4-BIT MICROCONTROLLER

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1. GENERAL DESCRIPTION

W541L260 is fully compatible with W741L260 in the terms of pin assignment and IC functon except main oscillator. It is a high-performance 4-bit microcontroller (μC) with an LCD driver. The device contains a 4-bit ALU, two 8-bit timers, two dividers, a 32 × 4 LCD driver, and five 4-bit I/O ports (including 1 output port to drive the LEDs). There are also five interrupt sources and 8-level subroutine nesting for interrupt applications. The W541L260 has one power reduction mode to help minimize power dissipation.

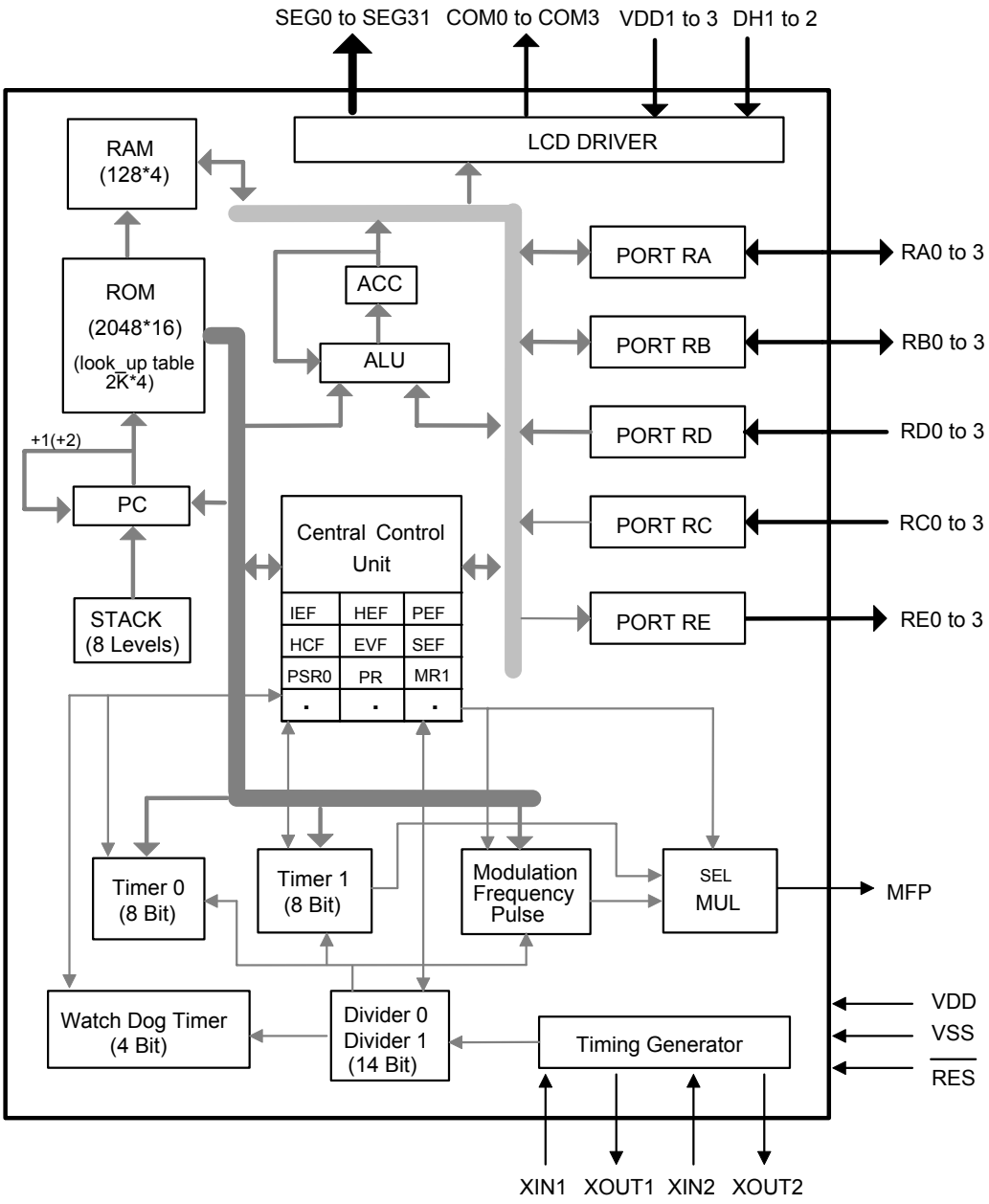
The W541L260 has two oscillator circuits and can work in dual-clock or single-clock operation mode. It is suitable for remote controllers, watches and clocks, speech synthesis LSI controllers, and other products.

2. FEATURES

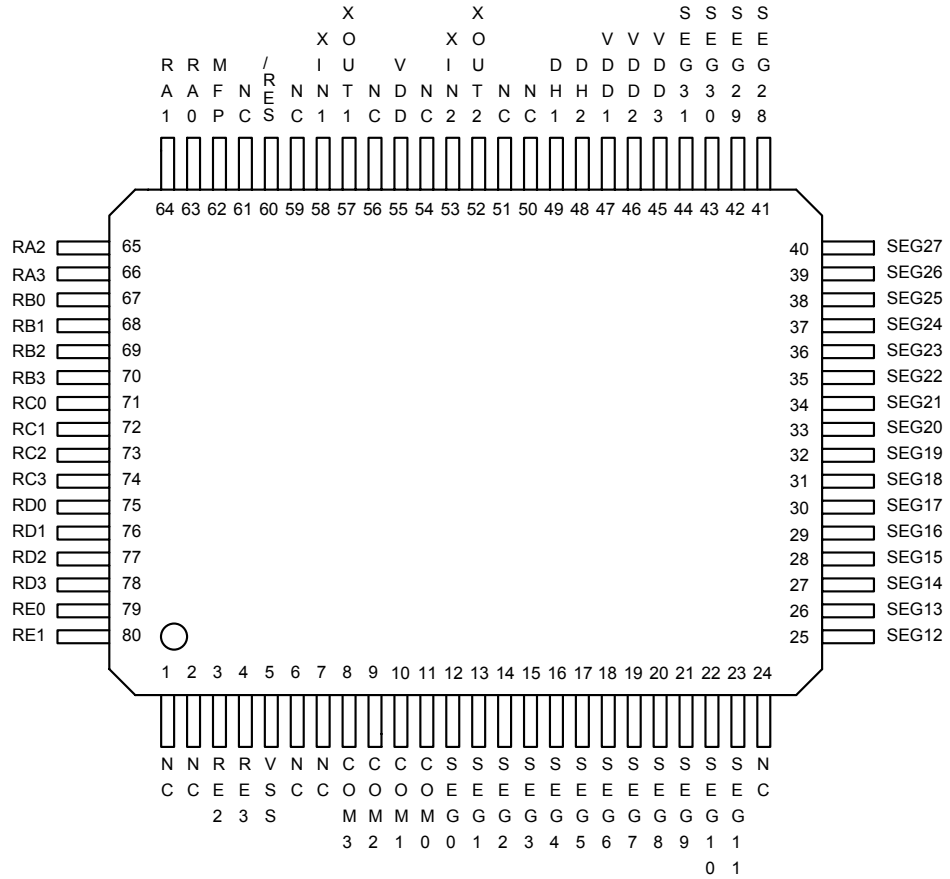
- Operating voltage: 1.2V~1.8V (LCD drive voltage: 3.0V, or 4.5V)
- Single or Dual Clock Mode
  - Single (main oscillator only) or dual clock (both main and sub-oscilator) by mask option .
  - Sub-oscillator is only 32.768 KHz crystal for dual clock mode.
  - Main oscillator is crystal or RC oscillation by mask code option .
  - Main clock : High-frequency clock (400 KHz to 1 MHz) or low-frequency clock (32.768 KHz) is selected by mask code option
- Memory
  - 2048 × 16 bit program ROM (including 2K × 4 bit look-up table)
  - 128 × 4 bit data RAM (including 16 working registers)
  - 32 × 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)
  - Do not be floating when it is as input or output open-drain (NMOS type).
- Power-down mode
  - Hold function: no operation (except for oscillator)
  - Stop function: no operation (including main clock)

- Five types of interrupts
  - Four internal interrupts (Divider 0, Divider 1, Timer 0, Timer 1)
  - One external interrupt (Port RC)
- LCD driver output
  - 32 segment × 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
- Two built-in 14-bit clock frequency divider circuit (divider 0 and divider 1)
- Two built-in 8-bit programmable countdown timers
  - Timer 0: one of two internal clock frequencies (FOSC/4 or FOSC/1024) can be selected
  - Timer 1: includes an auto-reload function; and one of two internal clock frequencies (FOSC or FOSC/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 4 μS instruction cycle (with 1 MHz operating frequency)
- Packaged in 80-pin QFP

3. BLOCK DIAGRAM



4. PIN CONFIGURATION



5. PIN DESCRIPTION

<table>
<tr><th>SYMBOL</th><th>I/O</th><th>FUNCTION</th></tr>
<tr><td>XIN1</td><td>I</td><td>Input pin for oscillator.
Connected to crystal or resistor to generate system clock by code option.
External 10~20pF capacitor uses to get accurate freq in crystal mode.</td></tr>
<tr><td>XOUT1</td><td>O</td><td>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.</td></tr>
<tr><td>XIN2</td><td>I</td><td>Input pin for sub-oscillator. Connected to a 32.768 KHz crystal. External 10~20pF capacitor uses to get accurate freq in crystal mode.</td></tr>
<tr><td>XOUT2</td><td>O</td><td>Output pin for sub-oscillator. Connected to a 32.768 KHz crystal. 20pF capacitor is built in internal for crystal mode.</td></tr>
<tr><td>RA0–RA3</td><td>I/O</td><td>Input/Output port.
Input/output mode specified by port mode 1 register (PM1).</td></tr>
<tr><td>RB0–RB3</td><td>I/O</td><td>Input/Output port.
Input/output mode specified by port mode 2 register (PM2).</td></tr>
<tr><td>RC0–RC3</td><td>I</td><td>4-bit port for input only.
Each pin has an independent interrupt capability. And build-in schmitt trigger.</td></tr>
<tr><td>RD0–RD3</td><td>I</td><td>4-bit port for input only.</td></tr>
<tr><td>RE0–RE3</td><td>O</td><td>Output port only.
This port provides high sink current to drive LEDs.</td></tr>
<tr><td>MFP</td><td>O</td><td>Output pin only.
This pin can output modulating or nonmodulating frequency, or Timer 1 clock output specified by mode register 1 (MR1).</td></tr>
<tr><td>$\overline{\text{RES}}$</td><td>I</td><td>System reset pin with pull-high resistor.</td></tr>
<tr><td>SEG0–SEG31</td><td>O</td><td>LCD segment output pins.
Can also be used as DC output ports specified by code option.</td></tr>
<tr><td>COM0–COM3</td><td>O</td><td>LCD common signal output pins.
<table>
<tr><th></th><th>Static</th><th>1/2 Duty</th><th>1/3 Duty</th><th>1/4 Duty</th></tr>
<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>
</table>
The LCD alternating frequency can be selected by code option.</td></tr>
<tr><td>DH1, DH2</td><td>I</td><td>Connection terminals for voltage doubler (halver) capacitor.</td></tr>
<tr><td>V_{DD1}, V_{DD2}
V_{DD3}</td><td>I</td><td>Positive (+) supply voltage terminal.
Refer to Functional Description.</td></tr>
<tr><td>V_{DD}</td><td>I</td><td>Positive power supply (+).</td></tr>
<tr><td>V_{SS}</td><td>I</td><td>Negative power supply (-).</td></tr>
</table>

6. ELECRICAL CHARACTERISTICS

6.1 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.

6.2 DC Characteristics

(V_{DD}–V_{SS} = 1.5V, $F_{OSC.}$ = 32.768 KHz, T_A = 25° C; unless otherwise specified)

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Op. Volt (Crystal type)	V_{DD1}	High-frequncy Oscillation	1.35	-	1.8	V
Op. Volt (RC type)	V_{DD2}	High-frequncy Oscillation	1.2	-	1.8	V
Op. Volt (RC, Crystal)	V_{DD3}	Low-frequncy Oscillation	1.2	-	1.8	V
Op. Current (RC Type)	I_{OP2}	No load (Ext-V) In dual-clock normal operation	-	100	400	μA
Op. Current (Crystal Type)	I_{OP3}	No load (Ext-V) In dual-clock slow operation and Fm is stopped	-	8.5	20	μA
Hold Current (RC Type)	I_{HM2}	Hold mode No load (Ext-V) In dual-clock normal operation	-	60	100	μA
Hold Current (Crystal Type)	I_{HM3}	Hold mode No load (Ext-V) In dual-clock slow operation and Fm is stopped	-	4.0	6	μA
Stop Current (Crystal type)	I_{SM1}	Stop mode No load (Ext-V) In dual-clock normal operation	-	4.0	6	μA
Stop Current (Crystal type)	I_{SM2}	Stop mode No load (Ext-V) In single-clock operation	-	0.1	2	μA

DC Characteristics, continue

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input Low Voltage	V_{IL}	-	V_{SS}	-	0.3 V_{DD}	V
Input High Voltage	V_{IH}	-	0.7 V_{DD}	-	V_{DD}	V
MFP Output Low Voltage	V_{ML}	I_{OL} = 0.9 mA	-	0.1	0.3	V
MFP Output High Voltage	V_{MH}	I_{OH} = 0.75 mA	1.2	1.4	-	V
Port RA, RB Output Low Voltage	V_{ABL}	I_{OL} = 1.0 mA	-	0.2	0.3	V
Port RA, RB Output High Voltage	V_{ABH}	I_{OH} = 0.5 mA	1.2	1.4	-	V
LCD Supply Current	I_{LCD}	All Seg. ON	-	-	6	μA
SEG0–SEG31 Sink Current (Used as LCD Output)	I_{OL1}	V_{OL} = 0.05V V_{LCD} = 0.0V	6	12	-	μA
SEG0–SEG31 Drive Current (Used as LCD Output)	I_{OH1}	V_{OH} = 4.45V V_{LCD} = 4.5V	1.5	12	-	μA
Segment Output Low Voltage (Used as DC Output)	V_{SL}	I_{OL} = 150 μA	-	0.1	0.15	V
Segment Output High Voltage (Used as DC Output)	*V_{SH}	I_{OH} = 1 μA	1.05	1.4	-	V
Port RE Sink Current	I_{EL}	V_{OL} = 0.3V	2	-	-	mA
Port RE Source Current	I_{EH}	V_{OH} = 1.2V	0.35	0.45	-	mA
Input Port Pull-up Resistor	R_{CD}	Port RC, RD	200	1000	1500	KΩ
$\overline{RES}$ Pull-up Resistor	R_{RES}	-	200	500	1500	KΩ

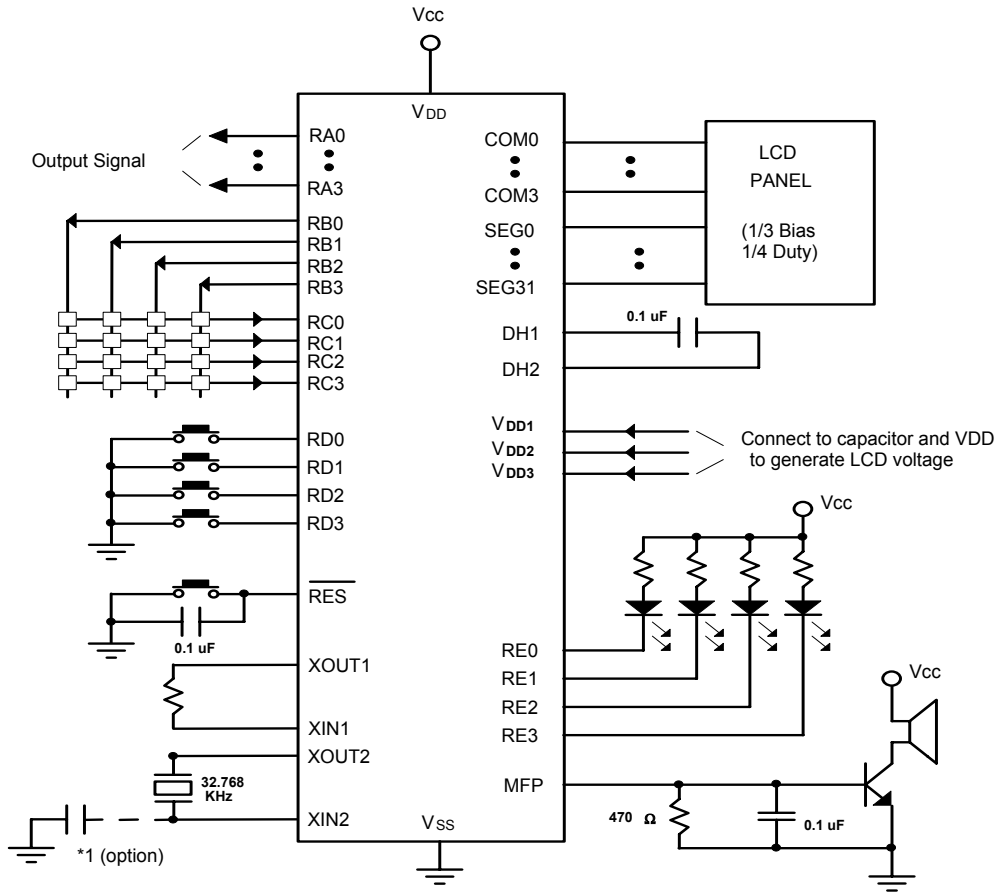
Note : *V_{SH}: Its ability is based on LCD power connected to 0.1 uF capacitor.

6.3 AC Characteristics

(V_{DD}–V_{SS} = 1.5V, T_A = 25° C, unless otherwise specified)

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Op. Frequency	F_{OSC}	RC type	-	-	1000	KHz
		Crystal type (Option low speed type only)	-	32.768	-	
Frequency Deviation by Voltage Drop for RC Oscillator	$\frac{\Delta f}{f}$	$\frac{f(1.5V) - f(1.2V)}{f(1.5V)}$	-	-	10	%
Oscillator Start-up Time	T_S	V_{DD}=1.2 V, F_{OSC}=32.768 KHz	-	1	2	S
Instruction Cycle Time	T_I	One machine cycle	-	4/F_{OSC}	-	mS
Reset Active Width	T_{RAW}	F_{OSC} = 32.768 KHz	1	-	-	μS
Interrupt Active Width	T_{IAW}	F_{OSC} = 32.768 KHz	1	-	-	μS

7. APPLICATION CIRCUIT



Note:
*1 is for accuracy

8. REVISION HISTORY

VERSION	DATE	DESCRIPTION
A2	-	Note: Recommend working voltage range for Hi freq X al mode (L series)
A3	-	Note: RC is built-in schmitt trigger
A4	May 29, 2003	Note: Do not be floating when it is as input or output open-drain (NMOS type)

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