AN1252
APPLICATION NOTE

Replacing the M28F102 with the M29F102BB Flash Memory

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INTRODUCTION

This application note will help you to replace the M28F102 in your designs with the M29F102BB. This upgrade 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 M29F102BB and should be read in conjunction with the M29F102BB Data Sheet.

The M29F102BB 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 M29F102BB 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 M28F102 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 M29F102BB 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 M29F102BB is offered in the same packages as the M28F102, namely in PLCC44 and TSOP40 (10 x 14 mm). The M29F102BB and the M28F102 have the same pin connections in both packages, with the exception of one pin which carries the signal V_{PP} on the M28F102 but the signal $\overline{RP}$ on the M29F102BB. The $\overline{RP}$ pin on the M29F102BB should either be left unconnected or be connected to V_{CC} during normal operations. 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 M28F102 to the M29F102BB Flash Memory.

The maximum supply current I_{CC} that the M29F102BB 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 M28F102 during read operations at 8MHz. It should thus be possible to replace the M28F102 by the M29F102BB without any changes to the 5V power supply. In fact upgrading to the M29F102BB will reduce the power consumption during read operations by half. Further power savings will result from the M29F102BB not requiring any current from the 12V supply during program and erase operations.

All the bus operations supported by the M28F102 are also supported by the M29F102BB. In particular the bus operation required to read the electronic signature of the M28F102 will also allow the electronic signature of the M29F102BB 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 M28F102 to the M29F102BB.

Most of the AC characteristics of the slowest M29F102BB are equal or faster than those of the fastest M28F102. Only a few timings (t_{WLWH} and t_{WLAX}) are faster on the 90ns M28F102 than on the 70ns M29F102BB of the corresponding speed. If either of these 2 timings are critical to your application configuration, you are advised to upgrade to the faster M29F102BB device read speed of 35ns. In any event STMicroelectronics recommend that you upgrade to M29F102BB Flash Memories with read speeds of 45ns or even 35ns.

SOFTWARE UPGRADE

Both the M29F102BB and the M28F102 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 M28F102 to the M29F102BB 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 M29F102BB and the content of its memory array is similar to that used by the M28F102: special sequences of bus write operations are recognized as commands, which cause the M29F102BB to start programming or erasing or to switch mode. However there are three main differences between the M29F102BB and the M28F102:

1. Different command sets. The M29F102BB supports a Block Erase as well as a Chip Erase command. The M29F102BB 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 M29F102BB 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 M29F102BB requires longer sequences of bus write operations for each command. The sequences are longer on the M29F102BB 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 M29F102BB 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 M29F102BB Flash Memory places a far smaller computational burden on your system micro controller or microprocessor.

The consequence of these differences between the M29F102BB and the M28F102 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 M29F102BB software drivers provided by STMicroelectronics or modify your application code directly using the guidelines provided below.

STMicroelectronics application note AN1167 describes software drivers to read, program and erase the M29F102BB. 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 AN1167 useful for understanding the operation of the M29F102BB. However this application note aims to provide you with sufficient information to enable you to upgrade your application software for the M29F102BB: note that you will need to refer to the M29F102BB Data Sheet for the details of the bus write operation sequences recognized as commands.

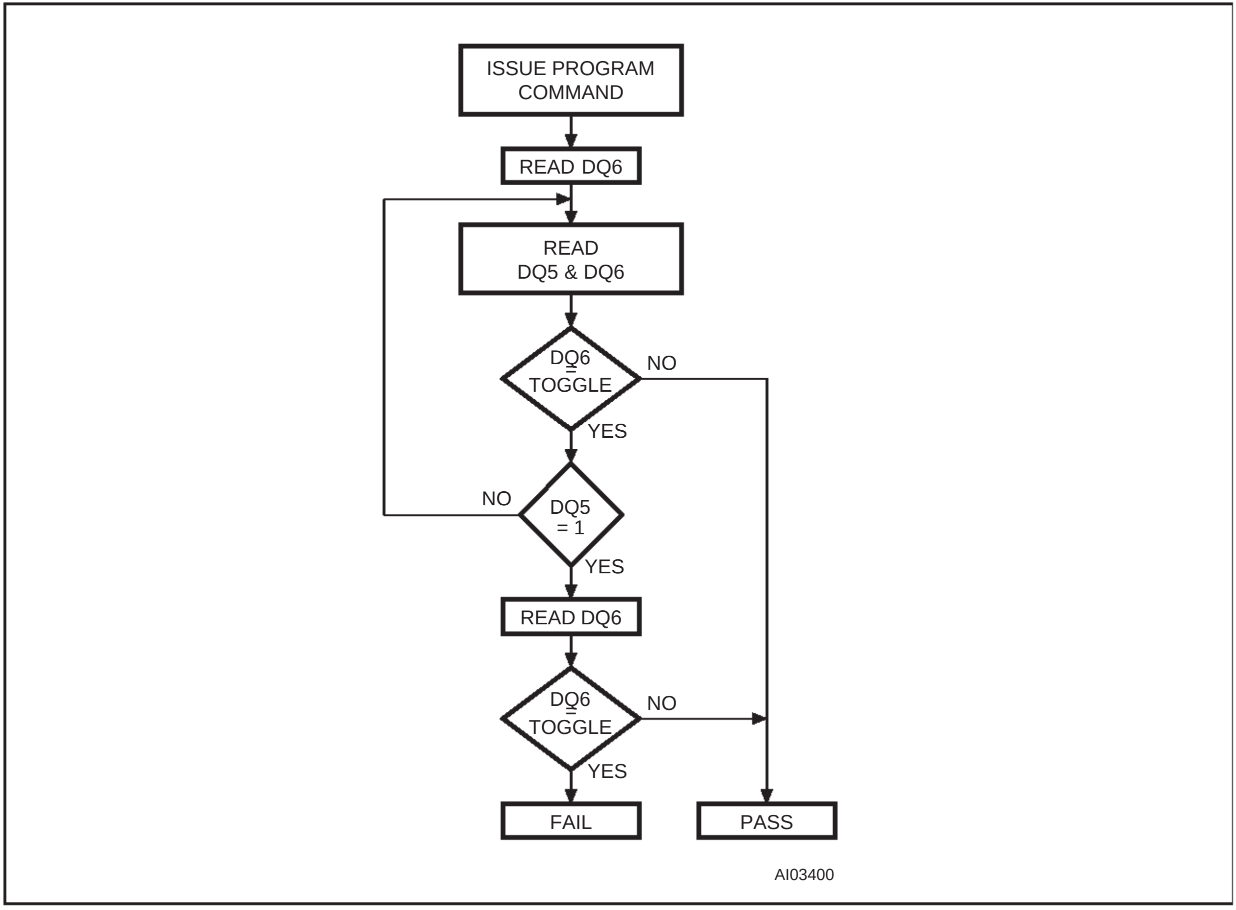
Reading the electronic signature. In order to read the electronic signature of the M29F102BB, the user first needs to issue the Auto Select command to place the device in Auto Select mode. The manufacturer and device identification codes may then be read from the Flash Memory by setting address bit A1 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 M28F102). The Auto Select mode also allows the user to read the Block protection status of the M29F102BB. 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 M29F102BB 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 M29F102BB 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 M29F102BB 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 M29F102BB Data Sheet leads to the algorithm described in Figure 1 for programming an address of the M29F102BB. 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 M28F102, the M29F102BB 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 M29F102BB Data Sheet leads to the algorithm described in Figure 2 for erasing the whole memory array of the M29F102BB. 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 M29F102BB memory array to ‘0’ before erasing. This is taken care of by the internal Program/Erase controller of the M29F102BB Flash Memory.

Figure 1. M29 series Program Flowchart

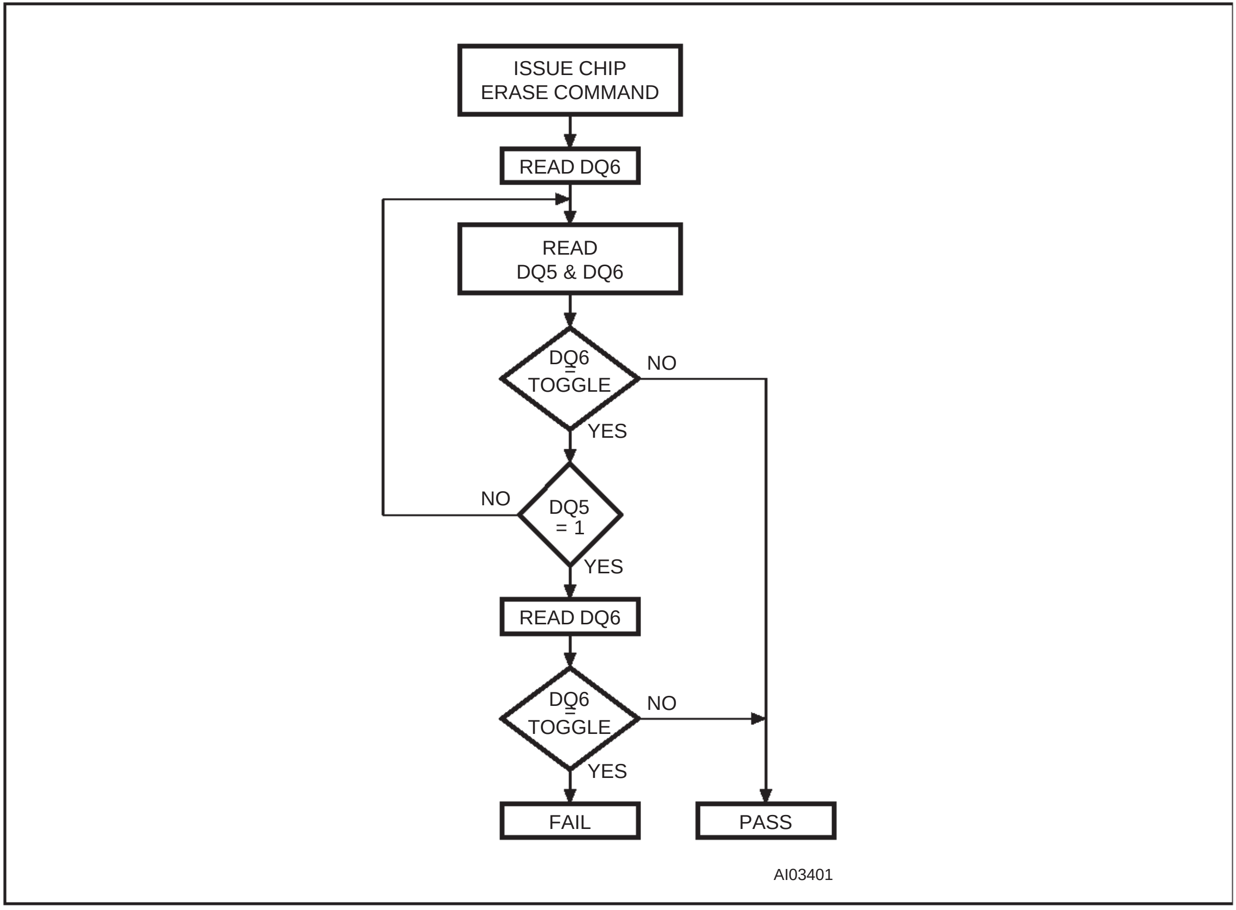


OTHER CONSIDERATIONS

This section outlines a number of differences between the M28F102 and the M29F102BB which may be relevant to your upgrade design:

1. The allowed range for the identification voltage V_{ID} on the M29F102BB (11.5V to 12.5V) is more restrictive than on the M28F102. If the identification voltage is to be used, care should be taken that it is controlled to remain within the range allowed on the M29F102BB.
2. The minimum lockout voltage V_{LKO} is higher on the M29F102BB than it is on the M28F102. This allows the M29F102BB 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 M29F102BB than on the M28F102 (6V instead of 7V). Care should be taken to ensure that the supply voltage on V_{CC} never exceeds the maximum rating of the M29F102BB.
4. The M29F102BB takes up to 10µs 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 M29F102BB during this 10µs period. Note that this 10µs period is similar to the 6µs required by the M28F102 to be ready following a command issued to change mode.
5. The M29F102BB takes 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 M28F102 to the M29F102BB; this may require the boot sequence of the target system to be modified so that the M29F102BB is not accessed during the initial 50µs.

Figure 2. M29 series Erase Flowchart



6. Under certain conditions the memory arrays of both the M28F102 and M29F102BB 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 M29F102BB, this will occur either if a device reset (caused by the supply voltage falling below the lockout voltage V_{LKO} or by $\overline{RP}$ 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 M29F102BB is organized in 5 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 M29F102BB Data Sheet and to application note AN1167 which provides the library C function FlashBlockErase() for the M29F102BB Flash Memory.

CONCLUSION

Upgrading from the M28F102 to the M29F102BB 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.

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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