



Preliminary

DESCRIPTION

The EM78267/467 A/B/C is an 8-bit microprocessor with low-power, high speed CMOS technology. Integrated onto a single chip are on-chip watchdog timer (WDT), RAM, ROM, programmable real time clock/counter, power down mode and bi-directional tri-state I/O ports. It can be developed as cordless phone or other applications.

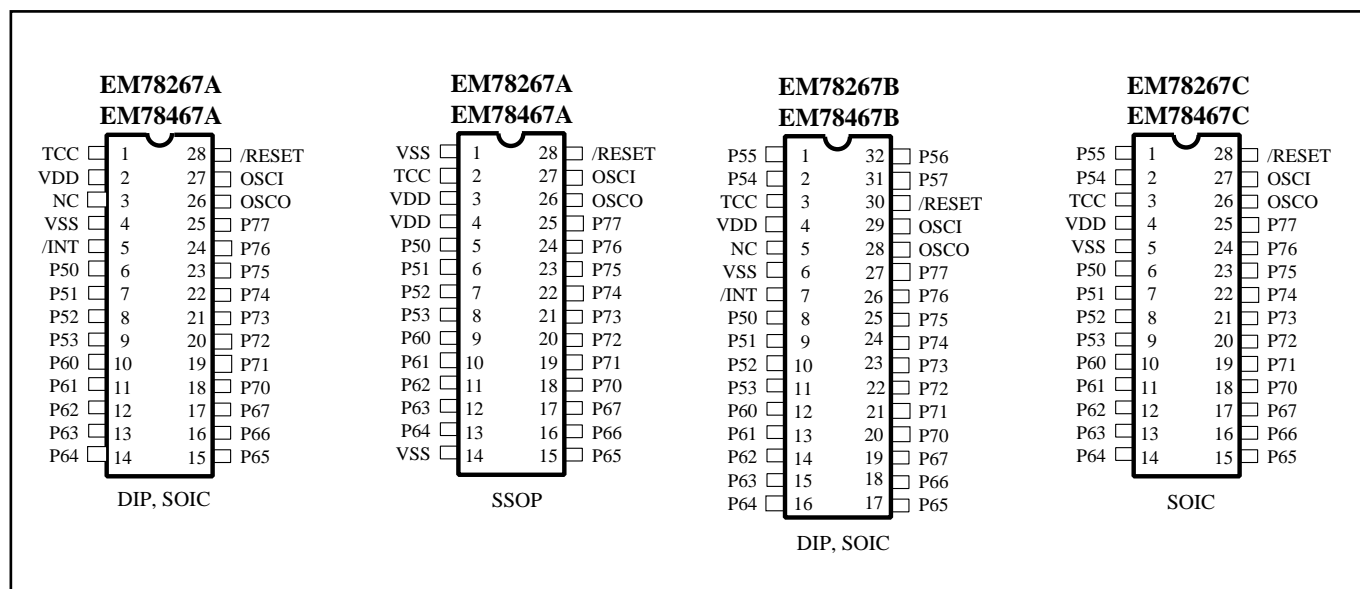
FEATURES

- Operating voltage range: 2.5V~5.5V
- Available in temperature range: 0°C~70°C
- Operating frequency range:
 Crystal Type: DC~20MHz at 5V DC~8MHz at 3V
 RC Type: DC~4MHz at 5V DC~4MHz at 3V
- 2Kx13 on chip ROM (EM78267A/B/C)
- 4Kx13 on chip ROM (EM78467A/B/C)
- 9 special function registers
- 148x8 general purpose registers (SRAM)
- 3 bi-directional tri-state I/O ports (20 I/O pins for EM78267/467A) (24 I/O pins for EM78267/467B) (22 I/O pins for EM78267/467C)
- 5 level stack for subroutine nesting
- 8-bit real time clock/counter (TCC) with selective signal sources and trigger edges, and with overflow interrupt
- Selectable oscillator options:
 XTAL1 type (High frequency)
 XTAL2 type (32.768KHz)
 RC type
 External clock input
- Two oscillator periods per instruction cycle
- Power down mode
- Programmable wake up from sleep circuit on I/O ports
- Programmable free running on-chip watchdog timer
- Ten pull-up and wake-up pins
- Two open-drain pins
- Two R-option pins
- Interrupt function available
- 28 pin DIP, SOIC, SSOP (EM78267/467A)
 28 pin SOIC (EM78267/467C)
 32 pin DIP, SOIC (EM78267/467B)



Preliminary

PIN ASSIGNMENTS



FUNCTIONAL BLOCK DIAGRAM

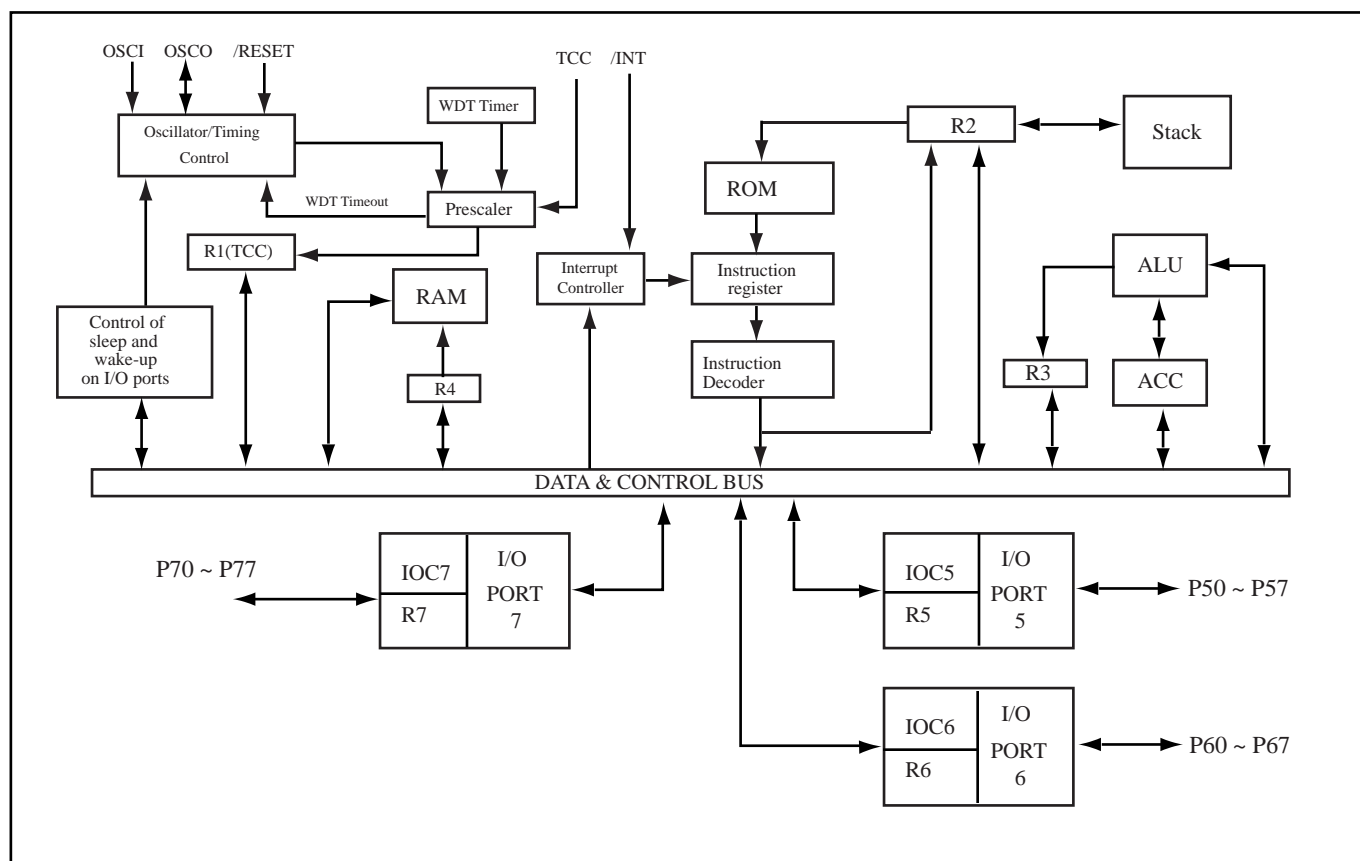


Fig. 2 Functional block diagram



PIN DESCRIPTION

Preliminary

| Symbol | Type | Function |
|---------------------------|------|--|
| OSCI | I | XTAL Type : Crystal input terminal or external clock input pin. RC type : RC oscillator input pin. |
| OSCO | I/O | XTAL type : output terminal for crystal oscillator or external clock input pin. RC type : clock output with a period of one instruction cycle is put on this pin. |
| TCC | I | Real time clock/counter, Schmitt trigger input pin. Must be tied to VDD or VSS if not in use. |
| $\overline{\text{RESET}}$ | I | Schmitt trigger input pin. If this pin remains logic low, the controller is resset. |
| P70~P77 | I/O | Port 7 is an 8-bit bi-directional I/O port. P74~P75 can be pulled-high internally by software control. P76~P77 can have open-drain output by software control. P70 and P71 are also the R-option pins. |
| P60~P67 | I/O | Port 6 is an 8-bit bi-direction I/O port. They can be pulled-high internally by software control. |
| P50~P53 | I/O | Low order 4 pins of Port 5. In case of EM78P447A, only low order 4 pins are used in port 5. |
| P54~P57 | I/O | High order 4 pins of Port 5. In case of EM78P447B, Port 5 is an 8-bit bi-directional I/O port. |
| $\overline{\text{INT}}$ | I | Falling edge triggered interrupt input pin. Indicates an interrupt if interrupt is enabled. It has internal pull-up (50k Ω). |
| NC | - | no connection. |
| VDD | - | Power supply pin. |
| VSS | - | Ground pin. |

FUNCTION DESCRIPTIONS

Operational Registers

R0 (Indirect Addressing Register)

R0 is not a physically implemented register. It is useful as indirect addressing pointer. Any instruction using R0 as register actually accesses data pointed by the RAM Select Register (R4).

R1 (TCC)

- Increased by an external signal edge applied to TCC pin, or by the instruction cycle clock.
- Written and read by the program as any other register.



Preliminary

R2 (Program Counter) & Stack

- Depending on the device type, R2 and hardware stack are 12 bits wide. The structure is depicted in Fig. 3.
- Generates 4Kx13 on-chip ROM addresses to the relative programming instruction codes. One program page is 1K words long.
- R2 is set all “1”s upon a RESET condition.
- “JMP” instruction allows the direct loading of the lower 10 program counter bits. Thus, “JMP” allows jump to any location on one page.
- “CALL” instruction loads the lower 10 bits of the PC, and then PC+1 is pushed into the stack. Thus, the subroutine entry address can be any location on one page.
- “RET” (“RETL k”, “RETI”) instruction loads the program counter with the contents at the top of stack.
- “MOV R2,A” allows the loading of an address from the “A” register to the lower 8 bits of PC, and the ninth and tenth bits (A8~A9) of PC are cleared.
- “ADD R2,A” allows a relative address be added to the current PC, and the ninth and tenth bits of PC are cleared.
- Any instruction which writes to R2 (e.g. “ADD R2,A”, “MOV R2,A”, “BC R2,6”,) (except “TBL”) will cause the ninth and tenth bits (A8~A9) of PC to be cleared. Thus, the computed jump is limited to the first 256 locations of any program page.
- “TBL” allows a relative address be added to the current PC ($R2+AR \rightarrow 2$), and contents of the ninth and tenth bits (A8~A9) of PC are not changed. Thus, the computed jump can be on the second (or third, 4th) 256 locations on one program page.
- In case of EM78267/467, the most significant bits (A10~A11) will be loaded with the contents of bits PS0~PS1 in the status register (R3) upon the execution of a “JMP”, “CALL”, or any instruction which writes to R2.

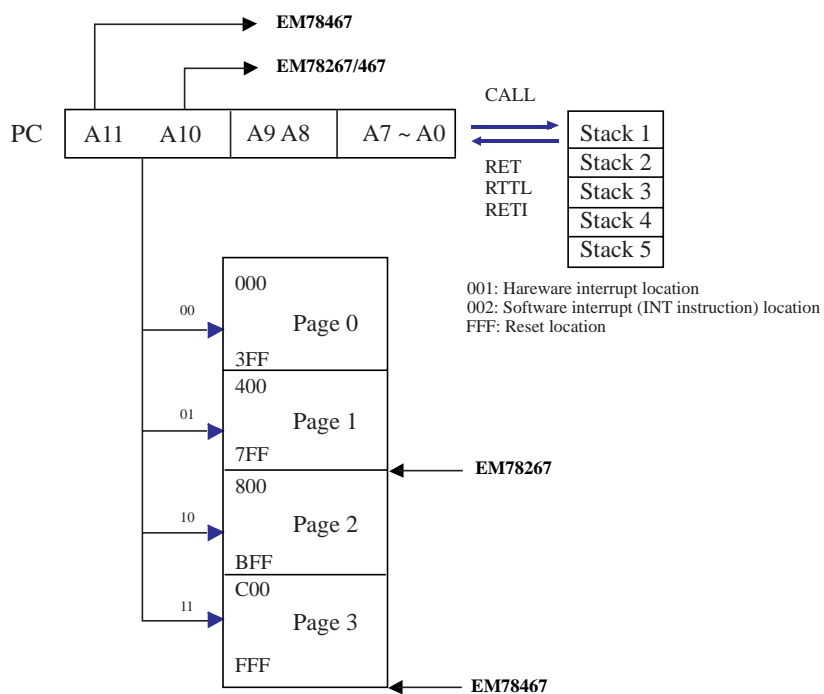


Fig. 3 Program counter organization



Preliminary

R3 (Status Register)

| | | | | | | | |
|----|-----|-----|---|---|---|----|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GP | PS1 | PS0 | T | P | Z | DC | C |

- **Bit 0 (C)** Carry flag
- **Bit 1 (DC)** Auxiliary carry flag
- **Bit 2 (Z)** Zero flag. Set to “1” if the result of an arithmetic or logic operation is zero.
- **Bit 3 (P)** Power down bit. Set to 1 during power on or by a “WDTC” command and reset to 0 by a “SLEP” command.
- **Bit 4 (T)** Time-out bit. Set to 1 by the “SLEP” and “WDTC” command, or during power up and reset to 0 by WDT time-out.
- **Bits 5 (PS0) ~ 6 (PS1)** Page select bits. PS0~PS1 are used to preselect a program memory page. When executing a “JMP”, “CALL”, or other instruction which causes the program counter to be changed (e.g. MOV R2,A), PS0~PS1 are loaded into the 11th and 12th bits of the program counter, selecting one of the available program memory pages. Note that RET (RETL, RETI) instruction does not change the PS0~PS1 bits. That is, the return will be always to the page from where the subroutine was called, regardless of the current setting of PS0~PS1 bits.

| PS1 | PS0 | Program memory page [Address] |
|-----|-----|-------------------------------|
| 0 | 0 | Page 0 [000-3FF] |
| 0 | 1 | Page 1 [400-7FF] |
| 1 | 0 | Page 2 [800-BFF] |
| 1 | 1 | Page 3 [C00-FFF] |

- **Bit 7 (GP)** General read/write bit.

R4 (RAM Select Register)

- Bits 0~5 are used to select the registers (address: 00~3F) in the indirect addressing mode.
- Bits 6~7 determine which bank is activated among the 4 banks.
- If no indirect addressing is used, the RSR can be used as an 8-bit wide general purpose read/write register.
- See the configuration of the data memory in Fig. 4.

R5 (Port 5)

- EM78267/467A: Only low order 4 bits are used in R5. The high order 4 bits of R5 will be read as “0”.
- EM78267/467B/C: All 8 bits are used in R5.

R6~R7 (Port 6 ~ Port 7)

- Two 8-bit I/O registers.

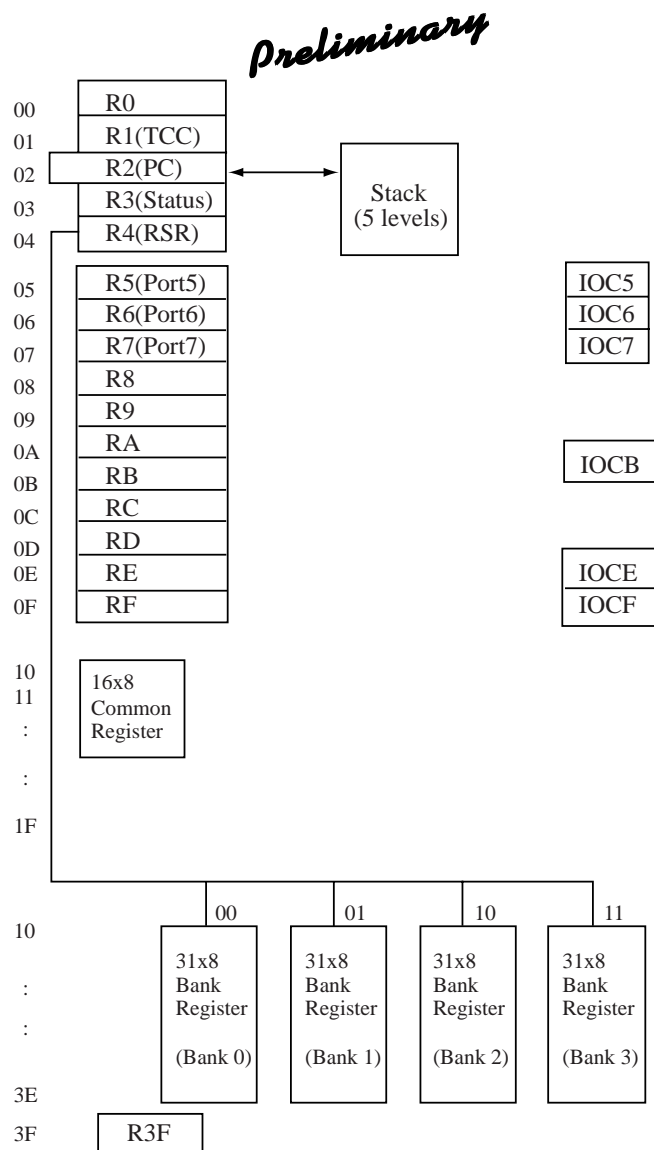


Fig. 4 Data memory configuration

R8~R1F, R20~R3E (General Purpose Register)

- R8~R1F, and R20~R3E (including Banks 0~3) are general purpose registers.

R3F (Interrupt Status Register)

| | | | | | | | |
|---|---|---|---|------|---|---|------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | - | - | - | EXIF | - | - | TCIF |

- **Bit 0 (TCIF)** TCC timer overflow interrupt flag. Set when TCC timer overflows, reset in software.
- **Bit 3 (EXIF)** External interrupt flag. Set by falling edge on /INT pin, reset in software.
- **Bits 1~2, 4~7** Not used.
- “1” means interrupt request, “0” means non-interrupt
- R3F can be cleared by instruction and cannot be set by instruction.

* This specification are subject to be changed without notice.



Preliminary

- IOCF is the interrupt mask register.
- Note that reading R3F by instruction will get the result of “logic AND” of R3F and IOCF.

Special Purpose Registers

A (Accumulator)

- Internal data transfer, or instruction operand holding
- It's not an addressable register.

CONT (Control Register)

| | | | | | | | |
|------|-----|----|----|-----|------|------|------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PHEN | INT | TS | TE | PAB | PSR2 | PSR1 | PSR0 |

- **Bit 0 (PSR0) ~ Bit 2 (PSR2)** TCC/WDT prescaler bits.

| PSR2 | PSR1 | PSR0 | TCC Rate | WDT Rate |
|------|------|------|----------|----------|
| 0 | 0 | 0 | 1:2 | 1:1 |
| 0 | 0 | 1 | 1:4 | 1:2 |
| 0 | 1 | 0 | 1:8 | 1:4 |
| 0 | 1 | 1 | 1:16 | 1:8 |
| 1 | 0 | 0 | 1:32 | 1:16 |
| 1 | 0 | 1 | 1:64 | 1:32 |
| 1 | 1 | 0 | 1:128 | 1:64 |
| 1 | 1 | 1 | 1:256 | 1:128 |

- **Bit 3 (PAB)** Prescaler assignment bit.
 - 0: TCC
 - 1: WDT
- **Bit 4 (TE)** TCC signal edge
 - 0: increment from low to high transition on TCC pin
 - 1: increment from high to low transition on TCC pin
- **Bit 5 (TS)** TCC signal source
 - 0: internal instruction cycle clock
 - 1: transition on TCC pin
- **Bit 6 (INT)** Interrupt enable flag which cannot be written by CONTW instruction.
 - 0: interrupt masked by DISI or hardware interrupt.
 - 1: interrupt enabled by ENI/RETI instruction.
- **Bit 7 (/PHEN)** I/O pin pull-high enable flag
 - 0: P60~P67 and P74~P75 have internal pull-high.
 - 1: pull-high is disabled.



Preliminary

- Bits 0~5, 7 of CONT register are readable and writable.

IOC5 ~ IOC7 (I/O Port Control Register)

- “1” put the relative I/O pin into high impedance, while “0” put the relative I/O pin as output.
- IOC5 ~ IOC7 are three I/O direction control registers. In case of EM78267/467A, only IOC7, IOC6 and lower four bits of IOC5 are used.

IOCB (Wake-up Control Register for Port 6)

| | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| /WUE7 | /WUE6 | /WUE5 | /WUE4 | /WUE3 | /WUE2 | /WUE1 | /WUE0 |

- Bit0 (/WUE0) Control bit used to enable the wake-up function of P60 pin.
0 : Enable wake-up function.
1 : Disable wake-up function.
- Bit1 (/WUE1) Control bit used to enable the wake-up function of P61 pin.
- Bit2 (/WUE2) Control bit used to enable the wake-up function of P62 pin.
- Bit3 (/WUE3) Control bit used to enable the wake-up function of P63 pin.
- Bit4 (/WUE4) Control bit used to enable the wake-up function of P64 pin.
- Bit5 (/WUE5) Control bit used to enable the wake-up function of P65 pin.
- Bit6 (/WUE6) Control bit used to enable the wake-up function of P66 pin.
- Bit7 (/WUE7) Control bit used to enable the wake-up function of P67 pin.
- IOCB register is readable and writable.

IOCE (WDT Control Register)

| | | | | | | | |
|---|-----|-----|------|-----|---|---|-----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | ODE | WTE | SLPC | ROC | - | - | WUE |

Bit 6 (ODE) Open-drain control bit.

- 0: Both P76 and P77 are normal I/O pins.
 - 1: Both P76 and P77 pins have open-drain output.
- ODE bit is readable and writable.

Bit 5 (WTE) Control bit used to enable Watchdog timer.

WTE bit is used only if the CODE Option bit WTC is “1”. If WTC bit is “1”, then WDT is disabled/enabled by WTE bit.

- 0: Disable WDT
- 1: Enable WDT

WTE bit is not used if the CODE Option bit WTC is “0”. That is, if WTC bit is “0”, WDT is always disabled no matter what the WTE bit is.

WTE bit is readable and writable.

Bit 4 (SLPC) This bit is set by hardware at the falling edge of wake-up signal and is cleared by software. SLPC is

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Preliminary

used to control the operation of oscillator. The oscillator is disabled (oscillator is stopped, the controller enters the SLEEP2 MODE) on high-to-low transition on SLPC bit and is enabled (the controller is awakened from SLEEP2 MODE) on low-to-high transition on SLPC bit. In order to ensure the stable output of the oscillator, once the oscillator is disabled and is enabled again, there is a delay for approximately 18 ms (oscillator start-up timer, OST) before the next instruction of program being executed. The OST is always activated by wake-up from sleep mode whether the Code Option bit WTC is “0” or not. After waking up, the WDT is enabled if Code Option WTC is “1”. The block diagram of SLEEP2 MODE and wake-up caused by input triggered is depicted in Fig. 5.

Bit 3 (ROC) ROC is used for the R-option. Setting ROC to “1” will enable the status of R-option pin (P70, P71) to be read by the controller. Clearing ROC will disable the R-option function. If the R-option function is used, the user must connect the P71 pin or/and P70 pin to VSS by a 560KΩ external resistor (Rex). If Rex is connected/disconnected, the status of P70(P71) will be read as “0”/”1” when ROC is set to “1”. Refer to Fig. 7(b). ROC bit is readable and writable.

Bit 0 (/WUE) Control bit used to enable wake-up function of P74~P75.

0: Enable wake-up function

1: Disable wake-up function

WUE bit is readable and writable.

Bits 1~2, 7 Not used.

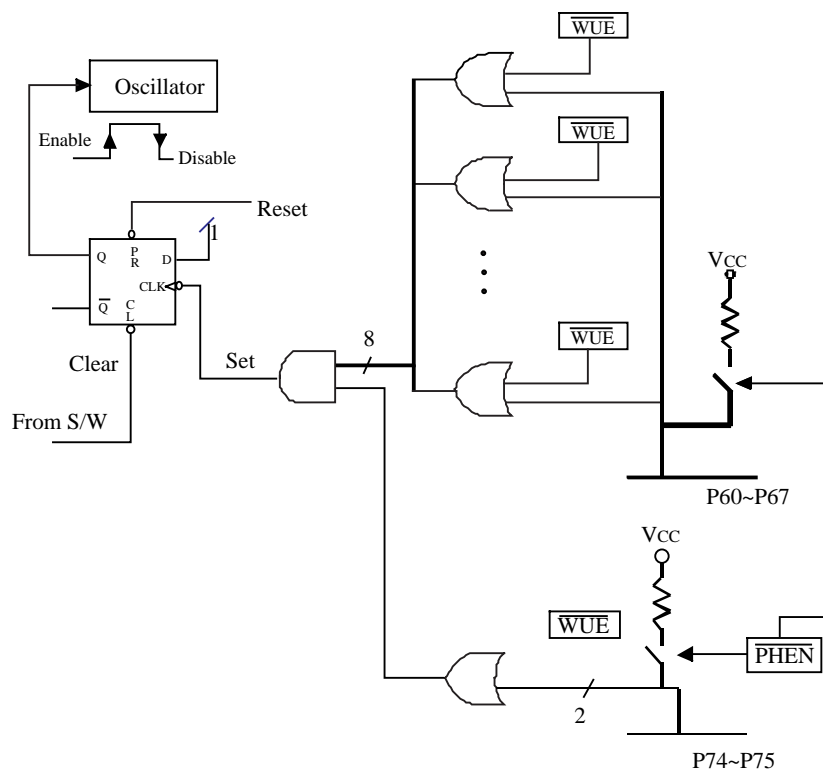


Fig. 5 Block diagram of sleep mode and wake-up circuits on I/O ports



Preliminary

IOCF (Interrupt Mask Register)

| | | | | | | | |
|---|---|---|---|------|---|---|------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | - | - | - | EXIE | - | - | TCIE |

Bit 0 (TCIE) TCIF interrupt enable bit.

0: disable TCIF interrupt

1: enable TCIF interrupt

Bit 3 (EXIE) EXIF interrupt enable bit.

0: disable EXIF interrupt

1: enable EXIF interrupt

Bits 1~2, 4~7 Not used.

- Individual interrupt is enabled by setting its associated control bit in IOCF to “1”.
- Global interrupt is enabled by ENI instruction and is disabled by DISI instruction. Refer to Fig. 9.
- IOCF Register is readable and writable.

TCC/WDT & Prescaler

There is an 8-bit counter available as prescaler for the TCC or WDT. The prescaler is available for the TCC only or WDT only at the same time and the PAB bit of CONT register is used to determine the prescaler assignment. The PSR0~PSR2 bits determine the prescale ratio. The prescaler will be cleared by instructions which write to TCC each time, when assigned to TCC mode. The WDT and prescaler, when assigned to WDT mode, will be cleared by the WDTC and SLEP instructions. Fig. 6 depicts the circuit diagram of TCC/WDT.

- R1(TCC) is an 8-bit timer/counter. The clock source of TCC can be internal clock or external clock input (edge selectable from TCC pin). If TCC signal source is from internal clock, TCC will increase by one in every instruction cycle (without prescaler). If TCC signal source is from external clock input, TCC will increase by 1 on every falling edge or rising edge of TCC pin.
- The watchdog timer is a free running on-chip RC oscillator. The WDT will keep running even the oscillator driver has been turned off (i.e. in sleep mode). During the normal operation or the sleep mode, a WDT time-out (if enabled) will cause the device to reset. The WDT can be enabled or disabled at any time during the normal mode by software programming (if Code Option bit WTC is “1”). Refer to WTE bit of IOCE register. With no prescaler, the WDT time-out period is approximately 18 ms.

I/O Ports

The I/O registers, Port 5 ~ Port 7, are bi-directional tri-state I/O ports. P60~P67, P74~P75 can have internal pull-high and wake-up function by software control. P76~P77 can have open-drain output by software control. P70~P71 are the R-option pins which are enabled by software. While R-option function is used, P70~P71 are recommended to be used as output pins. During the period of R-option being enabled, P70~P71 must be programmed as input pins. If external resistor is connected to P70(P71) for R-option function, the current consumption should be noticed in the applications that low power are concerned.

Preliminary

The I/O ports can be defined as “input” or “output” pins by the I/O control registers (IOC5~IOC7) under program control. The I/O registers and I/O control registers are both readable and writable. The I/O interface circuit is shown in Fig. 7. Note that the source is different between the reading path of input and output pin while reading the I/O port.

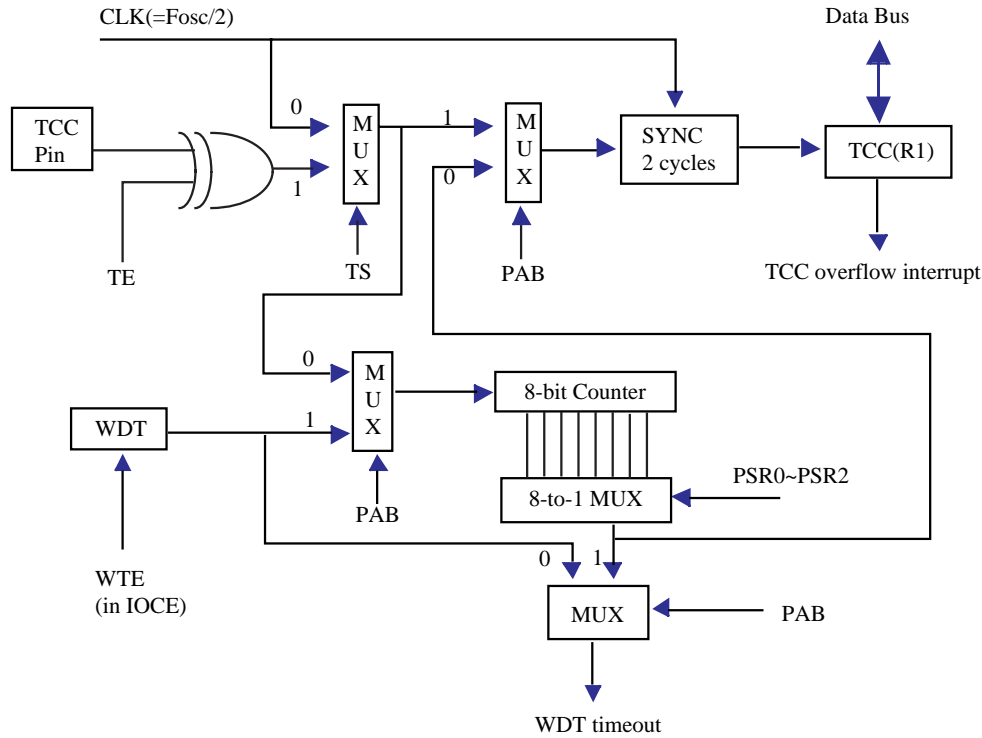


Fig. 6 Block diagram of TCC WDT

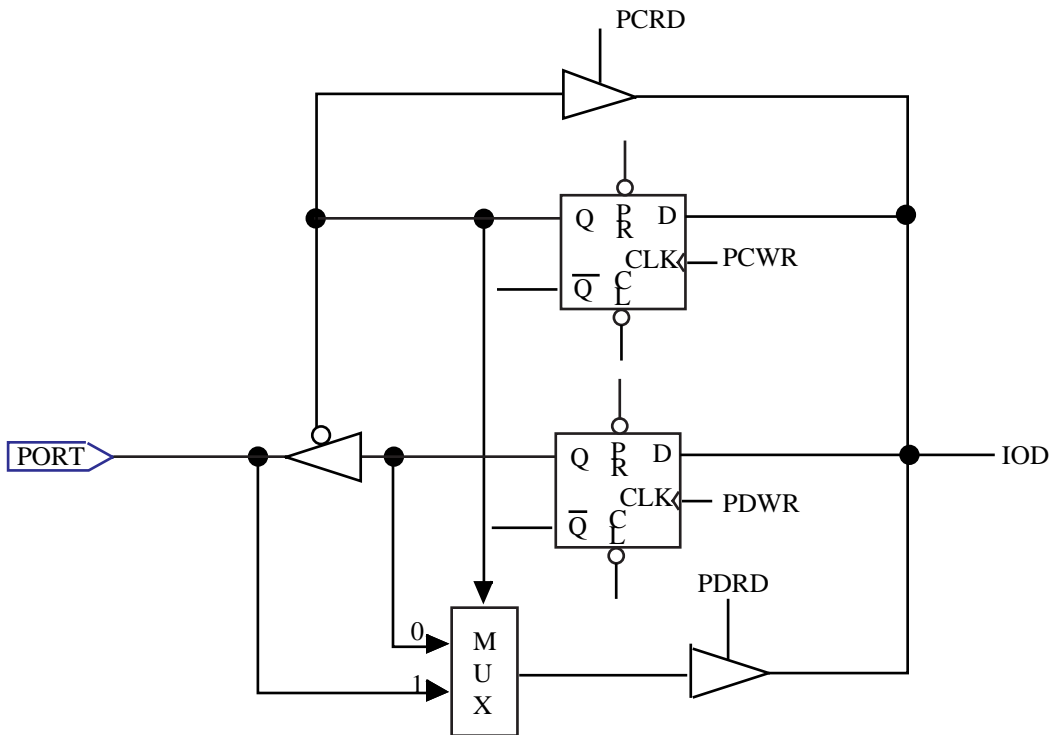


Fig. 7(a) The circuit of I/O port and I/O control register

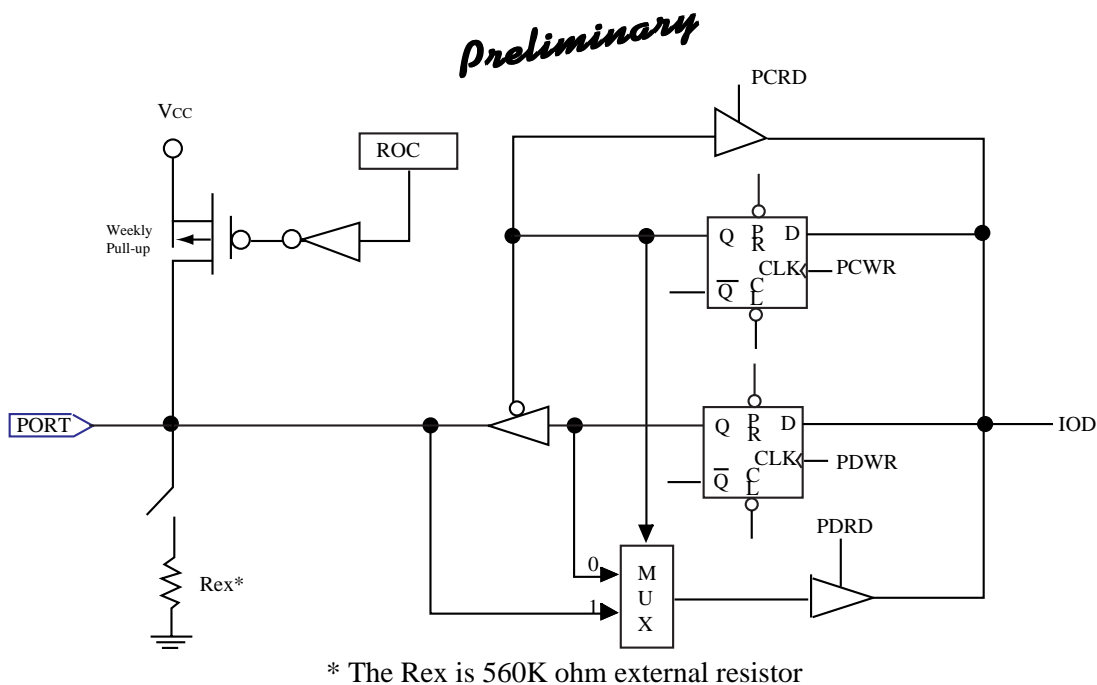


Fig. 7(b) The circuit of I/O port with R-option (P70,P71)

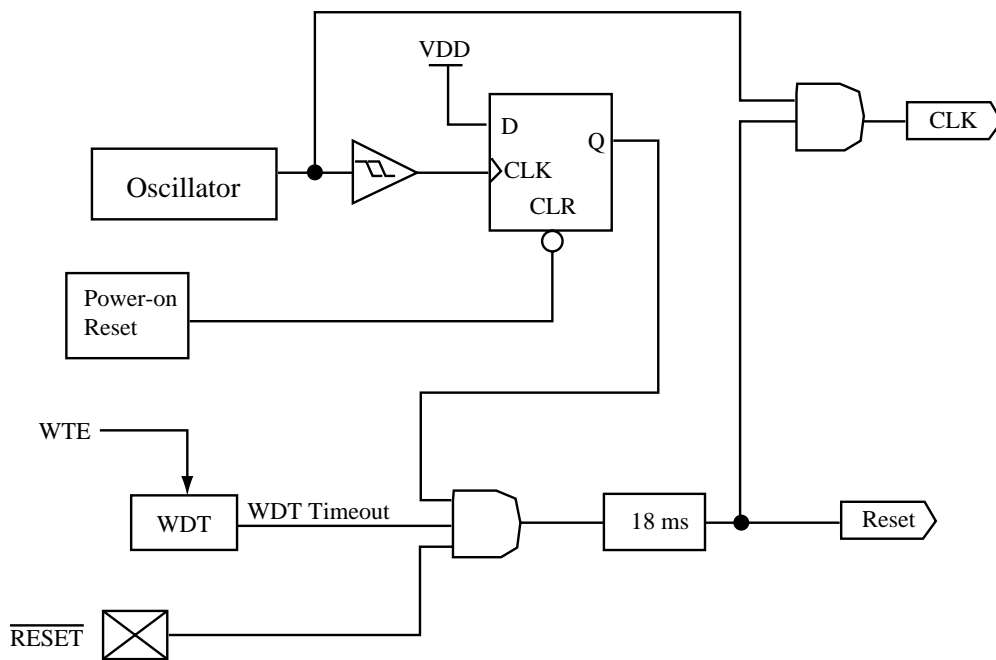


Fig. 8 Block diagram of Reset of controller

RESET and Wake-up

The RESET can be caused by

- (1) Power on reset,
- (2) /RESET pin input “low”, or



Preliminary

(3) WDT timeout. (if enabled)

The device will be kept in a RESET condition for a period of approx. 18ms (one oscillator start-up timer period) after the reset is detected. Once the RESET occurs, the following functions are performed.

- The oscillator is running, or will be started.
- The Program Counter (R2) is set to all “1”.
- When power on, bits 5~6 of R3 and the upper 2 bits of R4 are cleared.
- All I/O port pins are configured as input mode (high-impedance state).
- The Watchdog timer and prescaler are cleared.
- The Watchdog timer is enabled if Code Option bit WTC is “1”.
- The CONT register is set to all “1” except bit 6 (INT flag).
- IOCB register is set to all “1” (disable P60~P67 wake-up function).
- Bits 3,6 of IOCE register are cleared, bits 0,4~5 of IOCE register are set to “1”.
- Bits 0,3 of R3F and bits 0,3 of IOCF registers are cleared.

The sleep mode (power down mode) can be entered by executing the SLEP instruction (named as SLEEP1 MODE). While entering sleep mode, the WDT (if enabled) is cleared but keeping running. The controller can be awakened by

(1) WDT timeout (if enabled), or

(2) external reset input on /RESET pin.

The two cases will cause the controller to be reset. The T and P flags of R3 can be used to determine the source of the reset (wake-up).

In addition to the basic SLEEP1 MODE, EM78267/467 has another sleep mode (caused by clearing “SLPC” bit of IOCE register, named as SLEEP2 MODE). In the SLEEP2 MODE, the controller can be awakened by

(a) input triggered, refer to Fig. 5. When wake-up, the controller will continue to execute program in-line. In this case, before entering SLEEP2 MODE, the wake-up function of the trigger sources (P60~P67, and P74~P75) should be selected (e.g. input pin) and enabled (e.g. pull-high, wake-up control). One caution should be noted is that after waking up, the WDT is enabled if Code Option bit WTC is “1”. The WDT operation (to be enabled or disabled) should be appropriately controlled by software after waking up.

(b) WDT time-out (if enabled) or external reset input on /RESET pin. When wake-up, will cause the controller reset.

Interrupt

The EM78267/467 has the following interrupts:

(1) TCC overflow interrupt

(2) External interrupt (/INT).

R3F is the interrupt status register which records the interrupt request in flag bit. IOCF is the interrupt mask register. Global interrupt is enabled by ENI instruction and is disabled by DISI instruction. When one of the interrupts (when enabled) generated, will cause the next instruction to be fetched from address 001H. Once in the interrupt service routine the source of the interrupt can be determined by polling the flag bits in the R3F register. The interrupt flag bit must be cleared in software before leaving the interrupt service routine and enabling

Preliminary

interrupts to avoid recursive interrupts.

The flag in the Interrupt Status Register (R3F) is set regardless of the status of its mask bit or the execution of ENI instruction. Note that reading R3F will get the output of logic AND of R3F and IOCF. Refer to Fig. 9. The RETI instruction exits interrupt routine and enables the global interrupt (execution of ENI instruction).

When an interrupt is generated by INT instruction (when enabled), causes the next instruction to be fetched from address 002H.

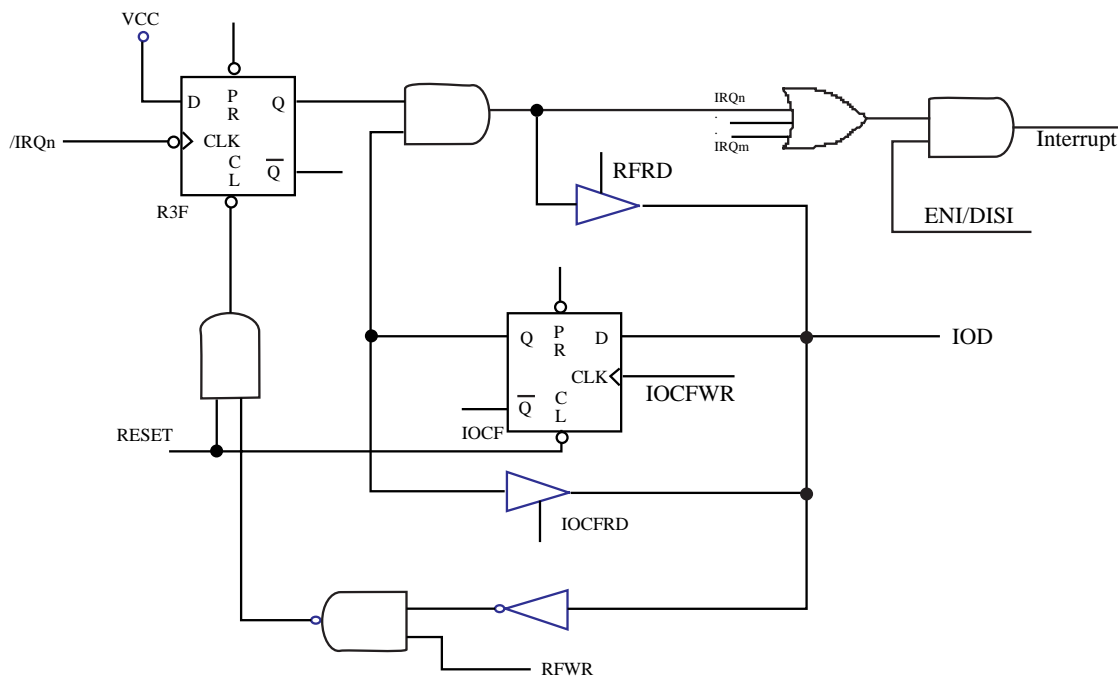


Fig. 9 Interrupt input circuit

Instruction Set

Each instruction in the instruction set is a 13-bit word divided into an OP code and one or more operands. All instructions are executed within one single instruction cycle (consists of 2 oscillator periods), unless the program counter is changed by

- (a) executing the instruction “MOV R2,A”, “ADD R2,A”, “TBL”, or any instruction which write to R2 (e.g. “SUB R2,A”, “BS R2,6”, “CLR R2”,).
- (b) CALL, RET, RETI, RETL, JMP, Conditional skip (JBS, JBC, JZ, JZA, DJZ, DJZA) tested to be true.

In these cases, the execution takes two instruction cycles.

In addition, the instruction set has the following features:

- (1) . Every bit of any register can be set, cleared, or tested directly.
- (2) . The I/O register can be regarded as general register. That is, the same instruction can operates on I/O register. The symbol “R” represents a register designator which specifies which one of the registers (including operational registers and general purpose registers) is to be utilized by the instruction. Bits 6 and 7 in R4 determine the selected register bank. “b” represents a bit field designator which selects the number of the bit, located in the register “R”,



Preliminary

affected by the operation. “k” represents an 8 or 10-bit constant or literal value.

| INSTRUCTION BINARY | HEX | HNEMONIC | OPERATION | STATUS AFFECTED |
|-----------------------|------|----------|--|--------------------|
| 0 0000 0000 0000 | 0000 | NOP | No Operation | None |
| 0 0000 0000 0001 | 0001 | DAA | Decimal Adjust A | C |
| 0 0000 0000 0010 | 0002 | CONTW | A → CONT | None |
| 0 0000 0000 0011 | 0003 | SLEP | 0 → WDT, Stop oscillator | T,P |
| 0 0000 0000 0100 | 0004 | WDTC | 0 → WDT | T,P |
| 0 0000 0000 rrrr | 000r | IOW R | A → IOCR | None <Note1> |
| 0 0000 0001 0000 | 0010 | ENI | Enable Interrupt | None |
| 0 0000 0001 0001 | 0011 | DISI | Disable Interrupt | None |
| 0 0000 0001 0010 | 0012 | RET | [Top of Stack] → PC | None |
| 0 0000 0001 0011 | 0013 | RETI | [Top of Stack] → PC, Enable Interrupt | None |
| 0 0000 0001 0100 | 0014 | CONTR | CONT → A | None |
| 0 0000 0001 rrrr | 001r | IOR R | IOCR → A | None <Note1> |
| 0 0000 0010 0000 | 0020 | TBL | R2+A → R2, Bits 8~9 of R2 unchanged | Z,C,DC |
| 0 0000 01rr rrrr | 00rr | MOV R,A | A → R | None |
| 0 0000 1000 0000 | 0080 | CLRA | 0 → A | Z |
| 0 0000 11rr rrrr | 00rr | CLR R | 0 → R | Z |
| 0 0001 00rr rrrr | 01rr | SUB A,R | R-A → A | Z,C,DC |
| 0 0001 01rr rrrr | 01rr | SUB R,A | R-A → R | Z,C,DC |
| 0 0001 10rr rrrr | 01rr | DECA R | R-1 → A | Z |
| 0 0001 11rr rrrr | 01rr | DEC R | R-1 → R | Z |
| 0 0010 00rr rrrr | 02rr | OR A,R | A ∨ R → A | Z |
| 0 0010 01rr rrrr | 02rr | OR R,A | A ∨ R → R | Z |
| 0 0010 10rr rrrr | 02rr | AND A,R | A & R → A | Z |
| 0 0010 11rr rrrr | 02rr | AND R,A | A & R → R | Z |
| 0 0011 00rr rrrr | 03rr | XOR A,R | A ⊕ R → A | Z |
| 0 0011 01rr rrrr | 03rr | XOR R,A | A ⊕ R → R | Z |
| 0 0011 10rr rrrr | 03rr | ADD A,R | A + R → A | Z,C,DC |
| 0 0011 11rr rrrr | 03rr | ADD R,A | A + R → R | Z,C,DC |
| 0 0100 00rr rrrr | 04rr | MOV A,R | R → A | Z |
| 0 0100 01rr rrrr | 04rr | MOV R,R | R → R | Z |
| 0 0100 10rr rrrr | 04rr | COMA R | /R → A | Z |
| 0 0100 11rr rrrr | 04rr | COM R | /R → R | Z |
| 0 0101 00rr rrrr | 05rr | INCA R | R+1 → A | Z |
| 0 0101 01rr rrrr | 05rr | INC R | R+1 → R | Z |
| 0 0101 10rr rrrr | 05rr | DJZA R | R-1 → A, skip if zero | None |
| 0 0101 11rr rrrr | 05rr | DJZ R | R-1 → R, skip if zero | None |
| 0 0110 00rr rrrr | 06rr | RRCA R | R(n) → A(n-1), R(0) → C, C → A(7) | C |
| 0 0110 01rr rrrr | 06rr | RRC R | R(n) → R(n-1), R(0) → C, C → R(7) | C |
| 0 0110 10rr rrrr | 06rr | RLCA R | R(n) → A(n+1), R(7) → C, C → A(0) | C |
| 0 0110 11rr rrrr | 06rr | RLC R | R(n) → R(n+1), R(7) → C, C → R(0) | C |



Preliminary

| INSTRUCTION BINARY | HEX | HNEMONIC | OPERATION | STATUS AFFECTED |
|-----------------------|------|----------|-------------------------------------|--------------------|
| 0 0111 00rr rrrr | 07rr | SWAPA R | R(0-3) → A(4-7), R(4-7) → A(0-3) | None |
| 0 0111 01rr rrrr | 07rr | SWAP R | R(0-3) ↔ R(4-7) | None |
| 0 0111 10rr rrrr | 07rr | JZA R | R+1 → A, skip if zero | None |
| 0 0111 11rr rrrr | 07rr | JZ R | R+1 → R, skip if zero | None |
| 0 100b bbrr rrrr | 0xxx | BC R,b | 0 → R(b) | None <Note2> |
| 0 101b bbrr rrrr | 0xxx | BS R,b | 1 → R(b) | None <Note3> |
| 0 110b bbrr rrrr | 0xxx | JBC R,b | if R(b)=0, skip | None |
| 0 111b bbrr rrrr | 0xxx | JBS R,b | if R(b)=1, skip | None |
| 1 00kk kkkk kkkk | 1kkk | CALL k | PC+1 → [SP], (Page, k) → PC | None |
| 1 01kk kkkk kkkk | 1kkk | JMP k | (Page, k) → PC | None |
| 1 1000 kkkk kkkk | 18kk | MOV A,k | k → A | None |
| 1 1001 kkkk kkkk | 19kk | OR A,k | A ∨ k → A | Z |
| 1 1010 kkkk kkkk | 1Akk | AND A,k | A & k → A | Z |
| 1 1011 kkkk kkkk | 1Bkk | XOR A,k | A ⊕ k → A | Z |
| 1 1100 kkkk kkkk | 1Ckk | RETL k | k → A, [Top of Stack] → PC | None |
| 1 1101 kkkk kkkk | 1Dkk | SUB A,k | k-A → A | Z,C,DC |
| 1 1110 0000 0010 | 1E02 | INT | PC+1 → [SP], 002H → PC | None |
| 1 1111 kkkk kkkk | 1Fkk | ADD A,k | k+A → A | Z,C,DC |

<Note1> This instruction can operate on IOC5~IOC7, IOCE~IOCF only.

<Note2> This instruction is not recommended to operate on R3F.

<Note3> This instruction cannot operate on R3F.

CODE Option Register

The EM78267/467 has one CODE option register which is not part of the normal program memory. The option bits cannot be accessed during normal program execution.

| | | | | | | | |
|----|--------|------|-----|-----|-----|-----|--------|
| 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 -- 0 |
| MS | ENWDTB | CLKS | /PT | HLF | HLP | TYP | ----- |

Bit 12 (MS): Oscillator type selection.

0: RC type

1: XTAL type

Bit 11 (ENWDTB): WDT option.

0: Enable

1: Disable

Bit 10 (CLKS): Clocks of each instruction cycle

0: Two clocks

1: Four clocks



Preliminary

Bit 9 (/PT): Protect bit

0: Protect enable

1: Protect disable

Bit 8 (HLF): XTAL frequency selection.

0: XTAL2 type (Low frequency, 32.768KHz)

1: XTAL1 type (High frequency)

This bit is useful only when Bit 0 (MS) is "1". When MS is "0", HLF must be "0".

Bit 7 (HLP): Power consumption selection

0: Low power

1: High power

Bit 6 (TYP): EM78267/467A/B/C selection.

0: EM78267/467B/C

1: EM78267/467A

Bits 5~0: Not used. (DEFAULT "000000b").



Preliminary

ABSOLUTE MAXIMUM RATINGS

| Items | Sym. | Condition | Rating |
|------------------------|------------------|-----------|----------------|
| Temperature under bias | T _{OPR} | | 0°C to 70°C |
| Storage temperature | T _{STR} | | -65°C to 150°C |
| Input voltage | V _{IN} | | -0.3V to +6.0V |
| Output voltage | V _O | | -0.3V to +6.0V |

DC ELECTRICAL CHARACTERISTIC (T_A=0°C ~ 70°C, V_{DD}=5.0V, V_{SS}=0V)

| Parameter | Sym. | Condition | Min. | Typ. | Max. | Unit |
|---|------------------|--|---------------------|------|---------------------|------|
| Input Leakage Current for input pins | I _{IL1} | V _{IN} = V _{DD} , V _{SS} | | | ±1 | μA |
| Input High Voltage | V _{IH} | | 2.0 | | | V |
| Input Low Voltage | V _{IL} | | | | 0.8 | V |
| Input High Threshold Voltage | V _{IHT} | RESET, TCC, INT | 0.85V _{DD} | | V _{DD} | V |
| Input Low Threshold Voltage | V _{ILT} | RESET, TCC, INT | V _{SS} | | 0.15V _{DD} | V |
| Clock Input High Voltage | V _{IHX} | OSCI | 3.5 | | | V |
| Clock Input Low Voltage | V _{ILX} | OSCI | | | 1.5 | V |
| Output High Voltage (Port 5,6,7) | V _{OH1} | I _{OH} = -12.0mA | 2.4 | | | V |
| Output Low Voltage (Port 5,6) | V _{OL1} | I _{OL} = 12.0mA | | | 0.4 | V |
| Output Low Voltage (Port 7 only) | V _{OL2} | I _{OL} = 20.0mA | | | 0.4 | V |
| Pull-high current | I _{PH} | Pull-high active, input pin at V _{SS} | -50 | -100 | -240 | μA |
| Power down current | I _{SB} | All input and I/O pins at V _{DD} , output pin floating, WDT enabled | | | 10 | μA |
| Operating supply current | I _{CC1} | RESET='High', Fosc=4MHz (MS="1", HLF="1", CK2="0"), output pin floating | | | 2 | mA |
| Operating supply current | I _{CC2} | RESET='High', Fosc=10MHz (MS="1", HLF="1", CK2="0"), output pin floating | | | 5 | mA |
| Operating supply current (V _{DD} =3.25V) | I _{CC3} | RESET='High', Fosc=32.768KHz (MS="1", HLF="0", CK2="0"), output pin floating, WDT disabled | | | 30 | μA |

AC ELECTRICAL CHARACTERISTICS (T_A=0°C ~ 70°C, V_{DD}=5.0V, V_{SS}=0V)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|----------------------------------|--------|-----------|--------------|------|------|------|
| Input CLK duty cycle | Dclk | | 45 | 50 | 55 | % |
| Instruction cycle time (CK2="0") | Tins | XTAL Type | 100 | | DC | ns |
| | | RC Type | 500 | | DC | ns |
| TCC input period | Ttcc | | (Tins+20)/N* | | | ns |
| Watchdog timer period | Twdt | Ta = 25°C | | 18 | | ms |
| Device reset hold period | Tdrh | Ta = 25°C | | 18 | | ms |

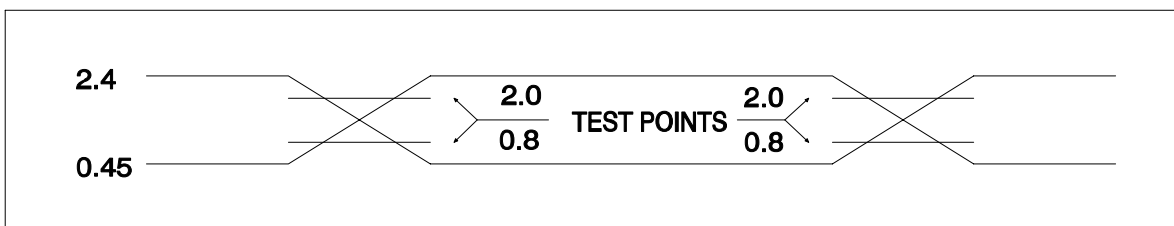
* N= selected prescaler ratio.

* This specification are subject to be changed without notice.



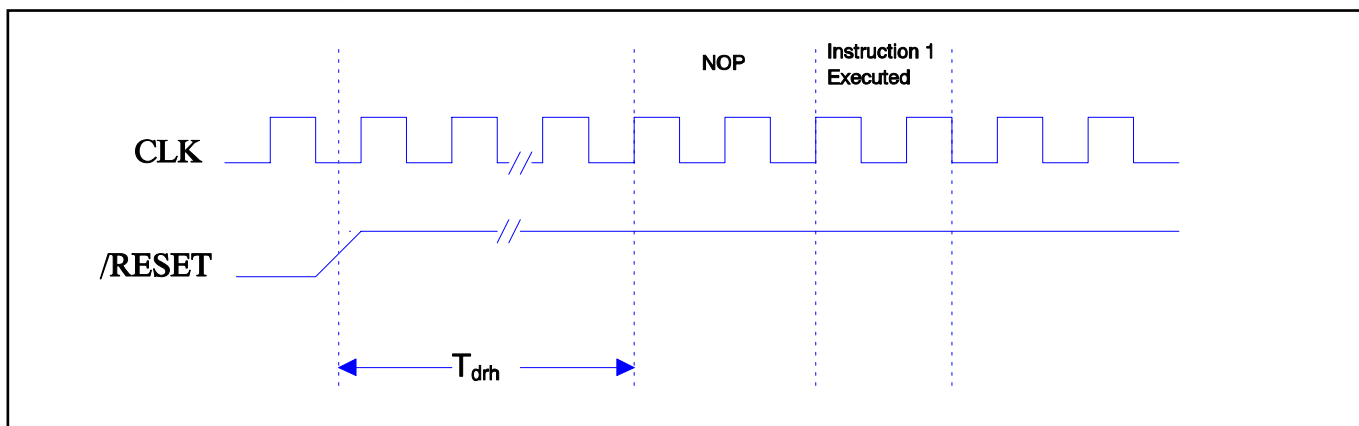
Preliminary

AC Test Input/Output Waveform



AC Testing: Input are driven at 2.4V for logic "1", and 0.45V for logic "0". Timing measurements are made at 2.0V for logic "1", and 0.8V for logic "0".

RESET Timing (CK2="0")



TCC Input Timing (CK2="0")

