

Technical Note

One-Time Programmable (OTP) Operations

Introduction

This technical note describes one-time programmable (OTP) operations in the following Micron NAND Flash devices:

- MT29F2G08ABAEAH4
- MT29F2G08ABAEAWP
- MT29F2G08ABBEAH4
- MT29F2G08ABBEAHC
- MT29F2G16ABAEAWP
- MT29F2G16ABBEAH4
- MT29F2G16ABBEAHC

The Micron NAND Flash devices specified in this technical note offer a protected, one-time programmable NAND Flash memory area. Thirty full pages (2112 bytes per page) of OTP data are available on the device, and the entire range is guaranteed to be good. The OTP area is accessible only through the OTP commands. Customers can use the OTP area any way they choose; typical uses include programming serial numbers or other data for permanent storage.

The OTP area leaves the factory in an unwritten state (all bits are 1s). Programming or partial-page programming enables the user to program only 0 bits in the OTP area. The OTP area cannot be erased, whether it is protected or not. Protecting the OTP area prevents further programming of that area.

This technical note does not provide detailed information on the devices. The standard component data sheet provides a complete description of device functionality, operating modes, and specifications unless specified herein.

One-Time Programmable (OTP) Operations

Micron provides a unique way to program and verify data before permanently protecting it and preventing future changes. The OTP area is only accessible while in OTP operation mode. To set the device to OTP operation mode, issue the SET FEATURE (EFh) command to feature address 90h and write 01h to P1, followed by three cycles of 00h to P2-P4. For parameters to enter OTP mode, see Features Operations in the component data sheet.

When the device is in OTP operation mode, all subsequent PAGE READ (00h-30h) and PROGRAM PAGE (80h-10h) commands are applied to the OTP area. The OTP area is assigned to page addresses 02h-1Fh. To program an OTP page, issue the PROGRAM PAGE (80h-10h) command. The pages must be programmed in the ascending order. Similarly, to read an OTP page, issue the PAGE READ (00h-30h) command.

Protecting the OTP is done by entering OTP protect mode. To set the device to OTP protect mode, issue the SET FEATURE (EFh) command to feature address 90h and write 03h to P1, followed by three cycles of 00h to P2-P4.

To determine whether the device is busy during an OTP operation, either monitor R/B# or use the READ STATUS (70h) command.

To exit OTP operation or protect mode, write 00h to P1 at feature address 90h.

Legacy OTP Commands

For legacy OTP commands, OTP DATA PROGRAM (A0h-10h), OTP DATA PROTECT (A5h-10h), and OTP DATA READ (AFh-30h), refer to the MT29F4GxxAxC data sheet.

OTP DATA PROGRAM (80h-10h)

The OTP DATA PROGRAM (80h-10h) command is used to write data to the pages within the OTP area. An entire page can be programmed at one time, or a page can be partially programmed up to eight times. Only the OTP area allows up to eight partial-page programs. The rest of the blocks support only four partial-page programs. There is no ERASE operation for OTP pages.

PROGRAM PAGE enables programming into an offset of an OTP page using two bytes of the column address (CA[12:0]). The command is compatible with the RANDOM DATA INPUT (85h) command. The PROGRAM PAGE command will not execute if the OTP area has been protected.

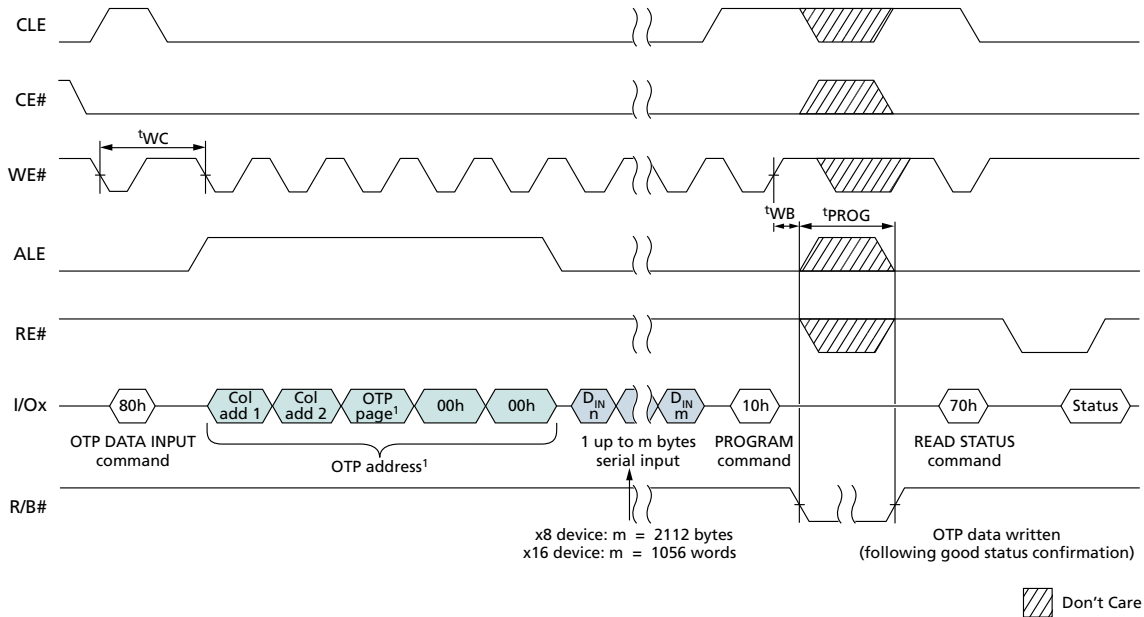
To use the PROGRAM PAGE command, issue the 80h command. Issue n address cycles. The first two address cycles are the column address. For the remaining cycles, select a page in the range of 02h-00h through 1Fh-00h. Next, write from 1–2112 bytes of data. After data input is complete, issue the 10h command. The internal control logic automatically executes the proper programming algorithm and controls the necessary timing for programming and verification.

R/B# goes LOW for the duration of the array programming time (t_{PROG}). The READ STATUS (70h) command is the only valid command for reading status in OTP operation mode. Bit 5 of the status register reflects the state of R/B#. When the device is ready, read bit 0 of the status register to determine whether the operation passed or failed (see Status Operations in the component data sheet). Each OTP page can be programmed to 8 partial-page programming.

RANDOM DATA INPUT (85h)

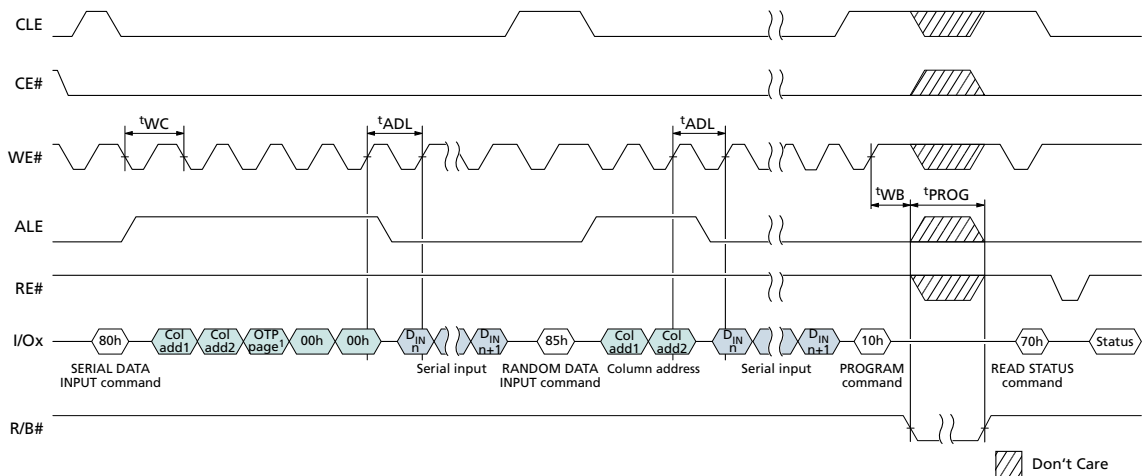
After the initial OTP data set is input, additional data can be written to a new column address with the RANDOM DATA INPUT (85h) command. The RANDOM DATA INPUT command can be used any number of times in the same page prior to the OTP PAGE WRITE (10h) command being issued.

Figure 1: OTP DATA PROGRAM (After Entering OTP Operation Mode)



Note: 1. The OTP page must be within the 02h–1Fh range.

Figure 2: OTP DATA PROGRAM Operation with RANDOM DATA INPUT (After Entering OTP Operation Mode)



OTP DATA PROTECT (80h-10)

The OTP DATA PROTECT (80h-10h) command is used to prevent further programming of the pages in the OTP area. To protect the OTP area, the target must be in OTP operation mode.

To protect all data in the OTP area, issue the 80h command. Issue n address cycles including the column address, OTP protect page address and block address; the column and block addresses are fixed to 0. Next, write 00h data for the first byte location and issue the 10h command. R/B# goes LOW for the duration of the array programming time, t_{PROG} .

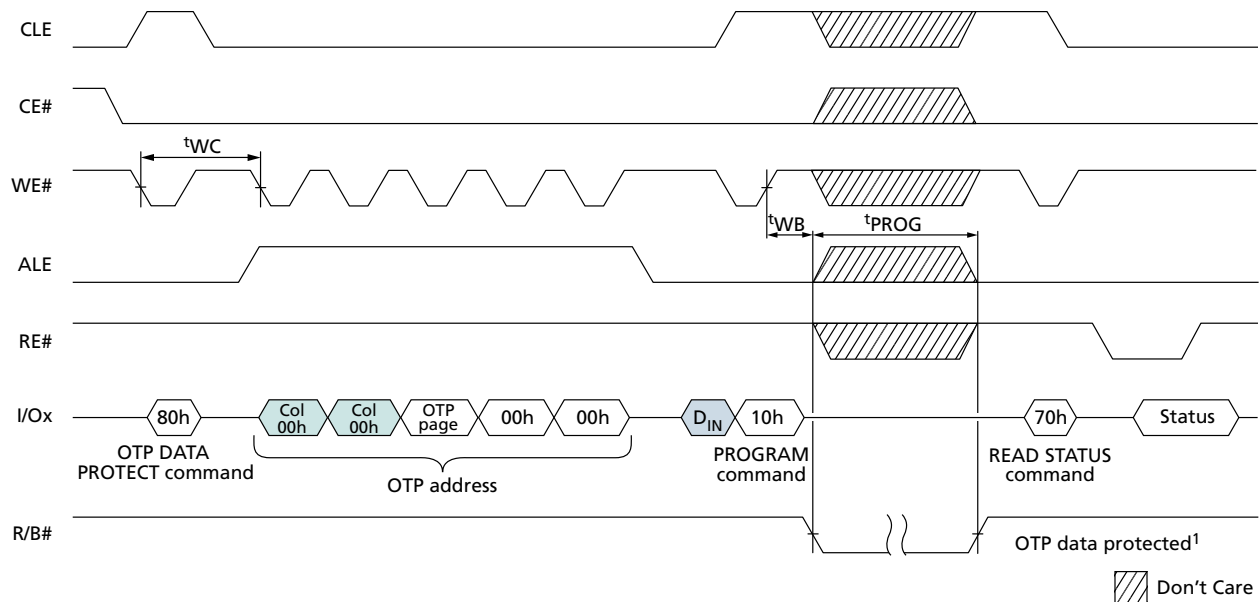
After the data is protected, it cannot be programmed further. When the OTP area is protected, the pages within the area are no longer programmable and cannot be unprotected.

The READ STATUS (70h) command is the only valid command for reading status in OTP operation mode. The RDY bit of the status register will reflect the state of R/B#. Use of the READ STATUS ENHANCED (78h) command is prohibited.

When the target is ready, read the FAIL bit of the status register to determine if the operation passed or failed.

If the OTP DATA PROTECT (80h-10h) command is issued after the OTP area has already been protected, R/B# goes LOW for t_{OBSY} . After t_{OBSY} , the status register is set to 60h.

Figure 3: OTP DATA PROTECT Operation (After Entering OTP Protect Mode)



Note: 1. OTP data is protected following a good status confirmation.

OTP DATA READ (00h-30h)

To read data from the OTP area, set the device to OTP operation mode, then issue the PAGE READ (00h-30h) command. Data can be read from OTP pages within the OTP area whether the area is protected or not.

To use the PAGE READ command for reading data from the OTP area, issue the 00h command, and then issue five address cycles: for the first two cycles, the column address; and for the remaining address cycles, select a page in the range of 02h-00h-00h through 1Fh-00h-00h. Lastly, issue the 30h command. The PAGE READ CACHE MODE command is not supported on OTP pages.

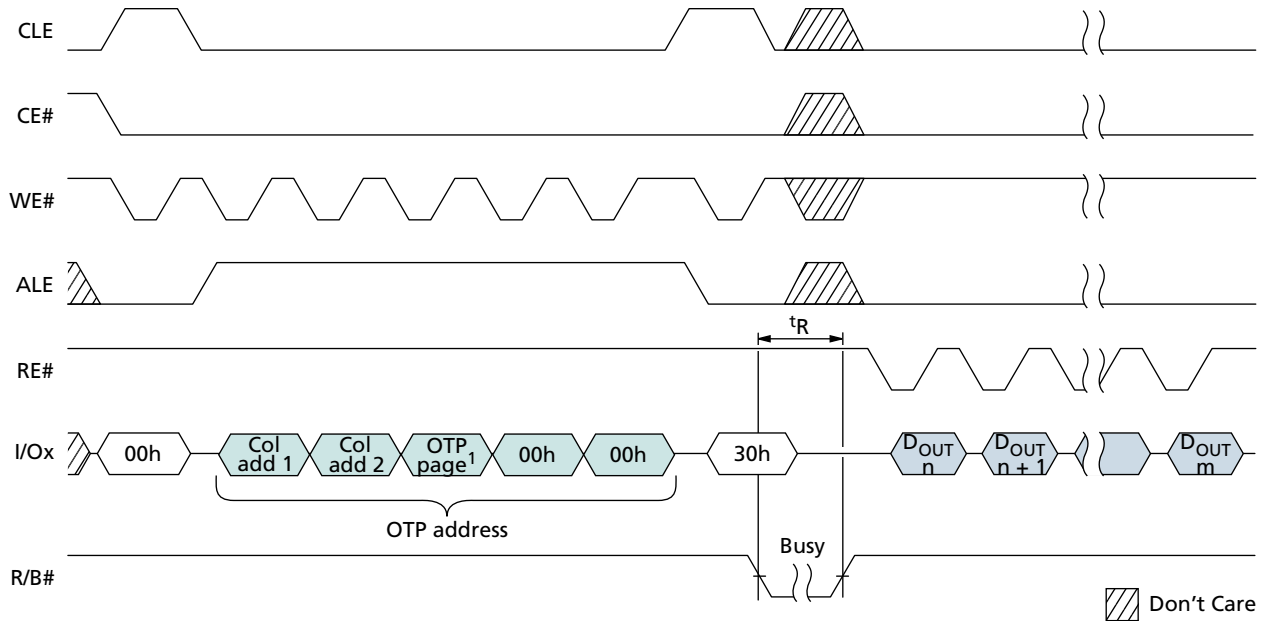
R/B# goes LOW (^tR) while the data is moved from the OTP page to the data register. The READ STATUS (70h) command is the only valid command for reading status in OTP operation mode. Bit 5 of the status register reflects the state of R/B# (see Status Operations in the component data sheet).

Normal READ operation timings apply to OTP read accesses. Additional pages within the OTP area can be selected by repeating the OTP DATA READ command.

The PAGE READ command is compatible with the RANDOM DATA OUTPUT (05h-E0h) command.

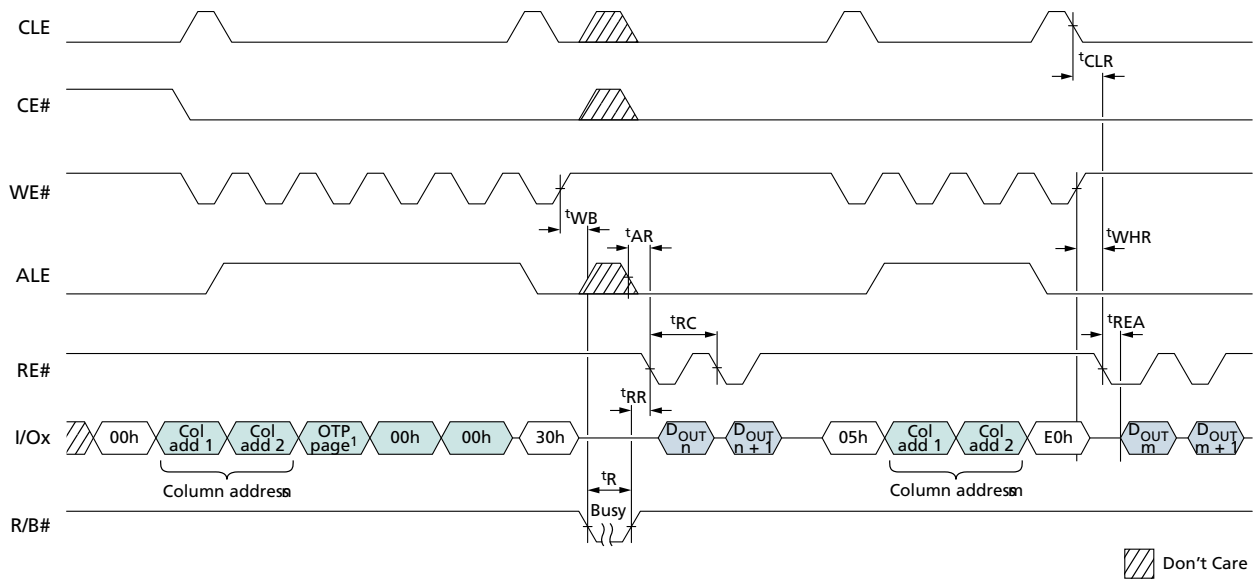
Only data on the current page can be read. Pulsing RE# outputs data sequentially.

Figure 4: OTP DATA READ



Note: 1. The OTP page must be within the 02h-1Fh range.

Figure 5: OTP DATA READ with RANDOM DATA READ Operation



Note: 1. The OTP page must be within the range 02h–1Fh.



Setting OTP Protection

Table 1: Feature Address 90h – Array Operation Mode

Subfeature Parameter	Options	I/O7	I/O6	I/O5	I/O4	I/O3	I/O2	I/O1	I/O0	Value	Notes
P1											
Operation mode option	Normal	Reserved (0)							0	00h	on page
	OTP operation	Reserved (0)							1	01h	
	OTP protection	Reserved (0)						1	1	03h	
	Disable ECC	Reserved (0)				0	0	0	0	00h	on page
	Enable ECC	Reserved (0)				1	0	0	0	08h	on page
P2											
Reserved		Reserved (0)								00h	
P3											
Reserved		Reserved (0)								00h	
P4											
Reserved		Reserved (0)								00h	

Note: 1. These bits are reset to 00h on power cycle.



Revision History

Rev. A – 7/12

- Initial release.

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