



### Replacing the M28F201 with the M29F002B Flash Memory

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#### INTRODUCTION

This application note will help you to replace the M28F201 in your designs with the M29F002B. Note that two types of M29F002B Flash Memories are equally suitable upgrades for the M28F201: these are the M29F002BB and the M29F002BT which will be referred to generically as the M29F002B in the rest of this application note. Upgrading to M29 Series Flash Memories is very straightforward and will bring you the additional benefits of lower power consumption, faster program and erase operations and greater performance. This application note briefly covers both the hardware and software consequences of upgrading to the M29F002B and should be read in conjunction with the M29F002B Data Sheet.

The M29F002B is a 5V only Flash Memory, which uses a single 5V supply voltage for program, erase and read operations. It generates the required program and erase voltages internally and thus does not have a  $V_{PP}$  12V input pin. The M29F002B is also equipped with a Program/Erase Controller which greatly simplifies the task of programming and erasing the Flash Memory by using internal algorithms instead of requiring the user software to work through every programming and erasing step. This leads to a device with over 100,000 program/erase cycles guaranteed.

If the M28F201 Flash Memories in your application are programmed on programming equipment and subsequently used as Read-Only-Memory (ROM) by your target system, then upgrading to the M29F002B Flash Memory is simply a matter of changing the setting on your programming equipment and making a single minor modification to the PCB layout of your target system.

#### HARDWARE COMPATIBILITY

The M29F002B is offered in the same packages as the M28F201, namely in PLCC32 and TSOP32 (8 x 20mm). The M29F002B and the M28F201 have the same pin connections in both packages, with the exception of one pin which carries the signal  $V_{PP}$  on the M28F201 but the signal  $\overline{RP}$  on the M29F002B. The  $\overline{RP}$  pin on the M29F002B should either be left unconnected or be connected to  $V_{CC}$  during normal operations.

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Therefore, unless your current design has the  $V_{PP}/\overline{RP}$  pin permanently connected to 5V, you will need to cut or remove the track to that pin. This is the only modification to the PCB layout that will be required in order to upgrade from the M28F201 to the M29F002B Flash Memory.

The maximum supply current  $I_{CC}$  that the M29F002B requires from its 5V supply on  $V_{CC}$  during program and erase operations is less than the maximum supply current  $I_{CC}$  required by the M28F201 during read operations at 10MHz. It should thus be possible to replace the M28F201 by the M29F002B without any changes to the 5V power supply. In fact upgrading to the M29F002B will reduce the power consumption during read operations by half. Further power savings will result from the M29F002B not requiring any current from the 12V supply during program and erase operations.

All the bus operations supported by the M28F201 are also supported by the M29F002B. In particular the bus operation required to read the electronic signature of the M28F201 will also allow the electronic signature of the M29F002B to be read. Please note that although both devices share the same manufacturer identification code, they have different device codes. No changes will be required to the address and data buses when upgrading from the M28F201 to the M29F002B.

STMicroelectronics always recommends that you upgrade to the fastest M29F002B device read speed available (currently 45ns). If the M28F201 you are replacing has a read speed of 90ns or more, then all the AC characteristics of any M29F002B upgrade will be faster or equal. However if you are upgrading from a 70ns M28F201, then it is essential for the compatibility of the Read AC characteristics that you upgrade to the 45ns M29F002B. Note however that a few Write AC characteristics of the 45ns M29F002B are 10ns slower than on the 70ns M28F201. It is very unlikely that such a small difference on  $t_{WLAX}$ ,  $t_{ELAX}$ ,  $t_{WLWH}$ ,  $t_{WHLW}$  and  $t_{EHEL}$  will be critical to your design upgrade, but if this is the case you will need to insert an additional microprocessor wait state during bus write operations to the M29F002B.

### SOFTWARE UPGRADE

Both the M29F002B and the M28F201 power up in Read mode. In this mode both devices behave like ROMs and each bus read operation outputs the content of the memory array at the selected memory address. If your target system never changes mode but assumes that the Flash Memory initializes in Read mode and subsequently behaves like a ROM, then you do not need to modify your target software when upgrading from the M28F201 to the M29F002B Flash Memory.

If however your application requires the Flash Memory to change mode (so that it may be programmed, erased, have its electronic signature read and be returned to Read mode) then you will need to upgrade your application software. The mechanism for changing the behavior (or mode) of the M29F002B and the content of its memory array is similar to that used by the M28F201: special sequences of bus write operations are recognized as commands, which cause the M29F002B to start programming or erasing or to switch mode. However there are three main differences between the M29F002B and the M28F201:

1. Different command sets. The M29F002B supports a Block Erase as well as a Chip Erase command. The M29F002B does not require Verify commands to be used in conjunction with the Program and Erase commands: the successful completion of the Program and Erase operations are verified using the Status Register instead. The M29F002B also offers the additional functionality of an Erase Suspend command, which allows parts of the Flash Memory not being erased to be accessed before the Block Erase operation has completed.
2. Different sequences of bus write operations are recognized as commands. Typically the M29F002B requires longer sequences of bus write operations for each command. The sequences are longer on the M29F002B because they contain coded cycles for added security against accidental programming or erasure due to a system software or hardware fault.
3. Different program and erase algorithms. The Program/Erase Controller inside the M29F002B takes care of sending the right current pulses to the cells being programmed and erased, of checking whether the program and erase operation have completed and of programming all cells to '0' before erasing the memory. This makes the user software algorithm required to program and erase the Flash Memory

much simpler; it also means that programming or erasing the M29F002B Flash Memory places a far smaller computational burden on your system micro controller or microprocessor.

The consequence of these differences between the M29F002B and the M28F201 Flash Memories is that you will need to upgrade the component of your application software which interfaces to the Flash Memory. This application note will describe the two simplest methods for upgrading your application software: use the M29F002B software drivers provided by STMicroelectronics or modify your application code directly using the guidelines provided below.

STMicroelectronics application note AN1193 describes software drivers to read, program and erase the M29F002B. Source files are provided for the drivers in C code, and the application note describes the hardware platform specific functions that the user needs to write in order to use the software drivers. The application software can then reset, read, program, erase and check the electronic signature of the Flash Memory by calling the library C functions `FlashReadReset()`, `FlashRead()`, `FlashProgram()`, `FlashChipErase()` and `FlashAutoSelect()`. The library functions take care of checking whether the program and erase operations complete successfully.

Even if your application requires you to adapt your current application software, you may find application note AN1193 useful for understanding the operation of the M29F002B. However this application note aims to provide you with sufficient information to enable you to upgrade your application software for the M29F002B: note that you will need to refer to the M29F002B Data Sheet for the details of the bus write operation sequences recognized as commands.

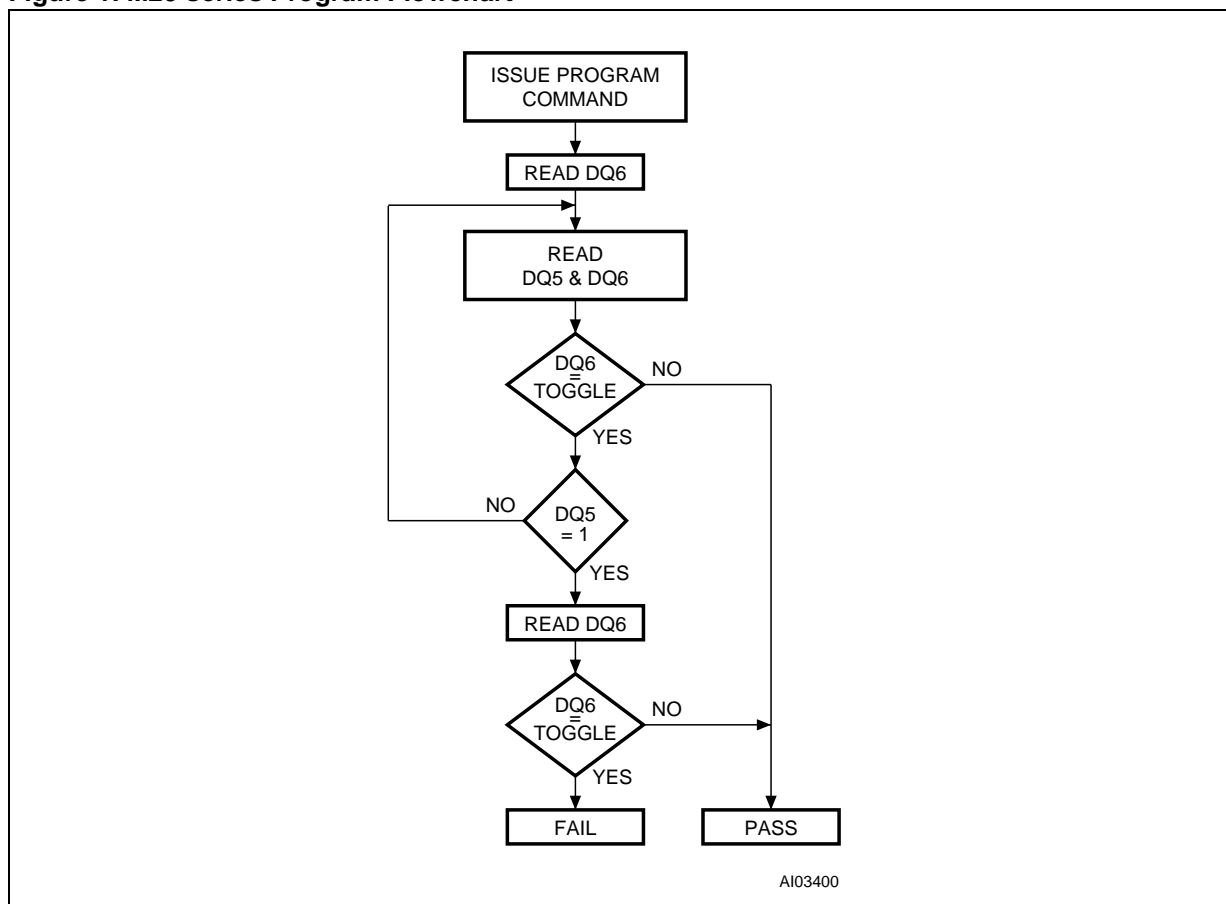
**Reading the electronic signature.** In order to read the electronic signature of the M29F002B, the user first needs to issue the Auto Select command to place the device in Auto Select mode. The manufacturer and device identification codes may then be read from the Flash Memory by setting address bit A1 to  $V_{IL}$  and address bit A0 to  $V_{IL}$  or  $V_{IH}$  respectively (this is similar to reading the manufacturer and device code from the M28F201). The Auto Select mode also allows the user to read the Block protection status of the M29F002B. To exit the Auto Select mode, the user should issue the Read/Reset command.

**The Status Register.** The Status Register bits indicate whether a program or erase operation is on-going, has failed or was successful. Bus read operations cause the Status Register to be output by the M29F002B while program and erase operations are on-going or have failed. Both the data polling bit (DQ7) and the data toggle bit (DQ6) indicate whether the operation is on-going or has completed. The error bit (DQ5) will be set if the operation failed to complete successfully. On successful completion of a program or erase operation, the M29F002B will stop to output the Status Register: bus read operations will output the content of the memory array instead. This is used by the Data Polling and the Data Toggle flowcharts of the M29F002B Data Sheet to determine when an operation has completed, and whether it was successful or not.

**Programming a Flash Memory address.** The data toggle flowchart of the M29F002B Data Sheet leads to the algorithm described in Figure 1 for programming an address of the M29F002B. After issuing the program command, the user keeps on checking the Error bit and the Data Toggle bit of the Status Register until completion of the operation. If the Error bit is set before completion, then the program operation has failed. Otherwise the operation has completed successfully. Note that, like the M28F201, the M29F002B cannot change a bit from '0' to '1' by programming. Your application software should therefore check that this is not being attempted prior to issuing the program command.

**Erasing the Flash Memory.** The data toggle flowchart of the M29F002B Data Sheet leads to the algorithm described in Figure 2 for erasing the whole memory array of the M29F002B. After issuing the Chip Erase command, the user keeps on checking the Error bit and the Data Toggle bit of the Status Register until completion of the operation. If the Error bit is set before completion, then the erase operation has failed. Otherwise the operation has completed successfully. Note that it is not necessary to program each cell of the M29F002B memory array to '0' before erasing. This is taken care of by the internal Program/Erase controller of the M29F002B Flash Memory.

Figure 1. M29 series Program Flowchart

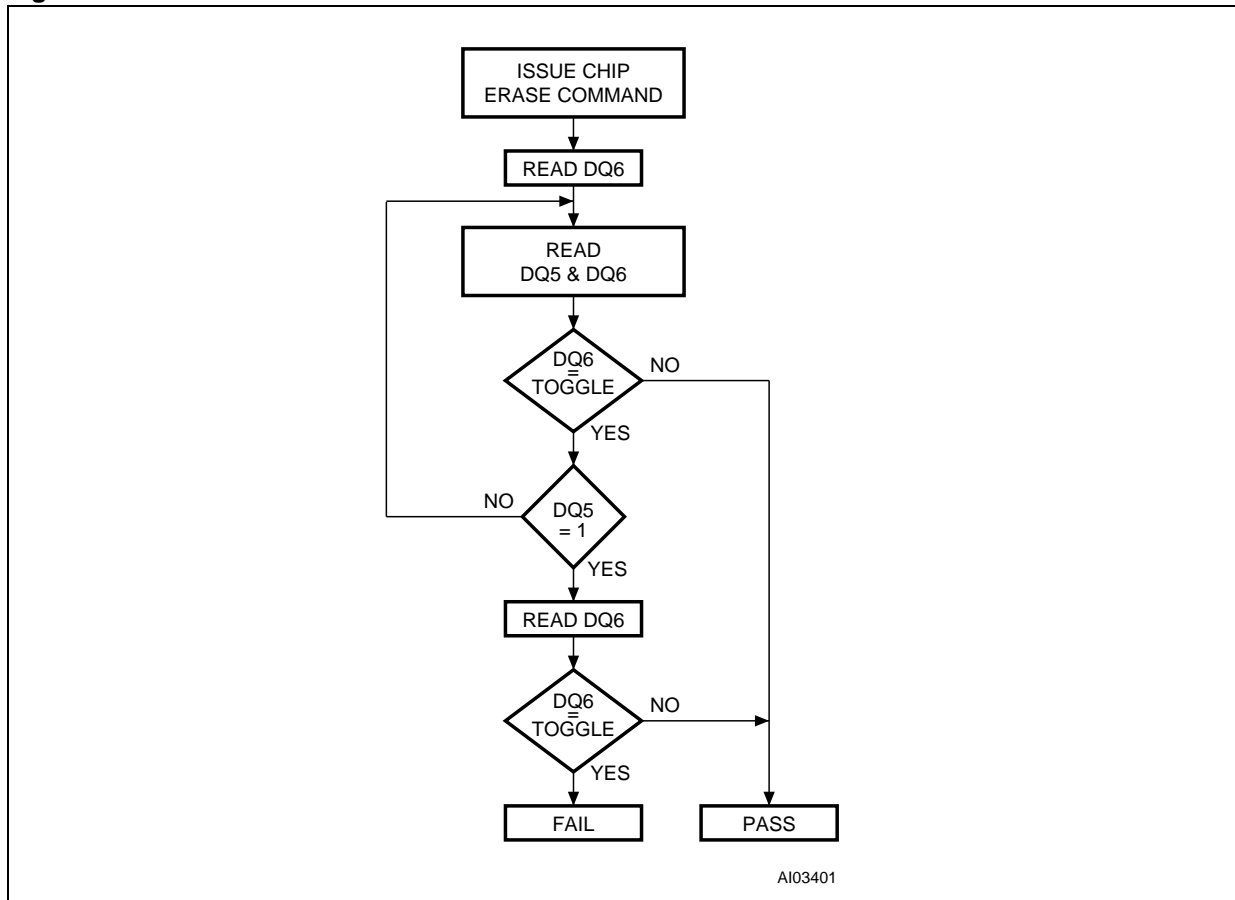


**OTHER CONSIDERATIONS**

This section outlines a number of differences between the M28F201 and the M29F002B which may be relevant to your upgrade design:

1. The allowed range for the identification voltage  $V_{ID}$  on the M29F002B (11.5V to 12.5V) is more restrictive than on the M28F201. If the identification voltage is to be used, care should be taken that it is controlled to remain within the range allowed on the M29F002B.
2. The minimum lockout voltage  $V_{LKO}$  is higher on the M29F002B than it is on the M28F201. This allows the M29F002B to offer better protection against accidental programming and erasure when the power supply is being switched on or off.
3. The absolute maximum rating for  $V_{CC}$  is less on the M29F002B than on the M28F201 (6V instead of 7V). Care should be taken to ensure that the supply voltage on  $V_{CC}$  never exceeds the maximum rating of the M29F002B.
4. The M29F002B takes up to 10 $\mu$ s to be ready following a Read/Reset command issued during a Block Erase command or after an erase or program error. The user software should not attempt to access the M29F002B during this 10 $\mu$ s period. Note that this 10 $\mu$ s period is similar to the 6 $\mu$ s required by the M28F201 to be ready following a command issued to change mode.
5. The M29F002B takes up to 50 $\mu$ s from the moment  $V_{CC}$  is applied to become ready. This initial delay of 50 $\mu$ s must be taken into account when upgrading from the M28F201 to the M29F002B; this may require the boot sequence of the target system to be modified so that the M29F002B is not accessed during the initial 50 $\mu$ s.

Figure 2. M29 series Erase Flowchart



6. Under certain conditions the memory arrays of both the M28F201 and M29F002B will be left in an indeterminate state, even though the devices continue to respond correctly to commands written to them. In the case of the M29F002B, this will occur either if a device reset (caused by the supply voltage falling below the lockout voltage  $V_{LKO}$  or by  $RP$  being pulled down to  $V_{IL}$ ) occurs during program or erase, or if a Read/Reset command is issued during a Block Erase operation. In both cases the user is advised to erase the parts of the memory array left in an indeterminate state before reprogramming them.
7. The memory array of the M29F002B is organized in 7 Blocks of varying sizes which may be erased individually as well as simultaneously. Whereas the Chip Erase command erases the whole memory array at once, the Block Erase command can be used to erase only a part of the memory array (consisting of one or more memory Blocks). For more information on this alternative to erasing the whole memory array at once, please refer to the M29F002B Data Sheet and to application note AN1193 which provides the library C function `FlashBlockErase()` for the M29F002B Flash Memory. Note that the differences between the M29F002BB and M29F002BT Flash Memories are only relevant if you intend to use the Block Erase command.

## CONCLUSION

Upgrading from the M28F201 to the M29F002B will only require a single modification to your target hardware system. Your application software will probably need to be upgraded, either by using software drivers provided by STMicroelectronics or by updating your program and erase algorithms. You will then enjoy a number of benefits which include lower power consumption, faster program and erase operations and increased Flash Memory performance.

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If you have any questions or suggestion concerning the matters raised in this document please send them to the following electronic mail address:

*ask.memory@st.com* (for general enquiries)

Please remember to include your name, company, location, telephone number and fax number.

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