Microcomputer Technical Information

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78K0S/KU1+, 78K0S/KY1+, 78K0S/KA1+, 78K0S/KB1+ Usage Restrictions	Document No.	ZBG-CC-06-0028	1/1
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Related documents 78K0S/KY1+ User's Manual: U16994EJ3V0UD00 78K0S/KA1+ User's Manual: U16898EJ3V0UD00 78K0S/KB1+ User's Manual: U17446EJ2V0UD00	Notification classification	√	Usage restriction
			Upgrade
			Document modification
			Other notification

1. Affected products

78K0S/KU1+

μPD78F9200, μPD78F9201, μPD78F9202

78K0S/KY1+

μPD78F9210, μPD78F9211, μPD78F9212

78K0S/KA1+

μPD78F9221, μPD78F9222

78K0S/KB1+

μPD78F9232, μPD78F9234

2. Restriction details

Restriction on using flash self-programming

When using flash self-programming, clear the FLCMD register to 0 immediately before shifting to normal mode or self-programming mode. In addition, execute NOP and HALT instructions after specific sequence processing to shift to self-programming mode.

* See the attachment for details on specific sequence processing.

This is a restriction to avoid an operation bug that occurs when the standby function performed by the HALT instruction and flash self-programming are used together and executed repeatedly.

3. Details on restriction and workaround

See the attachment for details on the restriction and its workaround.

4. Modification plan

This restriction is avoidable by using a software workaround, so the device will not be revised for this restriction. Please regard this item as a usage restriction.

The user's manual will be revised with descriptions on the above restriction.

Usage Restrictions in 78K0S/KU1+, 78K0S/KY1+, 78K0S/KA1+ and 78K0S/KB1+

1. Product History

<78K0S/KU1+>

Description	μPD78F9200, μPD78F9201, μPD78F9202
Restriction on using flash self-programming	Δ

<78K0S/KY1+>

Description	μPD78F9210, μPD78F9211, μPD78F9212
Restriction on using flash self-programming	Δ

<78K0S/KA1+>

Description	μPD78F9221, μPD78F9222
Restriction on using flash self-programming	Δ

<78K0S/KB1+>

Description	μPD78F9232, μPD78F9234
Restriction on using flash self-programming	Δ

Remark The meaning of each symbol is as follows.

Δ: Restriction applies (correction is not planned)

2. Restriction Details

- Restriction on using flash self-programming

[Description and cause]

If the standby function performed by the HALT instruction and flash self-programming are used together using the procedure shown in the figure on the next page, the subsequent operation becomes unexpected.

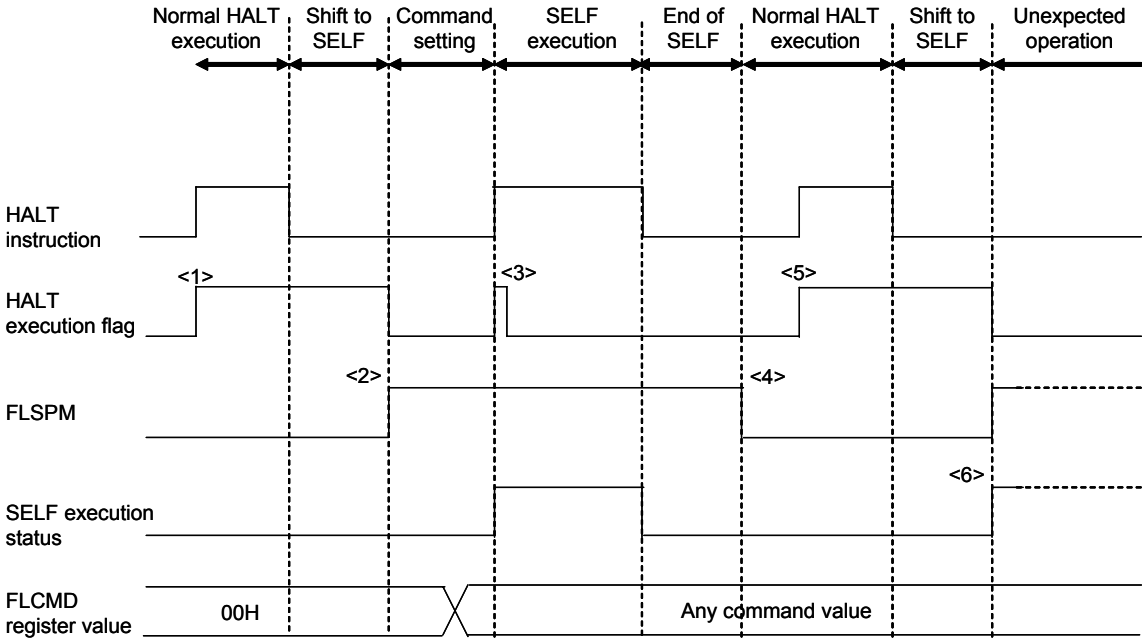
Specific sequence:

The following two modes are available in these products.

- Normal mode:
  The state in which normal operation is executed. Operation enters into a standby state after execution of the HALT instruction.
- Self-programming mode:
  The state in which self-programming commands are executable. After setting commands, addresses and write data and executing the HALT instruction, self-programming is executed.

The specific sequence described in this document is referring to the register manipulation to switch these two modes.

Process Leading up to Unexpected Operation



<1> An ordinary HALT instruction is executed and the internal HALT execution flag is set. Self-programming is executed by setting the FLSPM bit while the HALT execution flag is set.

<2> The specific sequence is executed and the operation then enters into self-programming mode. At this time, the FLSPM bit changes to indicate that self-programming is now executable. However, self-programming commands are not executed at this time, because the FLCMD register has been initialized to 00H.

<3> Once a command value is set to the FLCMD register and the HALT instruction is executed, the self-programming command is executed. The HALT execution flag is cleared just as the self-programming command is executed.

<4> Execution of the self-programming command is completed, the specific sequence is executed again, and operation enters into normal mode.

<5> The HALT instruction is executed again, operation enters into standby, and the HALT execution flag is set.

<6> After the standby state is released, the specific sequence is executed to shift to self-programming mode. If the command value set to the FLCMD register has not been initialized at this time, the command still set to the FLCMD register is reexecuted when the FLSPM bit is set. Self-programming is subsequently executed during CPU operation and the CPU fetches an incorrect instruction from the flash memory, resulting in an unexpected operation.

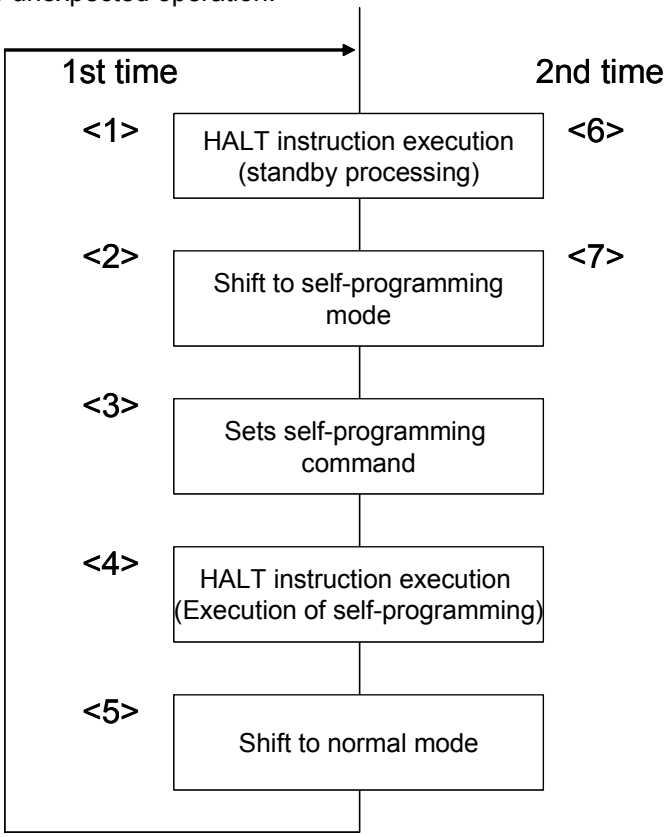
Remark The same situation occurs when flash self-programming is executed before <1>.

Workaround:

When using flash self-programming, clear the FLCMD register to 0 immediately before shifting to normal mode or self-programming mode; this prevents execution of illegal commands immediately after the mode is shifted. In addition, execute NOP and HALT instructions after specific sequence processing to shift to self-programming mode; this controls the execution timing between the CPU and the flash memory control block.

The flowcharts and source code examples for the operation bug and its workaround implementation are described on the following pages.

Flowchart leading up to unexpected operation:



<1> An ordinary HALT instruction is executed to shift to standby. After that, the standby state is released by a standby release signal, such as an interrupt.

<2> The specific sequence is executed to shift to self-programming mode.

<3> A self-programming command (block erase in the source code example) is set to the FLCMD register.

<4> The self-programming command is executed by executing the HALT instruction.

<5> After self-programming processing specified in <3> is completed, the specific sequence is executed to shift to normal mode. This example presumes that processes from <1> to <5> are performed repeatedly.

<6> An ordinary HALT instruction is executed to generate a standby release signal, and the standby state is released.

<7> A self-programming command (block erase in the source code example) is executed immediately after the specific sequence is executed to shift to self-programming mode for the second time. Consequently, microcontroller operation becomes unexpected.

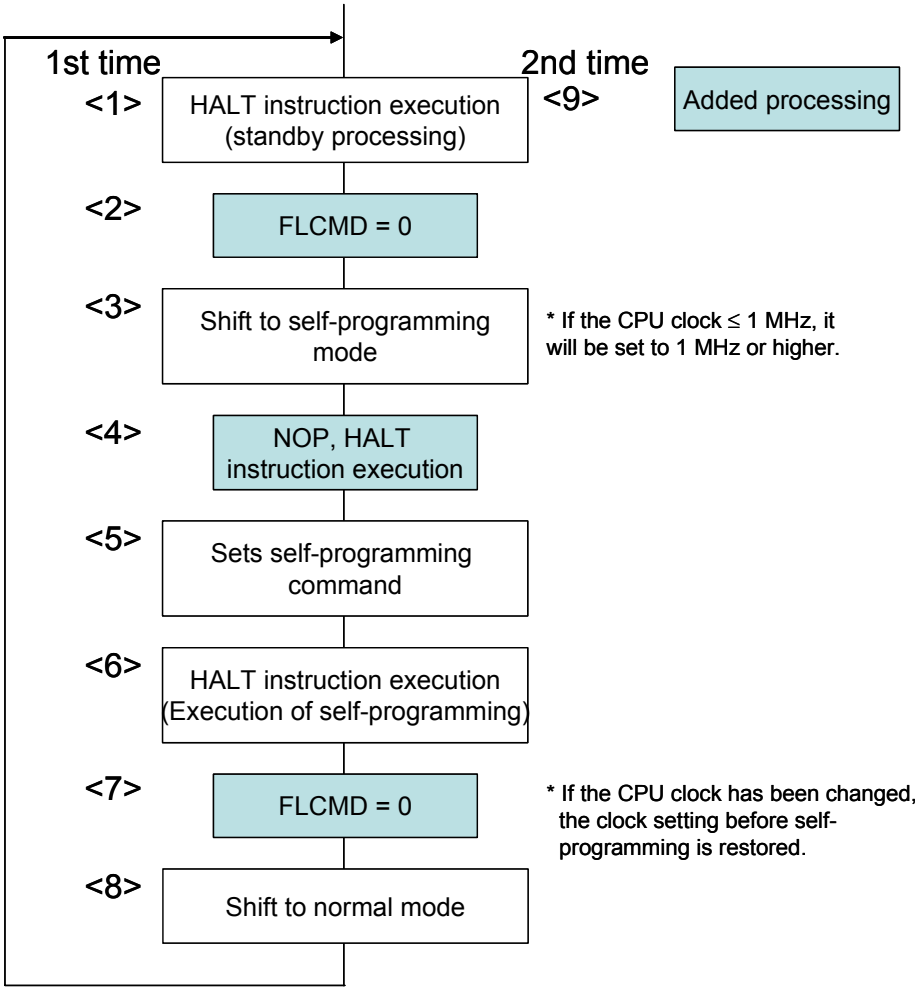
Example source code causing unexpected operation (assembly language):

```
MAINLOOP:
    ; Executes HALT to shift to standby state - <1> and <6> in flowchart
    HALT

    ; Saves the interrupt mask setting before executing self-programming.
    DI                              ; Disables interrupts
    MOV     A,MK0                   ; Saves interrupt mask setting
    XCH     A,X
    MOV     A,MK1                   ; Saves only MK0 in KU1+ and KY1+
    PUSH    AX
    MOV     MK0,#0FFH
    MOV     MK1,#0FFH

    ; Executes the specific sequence to shift to self-programming mode - <2> and <7> in flowchart
ModeOnLoop:
    MOV     PFCMD,#0A5H             ; Controls PFCMD register
    MOV     FLPMC,#01H              ; Controls FLPMC register (set value)
    MOV     FLPMC,#0FEH             ; Controls FLPMC register (inverted set value)
    MOV     FLPMC,#01H              ; Sets self-programming mode
    ; When using a clock generated by an external resonator or external input clock, insert a 16 μs wait.

    ; Operation becomes unexpected when entered into self-programming mode for the second time.
    BT      PFS.0,$ModeOnLoop       ; Confirms completion of mode shift

    ; Performs command settings - <3> in flowchart
    MOV     A, #0FH
    MOV     FLAPH,A                 ; Sets number of block to be erased
    MOV     FLAPHC,A                ; Sets compare number for block to be erased (value set to FLAPH)
    MOV     FLCMD,#03H              ; Sets flash control command (block erase)
    MOV     PFS,#00H                ; Clears flash status register
    MOV     WDTE,#0ACH              ; Clears and starts WDT

    ; Executes erase command - <4> in flowchart
    HALT                            ; Executes self-programming

    ; Executes the specific sequence to shift to normal mode - <5> in flowchart
ModeOffLoop:
    MOV     PFS,#00H
    MOV     PFCMD,#0A5H             ; Controls PFCMD register
    MOV     FLPMC,#00H              ; Controls FLPMC register (set value)
    MOV     FLPMC,#0FFH             ; Controls FLPMC register (inverted set value)
    MOV     FLPMC,#00H              ; Sets normal mode
    BT      PFS.0,$ModeOffLoop      ; Confirms completion of mode shift

    POP     AX                      ; Restores interrupt mask setting
    MOV     MK1,X
    XCH     A,X
    MOV     MK0,A
    BR      MAINLOOP
```

Example source code causing unexpected operation (C language):

```
while(1){
        /* Executes HALT to shift to standby state - <1> and <6> in flowchart */
        HALT();

        /* Saves interrupt mask settings */
        DI();                       // Disables interrupts
        ch_mask_bak0 = MK0;         // Saves only MK0 in KU1+ and KY1+
        ch_mask_bak1 = MK1;         // ch_mask_bak0/1 are variables for saving

        /* Shifts to self-programming mode - <2> and <7> in flowchart */
        do{
                PFS = 0;            // Clears flash status register
                PFCMD = 0xA5;       // Controls PFCMD register
                FLPMC = 0x01;       // Controls FLPMC register (set value)
                FLPMC = 0xFE;       // Controls FLPMC register (inverted set value)
                FLPMC = 0x01;       // Sets self-programming mode
                /* When using a clock generated by an external resonator or external input clock,
                insert a 16 μs wait.*/

                /* Operation becomes unexpected when entered into self-programming mode
                for the second time. */
        }while(PFS.0 == 1);   // Confirms completion of mode shift

        /* Performs command settings - <3> in flowchart */
        FLAPH = FLAPHC = 0x0F;      // Specifies block to be erased
        FLCMD = 0x03;               // Specifies erase command
        PFS = 0x00;                 // Clears flash status register
        WDTE = 0xAC;                // Clears WDT counter

        /* Executes erase command - <4> in flowchart */
        HALT();                     // Executes erase command

        /* Shifts to normal mode - <5> in flowchart */
        do{
                PFS = 0;            // Clears flash status register
                PFCMD = 0xA5;       // Controls PFCMD register
                FLPMC = 0x00;       // Controls FLPMC register (set value)
                FLPMC = 0xFF;       // Controls FLPMC register (inverted set value)
                FLPMC = 0x00;       // Sets normal mode
        }while(PFS.0 == 1);   // Confirms completion of mode shift

        /* Restores interrupt mask settings */
        MK0 = ch_mask_bak0;
        MK1 = ch_mask_bak1;

}
```

Flowchart of workaround implementation:



<1> An ordinary HALT instruction is executed to shift to standby. After that, the standby state is released by a standby release signal, such as an interrupt.

<2> The FLCMD register is cleared to 0 before executing the specific sequence to shift to self-programming mode. The CPU clock is set to 1 MHz or higher.

<3> The specific sequence is executed to shift to self-programming mode.

<4> After the specific sequence (1 assigned to FLPMC for the second time), NOP and HALT instructions are executed. It takes at most 10 μs until the HALT instruction is released.

<5> A self-programming command (such as write or erase) is set to the FLCMD register.

<6> The self-programming command is executed by executing the HALT instruction.

<7> The FLCMD register is cleared to 0 before the specific sequence is executed to shift to normal mode.

<8> Execute the specific sequence to shift to normal mode. If the CPU clock has been changed, the clock setting before self-programming is restored at this time.

<9> This bug is avoided by adding the above processes <2>, <4>, <7> and <8>.

Example of source code to which workaround is implemented (assembly language):

```
MAINLOOP:
        ; Executes HALT to shift to standby state - <1> and <9> in flowchart
        HALT

        ; Saves the interrupt mask setting before executing self-programming.
        DI                              ; Disables interrupts
        MOV     A,MK0                   ; Saves interrupt mask setting
        XCH     A,X
        MOV     A,MK1                   ; Saves only MK0 in KU1+ and KY1+
        PUSH    AX
        MOV     MK0, #0FFH
        MOV     MK1, #0FFH

        ; Initializes FLCMD register - <2> in flowchart
        MOV     FLCMD, #00H

        ; If CPU clock ≤ 1 MHz, sets CPU clock to 1 MHz or higher.

        ; Executes the specific sequence to shift to self-programming mode - <3> in flowchart
ModeOnLoop:
        MOV     PFCMD,#0A5H             ; Controls PFCMD register
        MOV     FLPMC,#01H              ; Controls FLPMC register (set value)
        MOV     FLPMC,#0FEH             ; Controls FLPMC register (inverted set value)
        MOV     FLPMC,#01H              ; Sets self-programming mode

        ; Executes NOP and HALT instructions - <4> in flowchart
        NOP
        HALT
        ; When using a clock generated by an external resonator or external input clock, insert an 8 μs wait.

        BT      PFS.0,$ModeOnLoop       ; Confirms completion of mode shift

        ; Performs command settings - <5> in flowchart
        MOV     A, #0FH
        MOV     FLAPH,A                 ; Sets number of block to be erased
        MOV     FLAPHC,A                ; Sets compare number for block to be erased (value set to FLAPH)
        MOV     FLCMD,#03H              ; Sets flash control command (block erase)
        MOV     PFS,#00H                ; Clears flash status register
        MOV     WDTE,#0ACH              ; Clears and starts WDT

        ; Executes erase command - <6> in flowchart
        HALT                            ; Executes self-programming

        ; Initializes FLCMD register - <7> in flowchart
        MOV     FLCMD, #00H

        ; If the CPU clock has been changed, the setting before self-programming is restored.
```

```
        ; Executes the specific sequence to shift to normal mode - <8> in flowchart
ModeOffLoop:
        MOV     PFS,#00H
        MOV     PFCMD,#0A5H             ; Controls PFCMD register
        MOV     FLPMC,#00H              ; Controls FLPMC register (set value)
        MOV     FLPMC,#0FFH             ; Controls FLPMC register (inverted set value)
        MOV     FLPMC,#00H              ; Sets normal mode
        BT      PFS.0,$ModeOffLoop      ; Confirms completion of mode shift

        POP     AX                      ; Restores interrupt mask setting
        MOV     MK1,X
        XCH     A,X
        MOV     MK0,A
        BR      MAINLOOP
```

Example of source code to which workaround is implemented (C language):

```
while(1){
        /* Executes HALT to shift to standby state - <1> and <9> in flowchart */
        HALT();

        /* Saves interrupt mask settings */
        DI();                       // Disables interrupts
        ch_mask_bak0 = MK0;         // Saves only MK0 in KU1+ and KY1+
        ch_mask_bak1 = MK1;         // ch_mask_bak0/1 are variables for saving

        /* Initializes FLCMD register - <2> in flowchart */
        FLCMD = 0;

        /* If CPU clock ≤ 1 MHz, sets CPU clock to 1 MHz or higher  */

        /* Enters into self-programming mode - <3> in flowchart */
        do{
                PFS = 0;            // Clears flash status register
                PFCMD = 0xA5;       // Controls PFCMD register
                FLPMC = 0x01;       // Controls FLPMC register (set value)
                FLPMC = 0xFE;       // Controls FLPMC register (inverted set value)
                FLPMC = 0x01;       // Sets self-programming mode
        }while(PFS.0 == 1);   // Confirms completion of mode shift

        /* Executes NOP and HALT instructions - <4> in flowchart */
        NOP();
        HALT();
        /* When using a clock generated by an external resonator or external input clock, insert an 8 μs wait.*/

        /* Performs command settings - <5> in flowchart */
        FLAPH = FLAPHC = 0x0F;              // Specifies block to be erased
        FLCMD = 0x03;                       // Specifies erase command
        PFS = 0x00;                         // Clears flash status register
        WDTE = 0xAC;                        // Clears WDT counter

        /* Executes erase command - <6> in flowchart */
        HALT();                             // Executes erase command

        /* Initializes FLCMD register - <7> in flowchart */
        FLCMD = 0;

        /* If the CPU clock has been changed, the setting before self-programming is restored. */

        /* Shifts to normal mode - <8> in flowchart */
        do{
                PFS = 0;            // Clears flash status register
                PFCMD = 0xA5;       // Controls PFCMD register
```

```
                FLPMC = 0x00;       // Controls FLPMC register (set value)
                FLPMC = 0xFF;       // Controls FLPMC register (inverted set value)
                FLPMC = 0x00;       // Sets normal mode
            }while(PFS.0 == 1);   // Confirms completion of mode shift

            /* Restores interrupt mask settings */
            MK0 = ch_mask_bak0;
            MK1 = ch_mask_bak1;

}
```