

Customer Notification

μPD78F9222 Subseries

8-Bit Single-Chip Microcontrollers

Operating Precautions

μPD78F9221

μPD78F9222

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μPD78F9222 Subseries

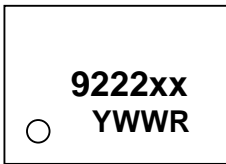
(A) Table of Operating Precautions

No.	Outline	μPD78F922x			
		Rev. ^{Note}	2.2	2.3	
		Rank ^{Note}	K	E	P
1	Restriction for STOP mode (Technical Limitation)	X	X	✓	
2	Restriction on using flash self-programming (Direction of use)	X	X	X	

✓ : Not applicable
 X : applicable

Note: -The version is indicated by the in the lot number, marked on each product.
 Pls. refer to the below marking on each package.
 - Older device versions are not part of this customer notification, because it is expected that they are not used anymore.

Marking for versions below V2.3

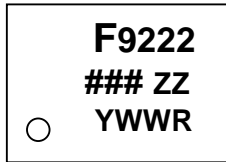


xx: DS or ES
 Y: Year Code
 WW: Week Code
 R: Rank

μPD78F9221/2

Revision	Marking
V 2.2 (ES)	F9222 V22ES 448K
V 2.3	F9221 xxxE F9222 xxxE

Marking for versions V2.3 or later



###: Code Number (only preprogrammed flash)
 ZZ: Flash Grade
 Y: Year Code
 WW: Week Code
 R: Rank

(B) Description of Operating Precautions

No. 1	Restriction for STOP mode (Technical Limitation)
<p><u>Details</u></p> <p>When CPU execute STOP instruction with IE flag = 0(DI instruction executed) and IF flag = 1 that is not masked, STOP mode will not be released. Then any other interrupts are occurred, STOP mode is not released, either.</p> <p>Case 1 : When CPU execute STOP instruction with IE flag = 0 and IF flag = 1, MK flag = 0. DI ; Interrupt is disabled SET1 PIF0 ; Set interrupt request flag(INTP0) CLR1 PMK0 ; Clear interrupt mask flag(INTP0) SET1 P2.0 ; Set Port20 to "1" STOP ; Changing STOP mode CLR1 P2.0 ; Clear Port20(Will not be executed)</p> <p>When interrupt enabled and standby release signal is occurred, and CPU execute interrupt request pending instruction right before STOP instruction executing, then STOP mode will not be released.</p> <p>Case2 : When CPU execute STOP instruction with IE flag = 1 and IF flag = 1, MK flag = 0. EI ; Interrupt is enabled SET1 P2.0 ; Set Port20 to "1" SET1 PIF0 ; Set interrupt request flag(INTP0) CLR1 PMK0 ; Executing interrupt request pending instruction STOP ; Changing STOP mode CLR1 P2.0 ; Clear Port20(Never executed)</p> <p>Note : interrupt request pending instruction Write access instruction for interrupt request flag register 0 (IF0) Write access instruction for interrupt mask flag register 0 (MK0)</p> <p><u>Workaround</u></p> <p>Execute EI instruction before STOP instruction execution. Then do not execute Interrupt request pending instruction right before STOP execution.</p> <p>Case3 : Executing EI instruction right before STOP instruction. DI ; Interrupt disabled SET1 PIF0 ; Set interrupt request flag(INTP0) CLR1 PMK0 ; Clear interrupt mask flag(INTP0) SET1 P2.0 ; Set Port20 to "1". EI ; Interrupt enabled STOP ; Changing STOP mode CLR1 P2.0 ; Clear Port20(will execute)</p> <p>Note: If interrupt is occurred before executing STOP instruction, it's necessary to generate interrupt for releasing from STOP mode because interrupt request flag is cleared before executing STOP instruction.</p>	

No. 2	Restriction on using flash self-programming (Direction of use)
<p><u>Details</u> If the standby function performed by the HALT instruction and flash self-programming are used together using the procedure shown below, the subsequent operation becomes unexpected.</p> <p><u>Workaround</u> 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.</p> <p><u>Detailed explanation</u> The following two modes are available in these products.</p> <ul style="list-style-type: none"> - 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. <p style="text-align: center;">Process Leading up to Unexpected Operation</p> <p>The diagram illustrates the timing of various signals during a sequence of operations. The top horizontal axis is divided into eight stages by vertical dashed lines: Normal HALT execution, Shift to SELF, Command setting, SELF execution, End of SELF, Normal HALT execution, Shift to SELF, and Unexpected operation. Below this, five signals are tracked: HALT instruction, HALT execution flag, FLSPM, SELF execution status, and FLCMD register value. Annotations <1> through <6> mark specific events: <1> is the start of the first HALT instruction; <2> is the start of the first Shift to SELF; <3> is the start of the first SELF execution; <4> is the start of the second Shift to SELF; <5> is the start of the second Normal HALT execution; <6> is the start of the Unexpected operation. The FLCMD register value is shown as 00H during the first Normal HALT execution and as 'Any command value' during the second Normal HALT execution.</p>	

- <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.

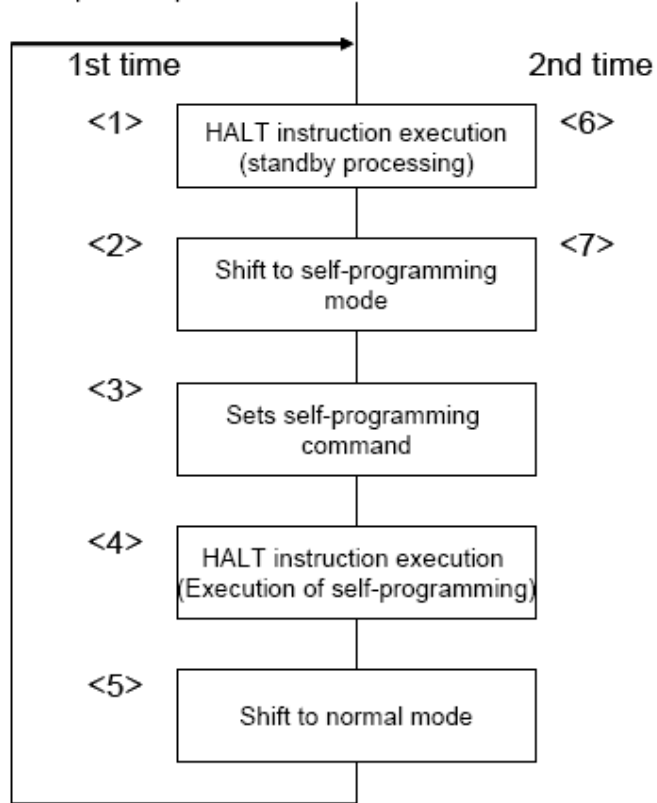
Remark The same situation occurs when flash self-programming is executed before <1>.

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 restriction 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  $\mu$ s 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
        FLPNC = 0x01; // Controls FLPNC register (set value)
        FLPNC = 0xFE; // Controls FLPNC register (inverted set value)
        FLPNC = 0x01; // Sets self-programming mode

        /* When using a clock generated by an external resonator or external input clock,
        insert a 16  $\mu$ s 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

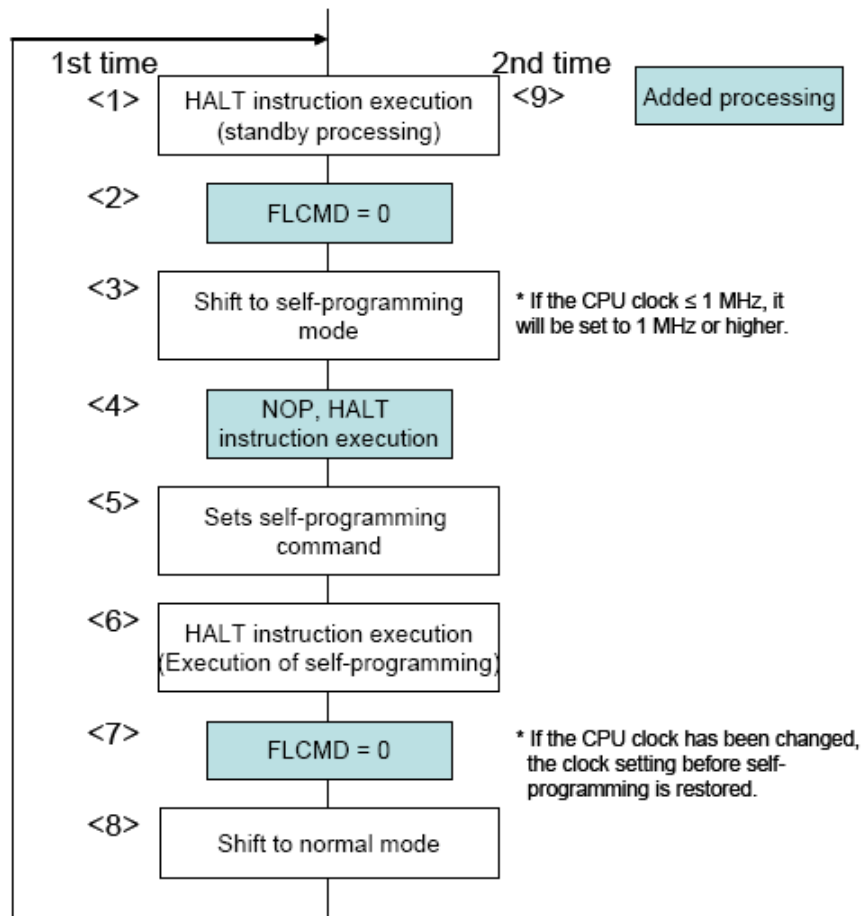
    /* Executes erase command - <4> in flowchart */
    HALT(); // Executes erase command

    /* Shifts to normal mode - <5> in flowchart */
    do{
        PFS = 0; // Clears flash status register
        PFCMD = 0xA5; // Controls PFCMD register
        FLPNC = 0x00; // Controls FLPNC register (set value)
        FLPNC = 0xFF; // Controls FLPNC register (inverted set value)
        FLPNC = 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 μ s 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 restriction 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 is 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
    BT PFS.0,$ModeOnLoop ; 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 8us wait

    ; 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  $\delta$  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
        FLPKC = 0x01; // Controls FLPKC register (set value)
        FLPKC = 0xFE; // Controls FLPKC register (inverted set value)
        FLPKC = 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 ext. resonator or external input clock, insert an 8 $\mu$ s 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
        FLPKC = 0x00; // Controls FLPKC register (set value)
        FLPKC = 0xFF; // Controls FLPKC register (inverted set value)
        FLPKC = 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;
}

```

(C) Valid Specification

Item	Date published	Document No.	Document Title
1	July 2005 or later	U16898EJ...	User's Manual

(D) Revision History

Item	Date published	Document No.	Comment
1	January 21, 2005	TPS-LE-OP-F9222-1	1 st Release
2	March 07, 2005	TPS-LE-OP-F9222-2	2 nd Release addition of version V 2.1 and later
3	March 22, 2006	TPS-LE-OP-F9222-3	3 rd Release addition of Rank "P"
4	May 2007	U18766EE1V0IF00	4 th Release, addition of restriction 2, removal of old versions, new doc no