W541E/C261 DATA SHEET

4BIT MICROCONTROLLER, 2K ×16 ROM, 128 ×4 RAM 128 -DOT LCD

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1. INTRODUCTION

The W541E261 and W541C261 are high-performance 4-bit microcontroller (μC) with an LCD driver and the flash EEPROM and mask ROM for the program memory. 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 W541E261 and W541C261 have two power reduction modes, hold mode and stop mode, which help to minimize power dissipation.

The W541E261 and W541C261 have 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, hand-held games and other products.

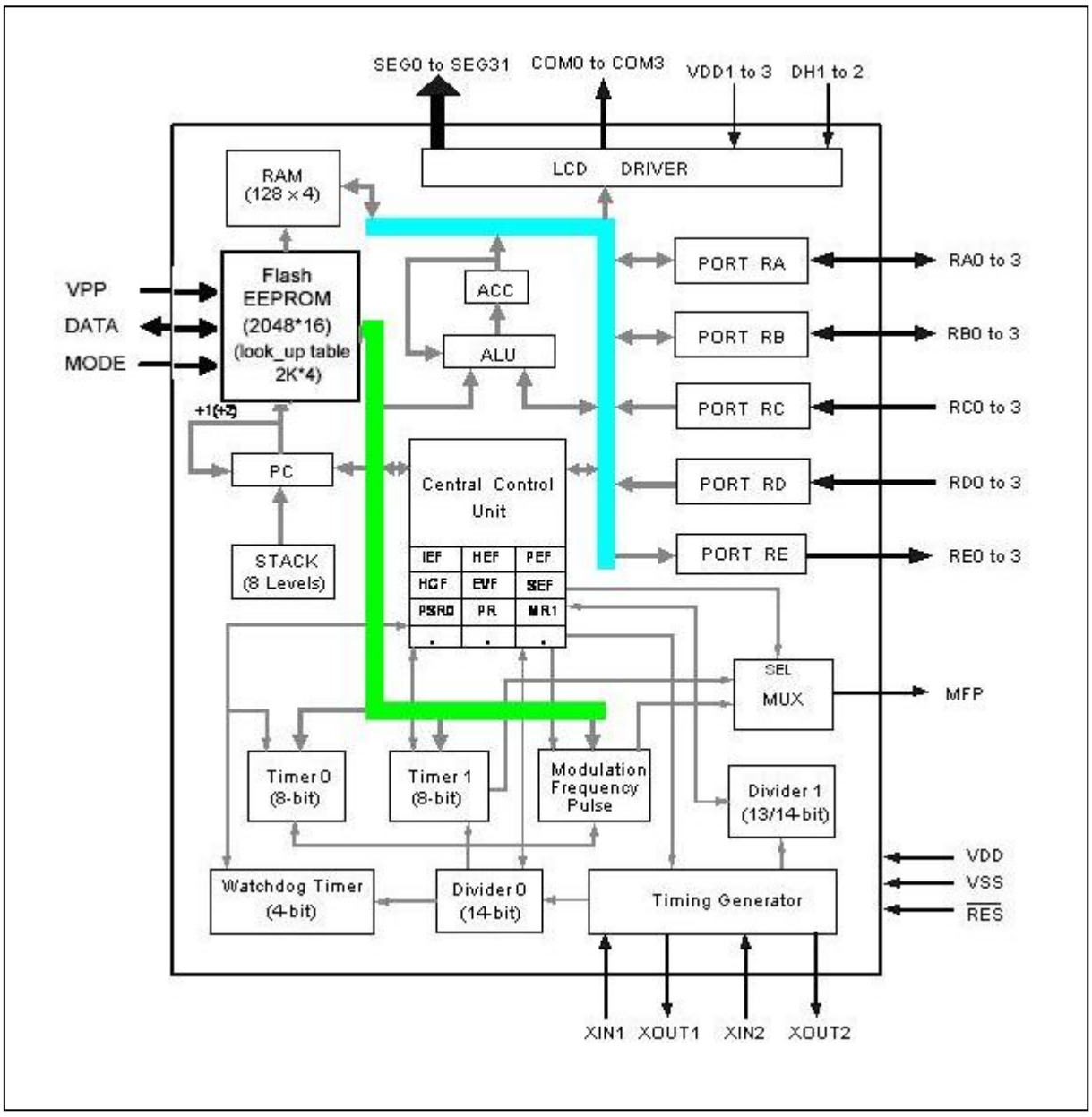
2. FEATURES

- Operating voltage: 2.4V to 5.5V (LCD drive voltage: 3.0V, or 4.5V)
- Operating frequency up to 4 MHz
- Crystal/RC oscillation circuit selectable by code option for system clock
- 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
- Single or Dual Clock Mode
  - Single (main oscillator only) or dual clock (both main and sub-oscilator) by mask option .
  - Dual-clock slow operation mode: system is operated by the sub-oscillator (FOSC = Fs and Fm is stopped)
  - 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 4 MHz) or low-frequency clock (32.768 KHz) is selected by mask code option.
- 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
- 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)

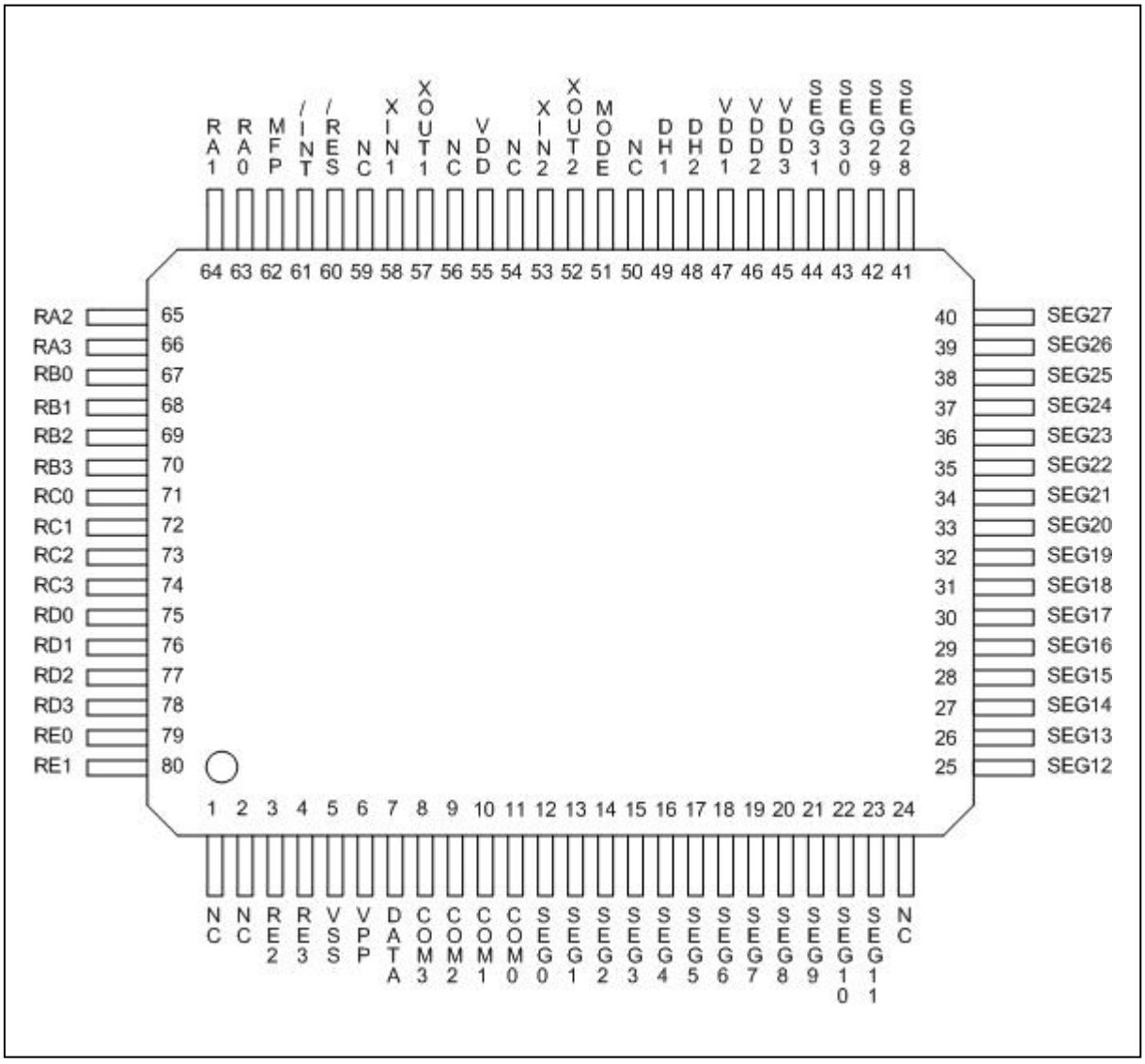
- Two built-in 8-bit programmable countdown timers
  - Timer 0: one of two internal clock frequencies (FOSC/4 or FOSC/1024) can be selected
  - Timer 1: includes an auto-reload function; and one of three internal clock frequencies (FOSC or FOSC/64,Fs) can be selected or falling edge of pin RC.0 can be selected (output through MFP pin)
- Built-in 18/14-bit watchdog timer selectable for system reset
- Powerful instruction set: 120 instructions
- 8-level subroutine (include interrupt) nesting
- Up to 1 μS instruction cycle (with 4 MHz operating frequency)
- Packaged in 80-pin QFP

3. ARCHITECTURE

3.1 BLOCK DIAGRAM



3.2 PIN CONFIGURATION



3.3 PAD 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 15~20pF 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 15~20pF capacitor uses to get accurate freq in crystal mode..</td></tr>
<tr><td>XOUT2</td><td>O</td><td>oscillator. Connected Output pin for sub 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.</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>/INT</td><td>I</td><td>External interrupt pin with pull-high resistor. This pin is bonding option for the W541C250 body. Only for W541E261.</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>VDD1, VDD2, VDD3</td><td>I</td><td>Positive (+) supply voltage terminal.
Refer to Functional Description.</td></tr>
<tr><td>VDD</td><td>I</td><td>Positive power supply (+).</td></tr>
</table>

PAD DESCRIPTION, continued

SYMBOL	I/O	FUNCTION
VSS	I	Negative power supply (-).
V_{PP}	I	Voltage control pin for the flash EEPROM programming, erasing and verifying. This pin has a built-in pull-low resistor. Only for W541E261.
MODE	I	Mode selection pin for the flash EEPROM programming, erasing and verifying. This pin has a built-in pull-low resistor. Only for W541E261.
DATA	I/O	Data I/O pin for the flash EEPROM programming and verifying. This pin has a built-in pull-low resistor. Only for W541E261.

4. 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.

5. DC CHARACTERISTICS

(V_{DD}–V_{SS} = 3.0V, Fm = 4 MHz, Fs = 32.768 KHz, T_A = 25° C, LCD on, no load; unless otherwise specified)

PARAMETER	SYM.	CONDITIONS		MIN.	TYP.	MAX.	UNIT
Operation current	IOP	Normal operation	Crystal mode	-	0.3	0.6	mA
			RC mode	-	1	2	
		Slow operation		-	3.5	8.0	μA
Hold current	IHM	Normal operation	Crystal mode	-	135	270	μA
			RC mode	-	500	600	
		Slow operation		-	2.0	4.0	
Stop current	ISM	Stop mode		-	0.1	1	μA

(V_{DD}–V_{SS} = 3.0V, Fm = 4 MHz, Fs = 32.768 KHz, T_A = 25° C, LCD on, Crystal mode, no load; unless otherwise specified)

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Op. Voltage	V_{DD}	-	2.4	-	5.5	V
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} = 6.0 mA	-	-	0.4	V
MFP Output High Voltage	V_{MH}	I_{OH} = 6.0 mA	2.4	-	-	V
Port RA, RB Output Low Voltage	V_{ABL}	I_{OL} = 6.0 mA	-	-	0.4	V
Port RA, RB Output High Voltage	V_{ABH}	I_{OH} = 3.0 mA	2.4	-	-	V
LCD Supply Current	I_{LCD}	All Seg. ON	-	-	6	μA
SEG0–SEG31 Sink Current (Used as LCD Output)	I_{OL1}	V_{OL} = 0.4V V_{LCD} = 0.0V	90	-	-	μA
SEG0–SEG31 Drive Current (Used as LCD Output)	I_{OH1}	V_{OH} = 2.4V V_{LCD} = 3.0V	90	-	-	μA
Segment Sink Current (Used as DC Output)	I_{SL}	V_{OL} = 0.4V V_{LCD} = 0.0V	-	4.0	-	mA
Segment Drive Current (Used as DC Output)	I_{SH}	V_{OH} = 2.4V V_{LCD} = 3.0V	-	1.5	-	mA
Port RE Sink Current	I_{EL}	V_{OL} = 0.9V	9	13.5	-	mA
Port RE Source Current	I_{EH}	V_{OH} = 2.4V	1.5	3.0	-	mA

Continued

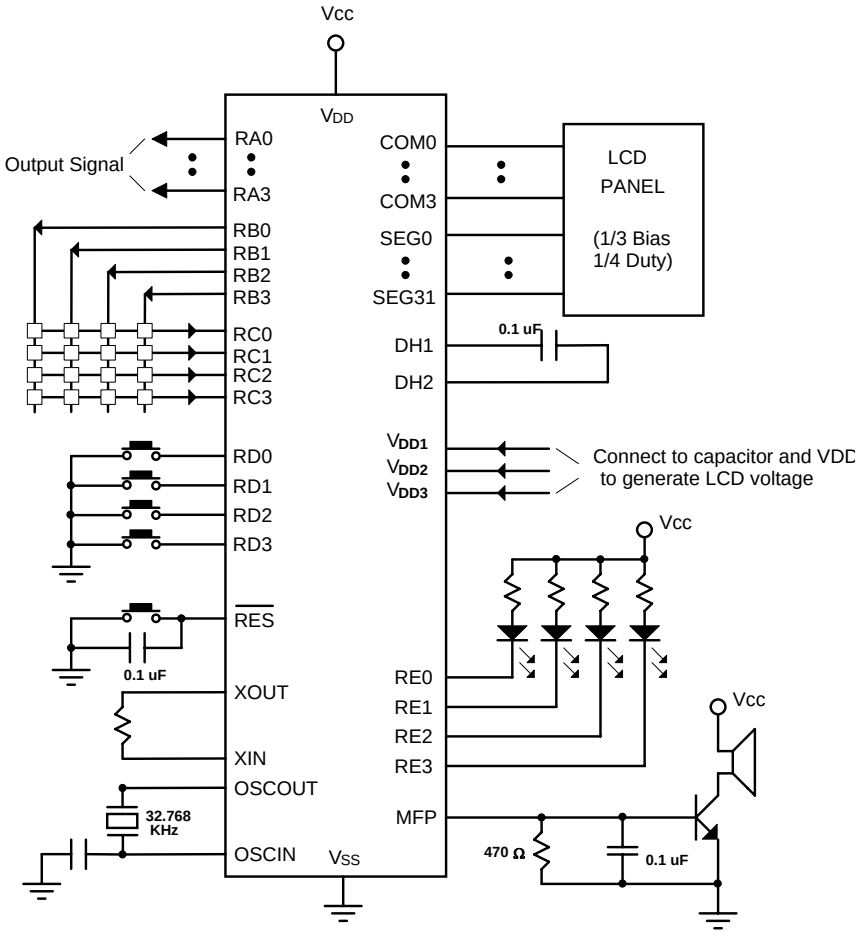
PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Port RA/RB Sink Current	I_{ABL}	V_{OL} = 0.4V	3	6	-	mA
Port RA/RB Source Current	I_{ABH}	V_{OH} = 2.4V	1.5	3.0	-	mA
Port MFP Sink current	I_{ML}	V_{OL} = 0.4V	3	6	-	mA
Port MFP Source current	I_{ML}	V_{OL} = 2.4V	3	6	-	mA
Input Port Pull-up Resistor	R_{CD}	Port RC, RD	100	350	600	KΩ
$\overline{RES}$ Pull-up Resistor	R_{RES}	-	100	150	200	KΩ
$\overline{INT}$ Pull-up Resistor	R_{INT}	-	100	150	200	KΩ
VPP Pull-down Resistor	R_{VPP}	V_{DD} = 5V	0.5	1	1.5	MΩ
MODE Pull-down Resistor	R_{MODE}	V_{DD} = 5V	0.5	1	1.5	MΩ
DATA Pull-down Resistor	R_{DATA}	V_{DD} = 5V	50	100	150	KΩ

6. AC CHARACTERISTICS

(V_{DD}–V_{SS} = 3.0V, T_A = 25° C, unless otherwise specified)

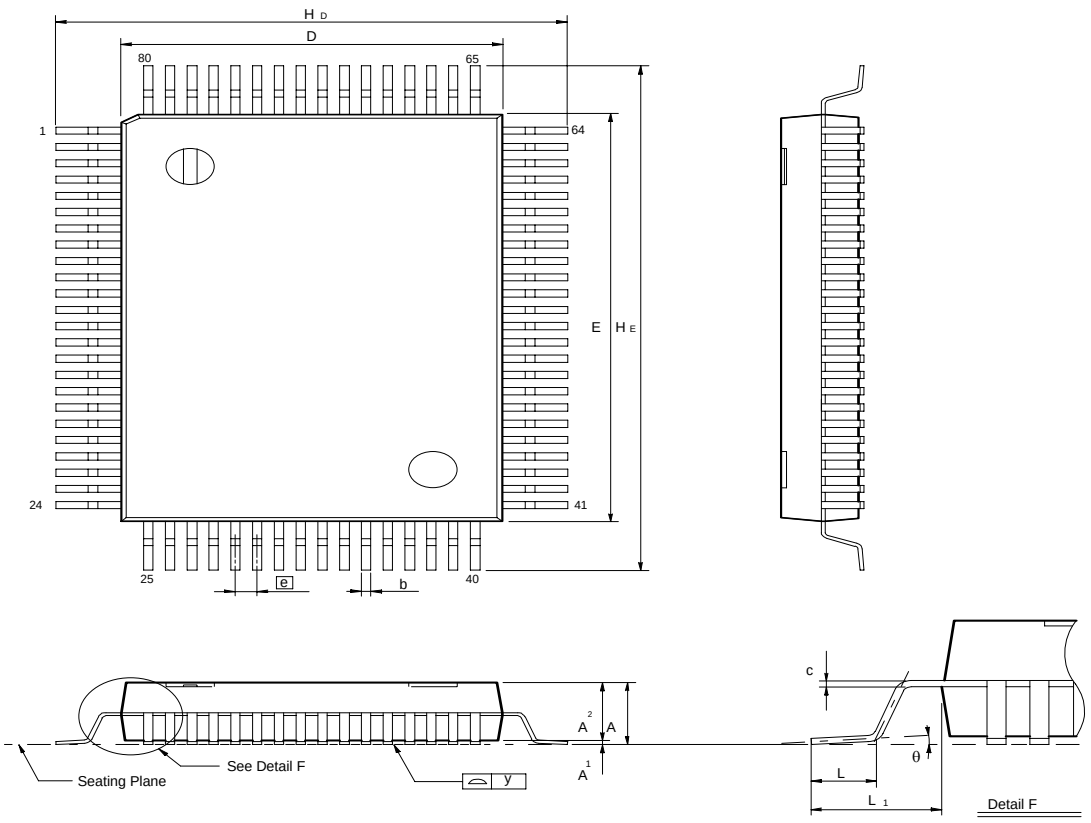
PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Op. Frequency	F_{OSC}	RC type	-	-	4000	KHz
		Crystal type 1 (Option low speed type)	-	32.768	-	
		Crystal type 2 (Option high speed type)	400	-	4000	
Frequency Deviation by Voltage Drop for RC Oscillator	$\frac{\Delta f}{f}$	$\frac{f(3V)\ f(2.4V)}{f(3V)}$	-	-	25	%
Instruction Cycle Time	T_I	One machine cycle	-	4/F_{OSC}	-	S
Reset Active Width	T_{RAW1}	Dual clock	1	-	-	μS
	T_{RAW2}	Single colck	1	-	-	
Interrupt Active Width	T_{IAW}	F_{OSC} = 32.768 KHz	1	-	-	μS

7. TYPICAL APPLICATION CIRCUIT



8. PACKAGE DIMENSION

80-Lead QFP



Symbol	Dimension in Inches			Dimension in mm		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	—	—	0.130	—	—	3.30
A 1	0.004	—	—	0.10	—	—
A 2	0.107	0.112	0.117	2.73	2.85	2.97
b	0.012	0.014	0.018	0.30	0.35	0.45
c	0.004	0.006	0.010	0.10	0.15	0.25
D	0.546	0.551	0.556	13.87	14.00	14.13
E	0.782	0.787	0.792	19.87	20.00	20.13
e	0.025	0.031	0.037	0.65	0.80	0.95
H D	0.728	0.740	0.752	18.49	18.80	19.10
H E	0.964	0.976	0.988	24.49	24.80	25.10
L	0.039	0.047	0.055	1.00	1.20	1.40
L 1	0.087	0.094	0.103	2.21	2.40	2.62
y	—	—	0.004	—	—	0.10
θ	0 °	—	12 °	0 °	—	12 °

9. VERSION HISTORY

VERSION	DATE	PAGE	DESCRITION
A1	June 12, 2007	-	Formal Release

Important Notice

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