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"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	8052
Core Size	8-Bit
Speed	40MHz
Connectivity	EBI/EMI, UART/USART
Peripherals	POR
Number of I/O	36
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	512 x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	44-LCC (J-Lead)
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/nuvoton-technology-corporation-america/w78e516b40pl

1. GENERAL DESCRIPTION

The W78E516B is an 8-bit microcontroller which has an in-system programmable Flash EPROM for firmware updating. The instruction set of the W78E516B is fully compatible with the standard 8052. The W78E516B contains a 64K bytes of main Flash EPROM and a 4K bytes of auxiliary Flash EPROM which allows the contents of the 64KB main Flash EPROM to be updated by the loader program located at the 4KB auxiliary Flash EPROM ROM; 512 bytes of on-chip RAM; four 8-bit bi-directional and bit-addressable I/O ports; an additional 4-bit port P4; three 16-bit timer/counters; a serial port. These peripherals are supported by a eight sources two-level interrupt capability. To facilitate programming and verification, the Flash EPROM inside the W78E516B allows the program memory to be programmed and read electronically. Once the code is confirmed, the user can protect the code for security.

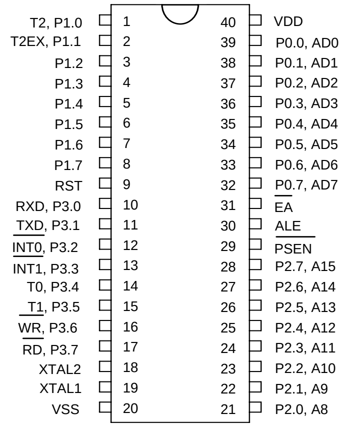
The W78E516B microcontroller has two power reduction modes, idle mode and power-down mode, both of which are software selectable. The idle mode turns off the processor clock but allows for continued peripheral operation. The power-down mode stops the crystal oscillator for minimum power consumption. The external clock can be stopped at any time and in any state without affecting the processor.

2. FEATURES

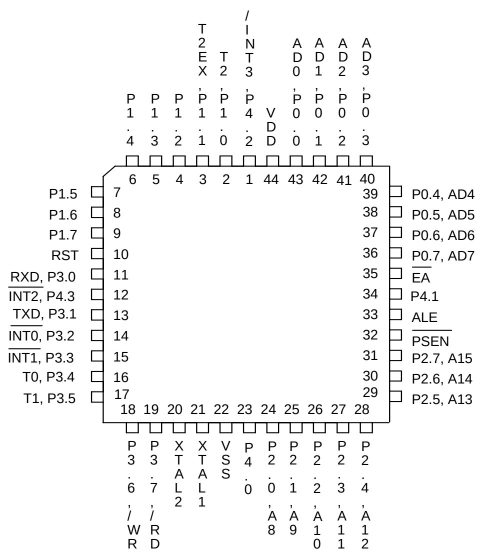
- Fully static design 8-bit CMOS microcontroller up to 40 MHz.
- 64K bytes of in-system programmable Flash EPROM for Application Program (APROM).
- 4K bytes of auxiliary Flash EPROM for Loader Program (LDROM).
- 512 bytes of on-chip RAM. (including 256 bytes of AUX-RAM, software selectable)
- 64K bytes program memory address space and 64K bytes data memory address space.
- Four 8-bit bi-directional ports.
- One 4-bit multipurpose programmable port.
- Three 16-bit timer/counters
- One full duplex serial port
- Six-sources, two-level interrupt capability
- Built-in power management
- Code protection
- Packaged in
  - Lead Free (ROHS) DIP 40: W78E516B40DL
  - Lead Free (ROHS) PLCC 44: W78E516B40PL
  - Lead Free (ROHS) PQFP 44: W78E516B40FL

3. PIN CONFIGURATIONS

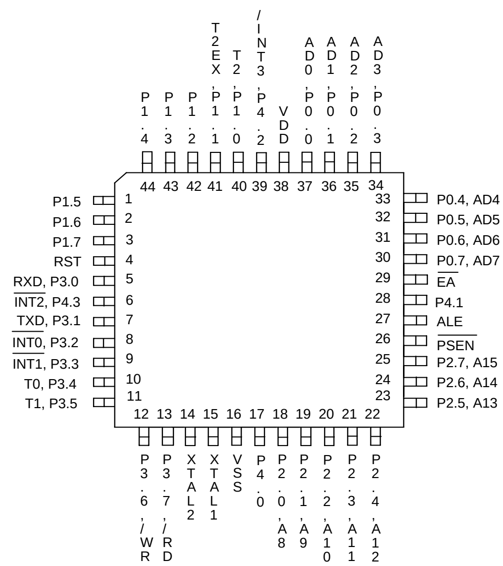
40-Pin DIP



44-Pin PLCC



44-Pin QFP



4. PIN DESCRIPTION

SYMBOL	TYPE	DESCRIPTIONS
$\overline{\text{EA}}$	I	EXTERNAL ACCESS ENABLE: This pin forces the processor to execute the external ROM. The ROM address and data will not be presented on the bus if the $\overline{\text{EA}}$ pin is high.
$\overline{\text{PSEN}}$	O H	PROGRAM STORE ENABLE: $\overline{\text{PSEN}}$ enables the external ROM data in the Port 0 address/data bus. When internal ROM access is performed, no $\overline{\text{PSEN}}$ strobe signal outputs originate from this pin.
ALE	O H	ADDRESS LATCH ENABLE: ALE is used to enable the address latch that separates the address from the data on Port 0. ALE runs at 1/6th of the oscillator frequency.
RST	I L	RESET: A high on this pin for two machine cycles while the oscillator is running resets the device.
XTAL1	I	CRYSTAL 1: This is the crystal oscillator input. This pin may be driven by an external clock.
XTAL2	O	CRYSTAL 2: This is the crystal oscillator output. It is the inversion of XTAL1.
V_{SS}	I	GROUND: ground potential.
V_{DD}	I	POWER SUPPLY: Supply voltage for operation.
P0.0 – P0.7	I/O D	PORT 0: Function is the same as that of standard 8052.
P1.0 – P1.7	I/O H	PORT 1: Function is the same as that of standard 8052.
P2.0 – P2.7	I/O H	PORT 2: Port 2 is a bi-directional I/O port with internal pull-ups. This port also provides the upper address bits for accesses to external memory.
P3.0 – P3.7	I/O H	PORT 3: Function is the same as that of the standard 8052.
P4.0 – P4.3	I/O H	PORT 4: A bi-directional I/O. See details below.

* **Note: TYPE** I: input, O: output, I/O: bi-directional, H: pull-high, L: pull-low, D: open drain

PORT4

Another bit-addressable port P4 is also available and only 4 bits (P4<3:0>) can be used. This port address is located at 0D8H with the same function as that of port P1.

Example:

```
P4      REG     0D8H
MOV     P4, #0AH        ; Output data "A" through P4.0 – P4.3.
MOV     A, P4           ; Read P4 status to Accumulator.
ORL     P4, #00000001B
ANL     P4, #11111110B
```

5. FUNCTIONAL DESCRIPTION

The W78E516B architecture consists of a core controller surrounded by various registers, four general purpose I/O ports, one special purpose programmable 4-bits I/O port, 512 bytes of RAM, three timer/counters, a serial port and an internal 74373 latch and 74244 buffer which can be switched to port2. The processor supports 111 different opcodes and references both a 64K program address space and a 64K data storage space.

5.1 RAM

The internal data RAM in the W78E516B is 512 bytes. It is divided into two banks: 256 bytes of scratchpad RAM and 256 bytes of AUX-RAM. These RAMs are addressed by different ways.

- RAM 0H – 7FH can be addressed directly and indirectly as the same as in 8051. Address pointers are R0 and R1 of the selected register bank.
- RAM 80H – FFH can only be addressed indirectly as the same as in 8051. Address pointers are R0, R1 of the selected registers bank.
- AUX-RAM 0H – FFH is addressed indirectly as the same way to access external data memory with the MOVX instruction. Address pointer are R0 and R1 of the selected register bank and DPTR register. An access to external data memory locations higher than FFH will be performed with the MOVX instruction in the same way as in the 8051. The AUX-RAM is disable after a reset. Setting the bit 4 in CHPCON register will enable the access to AUX-RAM. When AUX-RAM is enabled the instructions of "MOVX @Ri" will always access to on-chip AUX-RAM. When executing from internal program memory, an access to AUX-RAM will not affect the Ports P0, P2, $\overline{WR}$ and $\overline{RD}$.

Example,

```
CHPENR   REG      F6H
CHPCON   REG      BFH
MOV      CHPENR, #87H
MOV      CHPENR, #59H
ORL      CHPCON, #00010000B   ; enable AUX-RAM
MOV      CHPENR, #00H
MOV      R0, #12H
MOV      A, #34H
MOVX     @R0, A               ; Write 34h data to 12h address.
```

5.2 Timers 0, 1 and 2

Timers 0, 1, and 2 each consist of two 8-bit data registers. These are called TL0 and TH0 for Timer 0, TL1 and TH1 for Timer 1, and TL2 and TH2 for Timer 2. The TCON and TMOD registers provide control functions for timers 0, 1. The T2CON register provides control functions for Timer 2. RCAP2H and RCAP2L are used as reload/capture registers for Timer 2. The operations of Timer 0 and Timer 1 are the same as in the W78C51. Timer 2 is a 16-bit timer/counter that is configured and controlled by the T2CON register. Like Timers 0 and 1, Timer 2 can operate as either an external event counter or as an internal timer, depending on the setting of bit C/T2 in T2CON. Timer 2 has three operating modes: capture, auto-reload, and baud rate generator. The clock speed at capture or auto-reload mode is the same as that of Timers 0 and 1.

5.3 Clock

The W78E516B is designed with either a crystal oscillator or an external clock. Internally, the clock is divided by two before it is used by default. This makes the W78E516B relatively insensitive to duty cycle variations in the clock.

5.4 Crystal Oscillator

The W78E516B incorporates a built-in crystal oscillator. To make the oscillator work, a crystal must be connected across pins XTAL1 and XTAL2. In addition, a load capacitor must be connected from each pin to ground, and a resistor must also be connected from XTAL1 to XTAL2 to provide a DC bias when the crystal frequency is above 24 MHz.

5.5 External Clock

An external clock should be connected to pin XTAL1. Pin XTAL2 should be left unconnected. The XTAL1 input is a CMOS-type input, as required by the crystal oscillator. As a result, the external clock signal should have an input one level of greater than 3.5 volts.

5.6 Power Management

Idle Mode

Setting the IDL bit in the PCON register enters the idle mode. In the idle mode, the internal clock to the processor is stopped. The peripherals and the interrupt logic continue to be clocked. The processor will exit idle mode when either an interrupt or a reset occurs.

Power-down Mode

When the PD bit in the PCON register is set, the processor enters the power-down mode. In this mode all of the clocks are stopped, including the oscillator. To exit from power-down mode is by a hardware reset or external interrupts $\overline{\text{INT0}}$ to $\overline{\text{INT1}}$ when enabled and set to level triggered.

5.7 Reduce EMI Emission

The W78E516B allows user to diminish the gain of on-chip oscillator amplifier by using programmer to clear the B7 bit of security register. Once B7 is set to 0, a half of gain will be decreased. Care must be taken if user attempts to diminish the gain of oscillator amplifier, reducing a half of gain may affect the external crystal operating improperly at high frequency above 24 MHz. The value of R and C1, C2 may need some adjustment while running at lower gain.

5.8 Reset

The external RESET signal is sampled at S5P2. To take effect, it must be held high for at least two machine cycles while the oscillator is running. An internal trigger circuit in the reset line is used to deglitch the reset line when the W78E516B is used with an external RC network. The reset logic also has a special glitch removal circuit that ignores glitches on the reset line. During reset, the ports are initialized to FFH, the stack pointer to 07H, PCON (with the exception of bit 4) to 00H, and all of the other SFR registers except SBUF to 00H. SBUF is not reset.

5.9 Port 4

Port 4, address D8H, is a 4-bit multipurpose programmable I/O port. Each bit can be configured individually by software. The Port 4 has four different operation modes.

Mode 0: P4.0 – P4.3 is a bi-directional I/O port which is same as port 1. P4.2 and P4.3 also serve as external interrupt $\overline{\text{INT3}}$ and $\overline{\text{INT2}}$ if enabled.

Mode 1: P4.0 – P4.3 are read strobe signals that are synchronized with $\overline{\text{RD}}$ signal at specified addresses. These signals can be used as chip-select signals for external peripherals.

Mode 2: P4.0 – P4.3 are write strobe signals that are synchronized with $\overline{\text{WR}}$ signal at specified addresses. These signals can be used as chip-select signals for external peripherals.

Mode 3: P4.0 – P4.3 are read/write strobe signals that are synchronized with $\overline{\text{RD}}$ or $\overline{\text{WR}}$ signal at specified addresses. These signals can be used as chip-select signals for external peripherals.

When Port 4 is configured with the feature of chip-select signals, the chip-select signal address range depends on the contents of the SFR P4xAH, P4xAL, P4CONA and P4CONB. The registers P4xAH and P4xAL contain the 16-bit base address of P4.x. The registers P4CONA and P4CONB contain the control bits to configure the Port 4 operation mode.

5.10 $\overline{\text{INT2}}$ / $\overline{\text{INT3}}$

Two additional external interrupts, $\overline{\text{INT2}}$ and $\overline{\text{INT3}}$, whose functions are similar to those of external interrupt 0 and 1 in the standard 80C52. The functions/status of these interrupts are determined/shown by the bits in the XICON (External Interrupt Control) register. The XICON register is bit-addressable but is not a standard register in the standard 80C52. Its address is at 0C0H. To set/clear bits in the XICON register, one can use the "SETB ($\overline{\text{CLR}}$) bit" instruction. For example, "SETB 0C2H" sets the EX2 bit of XICON.

P4CONB (C3H)

BIT	NAME	FUNCTION
7, 6	P43FUN1 P43FUN0	00: Mode 0. P4.3 is a general purpose I/O port which is the same as Port1. 01: Mode 1. P4.3 is a Read Strobe signal for chip select purpose. The address range depends on the SFR P43AH, P43AL, P43CMP1 and P43CMP0. 10: Mode 2. P4.3 is a Write Strobe signal for chip select purpose. The address range depends on the SFR P43AH, P43AL, P43CMP1 and P43CMP0. 11: Mode 3. P4.3 is a Read/Write Strobe signal for chip select purpose. The address range depends on the SFR P43AH, P43AL, P43CMP1, and P43CMP0.
5, 4	P43CMP1 P43CMP0	Chip-select signals address comparison: 00: Compare the full address (16 bits length) with the base address register P43AH, P43AL. 01: Compare the 15 high bits (A15 – A1) of address bus with the base address register P43AH, P43AL. 10: Compare the 14 high bits (A15 – A2) of address bus with the base address register P43AH, P43AL. 11: Compare the 8 high bits (A15 – A8) of address bus with the base address register P43AH, P43AL.
3, 2	P42FUN1 P42FUN0	The P4.2 function control bits which are the similar definition as P43FUN1, P43FUN0.
1, 0	P42CMP1 P42CMP0	The P4.2 address comparator length control bits which are the similar definition as P43CMP1, P43CMP0.

P4CONA (C2H)

BIT	NAME	FUNCTION
7, 6	P41FUN1 P41FUN0	The P4.1 function control bits which are the similar definition as P43FUN1, P43FUN0.
5, 4	P41CMP1 P41CMP0	The P4.1 address comparator length control bits which are the similar definition as P43CMP1, P43CMP0.
3, 2	P40FUN1 P40FUN0	The P4.0 function control bits which are the similar definition as P43FUN1, P43FUN0.
1, 0	P40CMP1 P40CMP0	The P4.0 address comparator length control bits which are the similar definition as P43CMP1, P43CMP0.

P4 (D8H)

BIT	NAME	FUNCTION
7	-	Reserve
6	-	Reserve
5	-	Reserve
4	-	Reserve
3	P43	Port 4 Data bit which outputs to pin P4.3 at mode 0.
2	P42	Port 4 Data bit which outputs to pin P4.2 at mode 0.
1	P41	Port 4 Data bit which outputs to pin P4.1at mode 0.
0	P40	Port 4 Data bit which outputs to pin P4.0 at mode 0.

Here is an example to program the P4.0 as a write strobe signal at the I/O port address 1234H – 1237H and positive polarity, and P4.1 – P4.3 are used as general I/O ports.

```
MOV  P40AH, #12H
MOV  P40AL, #34H          ; Base I/O address 1234H for P4.0
MOV  P4CONA, #00001010B   ; P4.0 a write strobe signal and address line A0 and A1 are masked.
MOV  P4CONB, #00H         ; P4.1 – P4.3 as general I/O port which are the same as PORT1
MOV  P2ECON, #10H         ; Write the P40SINV = 1 to inverse the P4.0 write strobe polarity
                          ; default is negative.
```

Then any instruction MOVX @DPTR, A (with DPTR = 1234H – 1237H) will generate the positive polarity write strobe signal at pin P4.0. And the instruction MOV P4, #XX will output the bit3 to bit1 of data #XX to pin P4.3 – P4.1.

5.13 In-System Programming Control Register (CHPCON)

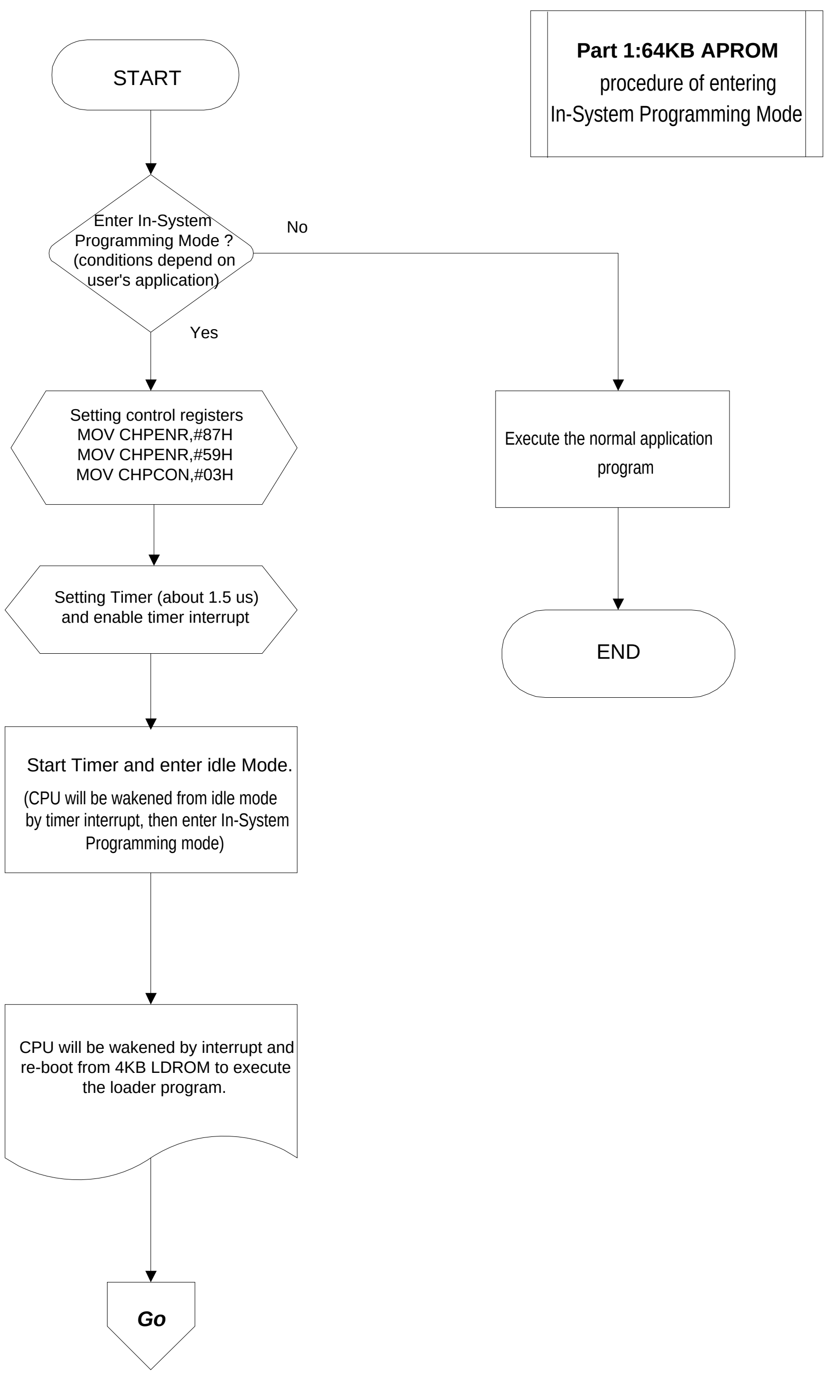
CHPCON (BFH)

BIT	NAME	FUNCTION
7	SWRESET (F04KMODE)	When this bit is set to 1, and both FBOOTSL and FPROGEN are set to 1. It will enforce microcontroller reset to initial condition just like power on reset. This action will re-boot the microcontroller and start to normal operation. To read this bit in logic-1 can determine that the F04KBOOT mode is running.
6	-	Reserve.
5	-	Reserve.
4	ENAUXRAM	1: Enable on-chip AUX-RAM. 0: Disable the on-chip AUX-RAM
3	0	Must set to 0.
2	0	Must set to 0.
1	FBOOTSL	The Program Location Select. 0: The Loader Program locates at the 64 KB APROM. 4KB LDROM is destination for re-programming. 1: The Loader Program locates at the 4 KB memory bank. 64KB APROM is destination for re-programming.
0	FPROGEN	FLASH EPROM Programming Enable. = 1: enable. The microcontroller enter the in-system programming mode after entering the idle mode and wake-up from interrupt. During in-system programming mode, the operation of erase, program and read are achieve when device enters idle mode. = 0: disable. The on-chip flash memory is read-only. In-system programmability is disabled.

F04KBOOT Mode (Boot from LDROM)

By default, the W78E516B boots from APROM program after a power on reset. On some occasions, user can force the W78E516B to boot from the LDROM program via following settings. The possible situation that you need to enter F04KBOOT mode when the APROM program can not run properly and device can not jump back to LDROM to execute in-system programming function. Then you can use this F04KBOOT mode to force the W78E516B jumps to LDROM and executes in-system programming procedure. When you design your system, you may reserve the pins P2.6, P2.7 to switches or jumpers. For example in a CD-ROM system, you can connect the P2.6 and P2.7 to PLAY and EJECT buttons on the panel. When the APROM program fails to execute the normal application program. User can press both two buttons at the same time and then turn on the power of the personal computer to force the W78E516B to enter the F04KBOOT mode. After power on of personal computer, you can release both buttons and finish the in-system programming procedure to update the APROM code. In application system design, user must take care of the P2, P3, ALE, $\overline{\text{EA}}$ and $\overline{\text{PSEN}}$ pin value at reset to prevent from accidentally activating the programming mode or F04KBOOT mode.

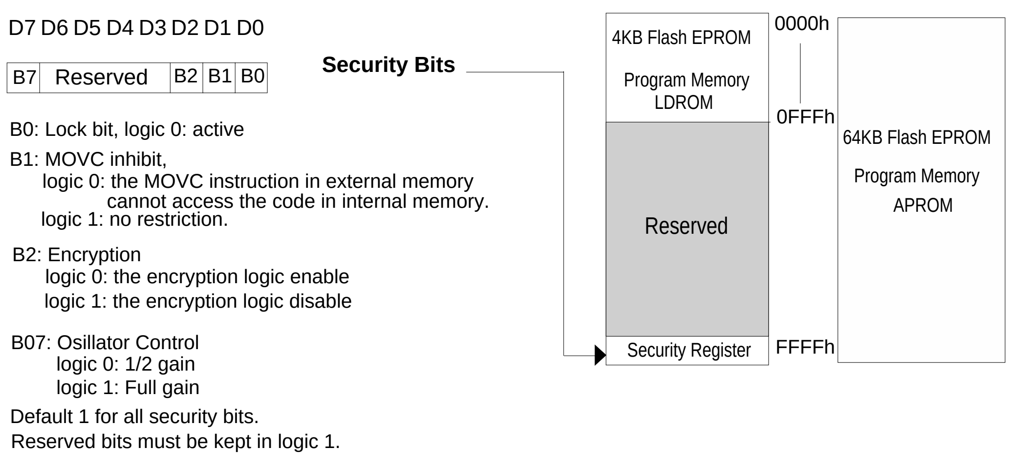
The Algorithm of In-System Programming



6. SECURITY

During the on-chip Flash EPROM programming mode, the Flash EPROM can be programmed and verified repeatedly. Until the code inside the Flash EPROM is confirmed OK, the code can be protected. The protection of Flash EPROM and those operations on it are described below.

The W78E516B has a Special Setting Register, the Security Register, which can not be accessed in programming mode. Those bits of the Security Register can not be changed once they have been programmed from high to low. They can only be reset through erase-all operation. The Security Register is located at the 0FFFFH of the LDROM space.



Special Setting Register

6.1 Lock Bit

This bit is used to protect the customer's program code in the W78E516B. It may be set after the programmer finishes the programming and verifies sequence. Once this bit is set to logic 0, both the Flash EPROM data and Special Setting Registers can not be accessed again.

6.2 MOVC Inhibit

This bit is used to restrict the accessible region of the MOVC instruction. It can prevent the MOVC instruction in external program memory from reading the internal program code. When this bit is set to logic 0, a MOVC instruction in external program memory space will be able to access code only in the external memory, not in the internal memory. A MOVC instruction in internal program memory space will always be able to access the ROM data in both internal and external memory. If this bit is logic 1, there are no restrictions on the MOVC instruction.

6.3 Encryption

This bit is used to enable/disable the encryption logic for code protection. Once encryption feature is enabled, the data presented on port 0 will be encoded via encryption logic. Only whole chip erase will reset this bit.

6.4 Oscillator Control

W78E516B/E516 allow user to diminish the gain of on-chip oscillator amplifier by using programmer to set the bit B7 of security register. Once B7 is set to 0, a half of gain will be decreased. Care must be taken if user attempts to diminish the gain of oscillator amplifier, reducing a half of gain may improperly affect the external crystal operation at high frequency above 24 MHz. The value of R and C1, C2 may need some adjustment while running at lower gain.

7. ELECTRICAL CHARACTERISTICS

7.1 Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
DC Power Supply	$V_{DD} - V_{SS}$	-0.3	+6.0	V
Input Voltage	V_{IN}	V_{SS} -0.3	V_{DD} +0.3	V
Operating Temperature	T_A	0	70	°C
Storage Temperature	T_{ST}	-55	+150	°C

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of the device.

7.2 D.C. Characteristics

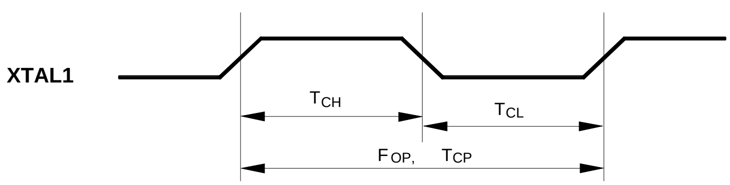
($V_{DD} - V_{SS}$ = 5V ±10%, T_A = 25°C, Fosc = 20 MHz, unless otherwise specified.)

PARAMETER	SYM.	SPECIFICATION			TEST CONDITIONS
		MIN.	MAX.	UNIT	
Operating Voltage	V_{DD}	4.5	5.5	V	RST = 1, P0 = V_{DD}
Operating Current	I_{DD}	-	20	mA	No load V_{DD} = 5.5V
Idle Current	I_{IDLE}	-	6	mA	Idle mode V_{DD} = 5.5V
Power Down Current	I_{PWDN}	-	50	μA	Power-down mode V_{DD} = 5.5V
Input Current P1, P2, P3, P4	I_{IN1}	-50	+10	μA	V_{DD} = 5.5V V_{IN} = 0V or V_{DD}
Input Current RST	I_{IN2}	-10	+300	μA	V_{DD} = 5.5V 0< V_{IN} <V_{DD}
Input Leakage Current P0, $\overline{EA}$	I_{LK}	-10	+10	μA	V_{DD} = 5.5V 0V< V_{IN} < V_{DD}
Logic 1 to 0 Transition Current P1, P2, P3, P4	I_{TL}[*4]	-500	-	μA	V_{DD} = 5.5V V_{IN} = 2.0V
Input Low Voltage P0, P1, P2, P3, P4, $\overline{EA}$	V_{IL1}	0	0.8	V	V_{DD} = 4.5V
Input Low Voltage RST	VIL2	0	0.8	V	VDD = 4.5V
Input Low Voltage XTAL1[*4]	VIL3	0	0.8	V	VDD = 4.5V

7.3 A.C. Characteristics

The AC specifications are a function of the particular process used to manufacture the part, the ratings of the I/O buffers, the capacitive load, and the internal routing capacitance. Most of the specifications can be expressed in terms of multiple input clock periods (TCP), and actual parts will usually experience less than a ±20 nS variation. The numbers below represent the performance expected from a 0.6 micron CMOS process when using 2 and 4 mA output buffers.

7.3.1 Clock Input Waveform



PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTES
Operating Speed	Fop	0	-	40	MHz	1
Clock Period	TCP	25	-	-	nS	2
Clock High	Tch	10	-	-	nS	3
Clock Low	Tcl	10	-	-	nS	3

Notes:

1. The clock may be stopped indefinitely in either state.
2. The TCP specification is used as a reference in other specifications.
3. There are no duty cycle requirements on the XTAL1 input.

7.3.2 Program Fetch Cycle

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTES
Address Valid to ALE Low	TAAS	1 TCP-Δ	-	-	nS	4
Address Hold from ALE Low	TAAH	1 TCP-Δ	-	-	nS	1, 4
ALE Low to $\overline{\text{PSEN}}$ Low	TAPL	1 TCP-Δ	-	-	nS	4
$\overline{\text{PSEN}}$ Low to Data Valid	TPDA	-	-	2 TCP	nS	2
Data Hold after $\overline{\text{PSEN}}$ High	TPDH	0	-	1 TCP	nS	3
Data Float after $\overline{\text{PSEN}}$ High	TPDZ	0	-	1 TCP	nS	
ALE Pulse Width	TALW	2 TCP-Δ	2 TCP	-	nS	4
$\overline{\text{PSEN}}$ Pulse Width	TPSW	3 TCP-Δ	3 TCP	-	nS	4

Notes:

1. P0.0 – P0.7, P2.0 – P2.7 remain stable throughout entire memory cycle.
2. Memory access time is 3 TCP.
3. Data have been latched internally prior to $\overline{\text{PSEN}}$ going high.
4. "Δ" (due to buffer driving delay and wire loading) is 20 nS.

7.3.3 Data Read Cycle

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTES
ALE Low to $\overline{RD}$ Low	TDAR	3 TCP-Δ	-	3 TCP+Δ	nS	1, 2
$\overline{RD}$ Low to Data Valid	TDDA	-	-	4 TCP	nS	1
Data Hold from $\overline{RD}$ High	TDDH	0	-	2 TCP	nS	
Data Float from $\overline{RD}$ High	TDDZ	0	-	2 TCP	nS	
$\overline{RD}$ Pulse Width	TDRD	6 TCP-Δ	6 TCP	-	nS	2

Notes:

1. Data memory access time is 8 TCP.
2. "Δ" (due to buffer driving delay and wire loading) is 20 nS.

7.3.4 Data Write Cycle

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
ALE Low to $\overline{WR}$ Low	TDAW	3 TCP-Δ	-	3 TCP+Δ	nS
Data Valid to $\overline{WR}$ Low	TDAD	1 TCP-Δ	-	-	nS
Data Hold from $\overline{WR}$ High	TDWD	1 TCP-Δ	-	-	nS
$\overline{WR}$ Pulse Width	TDWR	6 TCP-Δ	6 TCP	-	nS

Note: "Δ" (due to buffer driving delay and wire loading) is 20 nS.

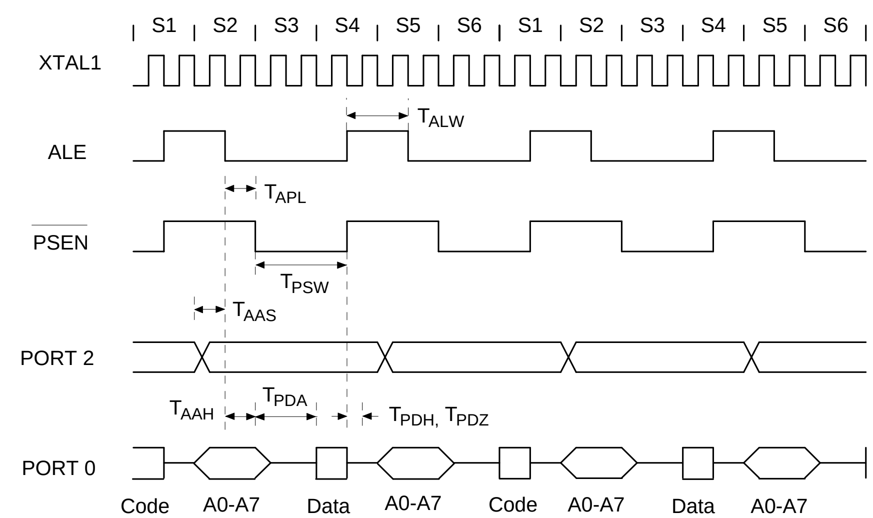
7.3.5 Port Access Cycle

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Port Input Setup to ALE Low	TPDS	1 TCP	-	-	nS
Port Input Hold from ALE Low	TPDH	0	-	-	nS
Port Output to ALE	TPDA	1 TCP	-	-	nS

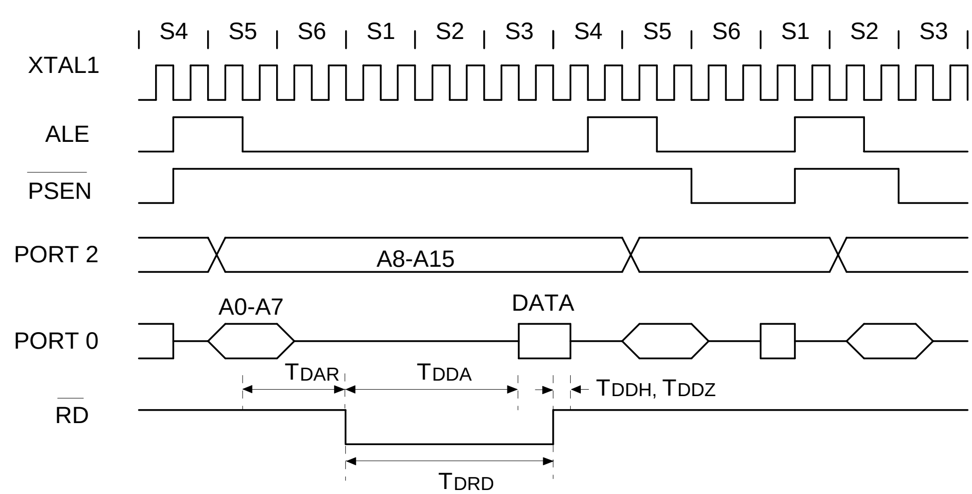
Note: Ports are read during S5P2, and output data becomes available at the end of S6P2. The timing data are referenced to ALE, since it provides a convenient reference.

8. TIMING WAVEFORMS

8.1 Program Fetch Cycle



8.2 Data Read Cycle



11. APPLICATION NOTE

11.1 In-system Programming Software Examples

This application note illustrates the in-system programmability of the Winbond W78E516B Flash EPROM microcontroller. In this example, microcontroller will boot from 64 KB APROM bank and waiting for a key to enter in-system programming mode for re-programming the contents of 64 KB APROM. While entering in-system programming mode, microcontroller executes the loader program in 4KB LDROM bank. The loader program erases the 64 KB APROM then reads the new code data from external SRAM buffer (or through other interfaces) to update the 64KB APROM.

EXAMPLE 1:

```
;*******************************************************************************************************************
;* Example of 64K APROM program: Program will scan the P1.0. if P1.0 = 0, enters in-system
;* programming mode for updating the content of APROM code else executes the current ROM code.
;* XTAL = 40 MHz
;*******************************************************************************************************************
        .chip 8052
        .RAMCHK OFF
        .symbols

        CHPCON     EQU     BFH
        CHPENR     EQU     F6H
        SFRAL      EQU     C4H
        SFRAH      EQU     C5H
        SFRFD      EQU     C6H
        SFRCN      EQU     C7H

        ORG     0H
        LJMP    100H            ; JUMP TO MAIN PROGRAM
   ;************************************************************************
   ;*  TIMER0 SERVICE VECTOR ORG = 000BH
   ;************************************************************************
        ORG     00BH
        CLR     TR0                     ; TR0 = 0, STOP TIMER0
        MOV     TL0, R6
        MOV     TH0, R7
        RETI
   ;************************************************************************
   ;*  64K APROM MAIN PROGRAM
   ;************************************************************************
      ORG 100H

MAIN_64K:
       MOV A, P1                          ; SCAN P1.0
       ANL A, #01H
       CJNE A, #01H, PROGRAM_64K   ; IF P1.0 = 0, ENTER IN-SYSTEM PROGRAMMING MODE
       JMP NORMAL_MODE

PROGRAM_64K:
        MOV CHPENR, #87H            ; CHPENR = 87H, CHPCON REGISTER WRTE ENABLE
        MOV CHPENR, #59H            ; CHPENR = 59H, CHPCON REGISTER WRITE ENABLE
        MOV CHPCON, #03H            ; CHPCON = 03H, ENTER IN-SYSTEM PROGRAMMING MODE
         MOV TCON, #00H             ; TR = 0 TIMER0 STOP
```

```
        MOV IP, #00H            ; IP = 00H
        MOV IE, #82H            ; TIMER0 INTERRUPT ENABLE FOR WAKE-UP FROM IDLE MODE
        MOV R6, #F0H            ; TL0 = F0H
        MOV R7, #FFH            ; TH0 = FFH
        MOV TL0, R6
        MOV TH0, R7
        MOV TMOD, #01H          ; TMOD = 01H, SET TIMER0 A 16-BIT TIMER
        MOV TCON, #10H          ; TCON = 10H, TR0 = 1,GO
        MOV PCON, #01H          ; ENTER IDLE MODE FOR LAUNCHING THE IN-SYSTEM
                                ; PROGRAMMABILITY
;*******************************************************************************
;* Normal mode 64KB APROM program: depending user's application
;*******************************************************************************
NORMAL_MODE:
            .                   ; User's application program
            .
            .
            .
```

EXAMPLE 2:

;*** ;* Example of 4KB LDROM program: This lorder program will erase the 64KB APROM first, then reads the new ;* code from external SRAM and program them into 64KB APROM bank. XTAL = 40 MHz

;***

```
    .chip 8052
    .RAMCHK OFF
    .symbols

    CHPCON    EQU    BFH
    CHPENR    EQU    F6H
    SFRAL     EQU    C4H
    SFRAH     EQU    C5H
    SFRFD     EQU    C6H
    SFRCN     EQU    C7H

        ORG    000H
        LJMP   100H             ; JUMP TO MAIN PROGRAM
  ;************************************************************************
  ;* 1. TIMER0 SERVICE VECTOR ORG = 0BH
  ;************************************************************************
        ORG 000BH
        CLR   TR0               ; TR0 = 0, STOP TIMER0
        MOV TL0, R6
        MOV TH0, R7
        RETI
;************************************************************************
  ;*  4KB LDROM MAIN PROGRAM
  ;************************************************************************
       ORG 100H
```

```
MAIN_4K:
        MOV SP, #C0H            ; BE INITIAL SP REGISTER
        MOV CHPENR, #87H        ; CHPENR = 87H, CHPCON WRITE ENABLE.
        MOV CHPENR, #59H        ; CHPENR = 59H, CHPCON WRITE ENABLE.
        MOV A, CHPCON
        ANL A, #80H
        CJNE A, #80H, UPDATE_64K   ; CHECK  F04KBOOT MODE ?

        MOV CHPCON, #03H        ; CHPCON = 03H, ENABLE IN-SYSTEM PROGRAMMING.
        MOV CHPENR, #00H        ; DISABLE CHPCON WRITE ATTRIBUTE

        MOV TCON, #00H          ; TCON = 00H, TR = 0 TIMER0 STOP
        MOV TMOD, #01H          ; TMOD = 01H, SET TIMER0 A 16BIT TIMER
        MOV IP, #00H            ; IP = 00H
        MOV IE, #82H            ; IE = 82H, TIMER0 INTERRUPT ENABLED
        MOV R6, #F0H
        MOV R7, #FFH
        MOV TL0, R6
        MOV TH0, R7
        MOV TCON, #10H          ; TCON = 10H, TR0 = 1, GO
        MOV PCON, #01H          ; ENTER IDLE MODE

UPDATE_64K:
        MOV CHPENR, #00H        ; DISABLE CHPCON WRITE-ATTRIBUTE
        MOV TCON, #00H          ; TCON = 00H, TR = 0 TIM0 STOP
        MOV IP, #00H            ; IP = 00H
        MOV IE, #82H            ; IE = 82H, TIMER0 INTERRUPT ENABLED
        MOV TMOD, #01H          ; TMOD = 01H, MODE1
        MOV R6, #3CH            ; SET WAKE-UP TIME FOR ERASE OPERATION, ABOUT 15 mS. DEPENDING
                                ; ON USER'S SYSTEM CLOCK RATE.
        MOV R7, #B0H
        MOV TL0, R6
        MOV TH0, R7

ERASE_P_4K:
        MOV SFRCN, #22H         ; SFRCN(C7H) = 22H  ERASE 64K
        MOV TCON, #10H          ; TCON = 10H, TR0 = 1,GO
        MOV PCON, #01H          ; ENTER IDLE MODE (FOR ERASE OPERATION)

;*********************************************************************
;* BLANK CHECK
;*********************************************************************
        MOV SFRCN, #0H          ; READ 64KB APROM MODE
        MOV SFRAH, #0H          ; START ADDRESS = 0H
        MOV SFRAL, #0H
        MOV R6, #FBH            ; SET TIMER FOR READ OPERATION, ABOUT 1.5 µS.
        MOV R7, #FFH
        MOV TL0, R6
        MOV TH0, R7

BLANK_CHECK_LOOP:
        SETB TR0                ; ENABLE TIMER 0
        MOV PCON, #01H          ; ENTER IDLE MODE
        MOV A, SFRFD            ; READ ONE BYTE
        CJNE A, #FFH, BLANK_CHECK_ERROR
```