Technical Note

How to Power On and Power Off the M29F Flash Memory Device

Introduction

This technical note provides guidelines for providing power to and removing power from the Micron® M29F parallel NOR Flash memory device.

Special attention is given to the required current for the power-on phase and to the operations that must be performed by a system designer to recover the device if a power loss occurs during a MODIFY operation on the device's main array.

This technical note replaces Application Note AN309016.

Power Overview

External power supplies provide memory devices with the electrical current necessary for internal and external operations.

When implementing power supply solutions, system designers must:

- Know the total power required by external supplies (also referred to as "rail power")
- Consider how much of the required total power dissipates inside the device (referred to as "thermal power" or "dissipated power") as compared to the portion of the total power that dissipates outside the device (such as in external output capacitive loads or balanced resistor termination networks)

The total power used by a device, the output loading, and external termination networks (if any) includes the following major components:

- Standby power
- Dynamic power
- I/O power

Standby power comes from the I_{CC2} current circulating within the device when it is in standby mode.

Core dynamic power comes from the internal switching within the device (such as charging and discharging capacitance on internal modes).

I/O power comes from the external switching of I/O drivers (such as charging and discharging external load capacitance connected to the device pins).

The thermal power is the component of total power that dissipates in the device's package while the remainder dissipates externally.

Designers must consider the thermal power dissipated in the device to understand if the device's intrinsic heat transfer ability (referred to as "thermal resistance") is sufficient to keep the internal die-junction temperatures within the normal operating specifications. If the device's thermal resistance is insufficient, additional thermal solutions, such as aluminum heat sinks, can be used to improve the heat transfer performance.

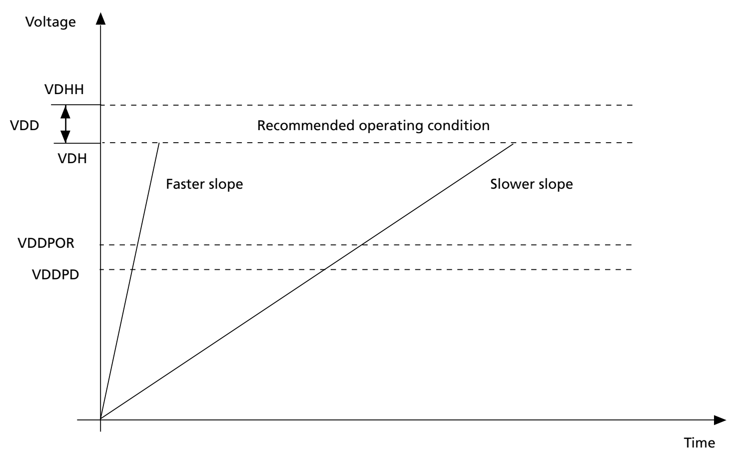
Designers must also be aware of the inrush current, which is the total current required by the device to power itself (see Inrush Current (page 3)).

Inrush Current

The inrush current is the current required by the device during power-up.

During power-up, the device requires a minimum level of current over a specific period of time. The length of this time depends on the slope of the power supply while this slope is set to I_{CC1}; that is, the slope is set to the Read current defined in the data sheet (see Figure 1).

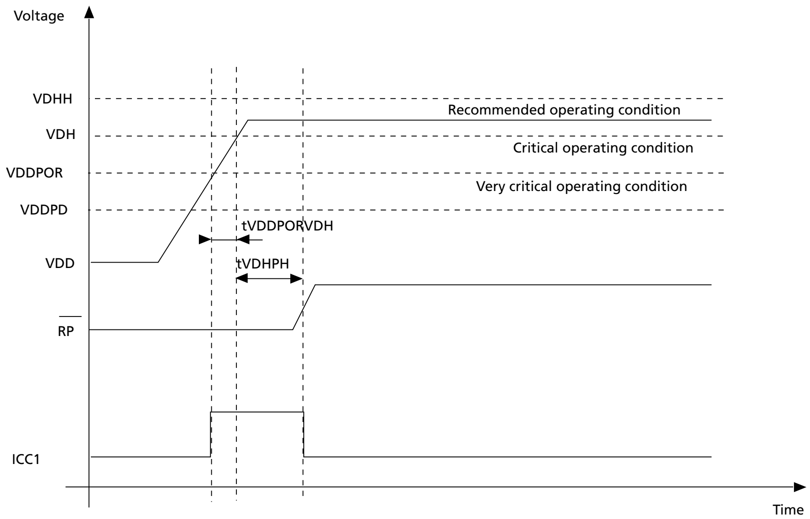
Figure 1: Different Slopes of Power Supply



Note: 1. The recommended operating condition is the range of power supply in which the memory device is designed to work properly.

When the voltage reaches ninety percent of its nominal value ($V_{DH} = V_{DD}$ min = 4.5V), the system can de-assert the Reset pin of the memory after a certain time (t_{VDHPH}). From this time on, the inrush current is no longer dissipated (see Figure 2).

Figure 2: Operating Conditions

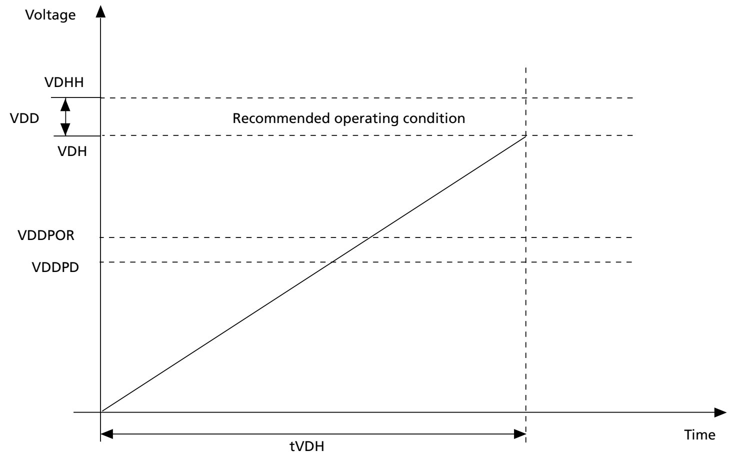


Notes:
1. The recommended operating condition is the range of power supply in which the memory device is designed to work properly.
2. The critical operating condition is the range of power supply in which the device is not designed to work properly. In this power supply range, the device works with reduced performance but without internal damage.
3. The very critical operating condition is the range of power supply in which the device is not designed to work properly. In this power supply range, only the standby status is guaranteed.

To efficiently charge the board capacitance when power is first applied, power supplies are commonly designed to provide more current instantaneously than they are rated for in terms of continuous output. For the majority of designs, the chosen power source is able to provide the required I_{CC1} without the need of additional components.

To guarantee the power-on of memory devices, the V_{DD} ramp time (t_{VDH}) must be no slower than 50ms during power-on (see Figure 3). This limitation refers to the slowest ramp time for which the power-on current is formally characterized and tested. t_{VDH} is measured with a load connected to the power supply.

Figure 3: Time to Ramp Up the V_{DD} Power Supply

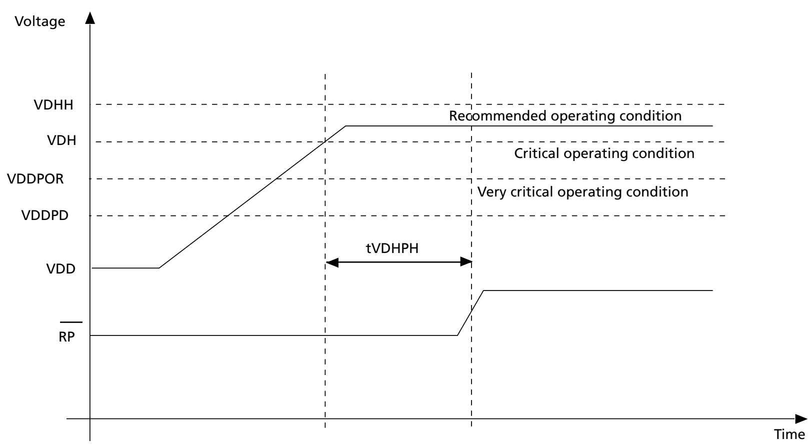


As long as the ramp time is inside the slope limit allowed for power supply, the I_{CC1} specification does not change. Even though V_{DD} ramps up quickly, as long as the I_{CC1} specification is met, the memory device powers on successfully.

Board Power Consideration

To avoid any spurious operations inside the memory device during the power-on phase, the Reset pin must be kept LOW (V_{IL}) for a certain period of time (t_{VDHPH}) as shown in Figure 4. The Reset pin LOW maintains the memory in the reset state until the device reaches the recommended operation condition.

Figure 4: t_{VDPHP} Definition



Critical Power Conditions

The M29F works in critical operating condition when its power supply drops into the voltage range between the V_{DDPOR} and V_{DH} values (see Figure 5). In critical operating condition, there is no damage to the device and it does not need to be reset.

When the power supply drops below V_{DDPOR} while remaining above the V_{DDPD} value, the memory works in very critical operating condition (see Figure 6). In very critical operating condition, the memory continues to work but its operation is not completely guaranteed because noise on the power supply can bring V_{DD} below the V_{DDPD} value.

When the power supply drops below the VDDPD threshold, the Reset pin of the memory must be kept LOW (VIL) until the power supply returns to the recommended operating condition (see Figure 7).

Figure 5: V_{DD} in Critical Operating Condition

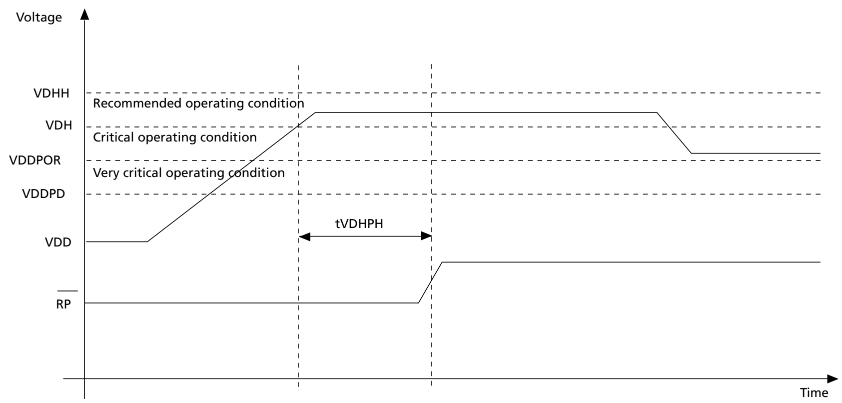


Figure 6: V_{DD} in Very Critical Operating Condition

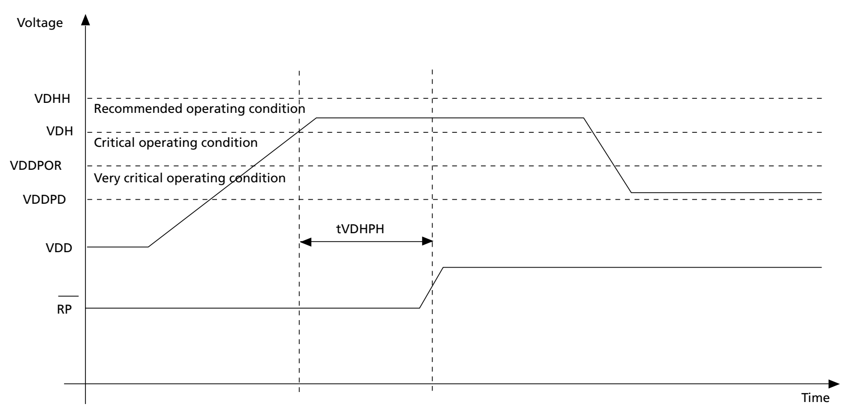
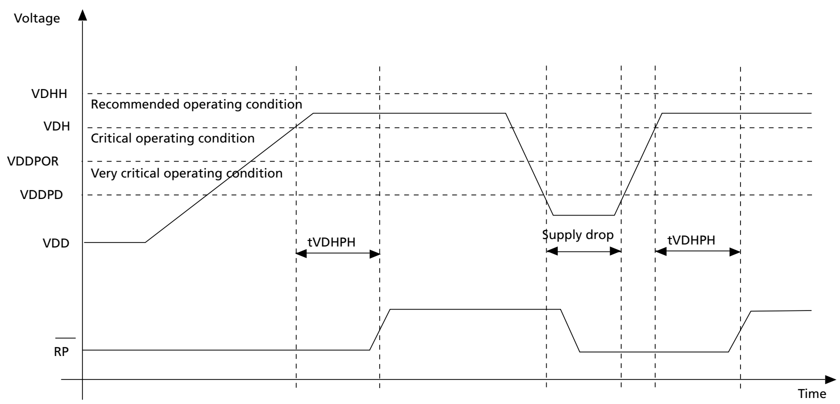


Figure 7: V_{DD} Below Very Critical Operating Condition



Recovery Operations After a Power Drop

MODIFY operations in Flash memory devices take a long time when compared to the average time required by system operations.

During a MODIFY operation, a drop in the memory's power supply is possible. In this situation, a system designer must know how to recover the memory's status by using the recovery operations shown in Table 1.

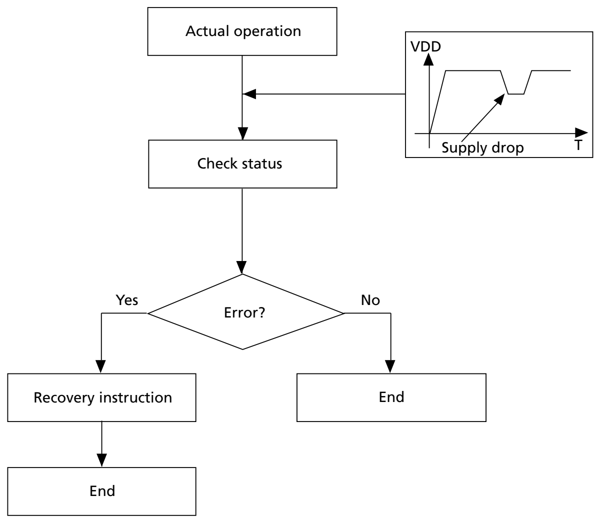
Table 1: Recover Operations

Before the Power Drop	To Recover
READ operations	
READ ARRAY AUTO SELECT READ CFI QUERY	Recovery depends on the previous status of the memory. If the status is in MODIFY, refer to the MODIFY Operations section below.
MODIFY Operations	
CHIP/BLOCK ERASE	Perform a CHIP/BLOCK ERASE
ERASE SUSPEND	Erase (same block)
ERASE RESUME	Erase (same block)
UNLOCK BYPASS Operations	
UNLOCK/BYPASS/UNLOCK BYPASS RESET	No specific recovery instruction is required
ULOCK BYPASS PROGRAM	Perform the same command (same address, same block) following the correct flow to issue it

If the power loss is not intense enough to trigger the power-down of the memory device, the ongoing Flash operation can be corrupted. In this case, the system designer must check the memory's Status Register to understand if the Flash memory device needs to be recovered.

The suggested recovery flow is shown in Figure 8 (page 10).

Figure 8: Recovery Flow



Glossary

Table 2: Glossary

Symbol	Description
I_{CC2}	Standby current when the chip is not selected
I_{CC1}	Current required to perform the power-on sequence correctly (required Read current)
V_{DH}	Minimum power supply voltage (equal to the Vdd min = 4.5V)
V_{DHH}	Maximum power supply voltage (equal to the Vdd min = 5.5V)
V_{DDPOR}	Minimum power supply during the ramp-up when the Flash memory begins to load all internal nodes (minimum VLKO voltage = 1.8V)
V_{DDPD}	Threshold value of power supply during the ramp-down at which point the device shuts down (maximum VLKO voltage = 2.3V)
t_{VDHPH}	Amount of time required to release the Reset pin after the power supply reaches the V_{DH} value (at least 50µs after the power supply reaches VDH)
t_{VDH}	Time required from power supply to reach the V_{DH} value (max 50ms, min 200µs)
$t_{VDDPORVDH}$	Time required between the power supply reaching the V_{DDPOR} value and its reaching the V_{DH} value (this value can be calculated based on the slope of the power supply)

Revision History

Rev. A – 03/13

- Initial release

8000 S. Federal Way, P.O. Box 6, Boise, ID 83707-0006, Tel: 208-368-3900
www.micron.com/productsupport Customer Comment Line: 800-932-4992