



## **4-BIT MICROCONTROLLER**

### **GENERAL DESCRIPTION**

The W541C250 is fully compatible with W741C250 in terms of pin assignment and IC function.. It is a high-performance 4-bit microcontroller ( $\mu\text{C}$ ) that provides an LCD driver. The device contains a 4-bit ALU, two 8-bit timers, a divider, a  $24 \times 4$  LCD driver, and five 4-bit I/O ports (including 1 output port for LED driving). There are also five interrupt sources and 8-level subroutine nesting for interrupt applications. The W541C250 operates on low voltage and very low current and has two power reduction modes, hold mode and stop mode, which help to minimize power dissipation.

The W541C250 is suitable for remote controllers, watches and clocks, multiple I/O products, keyboard controllers, speech synthesis LSI controllers, and other products.

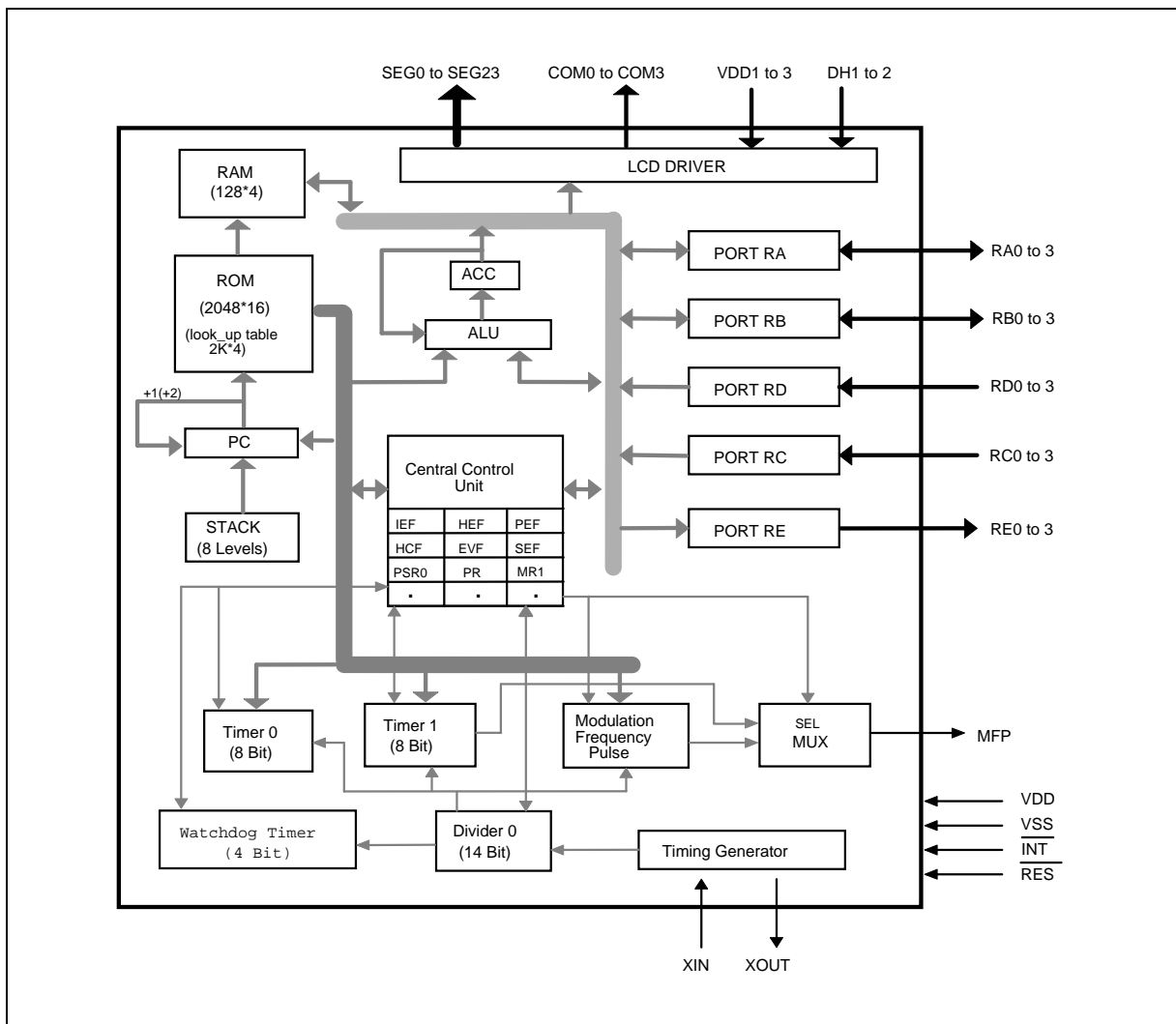
### **FEATURES**

- Operating voltage: 2.4 ~ 5.5V (LCD drive voltage: 3.0V, or 4.5V)
- Single system clock
  - Oscillation frequency up to 4 MHz , Crystal or RC oscillator is selected by mask code option ,
  - High-frequency (400 KHz to 4 MHz) or low-frequency (32.768 KHz) oscillation is selected by mask code option
- Memory
  - 2048  $\times$  16 bit program ROM (including 2K  $\times$  4 bit look-up table)
  - 128  $\times$  4 bit data RAM (including 16 working registers)
  - 24  $\times$  4 LCD data RAM
- 21 input/output pins
  - Ports for input only: 2 ports/8 pins
  - Input/output ports: 2 ports/8 pins
  - Port for output only: 1 port /4 pins (high sink current to drive LEDs)
  - MFP output pin: 1 pin (MFP)
- Power-down mode
  - Hold function: no operation (except for oscillator)
  - Stop function: no operation (including main clock)
- Five types of interrupts
  - Three internal interrupts (Divider 0, Timer 0, Timer 1)
  - Two external interrupt (Port RC and  $\overline{\text{INT}}$  pin)
- LCD driver output
  - 24 segment  $\times$  4 common
  - Static, 1/2 duty (1/2 bias), 1/3 duty (1/2 or 1/3 bias), 1/4 duty (1/3 bias) driving mode can be selected
  - LCD driver output pins can be used as DC output ports; selectable by code option

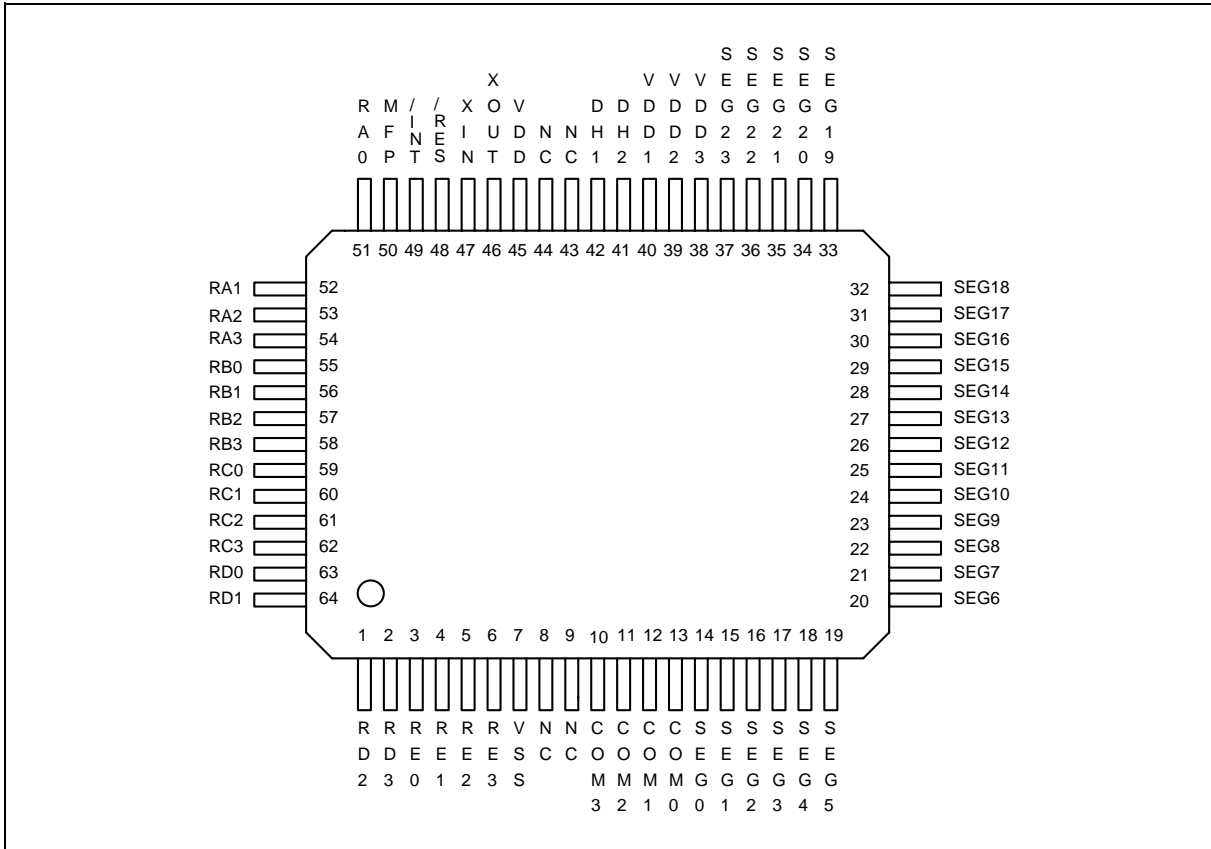


- MFP output pin
  - Output is software selectable as modulating or nonmodulating frequency
  - Works as frequency output specified by Timer 1
- Built-in 14-bit clock frequency divider circuit
- Two built-in 8-bit programmable countdown timers
  - Timer 0: one of two internal clock frequencies ( $F_{OSC}/4$  or  $F_{OSC}/1024$ ) can be selected
  - Timer 1: includes an auto-reload function; and one of two internal clock frequencies ( $F_{OSC}$  or  $F_{OSC}/64$ ) can be selected or falling edge of pin RC.0 can be selected (output through MFP pin)
- Built-in 18/14-bit watchdog timer selectable for system reset
- Powerful instruction set: 115 instructions
- 8-level subroutine (include interrupt) nesting
- Up to 1  $\mu$ S instruction cycle (with 4 MHz operating frequency)
- Packaged in 64-pin QFP

## BLOCK DIAGRAM



## PIN CONFIGURATION





## PAD DESCRIPTION

SYMBOL	I/O	FUNCTION																									
XIN	I	Input pin for oscillator. Connected to crystal or resistor to generate system clock by code option. External 15~20pF capacitor uses to get accurate freq in crystal mode.																									
XOUT	O	Output pin for oscillator. Connected to crystal or resistor to generate system clock by code option. 20PF capacitor is built in internal for crystal mode.																									
RA0~RA3	I/O	Input/Output port. Input/output mode specified by port mode 1 register (PM1).																									
RB0~RB3	I/O	Input/Output port. Input/output mode specified by port mode 2 register (PM2).																									
RC0~RC3	I	4-bit port for input only. Each pin has an independent interrupt capability.																									
RD0~RD3	I	4-bit port for input only.																									
RE0~RE3	O	Output port only. This port provides high sink current to drive LEDs.																									
MFP	O	Output pin only. This pin can output modulating or nonmodulating frequency, or Timer 1 clock output specified by mode register 1 (MR1).																									
$\overline{\text{INT}}$	I	External interrupt pin with pull-high resistor.																									
$\overline{\text{RES}}$	I	System reset pin with pull-high resistor.																									
SEG0~SEG23	O	LCD segment output pins. Can also be used as DC output ports specified by code option.																									
COM0~COM3	O	LCD common signal output pins. <table border="1" style="margin: 10px auto;"> <thead> <tr> <th></th> <th>Static</th> <th>1/2 Duty</th> <th>1/3 Duty</th> <th>1/4 Duty</th> </tr> </thead> <tbody> <tr> <td>COM0</td> <td>Used</td> <td>Used</td> <td>Used</td> <td>Used</td> </tr> <tr> <td>COM1</td> <td>Not Used</td> <td>Used</td> <td>Used</td> <td>Used</td> </tr> <tr> <td>COM2</td> <td>Not Used</td> <td>Not Used</td> <td>Used</td> <td>Used</td> </tr> <tr> <td>COM3</td> <td>Not Used</td> <td>Not Used</td> <td>Not Used</td> <td>Used</td> </tr> </tbody> </table> <p>The LCD alternating frequency can be selected by code option.</p>		Static	1/2 Duty	1/3 Duty	1/4 Duty	COM0	Used	Used	Used	Used	COM1	Not Used	Used	Used	Used	COM2	Not Used	Not Used	Used	Used	COM3	Not Used	Not Used	Not Used	Used
	Static	1/2 Duty	1/3 Duty	1/4 Duty																							
COM0	Used	Used	Used	Used																							
COM1	Not Used	Used	Used	Used																							
COM2	Not Used	Not Used	Used	Used																							
COM3	Not Used	Not Used	Not Used	Used																							
DH1, DH2	I	Connection terminals for voltage doubler (halver) capacitor.																									
VDD1, VDD2 VDD3	I	Positive (+) supply voltage terminal. Refer to Functional Description.																									
VDD	I	Positive power supply (+).																									
VSS	I	Negative power supply (-).																									



## ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNIT
Supply Voltage to Ground Potential	-0.3 to +7.0	V
Applied Input/Output Voltage	-0.3 to +7.0	V
Power Dissipation	120	mW
Ambient Operating Temperature	0 to +70	°C
Storage Temperature	-55 to +150	°C

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

## DC CHARACTERISTICS

(V<sub>DD</sub>-V<sub>SS</sub> = 3.0V, F<sub>osc</sub> = 32.768 KHz, T<sub>A</sub> = 25° C; unless otherwise specified)

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Op. Voltage	V <sub>DD</sub>	-	2.4	-	5.5	V
Op. Current (Crystal type)	I <sub>OP1</sub>	No load (Ext-V)	-	-	20	μA
Op. Current (RC type)	I <sub>OP2</sub>	No load (Ext-V)	-	-	65	μA
Hold Current (Crystal type)	I <sub>HM1</sub>	Hold mode No load (Ext-V)	-	-	6	μA
Hold Current (RC type)	I <sub>HM2</sub>	Hold mode No load (Ext-V)	-	-	40	μA
Stop Current (Crystal type)	I <sub>SM1</sub>	Stop mode No load (Ext-V)	-	0.1	2	μA
Stop Current (RC type)	I <sub>SM2</sub>	Stop mode No load (Ext-V)	-	0.1	2	μA
Input Low Voltage	V <sub>IL</sub>	-	V <sub>SS</sub>	-	0.3 V <sub>DD</sub>	V
Input High Voltage	V <sub>IH</sub>	-	0.7 V <sub>DD</sub>	-	V <sub>DD</sub>	V
MFP Output Low Voltage	V <sub>ML</sub>	I <sub>OL</sub> = 3.5 mA	-	-	0.4	V
MFP Output High Voltage	V <sub>MH</sub>	I <sub>OH</sub> = -3.5 mA	2.4	-	-	V
Port RA, RB Output Low Voltage	V <sub>ABL</sub>	I <sub>OL</sub> = 2.0 mA	-	-	0.4	V
Port RA, RB Output high Voltage	V <sub>ABH</sub>	I <sub>OH</sub> = -2.0 mA	2.4	-	-	V
LCD Supply Current	I <sub>LCD</sub>	All Seg. On	-	-	10	μA
SEG0-SEG23 Sink Current (work as LCD output pins)	I <sub>OL</sub>	V <sub>OL</sub> = 0.4V V <sub>LCD</sub> = 0.0V	0.4	-	-	μA
SEG0-SEG23 Drive Current (work as LCD output pins)	I <sub>OH</sub>	V <sub>OH</sub> = 2.4V V <sub>LCD</sub> = 3.0V	-0.3	-	-	μA



DC Characteristics, continued

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
SEG0–SEG23 Output Low Voltage (work as DC output pins)	VSL	IOL = 0.6 mA	-	-	0.4	V
SEG0–SEG23 Output High Voltage (work as DC output pins)	VSH	IOH = -0.3 $\mu$ A	2.4	-	-	V
Port RE Sink Current	IEL	VOL = 0.9V	9	-	-	mA
Port RE Source Current	IEH	VOH = 2.4V	-0.4	-1.2	-	mA
Pull-up Resistor	RCD	Port RC, RD	100	350	1000	K $\Omega$
$\overline{\text{INT}}$ Pull-up Resistor	RINT	-	50	250	1000	K $\Omega$
$\overline{\text{RES}}$ Pull-up Resistor	RRES	-	20	100	500	K $\Omega$

## AC CHARACTERISTICS

(V<sub>DD</sub>–V<sub>SS</sub> = 3V, T<sub>A</sub> = 25° C; unless otherwise specified)

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Op. Frequency	FOSC	RC type	-	-	4000	KHz
		Crystal type 1 (Option low-speed type)	-	32.768	-	
		Crystal type 2 (Option high-speed type)	400	-	2000	
Instruction Cycle Time	T <sub>I</sub>	One machine cycle	-	4/FOSC	-	mS
Reset Active Width	TRAW	FOSC = 32.768 KHz	1	-	-	$\mu$ S
Interrupt Active Width	TIAW	FOSC = 32.768 KHz	1	-	-	$\mu$ S

## TYPICAL APPLICATION CIRCUIT

