Welcome to E-XFL.COM

What is "Embedded - Microcontrollers"?

"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	Active
Core Processor	8051
Core Size	8-Bit
Speed	40MHz
Connectivity	EBI/EMI, Serial Port
Peripherals	POR, WDT
Number of I/O	36
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K 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/w77e532a40pl

1. GENERAL DESCRIPTION

The W77E532A is a fast 8051 compatible microcontroller with a redesigned processor core without wasted clock and memory cycles. As a result, it executes every 8051 instruction faster than the original 8051 for the same crystal speed. Typically, the instruction executing time of W77E532A is 1.5 to 3 times faster then that of traditional 8051, depending on the type of instruction. In general, the overall performance is about 2.5 times better than the original for the same crystal speed. Giving the same throughput with lower clock speed, power consumption has been improved. Consequently, the W77E532A is a fully static CMOS design; it can also be operated at a lower crystal clock. The W77E532A contains In-System Programmable(ISP) 128 KB bank-addressed Flash EPROM; 4KB auxiliary Flash EPROM for loader program; operating voltage from 4.5V to 5.5V; on-chip 1 KB MOVX SRAM; three power saving modes.

2. FEATURES

- 8-bit CMOS microcontroller
- High speed architecture of 4 clocks/machine cycle runs up to 40 MHz
- Pin compatible with standard 80C52
- Instruction-set compatible with MCS-51
- Four 8-bit I/O Ports; Port 0 has internal pull-up resisters enabled by software
- One extra 4-bit I/O port, chip select and Wait State control signal (available on 44-pin PLCC/QFP package)
- Three 16-bit Timers
- 12 interrupt sources with two levels of priority
- On-chip oscillator and clock circuitry
- Two enhanced full duplex serial ports
- Dual 64KB In-System Programmable Flash EPROM banks (APFLASH0 and APFLASH1)
- 4KB Auxiliary Flash EPROM for loader program (LDFLASH)
- 256 bytes scratch-pad RAM
- 1 KB on-chip SRAM for MOVX instruction
- Programmable Watchdog Timer
- Software Reset
- Dual 16-bit Data Pointers
- Software programmable access cycle to external RAM/peripherals
- Packages:
  - Lead Free(RoHS) DIP 40: W77E532A40DL
  - Lead Free(RoHS) PLCC 44: W77E532A40PL
  - Lead Free(RoHS) QFP 44: W77E532A40FL

TF1: Timer 1 overflow flag: This bit is set when Timer 1 overflows. It is cleared automatically when the program does a timer 1 interrupt service routine. Software can also set or clear this bit.

TR1: Timer 1 run control: This bit is set or cleared by software to turn timer/counter on or off.

TF0: Timer 0 overflow flag: This bit is set when Timer 0 overflows. It is cleared automatically when the program does a timer 0 interrupt service routine. Software can also set or clear this bit.

TR0: Timer 0 run control: This bit is set or cleared by software to turn timer/counter on or off.

IE1: Interrupt 1 edge detect: Set by hardware when an edge/level is detected on $\overline{INT1}$. This bit is cleared by hardware when the service routine is vectored to only if the interrupt was edge triggered. Otherwise it follows the pin.

IT1: Interrupt 1 type control: Set/cleared by software to specify falling edge/ low level triggered external inputs.

IE0: Interrupt 0 edge detect: Set by hardware when an edge/level is detected on $\overline{INT0}$. This bit is cleared by hardware when the service routine is vectored to only if the interrupt was edge triggered. Otherwise it follows the pin.

IT0: Interrupt 0 type control: Set/cleared by software to specify falling edge/ low level triggered external inputs.

Timer Mode Control

Bit:	7	6	5	4	3	2	1	0
	GATE	C / $\overline{T}$	M1	M0	GATE	C / $\overline{T}$	M1	M0
	TIMER1				TIMER0			

Mnemonic: TMOD Address: 89h

GATE: Gating control: When this bit is set, Timer/counter x is enabled only while $\overline{INTx}$ pin is high and TRx control bit is set. When cleared, Timer x is enabled whenever TRx control bit is set.

C / $\overline{T}$: Timer or Counter Select: When cleared, the timer is incremented by internal clocks. When set , the timer counts high-to-low edges of the Tx pin.

M1, M0: Mode Select bits:

M1	M0	MODE
0	0	Mode 0: 8-bits with 5-bit prescale.
0	1	Mode 1: 16-bits, no prescale.
1	0	Mode 2: 8-bits with auto-reload from THx
1	1	Mode 3: (Timer 0) TL0 is an 8-bit timer/counter controlled by the standard Timer 0 control bits. TH0 is a 8-bit timer only controlled by Timer 1 control bits. (Timer 1) Timer/counter is stopped.

Timer 0 LSB

Bit:	7	6	5	4	3	2	1	0
	TL0.7	TL0.6	TL0.5	TL0.4	TL0.3	TL0.2	TL0.1	TL0.0

Mnemonic: TL0 Address: 8Ah

TL0.7–0: Timer 0 LSB

Timer 1 LSB

Bit:	7	6	5	4	3	2	1	0
	TL1.7	TL1.6	TL1.5	TL1.4	TL1.3	TL1.2	TL1.1	TL1.0

Mnemonic: TL1 Address: 8Bh

TL1.7–0: Timer 1 LSB

Timer 0 MSB

Bit:	7	6	5	4	3	2	1	0
	TH0.7	TH0.6	TH0.5	TH0.4	TH0.3	TH0.2	TH0.1	TH0.0

Mnemonic: TH0 Address: 8Ch

TH0.7–0: Timer 0 MSB

Timer 1 MSB

Bit:	7	6	5	4	3	2	1	0
	TH1.7	TH1.6	TH1.5	TH1.4	TH1.3	TH1.2	TH1.1	TH1.0

Mnemonic: TH1 Address: 8Dh

TH1.7–0: Timer 1 MSB

Clock Control

Bit:	7	6	5	4	3	2	1	0
	WD1	WD0	T2M	T1M	T0M	MD2	MD1	MD0

Mnemonic: CKCON Address: 8Eh

WD1–0: Watchdog timer mode select bits: These bits determine the time-out period for the watchdog timer. In all four time-out options the reset time-out is 512 clocks more than the interrupt time-out period.

Port 3

Bit:	7	6	5	4	3	2	1	0
	P3.7	P3.6	P3.5	P3.4	P3.3	P3.2	P3.1	P3.0

Mnemonic: P3 Address: B0h

P3.7-0: General purpose I/O port. Each pin also has an alternate input or output function. The alternate functions are described below.

P3.7	$\overline{RD}$	Strobe for read from external RAM
P3.6	$\overline{WR}$	Strobe for write to external RAM
P3.5	T1	Timer/counter 1 external count input
P3.4	T0	Timer/counter 0 external count input
P3.3	$\overline{INT1}$	External interrupt 1
P3.2	$\overline{INT0}$	External interrupt 0
P3.1	TxD	Serial port 0 output
P3.0	RxD	Serial port 0 input

Interrupt Priority

Bit:	7	6	5	4	3	2	1	0
	-	PS1	PT2	PS	PT1	PX1	PT0	PX0

Mnemonic: IP Address: B8h

IP.7: This bit is un-implemented and will read high.
PS1: This bit defines the Serial port 1 interrupt priority. PS = 1 sets it to higher priority level.
PT2: This bit defines the Timer 2 interrupt priority. PT2 = 1 sets it to higher priority level.
PS: This bit defines the Serial port 0 interrupt priority. PS = 1 sets it to higher priority level.
PT1: This bit defines the Timer 1 interrupt priority. PT1 = 1 sets it to higher priority level.
PX1: This bit defines the External interrupt 1 priority. PX1 = 1 sets it to higher priority level.
PT0: This bit defines the Timer 0 interrupt priority. PT0 = 1 sets it to higher priority level.
PX0: This bit defines the External interrupt 0 priority. PX0 = 1 sets it to higher priority level.

Slave Address Mask Enable

Bit:	7	6	5	4	3	2	1	0

Mnemonic: SADEN Address: B9h

SADEN: This register enables the Automatic Address Recognition feature of the Serial port 0. When a bit in the SADEN is set to 1, the same bit location in SADDR will be compared with the incoming serial data. When SADEN.n is 0, then the bit becomes a “don’t care” in the comparison. This register enables the Automatic Address Recognition feature of the Serial port 0. When all the bits of SADEN are 0, interrupt will occur for any incoming address.

Timed 2 Mode Control

Bit:	7	6	5	4	3	2	1	0
	HC5	HC4	HC3	HC2	T2CR	-	T2OE	DCEN

Mnemonic: T2MOD Address: C9h

HC5: Hardware Clear $\overline{INT5}$ flag. Setting this bit allows the flag of external interrupt 5 to be automatically cleared by hardware while entering the interrupt service routine.

HC4: Hardware Clear INT4 flag. Setting this bit allows the flag of external interrupt 4 to be automatically cleared by hardware while entering the interrupt service routine.

HC3: Hardware Clear $\overline{INT3}$ flag. Setting this bit allows the flag of external interrupt 3 to be automatically cleared by hardware while entering the interrupt service routine.

HC3: Hardware Clear INT2 flag. Setting this bit allows the flag of external interrupt 3 to be automatically cleared by hardware while entering the interrupt service routine.

T2CR: Timer 2 Capture Reset. In the Timer 2 Capture Mode this bit enables/disables hardware automatically reset Timer 2 while the value in TL2 and TH2 have been transferred into the capture register.

T2OE: Timer 2 Output Enable. This bit enables/disables the Timer 2 clock out function.

DCEN: Down Count Enable: This bit, in conjunction with the T2EX pin, controls the direction that timer 2 counts in 16-bit auto-reload mode.

Timer 2 Capture LSB

Bit:	7	6	5	4	3	2	1	0
	RCAP2L.7	RCAP2L.6	RCAP2L.5	RCAP2L.4	RCAP2L.3	RCAP2L.2	RCAP2L.1	RCAP2L.0

Mnemonic: RCAP2L Address: Cah

RCAP2L: This register is used to capture the TL2 value when a timer 2 is configured in capture mode. RCAP2L is also used as the LSB of a 16-bit reload value when timer 2 is configured in auto-reload mode.

Timer 2 Capture MSB

Bit:	7	6	5	4	3	2	1	0
	RCAP2H.7	RCAP2H.6	RCAP2H.5	RCAP2H.4	RCAP2H.3	RCAP2H.2	RCAP2H.1	RCAP2H.0

Mnemonic: RCAP2H Address: CBh

RCAP2H: This register is used to capture the TH2 value when a timer 2 is configured in capture mode. RCAP2H is also used as the MSB of a 16-bit reload value when timer 2 is configured in auto-reload mode.

Timer 2 LSB

Bit:	7	6	5	4	3	2	1	0
	TL2.7	TL2.6	TL2.5	TL2.4	TL2.3	TL2.2	TL2.1	TL2.0

Mnemonic: TL2 Address: CCh

TL2: Timer 2 LSB

Timer 2 MSB

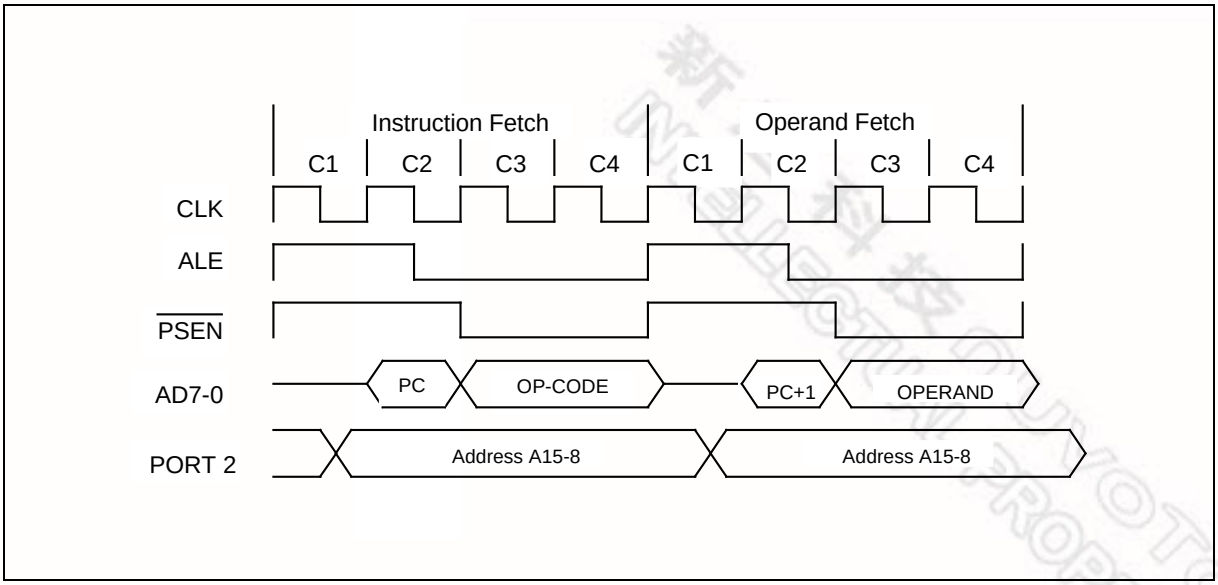


Figure 4. Two Cycle Instruction Timing

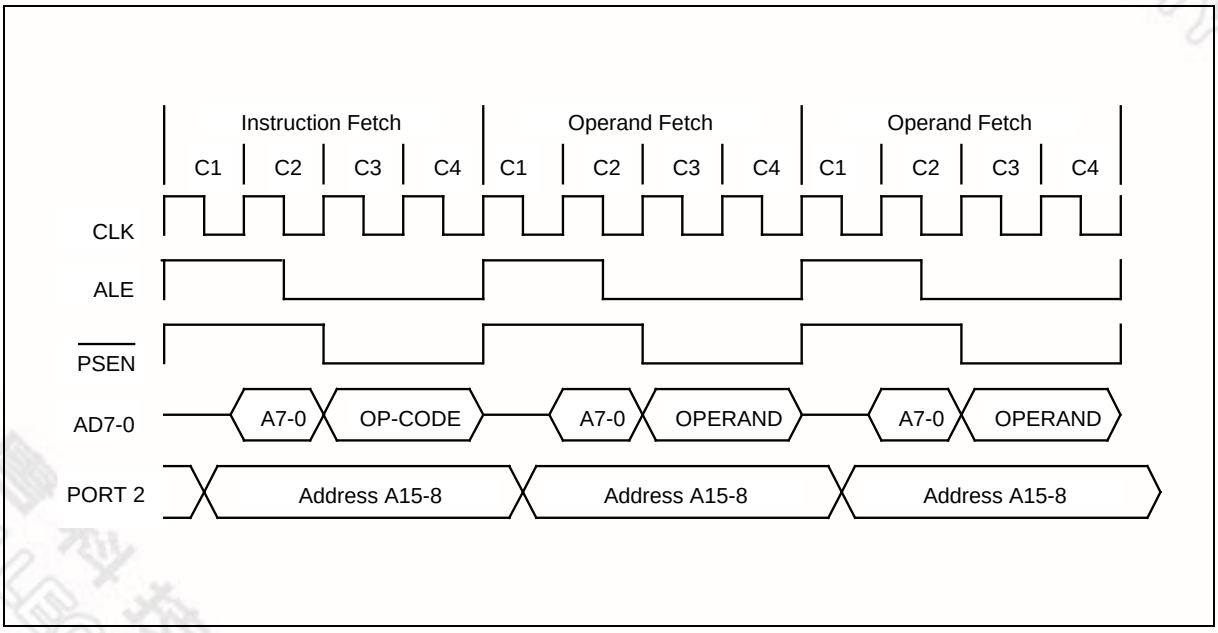


Figure 5. Three Cycle Instruction Timing

MOVX Instruction

The W77E532A, like the standard 8032, uses the MOVX instruction to access external Data Memory. This Data Memory includes both off-chip memory as well as memory mapped peripherals. While the results of the MOVX instruction are the same as in the standard 8032, the operation and the timing of the strobe signals have been modified in order to give the user much greater flexibility.

The MOVX instruction is of two types, the MOVX @Ri and MOVX @DPTR. In the MOVX @Ri, the address of the external data comes from two sources. The lower 8-bits of the address are stored in the Ri register of the selected working register bank. The upper 8-bits of the address come from the port 2 SFR. In the MOVX @DPTR type, the full 16-bit address is supplied by the Data Pointer.

Since the W77E532A has two Data Pointers, DPTR and DPTR1, the user has to select between the two by setting or clearing the DPS bit. The Data Pointer Select bit (DPS) is the LSB of the DPS SFR, which exists at location 86h. No other bits in this SFR have any effect, and they are set to 0. When DPS is 0, then DPTR is selected, and when set to 1, DPTR1 is selected. The user can switch between DPTR and DPTR1 by toggling the DPS bit. The quickest way to do this is by the INC instruction. The advantage of having two Data Pointers is most obvious while performing block move operations. The accompanying code shows how the use of two separate Data Pointers speeds up the execution time for code performing the same task.

Block Move with single Data Pointer:

```
; SH and SL are the high and low bytes of Source Address
; DH and DL are the high and low bytes of Destination Address
; CNT is the number of bytes to be moved
                                                    Machine cycles of W77E532A
                                                                              #
MOV   R2, #CNT          ; Load R2 with the count value                        2
MOV   R3, #SL           ; Save low byte of Source Address in R3               2
MOV   R4, #SH           ; Save high byte of Source address in R4              2
MOV   R5, #DL           ; Save low byte of Destination Address in R5          2
MOV   R6, #DH           ; Save high byte of Destination address in R6         2
LOOP:
MOV   DPL, R3           ; Load DPL with low byte of Source address            2
MOV   DPH, R4           ; Load DPH with high byte of Source address           2
MOVXA, @DPTR            ; Get byte from Source to Accumulator                 2
INC     DPTR            ; Increment Source Address to next byte               2
MOV   R3, DPL           ; Save low byte of Source address in R3               2
MOV   R4, DPH           ; Save high byte of Source Address in R4              2
MOV   DPL, R5           ; Load low byte of Destination Address in DPL         2
MOV   DPH, R6           ; Load high byte of Destination Address in DPH        2
MOVX@DPTR, A            ; Write data to destination                           2
INC     DPTR            ; Increment Destination Address                       2
MOV   DPL, R5           ; Save low byte of new destination address in R5      2
MOV   DPH, R6           ; Save high byte of new destination address in R6     2
DJNZ  R2, LOOP          ; Decrement count and do LOOP again if count <> 0     2
```

9. POWER MANAGEMENT

The W77E532A has several features that help the user to control the power consumption of the device. The power saving features are basically the POWER DOWN mode, ECONOMY mode and the IDLE mode of operation.

Idle Mode

The user can put the device into idle mode by writing 1 to the bit PCON.0. The instruction that sets the idle bit is the last instruction that will be executed before the device goes into Idle Mode. In the Idle mode, the clock to the CPU is halted, but not to the Interrupt, Timer, Watchdog timer and Serial port blocks. This forces the CPU state to be frozen; the Program counter, the Stack Pointer, the Program Status Word, the Accumulator and the other registers hold their contents. The ALE and PSEN pins are held high during the Idle state. The port pins hold the logical states they had at the time Idle was activated. The Idle mode can be terminated in two ways. Since the interrupt controller is still active, the activation of any enabled interrupt can wake up the processor. This will automatically clear the Idle bit, terminate the Idle mode, and the Interrupt Service Routine(ISR) will be executed. After the ISR, execution of the program will continue from the instruction which put the device into Idle mode.

The Idle mode can also be exited by activating the reset. The device can be put into reset either by applying a high on the external RST pin, a Power on reset condition or a Watchdog timer reset. The external reset pin has to be held high for at least two machine cycles i.e. 8 clock periods to be recognized as a valid reset. In the reset condition the program counter is reset to 0000h and all the SFRs are set to the reset condition. Since the clock is already running there is no delay and execution starts immediately. In the Idle mode, the Watchdog timer continues to run, and if enabled, a time-out will cause a watchdog timer interrupt which will wake up the device. The software must reset the Watchdog timer in order to preempt the reset which will occur after 512 clock periods of the time-out. When the W77E532A is exiting from an Idle mode with a reset, the instruction following the one which put the device into Idle mode is not executed. So there is no danger of unexpected writes.

Economy Mode

The power consumption of microcontroller relates to operating frequency. The W77E532A offers a Economy mode to reduce the internal clock rate dynamically without external components. By default, one machine cycle needs 4 clocks. In Economy mode, software can select 4, 64 or 1024 clocks per machine cycle. It keeps the CPU operating at a acceptable speed but eliminates the power consumption. In the Idle mode, the clock of the core logic is stopped, but all clocked peripherals such as watchdog timer are still running at a rate of clock/4. In the Economy mode, all clocked peripherals run at the same reduced clocks rate as in core logic. So the Economy mode may provide a lower power consumption than idle mode.

Software invokes the Economy mode by setting the appropriate bits in the SFRs. Setting the bits CD0(PMR.6), CD1(PMR.7) decides the instruction cycle rate as below:

CD1	CD0	clocks/machine cycle
0	0	Reserved
0	1	4 (default)
1	0	64
1	1	1024

The selection of instruction rate is going to take effect after a delay of one instruction cycle. Switching to divide by 64 or 1024 mode must first go from divide by 4 mode. This means software can not switch

Table 6. SFR Reset Value

SFR NAME	RESET VALUE	SFR NAME	RESET VALUE
P0	11111111b	IE	00000000b
SP	00000111b	SADDR	00000000b
DPL	00000000b	P3	11111111b
DPH	00000000b	IP	x0000000b
DPL1	00000000b	SADEN	00000000b
DPH1	00000000b	T2CON	00000000b
DPS	00000000b	T2MOD	00000x00b
PCON	00xx0000b	RCAP2L	00000000b
TCON	00000000b	RCAP2H	00000000b
TMOD	00000000b	TL2	00000000b
TL0	00000000b	TH2	00000000b
TL1	00000000b	TA	11111111b
TH0	00000000b	PSW	00000000b
TH1	00000000b	WDCON	0x0x0xx0b
CKCON	00000001b	ACC	00000000b
P1	11111111b	EIE	xxx00000b
P4CONA	00000000b	P4CONB	00000000b
P40AL	00000000b	P40AH	00000000b
P41AL	00000000b	P41AH	00000000b
P42AL	00000000b	P42AH	00000000b
P43Al	00000000b	P43AH	00000000b
CHPCON	00000000b	P4CSIN	00000000b
ROMCON	00000111b	SFRAL	00000000b
SFRAH	00000000b	SFRFD	00000000b
SFRCN	00111111b	B	00000000b
SCON	00000000b	EIP	xxx00000b
SBUF	xxxxxxxxb	PC	00000000b
P2	11111111b	SADEN1	00000000b
SADDR1	00000000b	SBUF1	xxxxxxxxb
SCON1	00000000b	PMR	010xx0x0b
WSCON	00000000b	STATUS	000x0000b
EXIF	0000xxx0b		
P4	xxxx1111b		

Table 7. Priority structure of interrupts

SOURCE	FLAG	PRIORITY LEVEL
External Interrupt 0	IE0	1(highest)
Timer 0 Overflow	TF0	2
External Interrupt 1	IE1	3
Timer 1 Overflow	TF1	4
Serial Port	RI + TI	5
Timer 2 Overflow	TF2 + EXF2	6
Serial Port 1	RI_1 + TI_1	7
External Interrupt 2	IE2	8
External Interrupt 3	IE3	9
External Interrupt 4	IE4	10
External Interrupt 5	IE5	11
Watchdog Timer	WDIF	12 (lowest)

The interrupt flags are sampled every machine cycle. In the same machine cycle, the sampled interrupts are polled and their priority is resolved. If certain conditions are met then the hardware will execute an internally generated LCALL instruction which will vector the process to the appropriate interrupt vector address. The conditions for generating the LCALL are

1. An interrupt of equal or higher priority is not currently being serviced.
2. The current polling cycle is the last machine cycle of the instruction currently being executed.
3. The current instruction does not involve a write to IP, IE, EIP or EIE registers and is not a RETI.

If any of these conditions are not met, then the LCALL will not be generated. The polling cycle is repeated every machine cycle, with the interrupts sampled in the same machine cycle. If an interrupt flag is active in one cycle but not responded to, and is not active when the above conditions are met, the denied interrupt will not be serviced. This means that active interrupts are not remembered; every polling cycle is new.

The processor responds to a valid interrupt by executing an LCALL instruction to the appropriate service routine. This may or may not clear the flag which caused the interrupt. In case of Timer interrupts, the TF0 or TF1 flags are cleared by hardware whenever the processor vectors to the appropriate timer service routine. In case of external interrupt, INT0 and INT1, the flags are cleared only if they are edge triggered. In case of Serial interrupts, the flags are not cleared by hardware. In the case of Timer 2 interrupt, the flags are not cleared by hardware. The Watchdog timer interrupt flag WDIF has to be cleared by software. The hardware LCALL behaves exactly like the software LCALL instruction. This instruction saves the Program Counter contents onto the Stack, but does not save the Program Status Word PSW. The PC is reloaded with the vector address of that interrupt which caused the LCALL. These vector address for the different sources are as follows

11. PROGRAMMABLE TIMERS/COUNTERS

The W77E532A has three 16-bit programmable timer/counters and one programmable Watchdog timer. The Watchdog timer is operationally quite different from the other two timers.

Timer/Counters 0 & 1

The W77E532A has two 16-bit Timer/Counters. Each of these Timer/Counters has two 8 bit registers which form the 16 bit counting register. For Timer/Counter 0 they are TH0, the upper 8 bits register, and TL0, the lower 8 bit register. Similarly Timer/Counter 1 has two 8 bit registers, TH1 and TL1. The two can be configured to operate either as timers, counting machine cycles or as counters counting external inputs.

When configured as a “Timer”, the timer counts clock cycles. The timer clock can be programmed to be thought of as 1/12 of the system clock or 1/4 of the system clock. In the “Counter” mode, the register is incremented on the falling edge of the external input pin, T0 in case of Timer 0, and T1 for Timer 1. The T0 and T1 inputs are sampled in every machine cycle at C4. If the sampled value is high in one machine cycle and low in the next, then a valid high to low transition on the pin is recognized and the count register is incremented. Since it takes two machine cycles to recognize a negative transition on the pin, the maximum rate at which counting will take place is 1/24 of the master clock frequency. In either the “Timer” or “Counter” mode, the count register will be updated at C3. Therefore, in the “Timer” mode, the recognized negative transition on pin T0 and T1 can cause the count register value to be updated only in the machine cycle following the one in which the negative edge was detected.

The “Timer” or “Counter” function is selected by the “$C/\overline{T}$” bit in the TMOD Special Function Register. Each Timer/Counter has one selection bit for its own; bit 2 of TMOD selects the function for Timer/Counter 0 and bit 6 of TMOD selects the function for Timer/Counter 1. In addition each Timer/Counter can be set to operate in any one of four possible modes. The mode selection is done by bits M0 and M1 in the TMOD SFR.

Time-Base Selection

The W77E532A gives the user two modes of operation for the timer. The timers can be programmed to operate like the standard 8051 family, counting at the rate of 1/12 of the clock speed. This will ensure that timing loops on the W77E532A and the standard 8051 can be matched. This is the default mode of operation of the W77E532A timers. The user also has the option to count in the turbo mode, where the timers will increment at the rate of 1/4 clock speed. This will straight-away increase the counting speed three times. This selection is done by the T0M and T1M bits in CKCON SFR. A reset sets these bits to 0, and the timers then operate in the standard 8051 mode. The user should set these bits to 1 if the timers are to operate in turbo mode.

Mode 0

In Mode 0, the timer/counters act as a 8 bit counter with a 5 bit, divide by 32 pre-scale. In this mode we have a 13 bit timer/counter. The 13 bit counter consists of 8 bits of THx and 5 lower bits of TLx. The upper 3 bits of TLx are ignored.

The negative edge of the clock increments the count in the TLx register. When the fifth bit in TLx moves from 1 to 0, then the count in the THx register is incremented. When the count in THx moves from FFh to 00h, then the overflow flag TFx in TCON SFR is set. The counted input is enabled only if TRx is set and either GATE = 0 or $\overline{INTx}$ = 1. When $C/\overline{T}$ is set to 0, then it will count clock cycles, and if $C/\overline{T}$ is set to 1, then it will count 1 to 0 transitions on T0 (P3.4) for timer 0 and T1 (P3.5) for timer 1. When the 13 bit count reaches 1FFFh the next count will cause it to roll-over to 0000h. The timer overflow flag TFx of the relevant timer is set and if enabled an interrupts will occur. Note that when used as a timer, the time-base may be either clock cycles/12 or clock cycles/4 as selected by the bits TxM of the CKCON SFR.

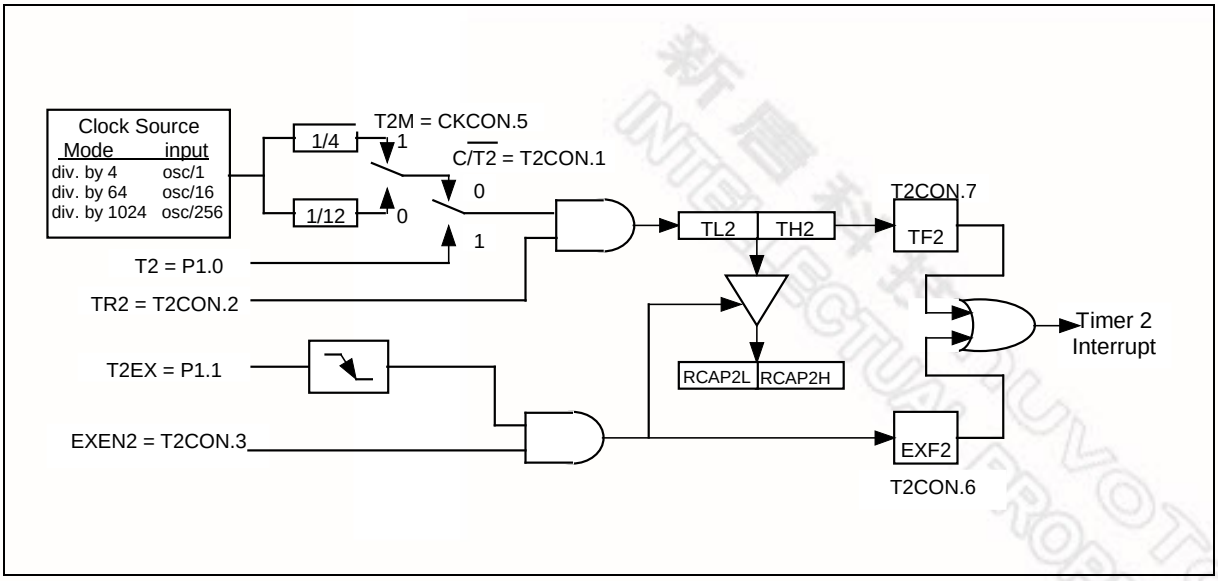


Figure 14. 16-Bit Capture Mode

Auto-reload Mode, Counting Up/Down

Timer/Counter 2 will be in auto-reload mode as an up/down counter if CP / $\overline{RL2}$ bit in T2CON is cleared and the DCEN bit in T2MOD is set. In this mode, Timer/Counter 2 is an up/down counter whose direction is controlled by the T2EX pin. A 1 on this pin cause the counter to count up. An overflow while counting up will cause the counter to be reloaded with the contents of the capture registers. The next down count following the case where the contents of Timer/Counter equal the capture registers will load an FFFFh into Timer/Counter 2. In either event a reload will set the TF2 bit. A reload will also toggle the EXF2 bit. However, the EXF2 bit can not generate an interrupt while in this mode.

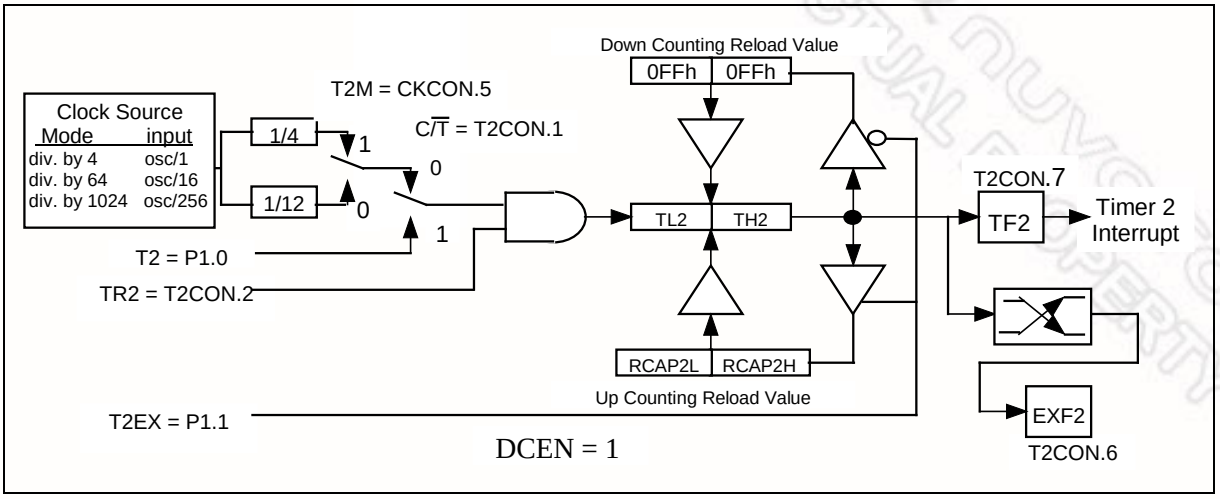


Figure 16. 16-Bit Auto-reload Up/Down Counter

Baud Rate Generator Mode

The baud rate generator mode is enabled by setting either the RCLK or TCLK bits in T2CON register. While in the baud rate generator mode, Timer/Counter 2 is a 16 bit counter with auto reload when the count rolls over from FFFFh. However, rolling over does not set the TF2 bit. If EXEN2 bit is set, then a negative transition of the T2EX pin will set EXF2 bit in the T2CON register and cause an interrupt request.

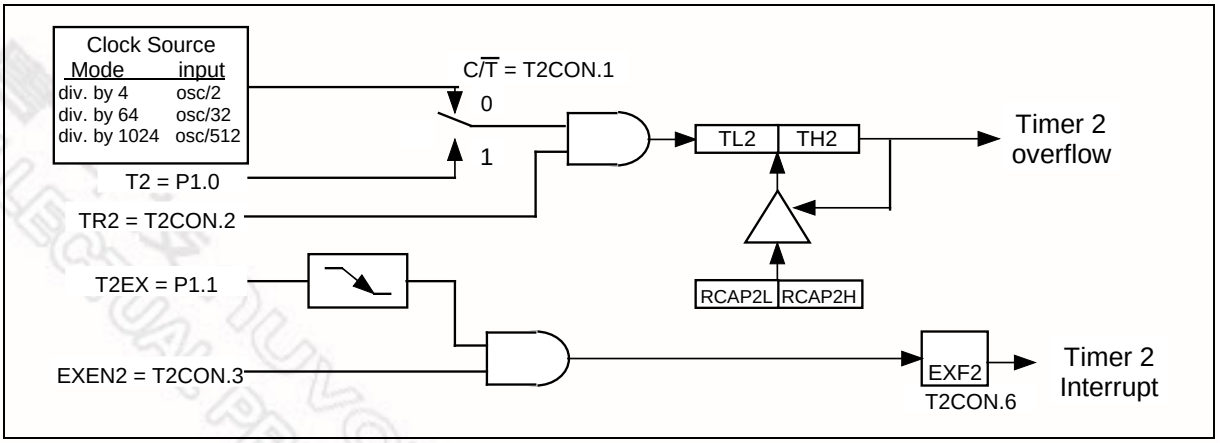


Figure 17. Baud Rate Generator Mode

1. RI must be 0 and
2. Either SM2 = 0, or the received stop bit = 1.

If these conditions are met, then the stop bit goes to RB8, the 8 data bits go into SBUF and RI is set. Otherwise the received frame may be lost. After the middle of the stop bit, the receiver goes back to looking for a 1-to-0 transition on the RxD pin.

Mode 3

This mode is similar to Mode 2 in all respects, except that the baud rate is programmable. The user must first initialize the Serial related SFR SCON before any communication can take place. This involves selection of the Mode and baud rate. The Timer 1 should also be initialized if modes 1 and 3 are used. In all four modes, transmission is started by any instruction that uses SBUF as a destination register. Reception is initiated in Mode 0 by the condition RI = 0 and REN = 1. This will generate a clock on the TxD pin and shift in 8 bits on the RxD pin. Reception is initiated in the other modes by the incoming start bit if REN = 1. The external device will start the communication by transmitting the start bit.

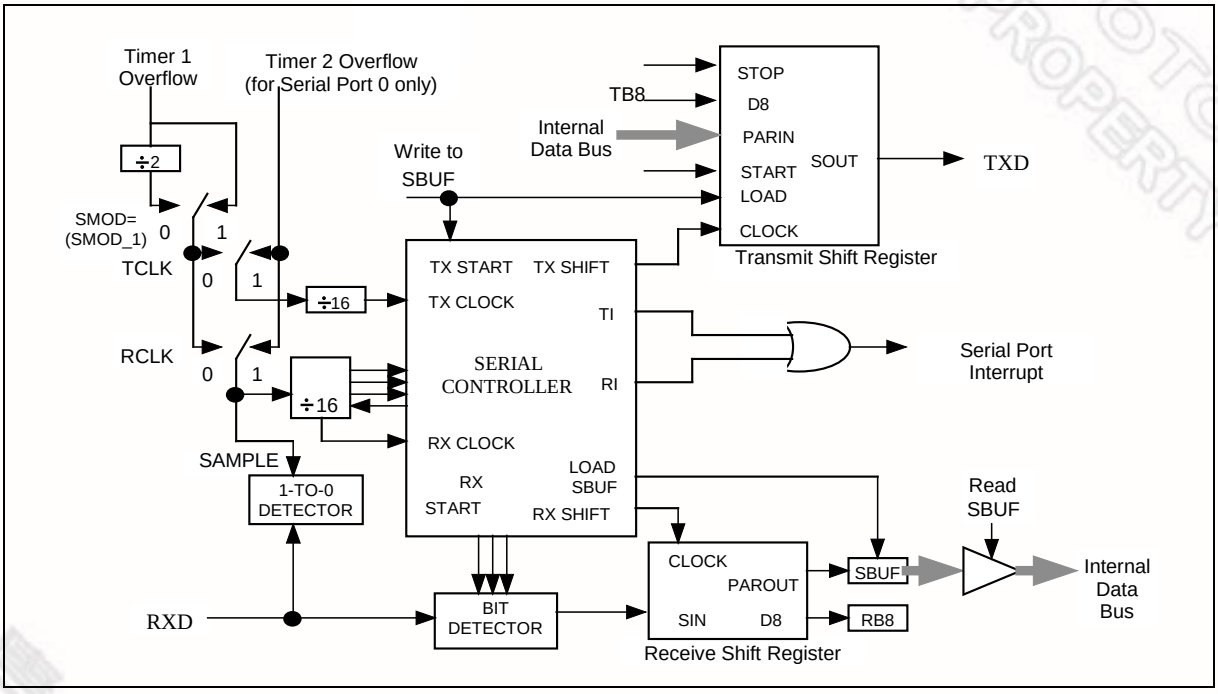


Figure 23. Serial Port Mode 3

Table 10. Serial Ports Modes

SM1	SM0	MODE	TYPE	BAUD CLOCK	FRAME SIZE	START BIT	STOP BIT	9TH BIT FUNCTION
0	0	0	Synch.	4 or 12 TCLKS	8 bits	No	No	None
0	1	1	Asynch.	Timer 1 or 2	10 bits	1	1	None
1	0	2	Asynch.	32 or 64 TCLKS	11 bits	1	1	0, 1
1	1	3	Asynch.	Timer 1 or 2	11 bits	1	1	0, 1

Slave 1:

SADDR 1010 0100
SADEN 1111 1010
Given 1010 0x0x

Slave 2:

SADDR 1010 0111
SADEN 1111 1001
Given 1010 0xx1

The Given address for slave 1 and 2 differ in the LSB. For slave 1, it is a don't care, while for slave 2 it is 1. Thus to communicate only with slave 1, the master must send an address with LSB = 0 (1010 0000). Similarly the bit 1 position is 0 for slave 1 and don't care for slave 2. Hence to communicate only with slave 2 the master has to transmit an address with bit 1 = 1 (1010 0011). If the master wishes to communicate with both slaves simultaneously, then the address must have bit 0 = 1 and bit 1 = 0. The bit 3 position is don't care for both the slaves. This allows two different addresses to select both slaves (1010 0001 and 1010 0101).

The master can communicate with all the slaves simultaneously with the Broadcast Address. This address is formed from the logical Oring of the SADDR and SADEN SFRs. The zeros in the result are defined as don't cares In most cases the Broadcast Address is FFh. In the previous case, the Broadcast Address is (1111111X) for slave 1 and (11111111) for slave 2.

The SADDR and SADEN SFRs are located at address A9h and B9h respectively. On reset, these two SFRs are initialized to 00h. This results in Given Address and Broadcast Address being set as XXXX XXXX(i.e. all bits don't care). This effectively removes the multiprocessor communications feature, since any selectivity is disabled.

新唐科技 NUVOTON INTELLECTUAL PROPERTY

Examples of Timed Assessing are shown below.

Example 1: Valid access

```
MOV   TA, #0Aah    3 M/C                Note: M/C = Machine Cycles
MOV   TA, #055h    3 M/C
MOV   WDCON, #00h       3 M/C
```

Example 2: Valid access

```
MOV   TA, #0Aah    3 M/C
MOV   TA, #055h    3 M/C
NOP                1 M/C
SETB  EWT          2 M/C
```

Example 3: Valid access

```
MOV   TA, #0Aah    3 M/C
MOV   TA, #055h    3 M/C
ORL   WDCON, #00000010B      3M/C
```

Example 4: Invalid access

```
MOV   TA, #0Aah    3 M/C
MOV   TA, #055h    3 M/C
NOP                1 M/C
NOP                1 M/C
CLR   POR          2 M/C
```

Example 5: Invalid Access

```
MOV   TA, #0Aah    3 M/C
NOP                1 M/C
MOV   TA, #055h    3 M/C
SETB  EWT          2 M/C
```

In the first two examples, the writing to the protected bits is done before the 3 machine cycle window closes. In Example 3, however, the writing to the protected bit occurs after the window has closed, and so there is effectively no change in the status of the protected bit. In Example 4, the second write to TA occurs 4 machine cycles after the first write, therefore the timed access window in not opened at all, and the write to the protected bit fails.

新唐科技 NUVOTON INTELLECTUAL PROPERTY

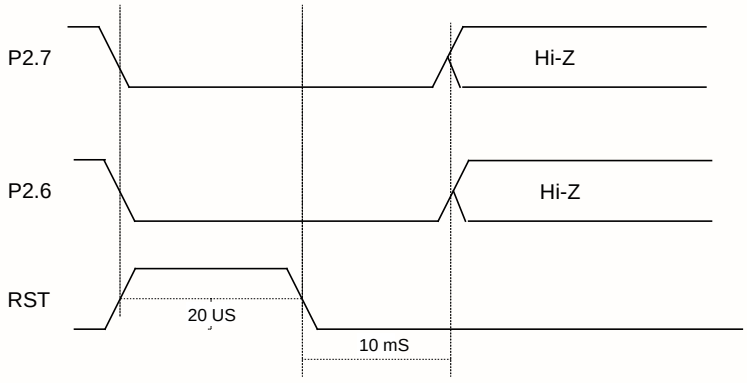
14. H/W REBOOT MODE (BOOT FROM 4K BYTES OF LDFLASH)

The W77E532A boots from APFLASH program (64K bytes) by default at the external reset. On some occasions, user can force W77E532A to boot from the LDFLASH program (4K bytes) at the external reset. The settings for this special mode is as follow. It is necessary to add 10K resistor on these P2.6, P2.7 and P4.3 pins.

Reboot Mode

OPTION BITS	RST	P4.3	P2.7	P2.6	MODE
Bit4 L	H	X	L	L	REBOOT
Bit5 L	H	L	X	X	REBOOT

The Reset Timing For Entering REBOOT Mode



Notes:

1: The possible situation that you need to enter REBOOT mode is when the APFLASH program can not run normally and W77E532A can not jump to LDFLASH to execute on chip programming function. Then you can use this REBOOT mode to force the CPU jump to LDFLASH and run on chip programming procedure. When you design your system, you can connect the pins P26, P27 to switches or jumpers. For example in a CD ROM system, you can connect the P26 and P27 to PLAY and EJECT buttons on the panel. When the APFLASH program is fail to execute the normal application program. User can press both two buttons at the same time and then switch on the power of the personal computer to force the W77E532A to enter the REBOOT mode. After power on of personal computer, you can release both PLAY and EJECT button. And re-run the on chip programming procedure to let the APFLASH have the normal program code. Then you can back to normal condition of CD ROM.

2: In application system design, user must take care the P4.3, P2, P3, ALE, /EA and /PSEN pin value at reset to avoid W77E532A entering the programming mode or REBOOT mode in normal operation.

External Clock Characteristics

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	NOTES
Clock High Time	t_{CHCX}	12	-	-	nS	
Clock Low Time	t_{CLCX}	12	-	-	nS	
Clock Rise Time	t_{CLCH}	-	-	10	nS	
Clock Fall Time	t_{CHCL}	-	-	10	nS	

18.3.1 AC Specification

PARAMETER	SYMBOL	VARIABLE CLOCK MIN.	VARIABLE CLOCK MAX.	UNITS
Oscillator Frequency	$1/t_{CLCL}$	0	40	MHz
ALE Pulse Width	t_{LHLL}	$1.5t_{CLCL} - 5$		nS
Address Valid to ALE Low	t_{AVLL}	$0.5t_{CLCL} - 5$		nS
Address Hold After ALE Low	t_{LLAX1}	$0.5t_{CLCL} - 5$		nS
Address Hold After ALE Low for MOVX Write	t_{LLAX2}	$0.5t_{CLCL} - 5$		nS
ALE Low to Valid Instruction In	t_{LLIV}		$2.5t_{CLCL} - 20$	nS
ALE Low to PSEN Low	t_{LLPL}	$0.5t_{CLCL} - 5$		nS
$\overline{PSEN}$ Pulse Width	t_{PLPH}	$2.0t_{CLCL} - 5$		nS
$\overline{PSEN}$ Low to Valid Instruction In	t_{PLIV}		$2.0t_{CLCL} - 20$	nS
Input Instruction Hold After PSEN	t_{PXIX}	0		nS
Input Instruction Float After PSEN	t_{PXIZ}		$t_{CLCL} - 5$	nS
Port 0 Address to Valid Instr. In	t_{AVIV1}		$3.0t_{CLCL} - 20$	nS
Port 2 Address to Valid Instr. In	t_{AVIV2}		$3.5t_{CLCL} - 20$	nS
$\overline{PSEN}$ Low to Address Float	t_{PLAZ}	0		nS
Data Hold After Read	t_{RHDX}	0		nS
Data Float After Read	t_{RHDZ}		$t_{CLCL} - 5$	nS
$\overline{RD}$ Low to Address Float	t_{RLAZ}		$0.5t_{CLCL} - 5$	nS

18.3.2 MOVX Characteristics Using Strech Memory Cycle

PARAMETER	SYMBOL	VARIABLE CLOCK MIN.	VARIABLE CLOCK MAX.	UNITS	STRECH
Data Access ALE Pulse Width	t_{LLHL2}	$1.5t_{CLCL} - 5$ $2.0t_{CLCL} - 5$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Address Hold After ALE Low for MOVX write	t_{LLAX2}	$0.5t_{CLCL} - 5$		nS	
$\overline{RD}$ Pulse Width	t_{RLRH}	$2.0t_{CLCL} - 5$ $t_{MCS} - 10$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
$\overline{WR}$ Pulse Width	t_{WLWH}	$2.0t_{CLCL} - 5$ $t_{MCS} - 10$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
$\overline{RD}$ Low to Valid Data In	t_{RLDV}		$2.0t_{CLCL} - 20$ $t_{MCS} - 20$	nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Data Hold after Read	t_{RHDX}	0		nS	
Data Float after Read	t_{RHDZ}		$t_{CLCL} - 5$ $2.0t_{CLCL} - 5$	nS	$t_{MCS} = 0$ $t_{MCS} > 0$
ALE Low to Valid Data In	t_{LLDV}		$2.5t_{CLCL} - 5$ $t_{MCS} + 2t_{CLCL} - 40$	nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Port 0 Address to Valid Data In	t_{AVDV1}		$3.0t_{CLCL} - 20$ $2.0t_{CLCL} - 5$	nS	$t_{MCS} = 0$ $t_{MCS} > 0$
ALE Low to $\overline{RD}$ or $\overline{WR}$ Low	t_{LLWL}	$0.5t_{CLCL} - 5$ $1.5t_{CLCL} - 5$	$0.5t_{CLCL} + 5$ $1.5t_{CLCL} + 5$	nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Port 0 Address to $\overline{RD}$ or $\overline{WR}$ Low	t_{AVWL}	$t_{CLCL} - 5$ $2.0t_{CLCL} - 5$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Port 2 Address to $\overline{RD}$ or $\overline{WR}$ Low	t_{AVWL2}	$1.5t_{CLCL} - 5$ $2.5t_{CLCL} - 5$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Data Valid to WR Transition	t_{QVWX}	-5 $1.0t_{CLCL} - 5$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
Data Hold after Write	t_{WHQX}	$t_{CLCL} - 5$ $2.0t_{CLCL} - 5$		nS	$t_{MCS} = 0$ $t_{MCS} > 0$
$\overline{RD}$ Low to Address Float	t_{RLAZ}		$0.5t_{CLCL} - 5$	nS	
$\overline{RD}$ or WR high to ALE high	t_{WHLH}	0 $1.0t_{CLCL} - 5$	10 $1.0t_{CLCL} + 5$	nS	$t_{MCS} = 0$ $t_{MCS} > 0$

Note: t_{MCS} is a time period related to the Stretch memory cycle selection. The following table shows the time period of t_{MCS} for each selection of the Stretch value.

```
PROGRAM_64:
      MOV  TA, #AAH              ; CHPCON register is written protect by TA register.
      MOV  TA, #55H
      MOV  CHPCON, #03H          ; CHPCON = 03H, ENTER IN-SYSTEM PROGRAMMING MODE
      MOV  SFRCN, #0H
        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
PROGRAMMING
;************** ********************************************************************
;* Normal mode 64KB APFLASH program: depending user's application
;*******************************************************************************
NORMAL_MODE:

                                 .
      ; User's application program
                                 .
                                 .
                                 .
```

EXAMPLE 2:

```
;*************************************************************************************************************************** ;*
Example of 4KB LDFLASH program: This loader program will erase the 64KB APFLASH first, then reads the new ;* code from external SRAM and program them into 64KB APFLASH bank. XTAL = 24 MHz
;*************************************************************************************************************************
.chip 8052
.RAMCHK OFF
.symbols

CHPCON    EQU        9FH
TA        EQU        C7H
SFRAL     EQU        ACH
SFRAH     EQU        ADH
SFRFD     EQU        AEH
SFRCN     EQU        AFH

          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
```