AN1251
APPLICATION NOTE

Replacing the M28F256, M28F512 and M28F101 with the M29F512B and M29F010B Flash Memories

CONTENTS

INTRODUCTION

This application note will help you to replace the M28F256, M28F512 and M28F101 Flash Memories in your designs with the M29F512B and M29F010B Flash Memories. This upgrade 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 M29 series Flash Memories and should be read in conjunction with the Data Sheet of the chosen M29 series Flash Memory.

The M29F512B and M29F010B are 5V only Flash Memories, which use a single 5V supply voltage for program, erase and read operations. They generate the required program and erase voltages internally and thus do not have a V_{PP} 12V input pin. The M29F512B and M29F010B are also equipped with a Program/Erase Controller which greatly simplifies the task of programming and erasing these Flash Memories by using internal algorithms instead of requiring the user software to work through every programming and erasing step. This leads to devices with over 100,000 program/erase cycles guaranteed.

If the M28F256, M28F512 and M28F101 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 M29F512B and M29F010B Flash Memories is simply a matter of changing the setting on your programming equipment and making a few (if any) minor modifications to the PCB layout of your target system.

HARDWARE COMPATIBILITY

After addressing the question of whether the M29F512B or the M29F010B is a more suitable upgrade for the M28F256, M28F512 and M28F101 Flash memories in your application, this section describes the hardware consequences of each upgrade path in turn.

M29F512B or M29F010B?

The main difference between the M29F512B and M29F010B are the sizes of their memory arrays (512 Kbit and 1024 Kbit respectively). If you are replacing an M28F101 Flash Memory, your application is likely to require more memory space than the 512 Kbit offered by the M29F512B, and you should upgrade to the M29F010B. If instead your current design uses M28F256 or M28F512 Flash Memories, you now have the choice of a direct upgrade to the M29F512B or upgrading to the M29F010B to increase the memory space available to your application.

The M29F512B is offered in a PLCC32 package with essentially the same pin connections as the M28F256 and M28F512 in PLCC32 packages, making upgrades of this package to the M29F512B possible with few (if any) minor modifications to the PCB layout of your application hardware. However if your application uses either an M28F256 or an M28F512 in PDIP32 package, you will either need to redesign your PCB layout to accept the M29F512B in PLCC32 or TSOP32 (8 x 14 mm) or you will need to upgrade to the M29F010B which is offered in a PDIP32 package.

The M29F010B is offered in all the same packages as the M28F256, M28F512 and M28F101, namely in PLCC32, TSOP32 (8 x 20 mm) and PDIP32. In each package, the M29F010B pin connections are compatible with the M28F256, M28F512 and M28F101, so that upgrading to the M29F010B does not require more than a few (if any) minor modifications to the PCB layout.

Table 1. Recommended device and package upgrade

M28 series Flash memory	recommended M29 series upgrade	alternative M29 series upgrade
M28F256 in PLCC32	**M29F512B in PLCC32** – 2 times memory space – minor PCB layout mods	**M29F010B in PLCC32** – 4 times memory space – minor PCB layout mods
M28F256 in PDIP32	**M29F010B in PDIP32** – 4 times memory space – minor PCB layout mods	**M29F512B (PLCC32 or TSOP32)** – 2 times memory space – PCB layout redesign
M28F512 in PLCC32	**M29F512B in PLCC32** – same memory space – no PCB layout mods	**M29F010B in PLCC32** – 2 times memory space – minor PCB layout mods
M28F512 in PDIP32	**M29F010B in PDIP32** – 2 times memory space – minor PCB layout mods	**M29F512B (PLCC32 or TSOP32)** – same memory space – PCB layout redesign
M28F101 in PLCC32	**M29F010B in PLCC32** – same memory space – no PCB layout mods	
M28F101 in PDIP32	**M29F010B in PDIP32** – same memory space – no PCB layout mods	
M28F101 in TSOP32	**M29F010B in TSOP32** – same memory space – no PCB layout mods	

Table 1 lists the recommended upgrade for each package of the M28F256, M28F512 and M28F101; alternative upgrades are also suggested when appropriate. The main considerations in recommending memory upgrades are providing at least as much memory space and minimizing changes to the PCB layout. Note that the indications on memory space in Table 1 refer to the amount of memory space available if your application hardware can be modified to connect additional address lines to the Flash Memory. The addition of 1 or 2 additional connections are described in Table 1 as minor PCB layout modifications, whilst a change of Flash Memory footprint and the consequent rerouting are referred to as PCB layout redesign.

Common hardware upgrade issues

The maximum supply current I_{CC} that the M29F512B and M29F010B require from their 5V supply on V_{CC} during program and erase operations is less than the maximum supply current I_{CC} required by the M28F256, M28F512 and M28F101 during read operations at 6MHz. It should thus be possible to replace the M28F256, M28F512 and M28F101 by the M29F512B or M29F010B without any changes to the 5V power supply. In fact upgrading to the M29F512B or M29F010B will reduce the power consumption during read operations by half. Further power savings will result from the M29 series Flash Memories not requiring any current from the 12V supply during program and erase operations.

All the bus operations supported by the M28F256, M28F512 and M28F101 are also supported by the M29F512B and M29F010B. In particular the bus operation required to read the electronic signature of the M28 series Flash Memories will also allow the electronic signature of the M29 series Flash Memories to be read. Please note that although all these devices share the same manufacturer identification code, they have different device codes. No major changes will be required to the address and data buses when upgrading from the M28F256, M28F512 and M28F101 to the M29F512B or M29F010B. Minor changes may be required for some of the upgrade paths recommended in Table 1, as described below.

Upgrading from the M28F256 to the M29F512B

The PLCC32 packages of the M29F512B and the M28F256 have the same pin connections, with the exception of the V_{PP} pin which exists on the M28F256 but not on the M29F512B where it is left as NC (not internally connected) and the A15 pin which exists on the M29F512B but not on the M28F256 where it is left as NC. The V_{PP} pin does not require any modifications to the PCB layout as the M29F512B is not affected by signals on the corresponding NC pin. The A15 pin of the M29F512B should be tied to the first address line unused by the M28F256 in order to allow your application to make use of the doubling in memory space offered by the M29F512B. Alternatively address pin A15 may be permanently connected to V_{IL} or V_{IH}, allowing your application to access only 256 Kbit of the 512 Kbit memory space of the M29F512B. In any event you should not leave address pin A15 floating.

The M29F512B is not offered in PDIP32 package. A PCB layout redesign will thus be required In order to upgrade from a PDIP32 M28F256 to an M29F512B. Consult the M29F512B Data Sheet for details of the pin connections in PLCC32 and TSOP32 (8 x 14 mm) packages. Note that there is no V_{PP} pin on the M29F512B, but that there is an additional address pin (A15). As discussed above, the A15 pin should either be tied to an address line to offer access to the full 512 Kbit of the M29F512B or be tied to V_{IL} or V_{IH}; in no event should the A15 pin be left floating.

Upgrading from the M28F256 to the M29F010B

The M29F010B is offered in all the same packages as the M28F256, namely in PLCC32 and PDIP32. The M29F010B and the M28F256 have the same pin connections in each package, with the exception of the V_{PP} pin which exists on the M28F256 but not on the M29F010B where it is left as NC (not internally connected) and pins A15 and A16 which exist on the M29F010B but not on the M28F256 where they are left as NC. The V_{PP} pin does not require any modifications to the PCB layout as the M29F010B is not affected by signals on the corresponding NC pin. The address pins A15 and A16 of the M29F010B should be tied to the first two address lines unused by the M28F256 in order to allow your application to make use of the quadrupling in memory space offered by the M29F010B. Alternatively address pins A15 and A16 may be permanently connected to V_{IL} or V_{IH}, allowing your application to access only 256 Kbit of the 1024 Kbit memory space of the M29F010B. In any event you should not leave address pins A15 and A16 floating.

Upgrading from the M28F512 to the M29F512B

The PLCC32 packages of the M29F512B and the M28F512 have the same pin connections, with the exception of the V_{PP} pin which exists on the M28F512 but not on the M29F512B where it is left as NC (not internally connected). As the M29F512B is not affected by signals such as V_{PP} on any NC pin, the PLCC32 M28F512 can be replaced by the PLCC32 M29F512B without any modification to the PCB layout.

The M29F512B is not offered in PDIP32 package. A PCB layout redesign will thus be required In order to upgrade from a PDIP32 M28F512 to an M29F512B. Consult the M29F512B Data Sheet for details of the pin connections in PLCC32 and TSOP32 (8 x 14 mm) packages. Note that there is no need to route the V_{PP} signal to the M29F512B.

Upgrading from the M28F512 to the M29F010B

The M29F010B is offered in all the same packages as the M28F512, namely in PLCC32 and PDIP32. The M29F010B and the M28F512 have the same pin connections in each package, with the exception of the V_{PP} pin which exists on the M28F512 but not on the M29F010B where it is left as NC (not internally connected) and the A16 pin which exists on the M29F010B but not on the M28F512 where it is left as NC. The V_{PP} pin does not require any modifications to the PCB layout as the M29F010B is not affected by signals on the corresponding NC pin. The A16 pin of the M29F010B should be tied to the first address line unused by the M28F512 in order to allow your application to make use of the doubling in memory space offered by the M29F010B. Alternatively address pin A16 may be permanently connected to V_{IL} or V_{IH}, allowing your application to access only 512 Kbit of the 1024 Kbit memory space of the M29F010B. In any event you should not leave address pin A16 floating.

Upgrading from the M28F101 to the M29F010B

The M29F010B is offered in all the same packages as the M28F101, namely in PLCC32, TSOP32 (8 x 20 mm) and PDIP32. The M29F010B and the M28F101 have the same pin connections in each package, with the exception of the V_{PP} pin which exists on the M28F101 but not on the M29F010B where it is left as NC (not internally connected). As the M29F010B is not affected by signals such as V_{PP} on any NC pin, the M28F101 can be replaced by the M29F010B without any modification to the PCB layout.

Device speed selection

Most of the AC characteristics of the M29F512B and M29F010B are equal or faster than those of the 28F256, M28F512 and M28F101 of the same read speed. Only a few timings (t_{WLWH}, t_{WLAX} and t_{ELEH}) are faster on the 70ns, 90ns and 100ns M28F512 and M28F101 than on the M29F512B and M29F010B of the corresponding speed. If any of these 3 timings are critical to your application configuration, you are advised to upgrade to the faster M29F512B and M29F010B device read speed of 45ns. In any event ST-Microelectronics recommend that you upgrade to M29F512B and M29F010B Flash Memories with read speeds of 70ns or even 45ns.

Note however that the timing of t_{WLWH} and t_{ELEH} on the 45ns M29F512B and M29F010B is 40ns and that this remains 5ns slower than the corresponding timing on the 70ns M28F101. This only affects upgrades from the M28F101 to the M29F010B and it is very unlikely that the difference of 5ns on these timings 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 M29F010B.

SOFTWARE UPGRADE

The M29F512B and M29F010B and the M28F256, M28F512 and M28F101 all power up in Read mode. In this mode the 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 M28F256, M28F512 and M28F101 to the M29F512B and M29F010B Flash Memories.

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) and the content of the memory array of the M29 series Flash Memories is similar to that used by the M28 series Flash Memories: special sequences of bus write operations are recognized as commands, which cause the M29 series Flash Memories to start programming or erasing or to switch mode. However there are three main differences between the M29 series and M28 series Flash Memories:

1. Different command sets. The M29 series Flash Memories do 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.
2. Different sequences of bus write operations are recognized as commands. Typically the M29 series Flash Memories require longer sequences of bus write operations for each command. The sequences are longer on the M29 series Flash Memories 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 M29 series Flash Memories 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 an M29 series Flash Memory places a far smaller computational burden on your system micro controller or microprocessor.

The consequence of these differences between the M29 and M28 series 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 M29F512B or M29F010B software drivers provided by STMicroelectronics or modify your application code directly using the guidelines provided below.

STMicroelectronics application notes AN1194 and AN1165 describe software drivers to read, program and erase the M29F512B and M29F010B respectively. 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 notes AN1194 and AN1165 useful for understanding the operation of the M29F512B and M29F010B. However this application note aims to provide you with sufficient information to enable you to upgrade your application software for the M29F512B and M29F010B: note that you will need to refer to the M29F512B and M29F010B Data Sheets for the details of the bus write operation sequences recognized as commands.

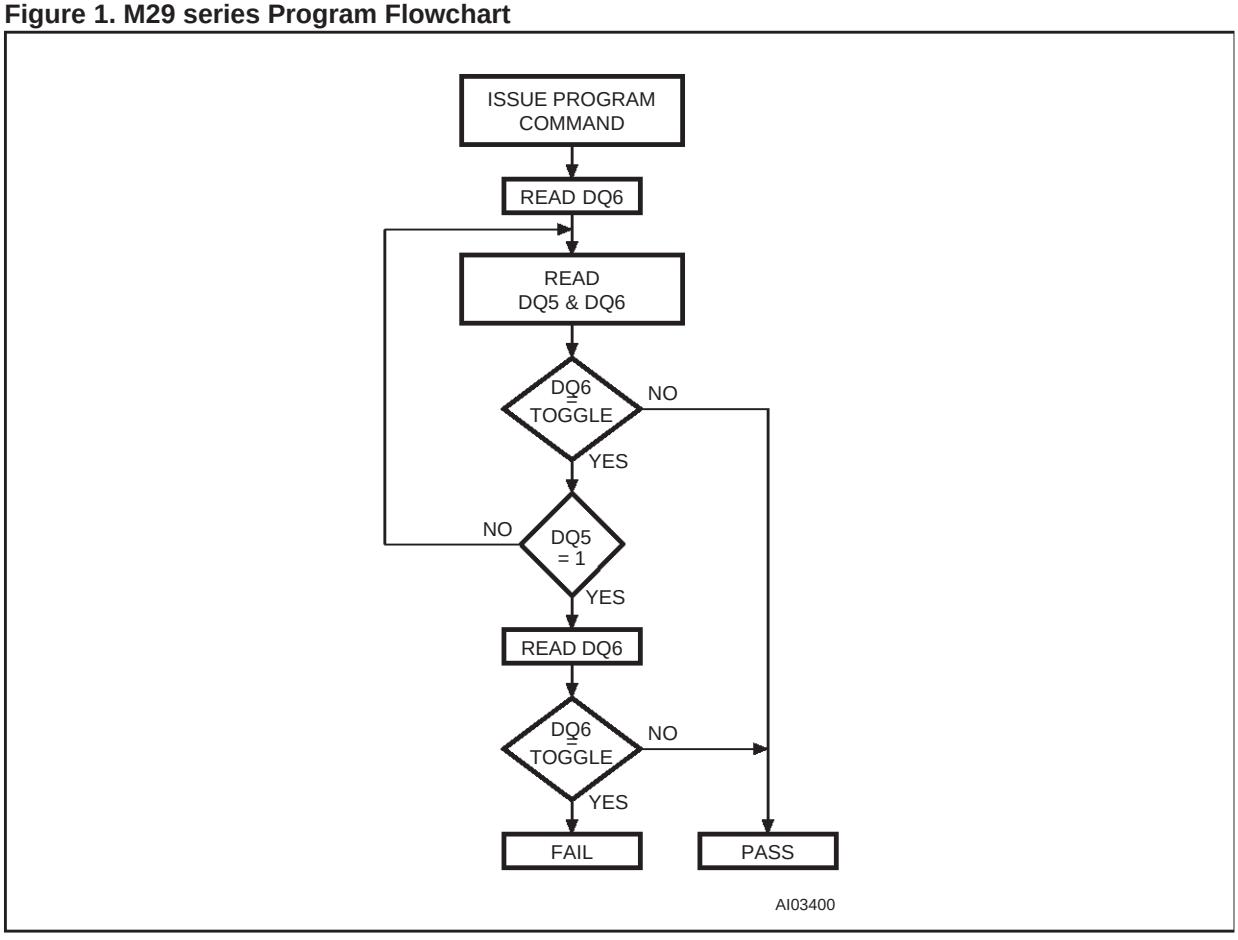
Reading the electronic signature. In order to read the electronic signature of the M29F512B and M29F010B, the user first needs to issue the Auto Select command to place the device in Auto Select mode. The manufacturer and device identification codes may then be read from the Flash Memory by set-

ting 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 M28F256, M28F512 and M28F101). 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 M29 series Flash Memory 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 M29 series Flash Memory 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 M29F512B and M29F010B Data Sheets to determine when an operation has completed, and whether it was successful or not. Note that correct interpretation of the Status Register (and its toggle bits in particular) can only be guaranteed when no interrupts access the Flash Memory.

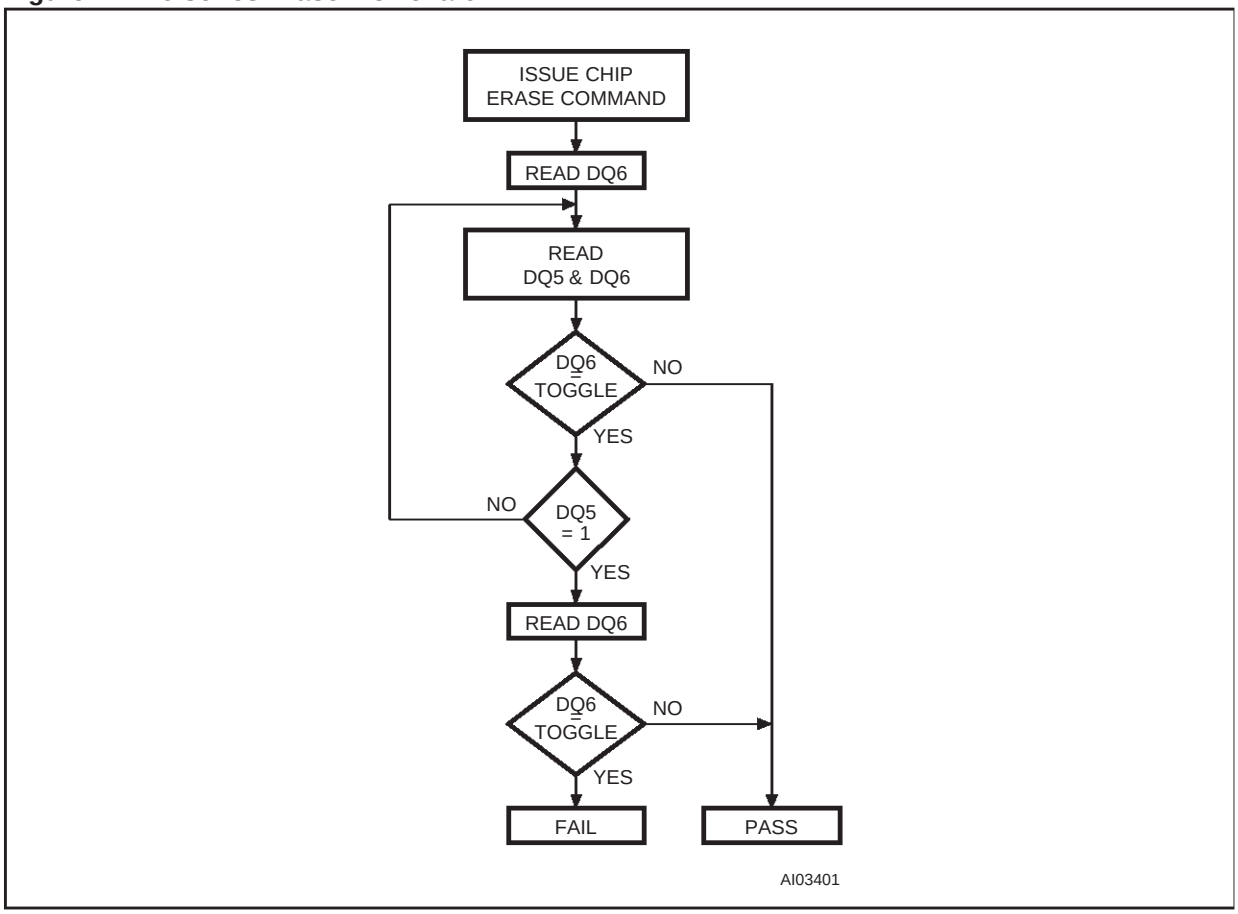
Programming a Flash Memory address. The Data Toggle flowchart of the M29F512B and M29F010B Data Sheets lead to the algorithm described in Figure 1 for programming an address of an M29 series Flash Memory. After issuing the program command, the user keeps on checking the Error bit and the Data Toggle 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 M28F256, M28F512 and M28F101, the M29F512B and M29F010B 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.

Figure 1. M29 series Program Flowchart



Erasing the Flash Memory. The Data Toggle flowchart of the M29F512B and M29F010B Data Sheets lead to the algorithm described in Figure 2 for erasing the whole memory array of an M29 series Flash Memory. 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 M29 series Flash Memory array to '0' before erasing. This is taken care of by the internal Program/Erase controller of the M29 series Flash Memories.

Figure 2. M29 series Erase Flowchart



OTHER CONSIDERATIONS

This section outlines a number of differences between the M28F256, M28F512 and M28F101 and the M29F512B and M29F010B which may be relevant to your upgrade design:

1. The allowed range for the identification voltage V_{ID} on the M29F512B and M29F010B (11.5V to 12.5V) is more restrictive than on the M28F256, M28F512 and M28F101. If the identification voltage is to be used, care should be taken that it is controlled to remain within the range allowed on the M29F512B and M29F010B.
2. The minimum lockout voltage V_{LKO} is higher on the M29F512B and M29F010B than it is on the M28F256, M28F512 and M28F101. This allows the M29F512B and M29F010B 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 M29F512B and M29F010B than on the M28F256, M28F512 and M28F101 (6V instead of 7V). Care should be taken to ensure that the supply voltage on V_{CC} never exceeds the maximum rating of the M29F512B and M29F010B.
4. The M29F512B and M29F010B take up to 10µs to be ready following a Read/Reset command issued after an erase or program error. The user software should not attempt to access the M29F512B and M29F010B during this 10µs period. Note that this 10µs period is similar to the 6µs required by the M28F256, M28F512 and M28F101 to be ready following a command issued to change mode.
5. The M29F512B and M29F010B take up to 50µs from the moment V_{CC} is applied to become ready. This initial delay of 50µs must be taken into account when upgrading from the M28F256, M28F512 and M28F101 to the M29F512B and M29F010B; this may require the boot sequence of the target system to be modified so that the M29F512B and M29F010B is not accessed during the initial 50µs.
6. Under certain conditions the memory arrays of both the M28F256, M28F512 and M28F101 and M29F512B and M29F010B 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 M29F512B and M29F010B, this will occur if a device reset (caused by the supply voltage falling below the lockout voltage V_{LKO}) occurs during program or erase. In both cases the user is advised to erase and then reprogram the memory array.
7. The memory array of the M29F010B is organized in 8 equally-sized Blocks 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 M29F010B Data Sheet and to application note AN1165 which provides the library C function FlashBlockErase() for the M29F010B Flash Memory.

CONCLUSION

Upgrading from the M28F256, M28F512 and M28F101 to the M29F512B and M29F010B can in most cases be done with few (if any) 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.

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.