Group | 010000h–01FFFFh | 008000h–0FFFFh |
| | 2 | 64/32 | | 020000h–02FFFFh | 010000h–17FFFh |
| | 3 | 64/32 | | 030000h–03FFFFh | 018000h–01FFFFh |
| | 4 | 64/32 | Protection Group | 040000h–04FFFFh | 020000h–027FFFh |
| | 5 | 64/32 | | 050000h–05FFFFh | 028000h–02FFFFh |
| | 6 | 64/32 | | 060000h–06FFFFh | 030000h–037FFFh |
| | 7 | 64/32 | | 070000h–07FFFFh | 038000h–03FFFFh |
| | 8 | 64/32 | Protection Group | 080000h–08FFFFh | 040000h–047FFFh |
| | 9 | 64/32 | | 090000h–09FFFFh | 048000h–04FFFFh |
| | 10 | 64/32 | | 0A0000h–0AFFFFh | 050000h–057FFFh |
| | 11 | 64/32 | | 0B0000h–0BFFFFh | 058000h–05FFFFh |
| | 12 | 64/32 | Protection Group | 0C0000h–0CFFFFh | 060000h–067FFFh |
| | 13 | 64/32 | | 0D0000h–0DFFFFh | 068000h–06FFFFh |
| | 14 | 64/32 | | 0E0000h–0EFFFFh | 070000h–077FFFh |
| | 15 | 64/32 | | 0F0000h–0FFFFFh | 078000h–07FFFFh |
| | 16 | 64/32 | Protection Group | 100000h–10FFFFh | 080000h–087FFFh |
| | 17 | 64/32 | | 110000h–11FFFFh | 088000h–08FFFFh |
| | 18 | 64/32 | | 120000h–12FFFFh | 090000h–097FFFh |
| | 19 | 64/32 | | 130000h–13FFFFh | 098000h–09FFFFh |
| | 20 | 64/32 | Protection Group | 140000h–14FFFFh | 0A0000h–0A7FFFh |
| | 21 | 64/32 | | 150000h–15FFFFh | 0A8000h–0AFFFFh |
| | 22 | 64/32 | | 160000h–16FFFFh | 0B0000h–0B7FFFh |
| | 23 | 64/32 | | 170000h–17FFFFh | 0B8000h–0BFFFFh |
| | 24 | 64/32 | Protection Group | 180000h–18FFFFh | 0C0000h–0C7FFFh |
| | 25 | 64/32 | | 190000h–19FFFFh | 0C8000h–0CFFFFh |
| | 26 | 64/32 | | 1A0000h–1AFFFFh | 0D0000h–0D7FFFh |
| | 27 | 64/32 | | 1B0000h–1BFFFFh | 0D8000h–0DFFFFh |
| | 28 | 64/32 | Protection Group | 1C0000h–1CFFFFh | 0E0000h–0E7FFFh |
| | 29 | 64/32 | | 1D0000h–1DFFFFh | 0E8000h–0EFFFFh |
| | 30 | 64/32 | | 1E0000h–1EFFFFh | 0F0000h–0F7FFFh |
| | 31 | 64/32 | | 1F0000h–1FFFFFh | 0F8000h–0FFFFFh |

| Bank | Block | (Kbytes/ Kwords) | Protection Block Group | (x8) | (x16) |
|--------|-------|---------------------|---------------------------|-----------------|-----------------|
| Bank B | 32 | 64/32 | Protection Group | 200000h–20FFFFh | 100000h–107FFFh |
| | 33 | 64/32 | | 210000h–21FFFFh | 108000h–10FFFFh |
| | 34 | 64/32 | | 220000h–22FFFFh | 110000h–117FFFh |
| | 35 | 64/32 | | 230000h–23FFFFh | 118000h–11FFFFh |
| | 36 | 64/32 | Protection Group | 240000h–24FFFFh | 120000h–127FFFh |
| | 37 | 64/32 | | 250000h–25FFFFh | 128000h–12FFFFh |
| | 38 | 64/32 | | 260000h–26FFFFh | 130000h–137FFFh |
| | 39 | 64/32 | | 270000h–27FFFFh | 138000h–13FFFFh |
| | 40 | 64/32 | Protection Group | 280000h–28FFFFh | 140000h–147FFFh |
| | 41 | 64/32 | | 290000h–29FFFFh | 148000h–14FFFFh |
| | 42 | 64/32 | | 2A0000h–2AFFFFh | 150000h–157FFFh |
| | 43 | 64/32 | | 2B0000h–2BFFFFh | 158000h–15FFFFh |
| | 44 | 64/32 | Protection Group | 2C0000h–2CFFFFh | 160000h–167FFFh |
| | 45 | 64/32 | | 2D0000h–2DFFFFh | 168000h–16FFFFh |
| | 46 | 64/32 | | 2E0000h–2EFFFFh | 170000h–177FFFh |
| | 47 | 64/32 | | 2F0000h–2FFFFFh | 178000h–17FFFFh |
| Bank A | 48 | 64/32 | Protection Group | 300000h–30FFFFh | 180000h–187FFFh |
| | 49 | 64/32 | | 310000h–31FFFFh | 188000h–18FFFFh |
| | 50 | 64/32 | | 320000h–32FFFFh | 190000h–197FFFh |
| | 51 | 64/32 | | 330000h–33FFFFh | 198000h–19FFFFh |
| | 52 | 64/32 | Protection Group | 340000h–34FFFFh | 1A0000h–1A7FFFh |
| | 53 | 64/32 | | 350000h–35FFFFh | 1A8000h–1AFFFFh |
| | 54 | 64/32 | | 360000h–36FFFFh | 1B0000h–1B7FFFh |
| | 55 | 64/32 | | 370000h–37FFFFh | 1B8000h–1BFFFFh |
| | 56 | 64/32 | Protection Group | 380000h–38FFFFh | 1C0000h–1C7FFFh |
| | 57 | 64/32 | | 390000h–39FFFFh | 1C8000h–1CFFFFh |
| | 58 | 64/32 | | 3A0000h–3AFFFFh | 1D0000h–1D7FFFh |
| | 59 | 64/32 | | 3B0000h–3BFFFFh | 1D8000h–1DFFFFh |
| | 60 | 64/32 | Protection Group | 3C0000h–3CFFFFh | 1E0000h–1E7FFFh |
| | 61 | 64/32 | | 3D0000h–3DFFFFh | 1E8000h–1EFFFFh |
| | 62 | 64/32 | | 3E0000h–3EFFFFh | 1F0000h–1F7FFFh |

| Bank | Block | (Kbytes/ Kwords) | Protection Block Group | (x8) | (x16) |
|--------|-------|---------------------|---------------------------|--------------------------------|--------------------------------|
| Bank A | 63 | 8/4 | Protection Group | 3F0000h–3F1FFFh ⁽¹⁾ | 1F8000h–1F8FFFh ⁽¹⁾ |
| | 64 | 8/4 | Protection Group | 3F2000h–3F3FFFh ⁽¹⁾ | 1F9000h–1F9FFFh ⁽¹⁾ |
| | 65 | 8/4 | Protection Group | 3F4000h–3F5FFFh ⁽¹⁾ | 1FA000h–1FAFFFh ⁽¹⁾ |
| | 66 | 8/4 | Protection Group | 3F6000h–3F7FFFh ⁽¹⁾ | 1FB000h–1FBFFFh ⁽¹⁾ |
| | 67 | 8/4 | Protection Group | 3F8000h–3F9FFFh ⁽¹⁾ | 1FC000h–1FCFFFh ⁽¹⁾ |
| | 68 | 8/4 | Protection Group | 3FA000h–3FBFFFh ⁽¹⁾ | 1FD000h–1FDFFFh ⁽¹⁾ |
| | 69 | 8/4 | Protection Group | 3FC000h–3FDFFFh ⁽¹⁾ | 1FE000h–1FEFFFh ⁽¹⁾ |
| | 70 | 8/4 | Protection Group | 3FE000h–3FFFFFh ⁽¹⁾ | 1FF000h–1FFFFFh ⁽¹⁾ |

Note: 1. Used as the Extended Block Addresses in Extended Block mode.

Table 22. Bottom Boot Block Addresses, M29DW323DB

| Bank | Block | (Kbytes/ Kwords) | Protection Block Group | (x8) | (x16) |
|--------|-------|---------------------|---------------------------|--------------------------------|--------------------------------|
| Bank A | 0 | 8/4 | Protection Group | 000000h-001FFFh ⁽¹⁾ | 000000h-000FFFh ⁽¹⁾ |
| | 1 | 8/4 | Protection Group | 002000h-003FFFh ⁽¹⁾ | 001000h-001FFFh ⁽¹⁾ |
| | 2 | 8/4 | Protection Group | 004000h-005FFFh ⁽¹⁾ | 002000h-002FFFh ⁽¹⁾ |
| | 3 | 8/4 | Protection Group | 006000h-007FFFh ⁽¹⁾ | 003000h-003FFFh ⁽¹⁾ |
| | 4 | 8/4 | Protection Group | 008000h-009FFFh ⁽¹⁾ | 004000h-004FFFh ⁽¹⁾ |
| | 5 | 8/4 | Protection Group | 00A000h-00BFFFh ⁽¹⁾ | 005000h-005FFFh ⁽¹⁾ |
| | 6 | 8/4 | Protection Group | 00C000h-00DFFFh ⁽¹⁾ | 006000h-006FFFh ⁽¹⁾ |
| | 7 | 8/4 | Protection Group | 00E000h-00FFFFh ⁽¹⁾ | 007000h-007FFFh ⁽¹⁾ |
| | 8 | 64/32 | Protection Group | 010000h-01FFFFh | 008000h-00FFFFh |
| | 9 | 64/32 | | 020000h-02FFFFh | 010000h-017FFFh |
| | 10 | 64/32 | | 030000h-03FFFFh | 018000h-01FFFFh |
| | 11 | 64/32 | Protection Group | 040000h-04FFFFh | 020000h-027FFFh |
| | 12 | 64/32 | | 050000h-05FFFFh | 028000h-02FFFFh |
| | 13 | 64/32 | | 060000h-06FFFFh | 030000h-037FFFh |
| | 14 | 64/32 | | 070000h-07FFFFh | 038000h-03FFFFh |
| | 15 | 64/32 | Protection Group | 080000h-08FFFFh | 040000h-047FFFh |
| | 16 | 64/32 | | 090000h-09FFFFh | 048000h-04FFFFh |
| | 17 | 64/32 | | 0A0000h-0AFFFFh | 050000h-057FFFh |
| | 18 | 64/32 | | 0B0000h-0BFFFFh | 058000h-05FFFFh |
| | 19 | 64/32 | Protection Group | 0C0000h-0CFFFFh | 060000h-067FFFh |
| | 20 | 64/32 | | 0D0000h-0DFFFFh | 068000h-06FFFFh |
| | 21 | 64/32 | | 0E0000h-0EFFFFh | 070000h-077FFFh |
| 22 | 64/32 | 0F0000h-0FFFFFh | | 078000h-07FFFFh | |
| Bank B | 23 | 64/32 | Protection Group | 100000h-10FFFFh | 080000h-087FFFh |
| | 24 | 64/32 | | 110000h-11FFFFh | 088000h-08FFFFh |
| | 25 | 64/32 | | 120000h-12FFFFh | 090000h-097FFFh |
| | 26 | 64/32 | | 130000h-13FFFFh | 098000h-09FFFFh |
| | 27 | 64/32 | Protection Group | 140000h-14FFFFh | 0A0000h-0A7FFFh |
| | 28 | 64/32 | | 150000h-15FFFFh | 0A8000h-0AFFFFh |
| | 29 | 64/32 | | 160000h-16FFFFh | 0B0000h-0B7FFFh |
| | 30 | 64/32 | | 170000h-17FFFFh | 0B8000h-0BFFFFh |

| Bank | Block | (Kbytes/ Kwords) | Protection Block Group | (x8) | (x16) |
|--------|-------|---------------------|---------------------------|-----------------|-----------------|
| Bank B | 31 | 64/32 | Protection Group | 180000h-18FFFFh | 0C0000h-0C7FFFh |
| | 32 | 64/32 | | 190000h-19FFFFh | 0C8000h-0CFFFFh |
| | 33 | 64/32 | | 1A0000h-1AFFFFh | 0D0000h-0D7FFFh |
| | 34 | 64/32 | | 1B0000h-1BFFFFh | 0D8000h-0DFFFFh |
| | 35 | 64/32 | Protection Group | 1C0000h-1CFFFFh | 0E0000h-0E7FFFh |
| | 36 | 64/32 | | 1D0000h-1DFFFFh | 0E8000h-0EFFFFh |
| | 37 | 64/32 | | 1E0000h-1EFFFFh | 0F0000h-0F7FFFh |
| | 38 | 64/32 | | 1F0000h-1FFFFFh | 0F8000h-0FFFFFh |
| | 39 | 64/32 | Protection Group | 200000h-20FFFFh | 100000h-107FFFh |
| | 40 | 64/32 | | 210000h-21FFFFh | 108000h-10FFFFh |
| | 41 | 64/32 | | 220000h-22FFFFh | 110000h-117FFFh |
| | 42 | 64/32 | | 230000h-23FFFFh | 118000h-11FFFFh |
| | 43 | 64/32 | Protection Group | 240000h-24FFFFh | 120000h-127FFFh |
| | 44 | 64/32 | | 250000h-25FFFFh | 128000h-12FFFFh |
| | 45 | 64/32 | | 260000h-26FFFFh | 130000h-137FFFh |
| | 46 | 64/32 | | 270000h-27FFFFh | 138000h-13FFFFh |
| | 47 | 64/32 | Protection Group | 280000h-28FFFFh | 140000h-147FFFh |
| | 48 | 64/32 | | 290000h-29FFFFh | 148000h-14FFFFh |
| | 49 | 64/32 | | 2A0000h-2AFFFFh | 150000h-157FFFh |
| | 50 | 64/32 | | 2B0000h-2BFFFFh | 158000h-15FFFFh |
| | 51 | 64/32 | Protection Group | 2C0000h-2CFFFFh | 160000h-167FFFh |
| | 52 | 64/32 | | 2D0000h-2DFFFFh | 168000h-16FFFFh |
| | 53 | 64/32 | | 2E0000h-2EFFFFh | 170000h-177FFFh |
| | 54 | 64/32 | | 2F0000h-2FFFFFh | 178000h-17FFFFh |
| | 55 | 64/32 | Protection Group | 300000h-30FFFFh | 180000h-187FFFh |
| | 56 | 64/32 | | 310000h-31FFFFh | 188000h-18FFFFh |
| | 57 | 64/32 | | 320000h-32FFFFh | 190000h-197FFFh |
| | 58 | 64/32 | | 330000h-33FFFFh | 198000h-19FFFFh |
| | 59 | 64/32 | Protection Group | 340000h-34FFFFh | 1A0000h-1A7FFFh |
| | 60 | 64/32 | | 350000h-35FFFFh | 1A8000h-1AFFFFh |
| | 61 | 64/32 | | 360000h-36FFFFh | 1B0000h-1B7FFFh |
| | 62 | 64/32 | | 370000h-37FFFFh | 1B8000h-1BFFFFh |

| Bank | Block | (Kbytes/ Kwords) | Protection Block Group | (x8) | (x16) |
|--------|-------|---------------------|---------------------------|------------------|------------------|
| Bank B | 63 | 64/32 | Protection Group | 380000h-38FFFFh | 1C0000h-1C7FFFh |
| | 64 | 64/32 | | 390000h-39FFFFh | 1C8000h-1CFFFFh |
| | 65 | 64/32 | | 3A0000h-3AFFFFh | 1D0000h-1D7FFFh |
| | 66 | 64/32 | | 3B0000h-3BFFFFh | 1D8000h-1DFFFFh |
| | 67 | 64/32 | Protection Group | 3C0000h-3CFFFFh | 1E0000h-1E7FFFh |
| | 68 | 64/32 | | 3D0000h-3DFFFFh | 1E8000h-1EFFFFh |
| | 69 | 64/32 | | 3E0000h-3EFFFFh | 1F0000h-1F7FFFh |
| | 70 | 64/32 | Protection Group | 3F0000h-3FFFFFFh | 1F8000h-1FFFFFFh |

Note: 1. Used as the Extended Block Addresses in Extended Block mode.

APPENDIX B. COMMON FLASH INTERFACE (CFI)

The Common Flash Interface is a JEDEC approved, standardized data structure that can be read from the Flash memory device. It allows a system software to query the device to determine various electrical and timing parameters, density information and functions supported by the memory. The system can interface easily with the device, enabling the software to upgrade itself when necessary.

When the CFI Query Command is issued the device enters CFI Query mode and the data structure

is read from the memory. Tables 23, 24, 25, 26, 27 and 28 show the addresses used to retrieve the data.

The CFI data structure also contains a security area where a 64 bit unique security number is written (see Table 28, Security Code area). This area can be accessed only in Read mode by the final user. It is impossible to change the security number after it has been written by ST.

Table 23. Query Structure Overview

| Address | | Sub-section Name | Description |
|---------|-----|---|---|
| x16 | x8 | | |
| 10h | 20h | CFI Query Identification String | Command set ID and algorithm data offset |
| 1Bh | 36h | System Interface Information | Device timing & voltage information |
| 27h | 4Eh | Device Geometry Definition | Flash device layout |
| 40h | 80h | Primary Algorithm-specific Extended Query table | Additional information specific to the Primary Algorithm (optional) |
| 61h | C2h | Security Code Area | 64 bit unique device number |

Note: Query data are always presented on the lowest order data outputs.

Table 24. CFI Query Identification String

| Address | | Data | Description | Value |
|---------|-----|-------|--|----------------|
| x16 | x8 | | | |
| 10h | 20h | 0051h | Query Unique ASCII String "QRY" | "Q" |
| 11h | 22h | 0052h | | "R" |
| 12h | 24h | 0059h | | "Y" |
| 13h | 26h | 0002h | Primary Algorithm Command Set and Control Interface ID code 16 bit ID code defining a specific algorithm | AMD Compatible |
| 14h | 28h | 0000h | | |
| 15h | 2Ah | 0040h | Address for Primary Algorithm extended Query table (see Table 27) | P = 40h |
| 16h | 2Ch | 0000h | | |
| 17h | 2Eh | 0000h | Alternate Vendor Command Set and Control Interface ID Code second vendor - specified algorithm supported | NA |
| 18h | 30h | 0000h | | |
| 19h | 32h | 0000h | Address for Alternate Algorithm extended Query table | NA |
| 1Ah | 34h | 0000h | | |

Note: Query data are always presented on the lowest order data outputs (DQ7-DQ0) only. DQ8-DQ15 are '0'.

Table 25. CFI Query System Interface Information

| Address | | Data | Description | Value |
|---------|-----|-------|---|--------|
| x16 | x8 | | | |
| 1Bh | 36h | 0027h | V _{CC} Logic Supply Minimum Program/Erase voltage bit 7 to 4 BCD value in volts bit 3 to 0 BCD value in 100 mV | 2.7V |
| 1Ch | 38h | 0036h | V _{CC} Logic Supply Maximum Program/Erase voltage bit 7 to 4 BCD value in volts bit 3 to 0 BCD value in 100 mV | 3.6V |
| 1Dh | 3Ah | 00B5h | V _{PP} [Programming] Supply Minimum Program/Erase voltage bit 7 to 4 HEX value in volts bit 3 to 0 BCD value in 100 mV | 11.5V |
| 1Eh | 3Ch | 00C5h | V _{PP} [Programming] Supply Maximum Program/Erase voltage bit 7 to 4 HEX value in volts bit 3 to 0 BCD value in 100 mV | 12.5V |
| 1Fh | 3Eh | 0004h | Typical timeout per single byte/word program = 2 ⁿ μs | 16μs |
| 20h | 40h | 0000h | Typical timeout for minimum size write buffer program = 2 ⁿ μs | NA |
| 21h | 42h | 000Ah | Typical timeout per individual block erase = 2 ⁿ ms | 1s |
| 22h | 44h | 0000h | Typical timeout for full chip erase = 2 ⁿ ms | NA |
| 23h | 46h | 0004h | Maximum timeout for byte/word program = 2 ⁿ times typical | 256 μs |
| 24h | 48h | 0000h | Maximum timeout for write buffer program = 2 ⁿ times typical | NA |
| 25h | 4Ah | 0003h | Maximum timeout per individual block erase = 2 ⁿ times typical | 8 s |
| 26h | 4Ch | 0000h | Maximum timeout for chip erase = 2 ⁿ times typical | NA |

Table 26. Device Geometry Definition

| Address | | Data | Description | Value |
|------------|------------|----------------|--|-------------------|
| x16 | x8 | | | |
| 27h | 4Eh | 0016h | Device Size = 2 ⁿ in number of bytes | 4 MByte |
| 28h 29h | 50h 52h | 0002h 0000h | Flash Device Interface Code description | x8, x16 Async. |
| 2Ah 2Bh | 54h 56h | 0000h 0000h | Maximum number of bytes in multi-byte program or page = 2 ⁿ | NA |
| 2Ch | 58h | 0002h | Number of Erase Block Regions. It specifies the number of regions containing contiguous Erase Blocks of the same size. | 2 |
| 2Dh 2Eh | 5Ah 5Ch | 0007h 0000h | Region 1 Information Number of identical size erase block = 0007h+1 | 8 |
| 2Fh 30h | 5Eh 60h | 0020h 0000h | Region 1 Information Block size in Region 1 = 0020h * 256 byte | 8Kbyte |
| 31h 32h | 62h 64h | 003Eh 0000h | Region 2 Information Number of identical size erase block = 003Eh+1 | 63 |
| 33h 34h | 66h 68h | 0000h 0001h | Region 2 Information Block size in Region 2 = 0100h * 256 byte | 64Kbyte |

Note: The region information contained in addresses 2Dh to 34h (or 5Ah to 68h) is correct for the M29DW323DB. For the M29DW323DT the regions must be reversed.

Table 27. Primary Algorithm-Specific Extended Query Table

| Address | | Data | Description | Value |
|---------|-----|-------|---|-------|
| x16 | x8 | | | |
| 40h | 80h | 0050h | Primary Algorithm extended Query table unique ASCII string "PRI" | "P" |
| 41h | 82h | 0052h | | "R" |
| 42h | 84h | 0049h | | "I" |
| 43h | 86h | 0031h | Major version number, ASCII | "1" |
| 44h | 88h | 0030h | Minor version number, ASCII | "0" |
| 45h | 8Ah | 0000h | Address Sensitive Unlock (bits 1 to 0) 00 = required, 01 = not required Silicon Revision Number (bits 7 to 2) | Yes |
| 46h | 8Ch | 0002h | Erase Suspend 00 = not supported, 01 = Read only, 02 = Read and Write | 2 |
| 47h | 8Eh | 0001h | Block Protection 00 = not supported, x = number of blocks in per group | 1 |
| 48h | 90h | 0001h | Temporary Block Unprotect 00 = not supported, 01 = supported | Yes |
| 49h | 92h | 0004h | Block Protect /Unprotect 04 = M29W400B | 4 |
| 4Ah | 94h | 0030h | Simultaneous Operations, x = number of blocks in Bank B | 48 |
| 4Bh | 96h | 0000h | Burst Mode, 00 = not supported, 01 = supported | No |
| 4Ch | 98h | 0000h | Page Mode, 00 = not supported, 01 = 4 page word, 02 = 8 page word | No |
| 4Dh | 9Ah | 00B5h | V _{PP} Supply Minimum Program/Erase voltage bit 7 to 4 HEX value in volts bit 3 to 0 BCD value in 100 mV | 11.5V |
| 4Eh | 9Ch | 00C5h | V _{PP} Supply Maximum Program/Erase voltage bit 7 to 4 HEX value in volts bit 3 to 0 BCD value in 100 mV | 12.5V |
| 4Fh | 9Eh | 000xh | Top/Bottom Boot Block Flag 02h = Bottom Boot device, 03h = Top Boot device | – |

Table 28. Security Code Area

| Address | | Data | Description |
|---------|----------|------|------------------------------|
| x16 | x8 | | |
| 61h | C3h, C2h | XXXX | 64 bit: unique device number |
| 62h | C5h, C4h | XXXX | |
| 63h | C7h, C6h | XXXX | |
| 64h | C9h, C8h | XXXX | |

APPENDIX C. EXTENDED MEMORY BLOCK

The M29DW323D has an extra block, the Extended Block, that can be accessed using a dedicated command.

This Extended Block is 32 KWords in x16 mode and 64 KBytes in x8 mode. It is used as a security block (to provide a permanent security identification number) or to store additional information.

The Extended Block is either Factory Locked or Customer Lockable, its status is indicated by bit DQ7. This bit is permanently set to either '1' or '0' at the factory and cannot be changed. When set to '1', it indicates that the device is factory locked and the Extended Block is protected. When set to '0', it indicates that the device is customer lockable and the Extended Block is unprotected. Bit DQ7 being permanently locked to either '1' or '0' is another security feature which ensures that a customer lockable device cannot be used instead of a factory locked one.

Bit DQ7 is the most significant bit in the Extended Block Verify Code and a specific procedure must be followed to read it. See "Extended Memory Block Verify Code" in Tables 3 and 4, Bus Operations, BYTE = V_{IL} and Bus Operations, BYTE = V_{IH}, respectively, for details of how to read bit DQ7.

The Extended Block can only be accessed when the device is in Extended Block mode. For details of how the Extended Block mode is entered and exited, refer to the Enter Extended Block Command and Exit Extended Block Command paragraphs, and to Tables 5 and 6, "Commands, 16-bit mode, BYTE = V_{IH}" and "Commands, 8-bit mode, BYTE = V_{IL}", respectively.

Factory Locked Extended Block

In devices where the Extended Block is factory locked, the Security Identification Number is written to the Extended Block address space (see Table 29, Extended Block Address and Data) in the factory. The DQ7 bit is set to '1' and the Extended Block cannot be unprotected.

Customer Lockable Extended Block

A device where the Extended Block is customer lockable is delivered with the DQ7 bit set to '0' and the Extended Block unprotected. It is up to the customer to program and protect the Extended Block but care must be taken because the protection of the Extended Block is not reversible.

There are two ways of protecting the Extended Block:

- Issue the Enter Extended Block command to place the device in Extended Block mode, then use the In-System Technique (refer to Appendix D, In-System Technique and to the corresponding flowcharts, Figures 22 and 23, for a detailed explanation of the technique).
- Issue the Enter Extended Block command to place the device in Extended Block mode, then use the Programmer Technique (refer to Appendix D, Programmer Technique and to the corresponding flowcharts, Figures 20 and 21, for a detailed explanation of the technique).

Once the Extended Block is programmed and protected, the Exit Extended Block command must be issued to exit the Extended Block mode and return the device to Read mode.

Table 29. Extended Block Address and Data

| Device | Address ⁽¹⁾ | | Data | |
|------------|------------------------|------------------|--------------------------------|------------------------|
| | x8 | x16 | Factory Locked | Customer Lockable |
| M29DW323DT | 3F0000h-3F000Fh | 1F8000h-1F8007h | Security Identification Number | Determined by Customer |
| | 3F0010h-3FFFFFFh | 1F8008h-1FFFFFFh | Unavailable | |
| M29DW323DB | 000000h-00000Fh | 000000h-000007h | Security Identification Number | Determined by Customer |
| | 000010h-00FFFFFFh | 000008h-007FFFh | Unavailable | |

Note: 1. See Tables 21 and 22, Top and Bottom Boot Block Addresses.



APPENDIX D. BLOCK PROTECTION

Block protection can be used to prevent any operation from modifying the data stored in the memory. The blocks are protected in groups, refer to Appendix A, Tables 21 and 22 for details of the Protection Groups. Once protected, Program and Erase operations within the protected group fail to change the data.

There are three techniques that can be used to control Block Protection, these are the Programmer technique, the In-System technique and Temporary Unprotection. Temporary Unprotection is controlled by the Reset/Block Temporary Unprotection pin, RP; this is described in the Signal Descriptions section.

Programmer Technique

The Programmer technique uses high (V_{ID}) voltage levels on some of the bus pins. These cannot be achieved using a standard microprocessor bus, therefore the technique is recommended only for use in Programming Equipment.

To protect a group of blocks follow the flowchart in Figure 20, Programmer Equipment Block Protect Flowchart. To unprotect the whole chip it is necessary to protect all of the groups first, then all groups can be unprotected at the same time. To unprotect the chip follow Figure 21, Programmer Equipment Chip Unprotect Flowchart. Table 30, Programmer Technique Bus Operations, gives a summary of each operation.

The timing on these flowcharts is critical. Care should be taken to ensure that, where a pause is specified, it is followed as closely as possible. Do not abort the procedure before reaching the end. Chip Unprotect can take several seconds and a user message should be provided to show that the operation is progressing.

In-System Technique

The In-System technique requires a high voltage level on the Reset/Blocks Temporary Unprotect pin, RP. This can be achieved without violating the maximum ratings of the components on the microprocessor bus, therefore this technique is suitable for use after the memory has been fitted to the system.

To protect a group of blocks follow the flowchart in Figure 22, In-System Block Protect Flowchart. To unprotect the whole chip it is necessary to protect all of the groups first, then all the groups can be unprotected at the same time. To unprotect the chip follow Figure 23, In-System Chip Unprotect Flowchart.

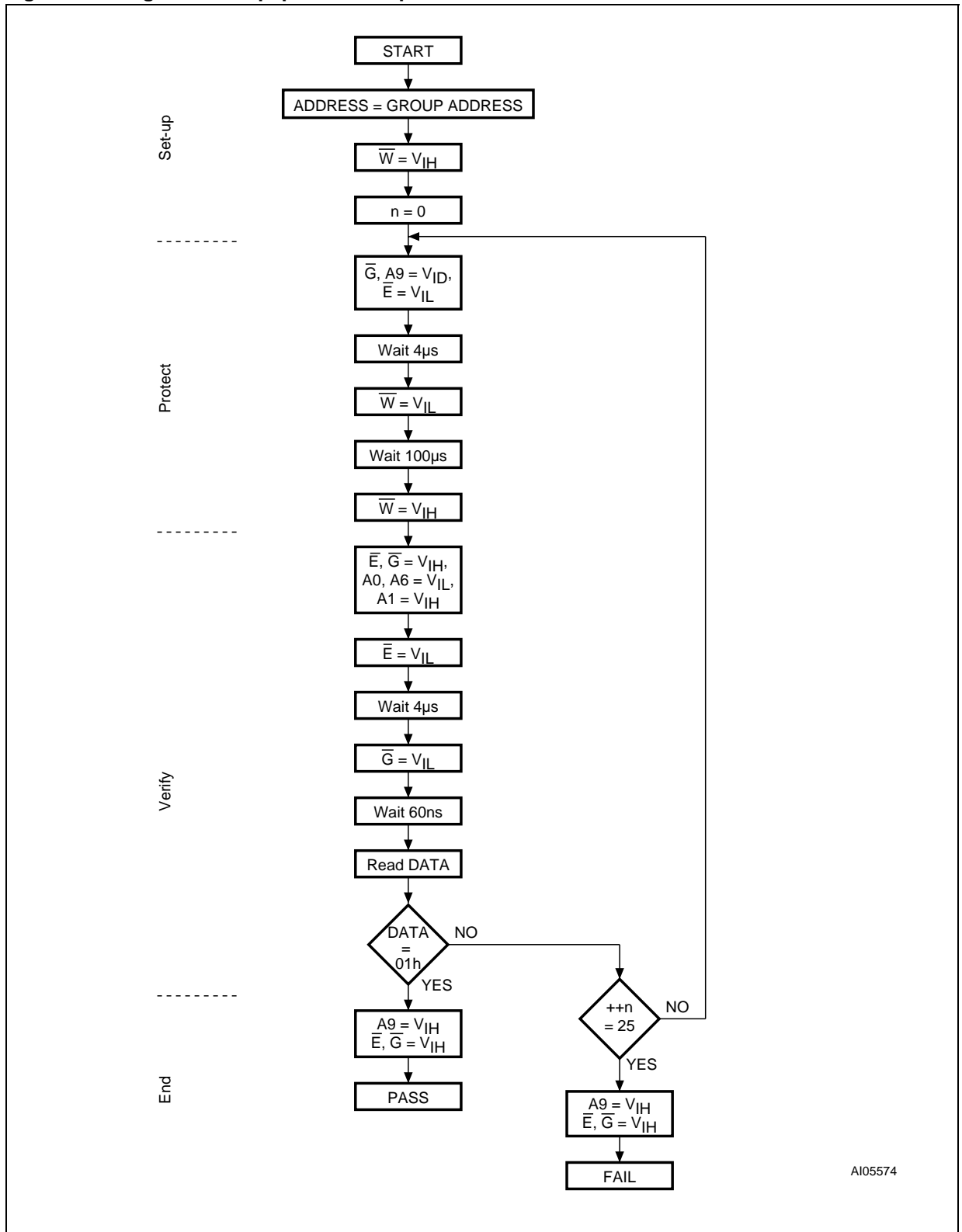
The timing on these flowcharts is critical. Care should be taken to ensure that, where a pause is specified, it is followed as closely as possible. Do not allow the microprocessor to service interrupts that will upset the timing and do not abort the procedure before reaching the end. Chip Unprotect can take several seconds and a user message should be provided to show that the operation is progressing.

Table 30. Programmer Technique Bus Operations, $\overline{\text{BYTE}} = V_{IH}$ or V_{IL}

| Operation | $\overline{\text{E}}$ | $\overline{\text{G}}$ | $\overline{\text{W}}$ | Address Inputs A0-A20 | Data Inputs/Outputs DQ15A-1, DQ14-DQ0 |
|--------------------------------------|-----------------------|-----------------------|-----------------------|--|--|
| Block (Group) Protect ⁽¹⁾ | V_{IL} | V_{ID} | V_{IL} Pulse | A9 = V_{ID} , A12-A20 Block Address Others = X | X |
| Chip Unprotect | V_{ID} | V_{ID} | V_{IL} Pulse | A9 = V_{ID} , A12 = V_{IH} , A15 = V_{IH} Others = X | X |
| Block (Group) Protection Verify | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IL} , A1 = V_{IH} , A6 = V_{IL} , A9 = V_{ID} , A12-A20 Block Address Others = X | Pass = XX01h Retry = XX00h |
| Block (Group) Unprotection Verify | V_{IL} | V_{IL} | V_{IH} | A0 = V_{IL} , A1 = V_{IH} , A6 = V_{IH} , A9 = V_{ID} , A12-A20 Block Address Others = X | Retry = XX01h Pass = XX00h |

Note: 1. Block Protection Groups are shown in Appendix A, Tables 21 and 22.

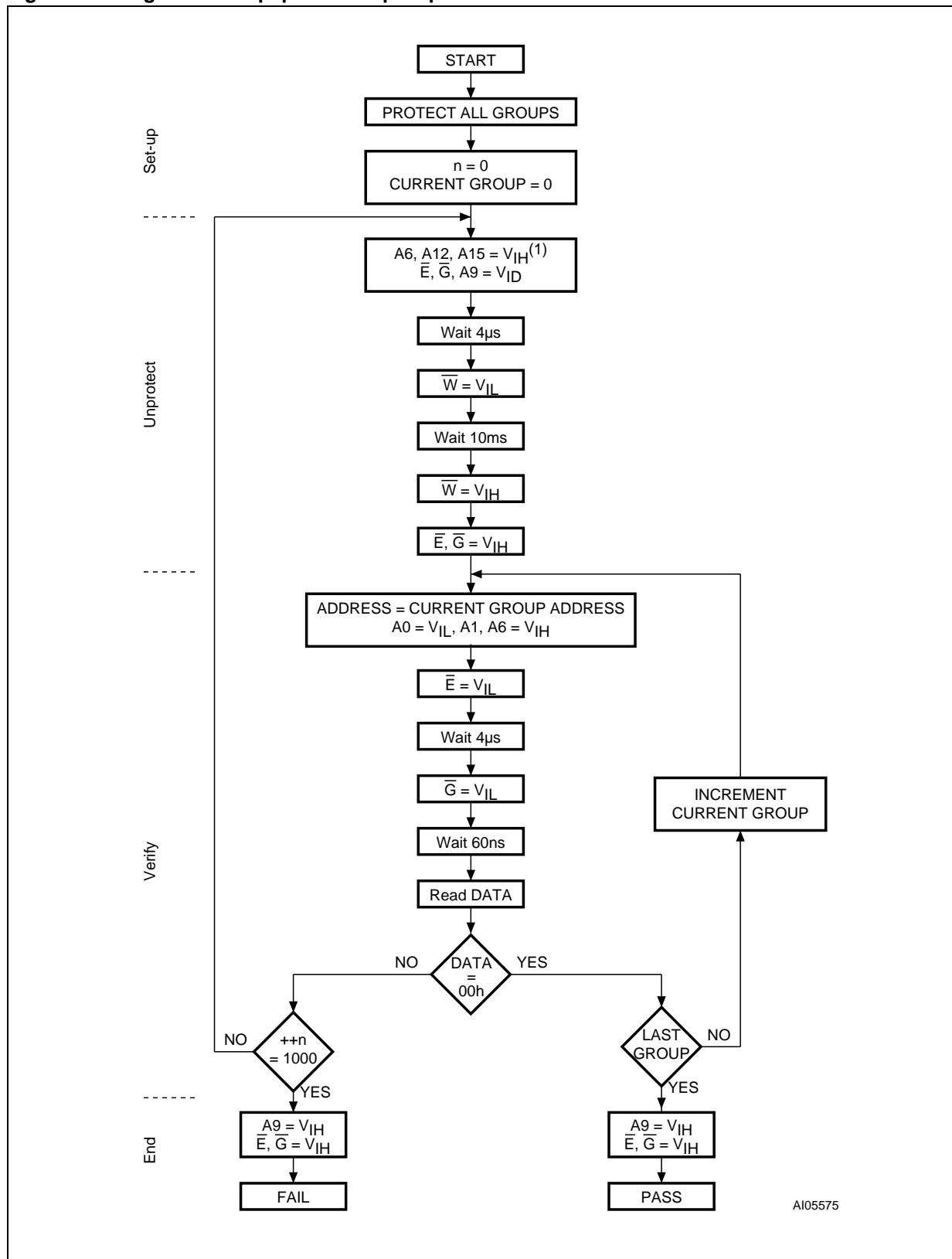
Figure 20. Programmer Equipment Group Protect Flowchart



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Note: Block Protection Groups are shown in Appendix D, Tables 21 and 22.

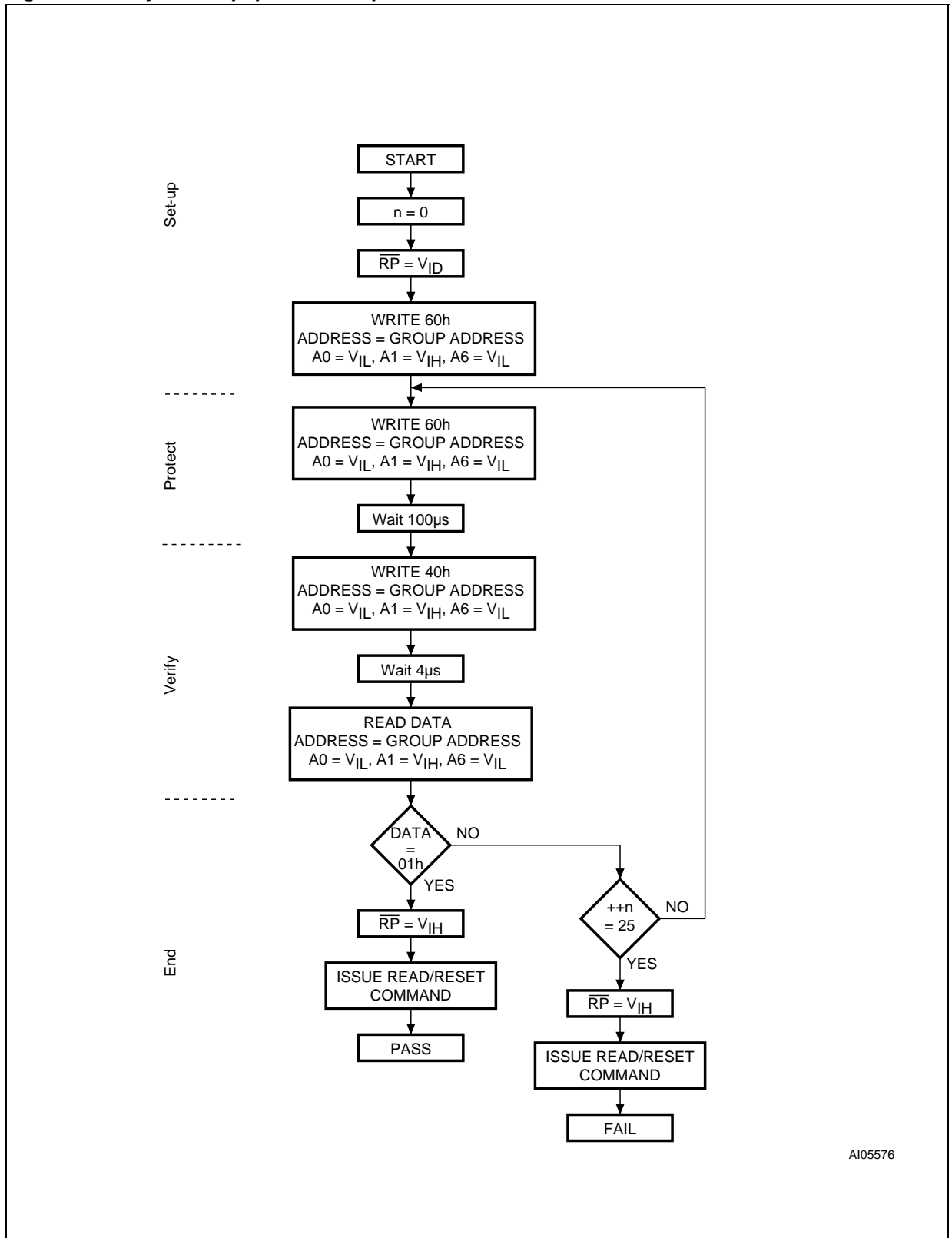
Figure 21. Programmer Equipment Chip Unprotect Flowchart



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Note: Block Protection Groups are shown in Appendix D, Tables 21 and 22.

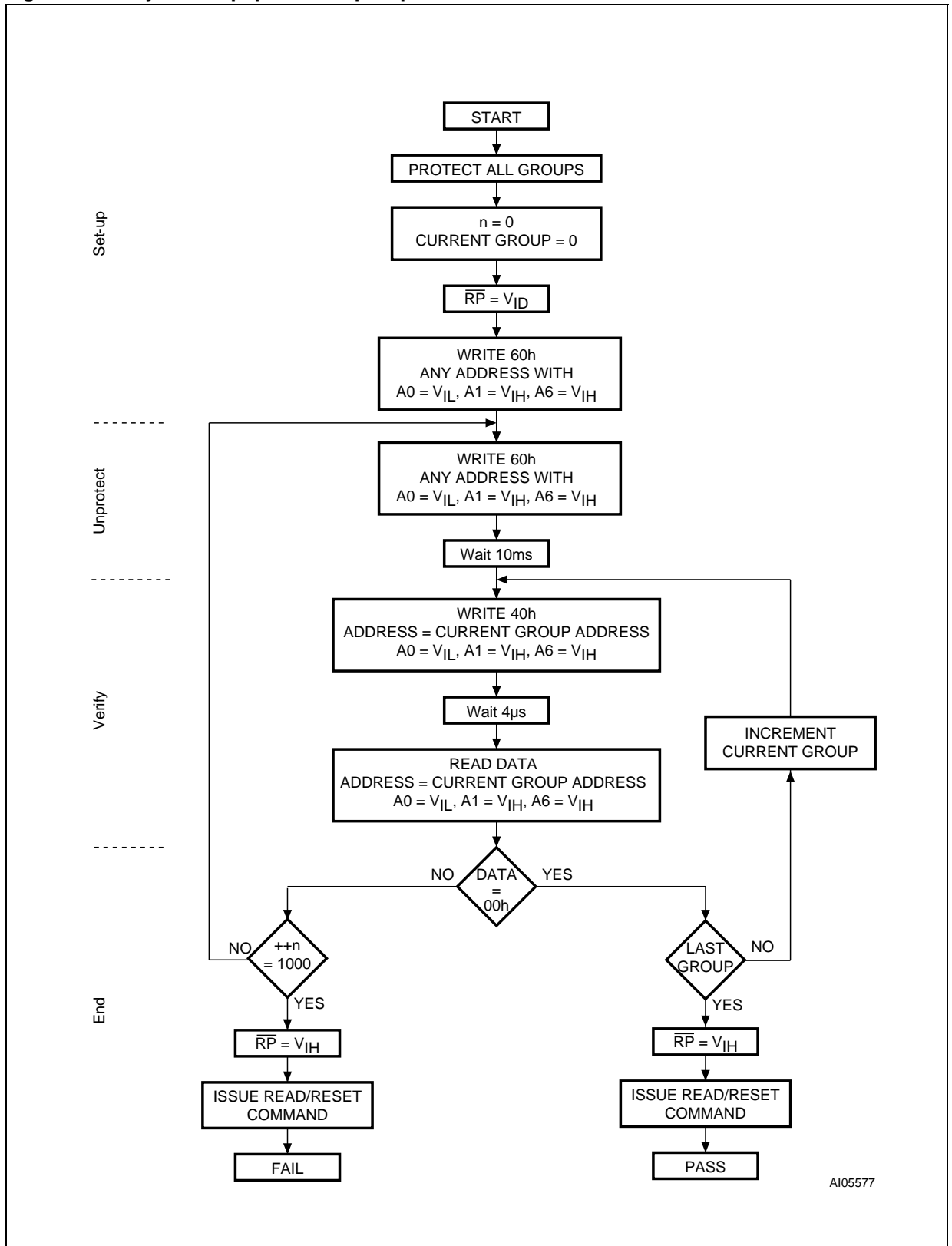
Figure 22. In-System Equipment Group Protect Flowchart



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Note: Block Protection Groups are shown in Appendix D, Tables 21 and 22.

Figure 23. In-System Equipment Chip Unprotect Flowchart



AI05577

Note: Block Protection Groups are shown in Appendix D, Tables 21 and 22.

REVISION HISTORY

Table 31. Document Revision History

| Date | Version | Revision Details |
|-------------|---------|--|
| 20-Sep-2001 | -01 | First Issue (Target Specification) |
| 26-Oct-2001 | -02 | Document expanded to full Product Preview |
| 16-Jan-2002 | -03 | Corrections made in "Primary Algorithm-Specific Extended Query" Table in Appendix-B |
| 19-Apr-2002 | -04 | Description of Ready/Busy signal clarified (and Figure 15 modified) Clarified allowable commands during block erase Clarified the mode the device returns to in the CFI Read Query command section tPLYH (time to reset device) re-specified. |
| 24-Apr-2002 | -05 | Values for addresses 23h and 25h corrected in CFI Query System Interface Information table in Appendix B |
| 19-Jul-2002 | -06 | When in Extended Block mode, the block at the boot block address can be used as OTP. Data Toggle Flow chart corrected. Document promoted from "Product Preview" to "Preliminary Data". |
| 08-Apr-2003 | 6.1 | Revision numbering modified: a minor revision will be indicated by incrementing the digit after the dot, and a major revision, by incrementing the digit before the dot (revision version 06 equals 6.0). Revision History moved to end of document. TFBGA48, 6 x 8mm, 0.80mm pitch package added. Identification Current I _{ID} removed from Table 12, DC Characteristics. Erase Suspend Latency time and Data Retention parameters and notes added to Table 7, Program, Erase Times and Program, Erase Endurance Cycles. Appendix C, EXTENDED MEMORY BLOCK, added. Auto Select Command used to read the Extended Memory Block. Extended Memory Block Verify Code row added to Tables 3 and 4, Bus Operations, BYTE = V _{IL} and Bus Operations, BYTE = V _{IH} . Bank Address modified in Auto Select Command. Chip Erase Address modified in Table 8, Status Register Bits. V _{SS} pin connection to ground clarified. Note added to Table 20, Ordering Information Scheme. |
| 07-May-2003 | 6.2 | Table 17, TSOP48 Lead Plastic Thin Small Outline, 12x20 mm, Package Mechanical Data and Figure 17, TSOP48 Lead Plastic Thin Small Outline, 12x20 mm, Bottom View Package Outline, corrected. |
| 25-Jun-2003 | 7.0 | Document promoted from Preliminary Data to full Datasheet status. Packing option added to Table 20, Ordering Information Scheme. |

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