

## LU8500F0/F1

8-bit Single-chip Microcomputer  
with built-in Flash Memory

### ■ Description

The LU8500F0/F1 are single chip 8-bit microcomputers, flash memory versions of SM8500 series. LU8500F0 is packaged in 100-pin QFP and LU8500F1 in 100-pin LQFP (0.5 mm pin-pitch).

The LU8500F0/F1's internal flash memory is user programmable: it can be programmed using a PROM writer, through the serial interface (UART) (on-board writing), or by

copying data stored in a PROM by using the copy board designed for this purpose.

LU8500F0/F1 are compatible with SM8500 series which contains ROM instead of flash memory. LU8500F0/F1 can be programmed to operate as ROM version. Once the program has been imported into the ROM, the user can run the program without having to verify it.

### ■ Features

1. CMOS silicon gate process
2. Flash memory capacity          61 440 × 8-bit
3. RAM capacity                      2 048 × 8-bit
4. Memory organization
  - It is possible to set the range of accessible address of the internal flash memory in unit of 4k bytes (4 to 60k bytes) by the user program.
5. External memory expansion
  - The LU8500F0/F1 can access external memory by program setting.
6. CPU core
  - 8-bit × 8 ports (or 16-bit × 4 ports) and 16-bit × 4 ports general purpose register are used as accumulator, register pointer, and index register.
  - 68 instructions sets include multiplication, division, and bit manipulation instruction.
  - 23 types of addressing mode.
  - System clock cycle 0.17 μs (MIN.) (When main clock cycle is 12 MHz.)
  - System clock cycle can be varied by program.
  - System clock can be derived from the main clock (divided by 1/2, 1/4, 1/8, 1/16 or 1/32) or sub clock (divided-by-2 32.768 kHz).
7. Oscillator circuit
  - Main clock oscillation circuit (CK<sub>IN</sub>, CK<sub>OUT</sub> pins) : 1.5 to 12 MHz
  - Sub clock crystal oscillation circuit (OSC<sub>IN</sub>, OSC<sub>OUT</sub> pins) : 32.768 kHz
8. Interrupt
  - Maskable interrupts : 14  
4 external interrupts and 10 internal interrupts from peripheral functions can be set to enable/disable independently and masked by 14-level priority.
  - Non-maskable interrupts : 2  
Watchdog timer interrupt.  
Illegal instruction trap
9. Standby modes
  - HALT Mode  
Changing the mode by HALT instruction.  
The system clock supplied to CPU will be stopped.
  - STOP Mode  
Changing the mode by STOP instruction.  
The main clock will be stopped (sub clock is kept running).

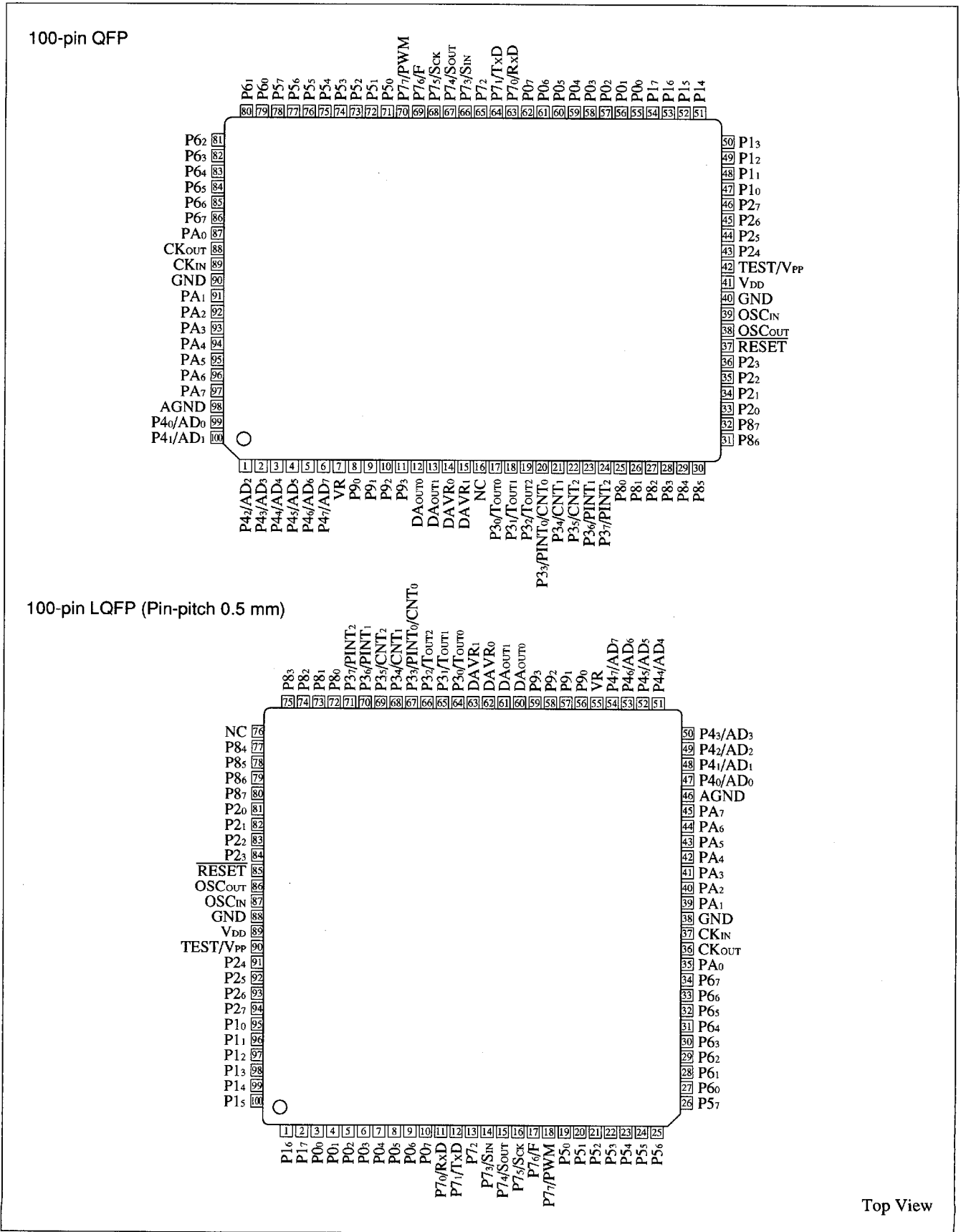
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| <p>10. I/O ports</p> <ul style="list-style-type: none"> <li>• 2 input ports (each 8 bits) ( one port also serves as A/D input)</li> <li>The pull-up resistor of one port can be turned on/off by software.</li> <li>• 2 output ports (each 8 bits)</li> <li>These are large current output pins.</li> <li>• 8-bit × 6 I/O ports and 4-bit × 1 I/O port</li> <li>The pull-up resistors can be turned on/off by software.</li> </ul> <p>11. Timer/event counter</p> <ul style="list-style-type: none"> <li>• Timer/event counter      16-bit × 1, 8-bit × 5</li> <li>• These timers can output PWM (period and duty cycle of 1 channel are variable, duty cycle of 3</li> <li>• Watchdog timer          8-bit × 1</li> <li>• Clock timer                8-bit × 1</li> </ul> <p>12. Serial interface</p> <ul style="list-style-type: none"> <li>• SIO                        8-bit clock sync. × 1</li> <li>• UART                      8-bit clock async. × 1</li> </ul> <p>13. A/D converter</p> <ul style="list-style-type: none"> <li>• Resolution                10-bit</li> <li>• Channel                    8 channels</li> </ul> | <p>14. D/A converter</p> <ul style="list-style-type: none"> <li>• Resolution                8-bit (4-bit for waveform generator)</li> <li>• Channel                    2 channels</li> </ul> <p>15. Waveform generator</p> <ul style="list-style-type: none"> <li>• Internal waveform RAM   2 channels</li> <li>• User programmable 16 level waveforms</li> <li>• Combined with external circuit, DTMF waveform can be output.</li> </ul> <p>16. Clock output</p> <ul style="list-style-type: none"> <li>• P7<sub>6</sub>/F pin can be used to drive a buzzer (timer 5 output)</li> </ul> <p>17. Operation power and voltage</p> <ul style="list-style-type: none"> <li>• 2.7 to 3.6 V : system clock frequency 3.0 MHz (MAX.)</li> <li>• 4.5 to 5.5 V : system clock frequency 6.0 MHz (MAX.)</li> </ul> <p>The LU8500F0/F1 can operate at the max. 12 MHz main clock if the operating voltage is in the range (2.7 to 5.5 V). However, the main clock frequency must be divided to the system clock according to the operating voltage range.</p> <p>18. Package</p> <ul style="list-style-type: none"> <li>• LU8500F0                100-pin QFP (QFP100-P-1420)</li> <li>• LU8500F1                100-pin LQFP (LQFP100-P-1414)<br/>(Pin-pitch 0.5 mm)</li> </ul> |
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### <Flash memory features >

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| <p>1. Writing method</p> <ul style="list-style-type: none"> <li>• Using instruction : in the same way as used for SHARP 8 M bits flash memory "LH28F008SA"</li> <li>• Auto byte write : through the command user interface (CUI)</li> <li>• V<sub>pp</sub> = 12 V (external)</li> </ul> <p>2. Erasing method</p> <ul style="list-style-type: none"> <li>• Auto block erase by CUI.</li> </ul> <p>3. Block configuration</p> <ul style="list-style-type: none"> <li>• 8 blocks (1 block by 4k bytes, 7 blocks by 8k bytes)</li> <li>• Each block can be cleared independently.</li> </ul> | <p>4. Reliability</p> <ul style="list-style-type: none"> <li>• Write/erase cycle : 100</li> </ul> <p>5. Three writing modes</p> <ul style="list-style-type: none"> <li>• PROM mode</li> <li>Program can be stored/erased by using general purpose PROM writer.</li> <li>• Serial mode (on-board mode)</li> <li>Data can be read/written/erased from PC.</li> <li>• Copy mode</li> <li>When the dedicated copy board is used, data stored in PROM can be copied into the internal flash memory.</li> </ul> |
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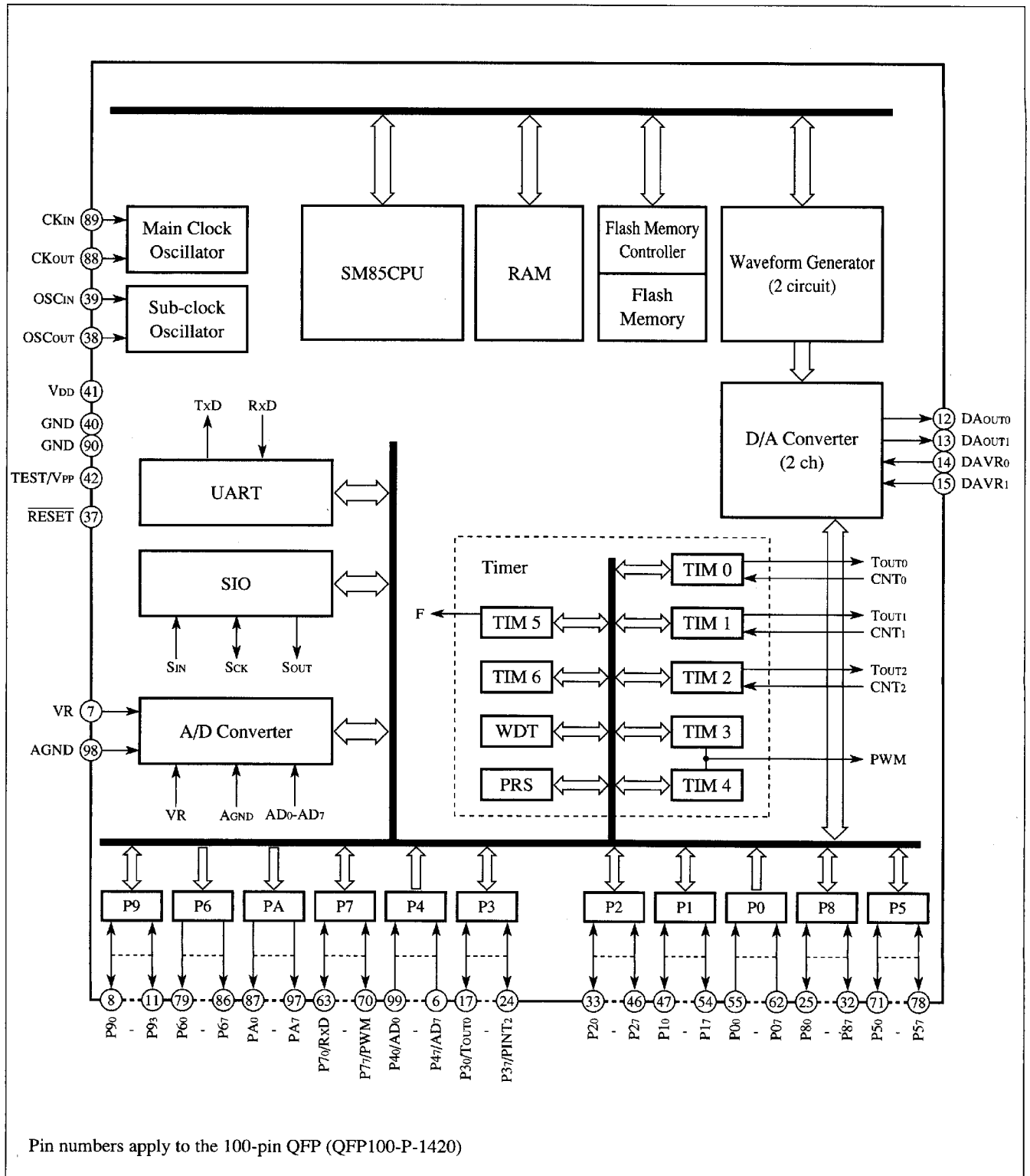
Pin Connections



## ■ Pin Description

Pin name	I/O	Function
P0 <sub>0</sub> -P0 <sub>7</sub>	I	Input ports
P1 <sub>0</sub> -P1 <sub>7</sub>	I/O	I/O ports / External memory data I/O ports
P2 <sub>0</sub> -P2 <sub>7</sub>	I/O	I/O ports / External memory address output ports
P3 <sub>0</sub> /TOUT <sub>0</sub> -P3 <sub>2</sub> /TOUT <sub>2</sub>	I/O	I/O ports / Timer outputs (TOUT <sub>0</sub> , TOUT <sub>1</sub> , TOUT <sub>2</sub> )
P3 <sub>3</sub> /PINT <sub>0</sub> /CNT <sub>0</sub>	I/O	I/O port / External interrupt input / Capture trigger input / Event count input (PINT <sub>0</sub> /CNT <sub>0</sub> )
P3 <sub>4</sub> /CNT <sub>1</sub> , P3 <sub>5</sub> /CNT <sub>2</sub>	I/O	I/O ports / Event count inputs (CNT <sub>1</sub> /CNT <sub>2</sub> )
P3 <sub>6</sub> /PINT <sub>1</sub> , P3 <sub>7</sub> /PINT <sub>2</sub>	I/O	I/O ports / External interrupt inputs (PINT <sub>1</sub> /PINT <sub>2</sub> )
P4 <sub>0</sub> /AD <sub>0</sub> -P4 <sub>7</sub> /AD <sub>7</sub>	I	Input ports / Analog input ports (AD <sub>0</sub> -AD <sub>7</sub> )
P5 <sub>0</sub> -P5 <sub>7</sub>	I/O	I/O ports / External memory address output ports
P6 <sub>0</sub> -P6 <sub>7</sub>	O	Output ports (Large current output : 10 mA) (By mask option, the port can be configured as a N-ch open drain pin)
P7 <sub>0</sub> /RxD	I/O	I/O port / UART data input
P7 <sub>1</sub> /TxD	I/O	I/O port / UART data output
P7 <sub>2</sub>	I/O	I/O port
P7 <sub>3</sub> /S <sub>IN</sub>	I/O	I/O port / SIO data input
P7 <sub>4</sub> /S <sub>OUT</sub>	I/O	I/O port / SIO data output
P7 <sub>5</sub> /S <sub>CK</sub>	I/O	I/O port / SIO transfer clock I/O
P7 <sub>6</sub> /F	I/O	I/O port (Buzzer output)
P7 <sub>7</sub> /PWM	I/O	I/O port (PWM output)
P8 <sub>0</sub> -P8 <sub>7</sub>	I/O	I/O ports
P9 <sub>0</sub> -P9 <sub>3</sub>	I/O	I/O ports
PA <sub>0</sub> -PA <sub>7</sub>	O	Output ports (Large current output : 10 mA) (By mask option, the port can be configured as a N-ch open drain pin)
DAVR <sub>0</sub> , DAVR <sub>1</sub>	I	D/A converter reference voltage input ports
DAOUT <sub>0</sub> , DAOUT <sub>1</sub>	O	D/A converter output ports
VR	I	A/D converter high-level reference voltage input port
AGND	I	A/D converter low-level reference voltage input port
CK <sub>IN</sub> , CK <sub>OUT</sub>	I, O	Oscillator pins for main clock (Connecting crystal oscillator)
OSC <sub>IN</sub> , OSC <sub>OUT</sub>	I, O	Oscillator pins for subclock (Connecting 32.768 kHz crystal oscillator)
RESET	I	Hardware reset signal input port
TEST/V <sub>PP</sub>	I	Test pin (Connect to GND normally)/writing high voltage pin
V <sub>DD</sub> , GND	I	Power supply pin, GND pin (Also serving as the D/A ground pin)

■ Block Diagram



## Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit	
Supply voltage	$V_{DD}$		-0.3 to +6.5	V	
Write voltage	$V_{PP}$		-0.2 to +14	V	
Input voltage	$V_i$		-0.3 to $V_{DD}+0.3$	V	
Output voltage	$V_o$		-0.3 to $V_{DD}+0.3$	V	
Maximum output current	High	$I_{OH}$	All output pins	4.0	mA
	Low	$I_{OL1}$	P60-P67, PA0-PA7	30	mA
		$I_{OL2}$	All output pin except P60-P67, PA0-PA7	4.0	mA
Total output current	High	$\Sigma I_{OH}$	All output pins	20	mA
	Low	$\Sigma I_{OL1}$	P60-P67, PA0-PA7	100	mA
		$\Sigma I_{OL2}$	All output pin except P60-P67, PA0-PA7	20	mA
Operating temperature	$T_{opr}$		-20 to +70	°C	
Store temperature	$T_{stg}$		-55 to +125	°C	

## Recommended Operating Conditions

Parameter	Symbol	Condition	Rating	Unit	Note
Supply voltage	$V_{DD}$	at 3 V mode	2.7 to 3.6	V	
		at 5 V mode	4.5 to 5.5		
System clock cycle	$t_{SYS}$	$V_{DD}=4.5$ to 5.5 V	0.17 to 61	$\mu s$	
		$V_{DD}=2.7$ to 3.6 V	0.33 to 61		
Maximum system clock frequency	$f_{smax}$	$V_{DD}=4.5$ to 5.5 V	6.0	MHz	
		$V_{DD}=2.7$ to 3.6 V	3.0		
Maximum main clock frequency	$f_{main}$	$V_{DD}=4.5$ to 5.5 V	12.0	MHz	1
		$V_{DD}=2.7$ to 3.6 V	6.0		
Subclock frequency	$f_{sub}$	$V_{DD}=2.7$ to 3.6 V	32.768	kHz	
		$V_{DD}=4.5$ to 5.5 V			
Operating temperature	$t_{opr}$		-20 to +70	°C	

Note 1. The system clock is divided-by-2 main clock. When deriving the system clock from a clock source other than divided-by-2 main clock, the main clock can be set to match the system clock frequency.

## DC Electrical Characteristics

(V<sub>DD</sub>=2.7 to 3.6 V, T<sub>a</sub>=-20 to +70 °C)

Parameter	Symbol	Condition	Rating			Unit	Note
			MIN.	TYP.	MAX.		
Input voltage	V <sub>IH1</sub>		0.8V <sub>DD</sub>		V <sub>DD</sub>	V	2
	V <sub>IL1</sub>		0		0.2V <sub>DD</sub>		
	V <sub>IH2</sub>		V <sub>DD</sub> -0.3		V <sub>DD</sub>	V	3
	V <sub>IL2</sub>		0		0.3		
Input current	I <sub>IH1</sub>	V <sub>IN</sub> =V <sub>DD</sub> , V <sub>DD</sub> =3.0 V			10	μA	4
	I <sub>IL1</sub>	V <sub>IN</sub> =0 V, V <sub>DD</sub> =3.0 V			-10		
	I <sub>IL2</sub>	V <sub>IN</sub> =0 V, V <sub>DD</sub> =3.0 V	-10	-25	-50	μA	5
Output voltage	V <sub>OH1</sub>	I <sub>OH</sub> =-0.6 mA, V <sub>DD</sub> =3.0 V	V <sub>DD</sub> -0.5			V	6
	V <sub>OL1</sub>	I <sub>OL</sub> =6.0 mA, V <sub>DD</sub> =3.0 V			1.0		
	V <sub>OH2</sub>	I <sub>OH</sub> =-0.6 mA, V <sub>DD</sub> =3.0 V	V <sub>DD</sub> -0.5			V	7
	V <sub>OL2</sub>	I <sub>OL</sub> =0.6 mA, V <sub>DD</sub> =3.0 V		0			
A/D conversion	Resolution			10		bits	
	Differential linear tolerance	VR = V <sub>DD</sub> = 3.0 V f <sub>sys</sub> = 3.0 MHz		±1.0	±2.5	LSB	
	Linear tolerance			±3.0	±5.0	LSB	
	Combined tolerance			±4.0	±6.0	LSB	
D/A conversion	Resolution		DAVR = V <sub>DD</sub> = 3.0 V		8.0		bits
	Output voltage range	0.8			V <sub>DD</sub> -0.8	kΩ	
	Total tolerance			±0.03	±0.06	V	
Current consumption	I <sub>DD</sub>	f <sub>sys</sub> = 3.0 MHz		9.0	15	mA	9
	I <sub>DDH</sub>	f <sub>sys</sub> = 3.0 MHz, HALT mode		1.0	2.0		
	I <sub>DDS1</sub>	OSC running, STOP mode		20	40	μA	10
	I <sub>DDS2</sub>	OSC in stop, STOP mode		1.0	6.0	μA	11

Note 2. Applied to pins P10-P17, P20-P27, P30-P32, P40-P47, P50-P57, P71, P72, P74, P76, P77, P80-P87, P90-P93, CKIN

Note 3. Applied to pins RESET, OSCIN, P00-P07, P33-P37, P70, P73, P75

Note 4. Applied to pins (with pull-up resistors disconnected) P00-P07, P10-P17, P20-P27, P30-P37, P40-P47, P50-P57, P70-P77, P80-P87, P90-P93

Note 5. Applied to pins RESET

(with pull-up resistors disconnected) P00-P07, P10-P17, P20-P27, P30-P37, P50-P57, P70-P77, P80-P87, P90-P93

Note 6. Applied to pins P60-P67, PA0-PA7

Note 7. Applied to pins P10-P17, P20-P27, P30-P37, P50-P57, P70-P77, P80-P87, P90-P93

P00 (RD), P01 (WR) (in external memory expansion mode)

Note 8. Applied to pins DAOUT0, DAOUT1

Note 9. Without load V<sub>DD</sub>=3.0 V, main clock frequency = 16 MHz

Note 10. Without load V<sub>DD</sub>=3.0 V, OSC running (32.768 kHz), VR=GND, constant input signal

Note 11. Without load V<sub>DD</sub>=3.0 V, OSCIN=GND, VR=GND, constant input signal

( $V_{DD}=4.5$  to  $5.5$  V,  $T_a=-20$  to  $+70$  °C)

Parameter	Symbol	Condition	Rating			Unit	Note
			MIN.	TYP.	MAX.		
Input voltage	$V_{IH1}$		$0.8V_{DD}$		$V_{DD}$	V	12
	$V_{IL1}$		0		$0.2V_{DD}$		
	$V_{IH2}$		$V_{DD}-0.5$		$V_{DD}$	V	13
	$V_{IL2}$		0		0.5		
Input current	$I_{IH1}$	$V_{IN}=V_{DD}, V_{DD}=5.0$ V			-10	$\mu$ A	14
	$I_{IL1}$	$V_{IN}=0$ V, $V_{DD}=5.0$ V			10		
	$I_{IL2}$	$V_{IN}=0$ V, $V_{DD}=5.0$ V	-40	-75	-150	$\mu$ A	15
Output voltage	$V_{OH1}$	$I_{OH}=-1.0$ mA, $V_{DD}=5.0$ V	$V_{DD}-0.5$			V	16
	$V_{OL1}$	$I_{OL}=10$ mA, $V_{DD}=5.0$ V			2.0		
	$V_{OH2}$	$I_{OH}=-1.0$ mA, $V_{DD}=5.0$ V	$V_{DD}-0.5$			V	17
	$V_{OL2}$	$I_{OL}=1.0$ mA, $V_{DD}=5.0$ V		0			
A/D conversion	Resolution			10		bits	
	Differential linear tolerance	$V_R=V_{DD}=5.0$ V $f_{sys}=6.0$ MHz		$\pm 1.0$	$\pm 2.5$	LSB	
	Linear tolerance			$\pm 3.0$	$\pm 5.0$	LSB	
	Combined tolerance			$\pm 4.0$	$\pm 6.0$	LSB	
D/A conversion	Resolution		$DAVR=V_{DD}=5.0$ V		8.0		bits
	Output voltage range	0.8			$V_{DD}-0.8$	k $\Omega$	
	Total tolerance			$\pm 0.05$	$\pm 0.10$	V	
Current consumption	$I_{DD}$	$f_{sys}=6.0$ MHz		20	30	mA	19
	$I_{DDH}$	$f_{sys}=6.0$ MHz, HALTmode		3.0	6.0		
	$I_{DDs1}$	OSC running STOP mode		30	60	$\mu$ A	20
	$I_{DDs2}$	OSC in stop, STOP mode		1.0	10	$\mu$ A	21

- Note 12. Applied to pins P10-P17, P20-P27, P30-P32, P40-P47, P50-P57, P71, P72, P74, P76, P77, P80-P87, P90-P93, CKIN
- Note 13. Applied to pins  $\overline{RESET}$ , OSCIN, P00-P07, P33-P37, P70, P73, P75
- Note 14. Applied to pins (with pull-up resistors disconnected) P00-P07, P10-P17, P20-P27, P30-P37, P40-P47, P50-P57, P70-P77, P80-P87, P90-P93
- Note 15. Applied to pins  $\overline{RESET}$   
(with pull-up resistors disconnected) P00-P07, P10-P17, P20-P27, P30-P37, P50-P57, P70-P77, P80-P87, P90-P93
- Note 16. Applied to pins P60-P67, PA0-PA7
- Note 17. Applied to pins P10-P17, P20-P27, P30-P37, P50-P57, P70-P77, P80-P87, P90-P93  
P00 ( $\overline{RD}$ ), P01 ( $\overline{WR}$ ) (in external memory expansion mode)
- Note 18. Applied to pins DAOUT0, DAOUT1
- Note 19. Without load  $V_{DD}=5.0$  V, main clock frequency = 12 MHz
- Note 20. Without load  $V_{DD}=5.0$  V, OSC running (32.768 kHz),  $V_R=GND$ , constant input signal
- Note 21. Without load  $V_{DD}=5.0$  V, OSCIN=GND,  $V_R=GND$ , constant input signal

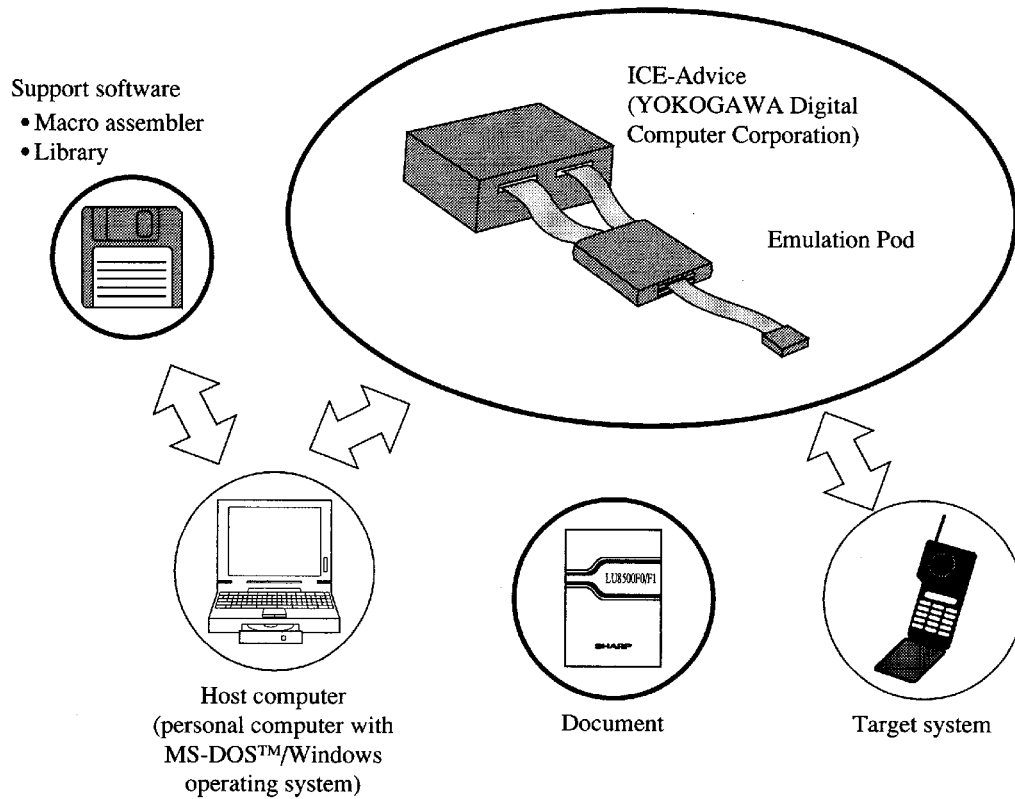


**LU8500F0/F1 Development Support System**

The software program for LU8500F0/F1 can be developed through a system consisting of a personal computer (MS-DOS™)\* serving as a host, an in-circuit emulator and many types of development devices for user's system evaluation.

If a GP-IB interface is used in place of the standard RS-232C interface, programs can be transferred to an emulator at high speed.

\* MS-DOS™ is a trademark of Microsoft Corporation.



ICE	Debugger	Support language
YOKOGAWA Digital Computer Corporation AD200-S56/PP150A	Micro VIEW-G (Windows)	<ul style="list-style-type: none"> <li>• Assembler (SHARP)</li> <li>• Structured assembler / C compiler (ADaC Corporation)</li> </ul>

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Ref. No. NP 169C

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