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Motorola Semiconductor Engineering Bulletin

EB348

Testing for Marginally Programmed FLASH on 1.5T FLASH Devices

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Introduction

This engineering bulletin describes the basic testing techniques used to test for marginally programmed FLASH devices in the Motorola microcontroller (MCU) families which use 1.5T FLASH technology.

This testing is designed to isolate defective or inadequate V_{FP} power supply designs or improperly implemented FLASH modification code in a user's system.

Devices affected include all Motorola MCUs which share this 1.5T FLASH EEPROM (electrically erasable programmable read-only memory), also called UDR (unified design rules) FLASH technology.

Included in this list are:

- Entire current MC68HC12 FLASH MCU Family
- M68HC16 Family
- 683xx Families

Some of the newest M68HC12 Family devices are moving to a new second generation 16-bit FLASH technology and contain an A at the end of the part number to differentiate the FLASH technology used. An example is MC68HC912D60A.

Symptom — Bits Change State

Some customers return devices claiming defective memory cells, as the.s19 files won't verify due to bits that don't seem to be programmed or they seem to change state after programming.

One of the root causes might likely be inadequately programmed FLASH cells. This could be due to situations such as insufficient program pulses, inadequate programming voltage supplies, etc.

Testing Method

If there is reason to believe that this might be the case, a simple test can be run to determine whether the FLASH is strongly or marginally programmed. This method is not exact, but it can be effective in detecting marginally programmed parts relative to strongly programmed ones.

Most importantly, this test should be used to help identify insufficient programming voltage supplies.

CAUTION: *This testing method should be considered a destructive test method, rendering the device being tested unusable for production units. Motorola does not guarantee the operation of these devices after performing this type of test, as it might involve operating the device outside of specified voltage ranges.*

Often a long time must pass before weakly programmed bitcells change state. So this procedure is intended to examine field returned parts rather than programming parts in the lab and immediately testing them.

The procedure to check for marginal programming is simple to implement:

- First, ensure that the parts to be tested are not erased or programmed again once they have been programmed initially by the suspect V_{FP} supply.
- From this point, it is simply a matter of reading back the contents of the FLASH and comparing it to the .s19 file, gradually increasing V_{DD} from 3 volts or 4 volts to 6.5 volts until the device fails to read back properly.
- Record the V_{DD} value at which the unit fails, failing memory locations, and data values for reference purposes. If a field applications engineer (FAE) must be consulted or the devices are returned, this information will be needed.

NOTE: *If V_{DD} is allowed to exceed 6.5 volts, the part is now out of specified absolute maximum ratings.*

If the device fails to read back properly when V_{DD} voltage is between 4.5 volts and 5.5 volts, then V_{DD} is in spec and the FLASH is likely weakly programmed. Check V_{FP} supply and reprogram.

If the device continues to fail in this range, verify that your code meets the specified FLASH programming algorithm and reprogram. If the device still doesn't work in the V_{DD} operating range, the part might be damaged or defective. In this case, consult an FAE.

Clearly, this is not an exact test, but it does give some idea of the likelihood of the V_{FP} supply or the programming code being the source of concern.

If two identically programmed devices (using different supplies) from the same lot fail at very different voltage levels, it is an indication of the relative strength of the V_{FP} supplies. However, if these devices fail at very similar voltage levels, it could be an indication of a problem with the programming code. If the code does not allow the specified number of programming pulses (including 100 percent programming margin), then it would be expected that all devices of the same lot would fail at about the same level.

The higher the threshold of V_{DD} at which the devices fail, the less likely that the parts were marginally programmed.

NOTE: *It is extremely important to realize that different lots of parts will have different thresholds, so this testing should be used only as a relative programming strength test.*

Remarks

This test is intended to be implemented by FAEs, due to the possibility of electrical specification violations during the procedure, misinterpretation of testing results and so on.

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