



## LC864164B/56B/48B/40B

### 8-bit Single Chip Microcontroller

## Overview

The LC864164B/56B/48B/40B microcontrollers are 8-bit single chip microcontrollers with the following on-chip functional blocks:

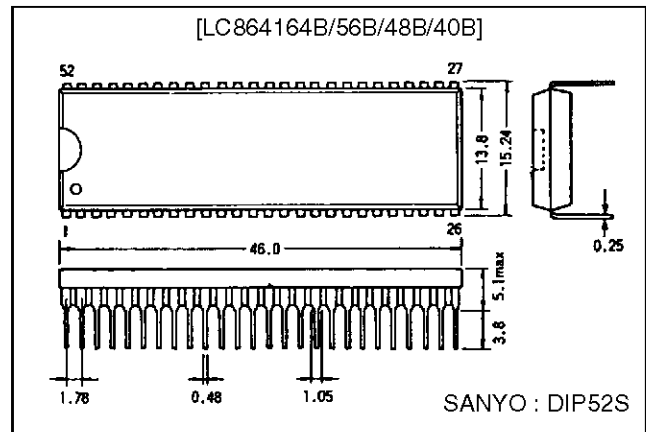
- CPU : Operable at a minimum bus cycle time of 0.5  $\mu$ s
- On-chip ROM maximum capacity : 64 K bytes
- On-chip RAM capacity : 384 bytes
- CRT display RAM : 640  $\times$  9 bits
- Closed-caption TV controller and the on-screen display controller
- 16-bit timer/counter
- 4 channel  $\times$  4-bit A/D Converter
- 8-bit synchronous serial-interface circuit
- Closed-caption data slicer
- 12-source 10-vectored interrupt system

All of the above functions are fabricated on a single chip.

## Package Dimensions

unit : mm

### 3128-DIP52S



## Features

- |                                  |           |                                       |
|----------------------------------|-----------|---------------------------------------|
| (1) Read-only memory (ROM) :     | LC864164B | 65280 $\times$ 8 bits                 |
|                                  | LC864156B | 57344 $\times$ 8 bits                 |
|                                  | LC864148B | 49152 $\times$ 8 bits                 |
|                                  | LC864140B | 40960 $\times$ 8 bits                 |
| (2) Random access memory (RAM) : |           | 384 $\times$ 8 bits                   |
|                                  |           | 640 $\times$ 9 bits (for CRT display) |

(3) OSD functions

- Screen for display : 34 columns × 16 rows (at standard character size)
- Display for RAM : 640 × 9 bits (6 columns for control + 34 columns for display) × 16 rows × 9 bits
- 252 kinds of user specified characters
  - 125 kinds 9 × 9 dots
  - 127 kinds 12 × 18 dots
- Various character attributes
  - Character colors : 16 colors
  - Character background colors : 16 colors
  - Fringe / shadow colors : 16 colors
  - Full screen colors : 16 colors
  - Fringe / shadow
  - Rounding
  - Underline
  - Italic character (slanting)
- Close-character attribute data changing available
- Vertical display start line setting available (Row overlapping available)
- Horizontal display start position setting available
- Display mode specification by row (Display mode mixable)
  - capto mode / text mode / OSD mode
- Eight kinds of characters size
  - Horiz × Vert. = (1 × 1), (1 × 2), (2 × 2), (2 × 4)
  - (1.5 × 1), (1.5 × 2), (3 × 2), (3 × 4)
- Shuttering and scrolling in row unit available
- Horizontal character pitch selectable : 9 to 16 dots
- Polarity of R, G, B, I, BL output programmable
- Polarity of HS, VS input programmable

(4) Bus cycle time / Instruction-cycle time

The LC864164A/56A/48A/40A microcontrollers are designed to read the ROM twice within one instruction cycle. It has about 1.7 times performance capability within the same instruction-cycle compared to our 4-bit microcontrollers (LC66000 series).

The bus cycle time indicates the speed to read ROM.

Bus cycle time	Instruction cycle time	System clock oscillation	Oscillation frequency	Voltage
0.5 μs	1.0 μs	Ceramic (CR)	12 MHz	4.5 V to 5.5 V
7.5 μs	15.0 μs	Internal RC	800 kHz	4.5 V to 5.5 V

(5) Ports

- Input/output port : 2 ports (16 lines)
- Input/output port programmable in nibble unit : 1 port (8 lines)
- (When the N-channel open drain output is selected, the data in a bit can be inputted.)
- Input/output port programmable in a bit : 1 port (8 lines)
- Input port : 2 ports (8 lines)

(6) A/D converter

- 4-channel × 4-bit A/D converter (converted with program)

(7) PWM output

- 10-channel × 7-bit PWM

(8) Timer

- Timer 0 : 16-bit timer / counter

2-bit prescaler + 8-bit built-in programmable prescaler

Mode 0 : Two 8-bit timers with a programmable prescaler

Mode 1 : 8-bit timer with a programmable prescaler + 8-bit counter

Mode 2 : 16-bit timer with a programmable prescaler

Mode 3 : 16-bit counter

The resolution of timer is 1 tCYC.

- Timer 1 : 16-bit timer / PWM

Mode 0 : Two 8-bit timers

Mode 1 : 8-bit timer + 8-bit PWM

Mode 2 : 16-bit timer

Mode 3 : Variable-bit PWM (9 to 16 bits)

In Mode 0 and Mode 1, the resolution of Timer and PWM is tCYC.

In Mode 2 and Mode 3, the resolution of Timer and PWM selectable : tCYC or 1/2tCYC by program.

(9) Remote control receiver circuit (shares with the P73/INT3/T0IN terminal)

- Noise rejection function

- Polarity switching

(10) Watchdog timer

External RC circuit is required

Interrupt or system reset is selectable

(11) Interrupts

- 12-source 10-vectored interrupts

1. External interrupt INT0

2. External interrupt INT1

3. External interrupt INT2, Timer/counter T0L (Lower 8 bits)

4. External interrupt INT3

5. Timer/counter T0H (Upper 8 bits)

6. Timer T1H, T1L

7. Serial interface 0 (SIO0)

8. Data slicer

9. Vertical synchronous signal interrupt ( $\overline{VS}$ )

10. Port 0

- Interrupt priority control available

Three interrupt priorities are supported (low, high and the highest) and multilevel nesting is possible. Low or high priority can be assigned to the interrupt from 3 to 10 listed above. For the external interrupt INT0 and INT1, high or the highest priority can be set.

(12) Sub-routine stack level

- A maximum of 128 levels (Sets the stack inside a RAM.)

(13) Multiplication/division instruction

- 16 bits  $\times$  8 bits ( 7 instruction cycle times)

- 16 bits / 8 bits ( 7 instruction cycle times)

(14) 3 oscillation circuits

- On-chip RC oscillation circuit for the system clock
- On-chip CP oscillation circuit for the system clock
- On-chip LC oscillation circuit for the CRT synchronization

(15) Standby function

- HALT mode function

The HALT mode is used to reduce the power dissipation. In this operation mode, the program execution is stopped.

This mode can be released by the interrupt request signals or the system reset.

- HOLD mode

The HOLD mode is used to stop oscillations ; the RC (internal) and the ceramic oscillations.

This mode can be released by the following conditions.

- Pull the reset terminal ( $\overline{\text{RES}}$ ) to low level.
- Feed the selected level to either P70/INT0 or P71/INT1.
- Feed the Port 0 interrupt condition.

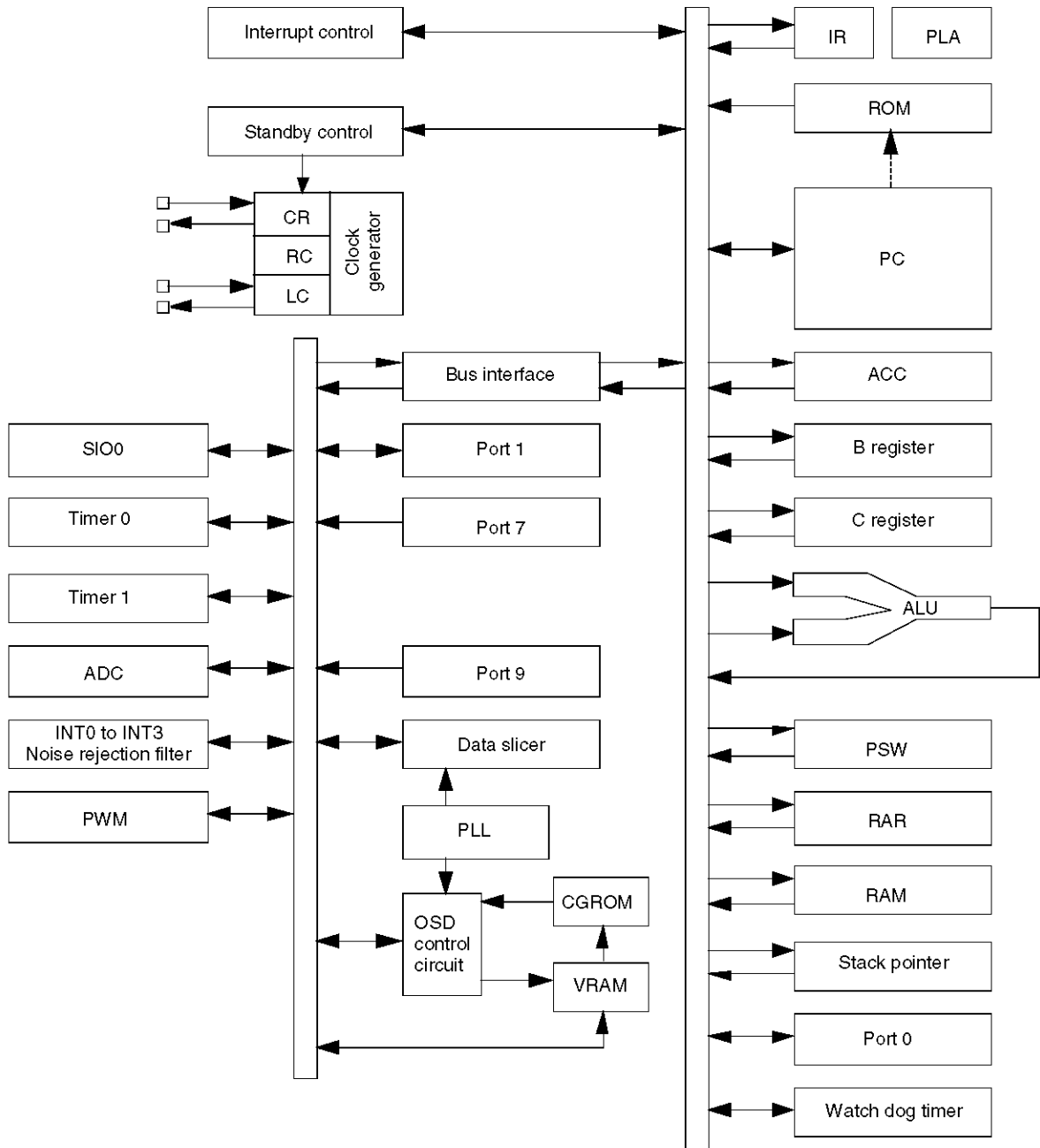
(16) Factory shipment

DIP52S

(17) Development Tool

- Evaluation chip : LC866098
- EPROM with a window : LC86E4164
- One time : LC86P4164
- Emulator : EVA86000 (Main) + ECB864100 (Evaluation board) + POD864100 (Pod)

System Block Diagram



## LC864164B/56B/48B/40B

### Pin Assignment

P10/SO0	□ 1	□ 52	P07
P11/SI0/SB0	□ 2	□ 51	P06
P12/SCK0	□ 3	□ 50	P05
P13	□ 4	□ 49	P04
P14	□ 5	□ 48	P03
P15	□ 6	□ 47	P02
P16	□ 7	□ 46	P01
P17/PWM	□ 8	□ 45	P00
DVSS	□ 9	□ 44	P73/INT3/T0IN
CF1	□ 10	□ 43	P72/INT2/T0IN
CF2	□ 11	□ 42	P71/INT1
DVDD	□ 12	□ 41	P70/INT0
P90/AN0	□ 13	□ 40	PWM9
P91/AN1	□ 14	□ 39	PWM8
P92/AN2	□ 15	□ 38	PWM7
P93/AN3	□ 16	□ 37	PWM6
$\overline{\text{RES}}$	□ 17	□ 36	PWM5
LC1	□ 18	□ 35	PWM4
LC2	□ 19	□ 34	PWM3
FILT	□ 20	□ 33	PWM2
AVDD	□ 21	□ 32	PWM1
AVSS	□ 22	□ 31	PWM0
CVIN	□ 23	□ 30	BL
$\overline{\text{VS}}$	□ 24	□ 29	B
$\overline{\text{HS}}$	□ 25	□ 28	G
I	□ 26	□ 27	R

Top view

## LC864164B/56B/48B/40B

### Pin Description

- Port option can be specified in bit units except the pull-up resistor selection of port 0.

Pin name	Pin No.	I/O	Function description	Option																																			
DVSS	9	—	Negative power supply for digital circuit																																				
CF1	10	Input	Input terminal for ceramic resonator																																				
CF2	11	Output	Output terminal for ceramic resonator																																				
DVDD	12	—	Positive power supply for digital circuit																																				
$\overline{\text{RES}}$	17	Input	Reset terminal																																				
LC1	18	Input	LC oscillation circuit input terminal																																				
LC2	19	Output	LC oscillation circuit output terminal																																				
FILT	20	Output	Filter terminal for PLL																																				
AVDD	21	—	Positive power supply for analog circuit																																				
AVSS	22	—	Negative power supply for analog circuit																																				
CVIN	23	Input	Video signal input terminal																																				
$\overline{\text{VS}}$	24	Input	Vertical synchronization signal input terminal																																				
$\overline{\text{HS}}$	25	Input	Horizontal synchronization signal input terminal																																				
I	26	Output	Image intensity output																																				
R	27	Output	Red (R) output terminal of RGB image output																																				
G	28	Output	Green (G) output terminal of RGB image output																																				
B	29	Output	Blue (B) output terminal of RGB image output																																				
BL	30	Output	Fast blanking control signal Switch TV image signal and caption/OSD image signal																																				
PWM0 to PWM9	31 to 40	Output	PWM0 to 9 output terminals 15 V withstand																																				
Port 0 P00 to P07	45 to 52	I/O	8-bit Input/output port Input/output can be specified in nibble units HOLD release input Interrupt input	Pull-up resistor Provided/not provided (in bit units) Output Format CMOS/Nch-OD (in bit units)																																			
Port 1 P10 to P17	1 to 8	I/O	8-bit Input/output port Input/output can be specified in bit units Other function <table border="1" style="margin-left: 20px;"> <tr> <td>P10</td> <td>SIO0 data output</td> </tr> <tr> <td>P11</td> <td>SIO0 data input / bus input/output</td> </tr> <tr> <td>P12</td> <td>SIO0 clock input/output</td> </tr> <tr> <td>P17</td> <td>Timer 1 (PWM) output</td> </tr> </table>	P10	SIO0 data output	P11	SIO0 data input / bus input/output	P12	SIO0 clock input/output	P17	Timer 1 (PWM) output	Output Format CMOS/Nch-OD (in bit units)																											
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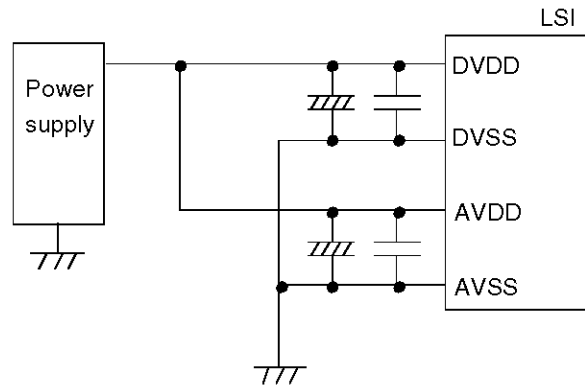
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Pin name	Pin No.	I/O	Function description	Option
Port 9	13 to 16	Input	4-bit input port Other functions A/D converter input port (4 lines)	
P90 to P93				

- Any port option can be selected in bit units.
- Port 0 option : Pull-up resistor is provided when CMOS output is selected.  
The pull-up resistor is not provided when N-ch Open Drain is selected.
- Port 1 option: Programmable pull-up resistor is provided when any output form is selected.
- Port status during reset

Terminal	I/O	Pull-up resistor status at selecting pull-up option
Port 0	Input	Pull-up resistor OFF, ON after reset release
Port 1	Input	Programmable pull-up resistor OFF
Port 7	Input	Fixed pull-up resistor provided

\* AVDD and AVSS are the power supply terminals for built-in analog circuit while DVDD and DVSS are the power supply terminals for built-in digital circuit. Connect them like the following figure to reduce the mutual noise influence.





# LC864164B/56B/48B/40B

## Specifications

### 1. Absolute Maximum Ratings at Ta = 25°C, VSS = 0 V

Parameter	Symbol	Pins	Conditions	Ratings			Unit		
				VDD [V]	min	typ		max	
Supply voltage	VDDmax	DVDD, AVDD	DVDD = AVDD		-0.3		7.0	V	
Input voltage	VI(1)	<ul style="list-style-type: none"> <li>• P71, 72, 73</li> <li>• Port 9</li> <li>• <math>\overline{\text{RES}}</math>, <math>\overline{\text{HS}}</math>, <math>\overline{\text{VS}}</math>, CVIN</li> </ul>			-0.3		VDD+0.3		
Output voltage	VO(1)	R, G, B, BL, I, FILT			-0.3		VDD+0.3		
	VO(2)	PWM0 to PWM9			-0.3		15		
Input/output voltage	VIo(1)	Ports 0, 1, P70			-0.3		VDD+0.3		
High-level output current	Peak output current	IOPH(1)	Ports 0, 1	<ul style="list-style-type: none"> <li>• Pull-up MOS Transistor output</li> <li>• At each pin</li> </ul>		-2			mA
		IOPH(2)	Ports 0, 1	<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• At each pin</li> </ul>		-4			
		IOPH(3)	R, G, B, BL, I	<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• At each pin</li> </ul>		-5			
	Total output current	$\Sigma I_{OAH}(1)$	Port 1	The total of all pins		-10			
		$\Sigma I_{OAH}(2)$	Port 0	The total of all pins		-10			
		$\Sigma I_{OAH}(3)$	R, G, B, BL, I	The total of all pins		-15			
Low-level output current	Peak output current	ILOPL(1)	Ports 0, 1	At each pin			20		
		ILOPL(2)	P70	At each pin			30		
		ILOPL(3)	<ul style="list-style-type: none"> <li>• R, G, B, BL, I</li> <li>• PWM0 to PWM9</li> </ul>	At each pin			5		
	Total output current	$\Sigma I_{OAL}(1)$	Port 0	The total of all pins					40
		$\Sigma I_{OAL}(2)$	Port 1, P70	The total of all pins					40
		$\Sigma I_{OAL}(3)$	R, G, B, BL, I	The total of all pins					15
		$\Sigma I_{OAL}(4)$	PWM0 to PWM9	The total of all pins					30
Maximum power dissipation	Pd max	DIP52S	Ta = -30 to +70°C				430	mW	
Operating temperature range	Topr				-30		+70	°C	
Storage temperature range	Tstg				-55		+150		

\*DVSS and AVSS must be supplied the same voltage, VSS.  
 DVDD and AVDD must be supplied the same voltage, VDD.

VSS = DVSS = AVSS  
 VDD = DVDD = AVDD

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### 2. Recommended Operating Range at Ta = -30°C to +70°C, V<sub>SS</sub> = 0 V

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				V <sub>DD</sub> [V]	min	typ		max
Operating supply voltage range	V <sub>DD</sub>	DVDD, AVDD	0.98 μs ≤ tCYC tCYC ≤ 1.02 μs		4.5		5.5	V
Hold voltage	V <sub>HD</sub>	DVDD, AVDD	RAMs and the registers hold data at HOLD mode.		2.0		5.5	
Input high-level voltage	V <sub>IH</sub> (1)	Port 0 (Schmitt)	Output disable	4.5 to 5.5	0.6V <sub>DD</sub>		V <sub>DD</sub>	
	V <sub>IH</sub> (2)	• Port 1 (Schmitt) • P72,73 • HS,VS	Output disable	4.5 to 5.5	0.75V <sub>DD</sub>		V <sub>DD</sub>	
	V <sub>IH</sub> (3)	• P70 port input / interrupt • P71 • RES (Schmitt)	Output N-channel transistor OFF	4.5 to 5.5	0.75V <sub>DD</sub>		V <sub>DD</sub>	
	V <sub>IH</sub> (4)	P70 Watchdog timer input	Output N-channel transistor OFF	4.5 to 5.5	V <sub>DD</sub> -0.5		V <sub>DD</sub>	
	V <sub>IH</sub> (5)	Port 9 port input		4.5 to 5.5	0.7V <sub>DD</sub>		V <sub>DD</sub>	
Input low-level voltage	V <sub>IL</sub> (1)	Port 0 (Schmitt)	Output disable	4.5 to 5.5	V <sub>SS</sub>		0.2V <sub>DD</sub>	
	V <sub>IL</sub> (2)	• Port 1 (Schmitt) • P72,73 • HS,VS • Port 9	Output disable	4.5 to 5.5	V <sub>SS</sub>		0.25V <sub>DD</sub>	
	V <sub>IL</sub> (3)	• P70 port input / interrupt • P71 • RES (Schmitt)	N-channel transistor OFF	4.5 to 5.5	V <sub>SS</sub>		0.25V <sub>DD</sub>	
	V <sub>IL</sub> (4)	P70 Watchdog timer input	N-channel transistor OFF	4.5 to 5.5	V <sub>SS</sub>		0.6V <sub>DD</sub>	
	V <sub>IL</sub> (5)	Port 9 port input		4.5 to 5.5	V <sub>SS</sub>		0.3V <sub>DD</sub>	
CVIN input amplitude	V <sub>CVIN</sub>	CVIN		5.0	1Vp-p -3dB	1Vp-p	1Vp-p +3dB	Vp-p *
Operation cycle time	tCYC(1)		OSD function	4.5 to 5.5	0.98	1	1.02	μs
	tCYC(2)		Except OSD function	4.5 to 5.5	0.98		30	

\* Vp-p : Peak-to-peak voltage

## LC864164B/56B/48B/40B

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				V <sub>DD</sub> [V]	min	typ		max
Oscillation frequency range (Note 1)	FmCF	CF1, CF2	12 MHz (ceramic resonator oscillation) Refer to Figure 1.	4.5 to 5.5	11.76	12	12.24	MHz
	FmLC	LC1, LC2	14.11 MHz (LC oscillation) Refer to Figure 2.	4.5 to 5.5		14.11		
	FmRC		RC oscillation	4.5 to 5.5	0.4	1.5	3.0	
Oscillation stable time period (Note 2)	tmsCF	CF1, CF2	12 MHz (ceramic resonator oscillation) Refer to Figure 3.	4.5 to 5.5		0.02	0.2	ms

(Note 1) The oscillation constant is shown on Table 1 and Table 2.

(Note 2) The oscillation stable time period is the time necessary for the oscillation to become stable after the following conditions.

1. Supplying voltage.
2. Release the HOLD mode.
3. Release stopping the main-clock oscillation.

Refer to Page 3 for details.

## LC864164B/56B/48B/40B

### 3. Electrical Characteristics at Ta = -30°C to +70°C, V<sub>SS</sub> = 0 V

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				V <sub>DD</sub> [V]	min	typ		max
Input high-level current	I <sub>IH</sub> (1)	<ul style="list-style-type: none"> <li>Port 1</li> <li>Port 0 without pull-up MOS transistor</li> </ul>	<ul style="list-style-type: none"> <li>Output disable</li> <li>Pull-up MOS transistor OFF</li> <li>V<sub>IN</sub> = V<sub>DD</sub></li> </ul> (including the off-leak current of the output transistor)	4.5 to 5.5			1	μA
	I <sub>IH</sub> (2)	<ul style="list-style-type: none"> <li>Port 7 without pull-up MOS transistor</li> <li>Port 9</li> <li><u>RES</u></li> <li>HS, VS</li> </ul>	V <sub>IN</sub> = V <sub>DD</sub>	4.5 to 5.5			1	
Input low-level current	I <sub>IL</sub> (1)	<ul style="list-style-type: none"> <li>Port 1</li> <li>Port 0 without pull-up MOS transistor</li> </ul>	<ul style="list-style-type: none"> <li>Output disable</li> <li>Pull-up MOS transistor OFF</li> <li>V<sub>IN</sub> = V<sub>SS</sub></li> </ul> (including the off-leak current of the output transistor)	4.5 to 5.5	-1			
	I <sub>IL</sub> (2)	<ul style="list-style-type: none"> <li>Port 7 without pull-up MOS transistor</li> <li>Port 9</li> </ul>	V <sub>IN</sub> = V <sub>SS</sub>	4.5 to 5.5	-1			
	I <sub>IL</sub> (3)	<ul style="list-style-type: none"> <li><u>RES</u></li> <li>HS, VS</li> </ul>	V <sub>IN</sub> = V <sub>SS</sub>	4.5 to 5.5	-1			
Output high-level voltage	V <sub>OH</sub> (1)	CMOS output of ports 0, 1	I <sub>OH</sub> = -1.0 mA	4.5 to 5.5	V <sub>DD</sub> -1			V
	V <sub>OH</sub> (2)	R, G, B, BL, I	I <sub>OH</sub> = -0.1 mA	4.5 to 5.5	V <sub>DD</sub> -0.5			
Output low-level voltage	V <sub>OL</sub> (1)	Ports 0, 1	I <sub>OL</sub> = 10 mA	4.5 to 5.5			1.5	
	V <sub>OL</sub> (2)	Ports 0, 1	<ul style="list-style-type: none"> <li>I<sub>OL</sub> = 1.6 mA</li> <li>The total current of the ports 0,1 is not over 40 mA.</li> </ul>	4.5 to 5.5			0.4	
	V <sub>OL</sub> (3)	<ul style="list-style-type: none"> <li>R, G, B, BL, I</li> <li>PWM0 to PWM9</li> </ul>	<ul style="list-style-type: none"> <li>I<sub>OL</sub> = 3.0 mA</li> <li>The current of any unmeasured pin is not over 3 mA.</li> </ul>	4.5 to 5.5			0.4	
	V <sub>OL</sub> (4)	P70	I <sub>OL</sub> = 1 mA	4.5 to 5.5			0.4	
Pull-up MOS transistor resistance	R <sub>pu</sub>	<ul style="list-style-type: none"> <li>Ports 0, 1</li> <li>Port 7</li> </ul>	V <sub>OH</sub> = 0.9V <sub>DD</sub>	4.5 to 5.5	13	38	80	kΩ
Output off-leakage current	I <sub>OFF</sub>	PWM0 to PWM9	V <sub>OUT</sub> = 13.5V	4.5 to 5.5			5	μA
Hysteresis voltage	V <sub>HIS</sub>	<ul style="list-style-type: none"> <li>Ports 0, 1</li> <li>Port 7</li> <li><u>RES</u></li> <li>HS, VS</li> </ul>	Output disable	4.5 to 5.5		0.1V <sub>DD</sub>		V

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Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				V <sub>DD</sub> [V]	min	typ		max
Input clamp voltage	V <sub>CLMP</sub>	CVIN		5.0	2.3	2.5	2.7	V
Pin capacitance	CP	All pins	<ul style="list-style-type: none"> <li>• f = 1 MHz</li> <li>• Unmeasured terminals for the input are set to V<sub>SS</sub> level.</li> <li>• Ta = 25°C</li> </ul>	4.5 to 5.5		10		pF

### 4. Serial Input/Output Characteristics at Ta = -30°C to +70°C, V<sub>SS</sub> = 0 V

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				V <sub>DD</sub> [V]	min	typ		max
Serial clock	Input clock	Cycle	tCKCY(1)	<ul style="list-style-type: none"> <li>• SCK0</li> <li>• SCLK0</li> </ul> Refer to Figure 5	4.5 to 5.5	2		tCYC
		Low-level pulse width	tCKL(1)		4.5 to 5.5	1		
		High-level pulse width	tCKH(1)		4.5 to 5.5	1		
	Output clock	Cycle	tCKCY(2)	<ul style="list-style-type: none"> <li>• Use a pull-up resistor (1 kΩ) during open drain output</li> <li>• Refer to Figure 5.</li> </ul>	4.5 to 5.5	2		
		Low-level pulse width	tCKL(2)		4.5 to 5.5		1/2tCKCY	
		High-level pulse width	tCKH(2)		4.5 to 5.5		1/2tCKCY	
Serial input	Data set-up time	tICK	SI0	<ul style="list-style-type: none"> <li>• Data set-up to SCK0 rising</li> <li>• Data hold from SCK0 rising</li> <li>• Refer to Figure 5.</li> </ul>	4.5 to 5.5	0.1		μs
	Data hold time	tCKI			4.5 to 5.5	0.1		
Serial output	Output delay time (External serial clock)	tCKO(1)	SO0	<ul style="list-style-type: none"> <li>• Use a pull-up resistor (1 kΩ) during open drain output.</li> <li>• Data set-up to SCK0 falling</li> <li>• Data hold from SCK0 falling</li> <li>• Refer to Figure 5.</li> </ul>	4.5 to 5.5		7/12tCYC +0.2	μs
	Output delay time (Internal serial clock)	tCKO(2)			4.5 to 5.5		1/3tCYC +0.2	

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### 5. Pulse Input Conditions at $T_a = -30^\circ\text{C}$ to $+70^\circ\text{C}$ , $V_{SS} = 0\text{ V}$

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				$V_{DD}$ [V]	min	typ		max
High/low level pulse width	tPIH(1) tPIL(1)	•INT0, INT1 •INT2/T0IN	•Interrupt acceptable •Timer0-countable	4.5 to 5.5	1		tCYC	
	tPIH(2) tPIL(2)	INT3/T0IN (The noise rejection filter time constant is 1/1)	•Interrupt acceptable •Timer0-countable	4.5 to 5.5	2			
	tPIH(3) tPIL(3)	INT3/T0IN (The noise rejection filter time constant is 1/16)	•Interrupt acceptable •Timer0-countable	4.5 to 5.5	32			
	tPIL(4)	$\overline{\text{RES}}$	Reset acceptable	4.5 to 5.5	200		$\mu\text{s}$	
	tPIH(5) tPIL(5)	$\overline{\text{HS}}$ , $\overline{\text{VS}}$	Display position controllable Each active edge of $\overline{\text{HS}}$ , $\overline{\text{VS}}$ must be more than 1tCYC. Refer to Figure 7.	4.5 to 5.5	10		tCYC	
Rising/falling time	tTHL tTLH	$\overline{\text{HS}}$	Refer to Figure 7.	4.5 to 5.5		500	ns	
Horizontal pull-in range	FH	$\overline{\text{HS}}$	The monitor point in figure 10 is $1/2 V_{DD}$ .	4.5 to 5.5	15.23	15.73	16.23	kHz

### 6. A/D Converter Characteristics at $T_a = -30^\circ\text{C}$ to $+70^\circ\text{C}$ , $V_{SS} = 0\text{ V}$

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				$V_{DD}$ [V]	min	typ		max
Resolution	N			4.5 to 5.5		4	bit	
Absolute precision	ET		(Note 3)	4.5 to 5.5		$\pm 1/4$	$\pm 1/2$	LSB
Conversion time	tCAD	From selecting $V_{ref}$ to resulting	1 bit conversion time = 2tCYC	4.5 to 5.5			1.96	$\mu\text{s}$
Reference current	$I_{REF}$		(Regulate the ladder resistor)	4.5 to 5.5		1.0	2.0	mA
Analog input voltage range	$V_{AIN}$	AN0 to AN3		4.5 to 5.5	$V_{SS}$		$V_{DD}$	V
Analog port input current	$I_{AINH}$		$V_{AIN} = V_{DD}$	4.5 to 5.5			1	$\mu\text{A}$
	$I_{AINL}$		$V_{AIN} = V_{SS}$	4.5 to 5.5	-1			

(Note 3) Absolute precision excepts quantizing error ( $\pm 1/2$  LSB).

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### 7. Current Drain Characteristics at $T_a = -30^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ , $V_{SS} = 0\text{ V}$

Parameter	Symbol	Pins	Conditions	Ratings			Unit	
				$V_{DD}$ [V]	min	typ		max
Current drain during basic operation (Note 4)	$I_{DDOP}(1)$	DVDD, AVDD	<ul style="list-style-type: none"> <li>• FmCF = 12 MHz Ceramic resonator oscillation</li> <li>• FmLC = 14.11 MHz LC oscillation</li> <li>• System clock : CF oscillation</li> <li>• Internal RC oscillation stops.</li> </ul>	4.5 to 5.5		16	28	mA
Current drain in HALT mode (Note 4)	$I_{DDHALT}(1)$	DVDD, AVDD	<ul style="list-style-type: none"> <li>• HALT mode</li> <li>• FmCF = 12 MHz Ceramic resonator oscillation</li> <li>• FmLC = 0 Hz (oscillation stops)</li> <li>• System clock : CF oscillation</li> <li>• Internal RC oscillation stops.</li> </ul>	4.5 to 5.5		5	10	mA
	$I_{DDHALT}(2)$	DVDD, AVDD	<ul style="list-style-type: none"> <li>• HALT mode</li> <li>• FmCF = 0 MHz (oscillation stops)</li> <li>• FmLC = 0 Hz (oscillation stops)</li> <li>• System clock : Internal RC</li> </ul>	4.5 to 5.5		600	1200	$\mu\text{A}$
Current drain in HOLD mode (Note 4)	$I_{DDHOLD}$	DVDD, AVDD	<ul style="list-style-type: none"> <li>• HOLD mode</li> <li>• All oscillation stops.</li> </ul>	4.5 to 5.5		0.05	20	$\mu\text{A}$

(Note 4) The currents of the output transistors and the pull-up MOS transistors are ignored.

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Oscillation type	Manufacturer	Oscillator	C1	C2
12 MHz ceramic resonator oscillation	Murata	CSA12.0MTZ	33 pF	33 pF
		CST12.0MTW	on chip	
	Kyocera	KBR-12.0M	47 pF	47 pF

\* Both C1 and C2 must use an K rank ( $\pm 10\%$ ) and an SL characteristics.

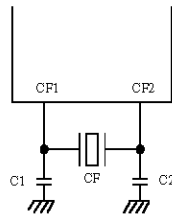
**Table 1. Ceramic Resonator Oscillation Guaranteed Constant (main-clock)**

Oscillation type	L	C3	C4
14.11MHz LC oscillation	4.7 $\mu$ H	33 pF	45 pF (Trimmer)
	4.7 $\mu$ H $\pm 10\%$ (Variable)	33 pF	33 pF

\* See Figure 11,12.

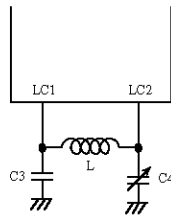
**Table 2. LC Oscillation Guaranteed Constant (OSD clock)**

- (Notes)
- Since the circuit pattern may affect the oscillation frequency, place the oscillation-related parts as close to the oscillation pins as possible with the shortest pattern length.
  - If you use other oscillators than those shown above, we provide no guarantee for the characteristics.
  - Adjust the voltage of monitor point in figure 10 to  $1/2V_{DD}\pm 10\%$  by the LC oscillation constant 'L' or 'C' to lock the PLL circuit.



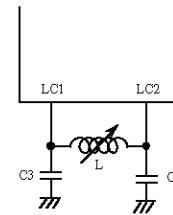
Main clock

**Figure 1 Ceramic Resonator Oscillation**



OSD clock

**Figure 2 LC Resonator Oscillation**





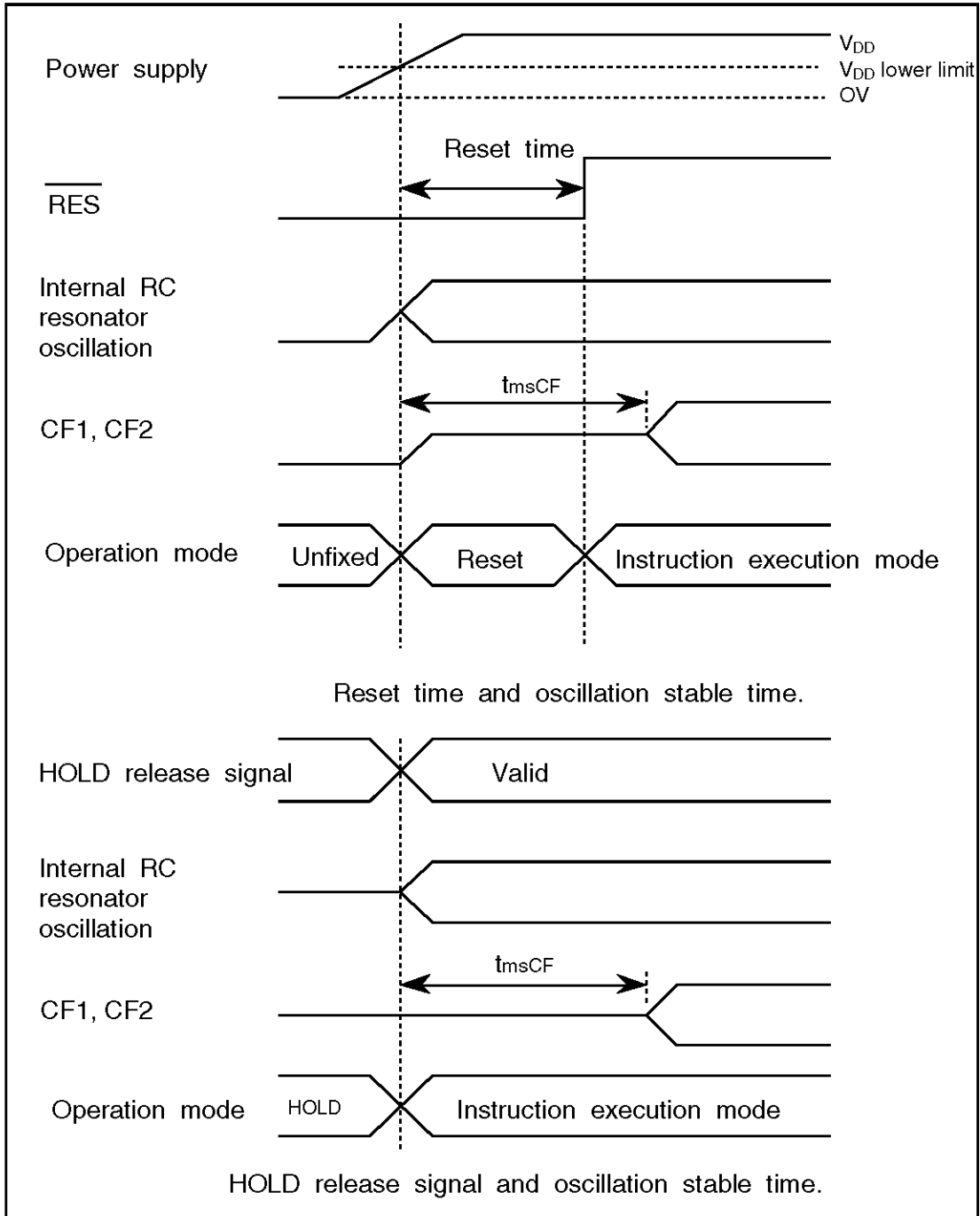


Figure 3 Oscillation Stable Time

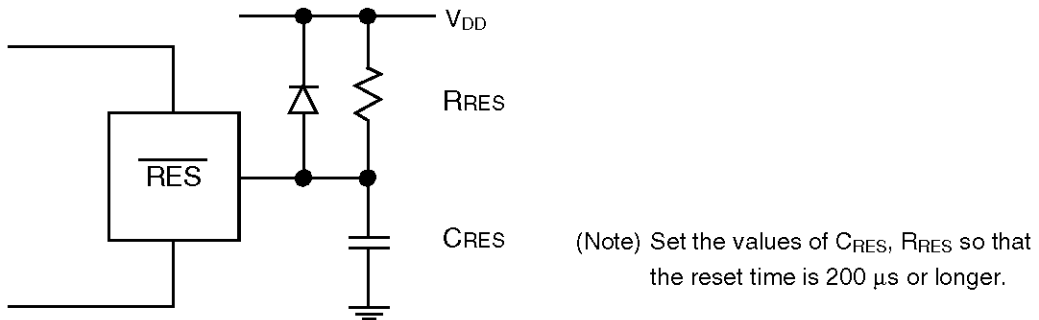


Figure 4 Reset Circuit

LC864164B/56B/48B/40B

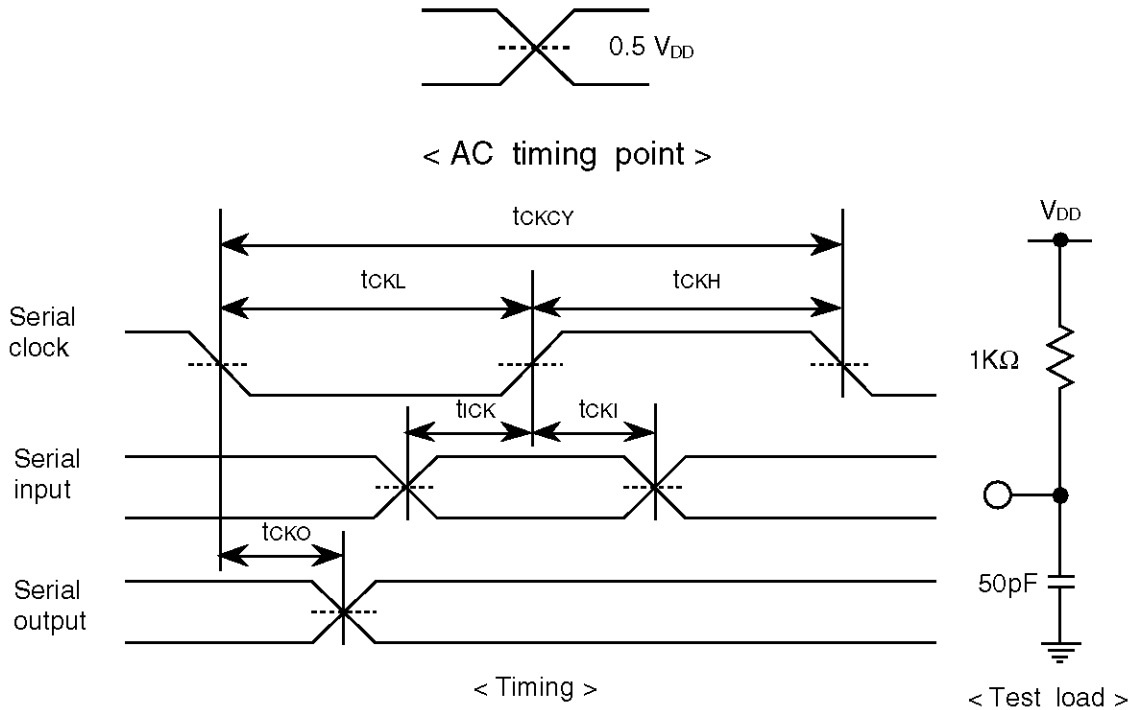


Figure 5 Serial Input/output Test Condition

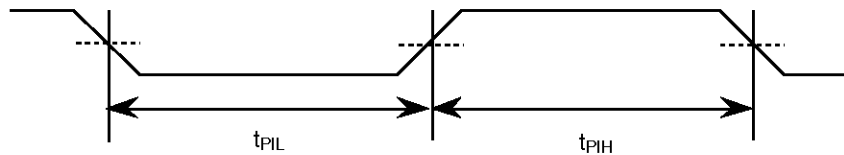


Figure 6 Pulse Input Timing Condition - 1

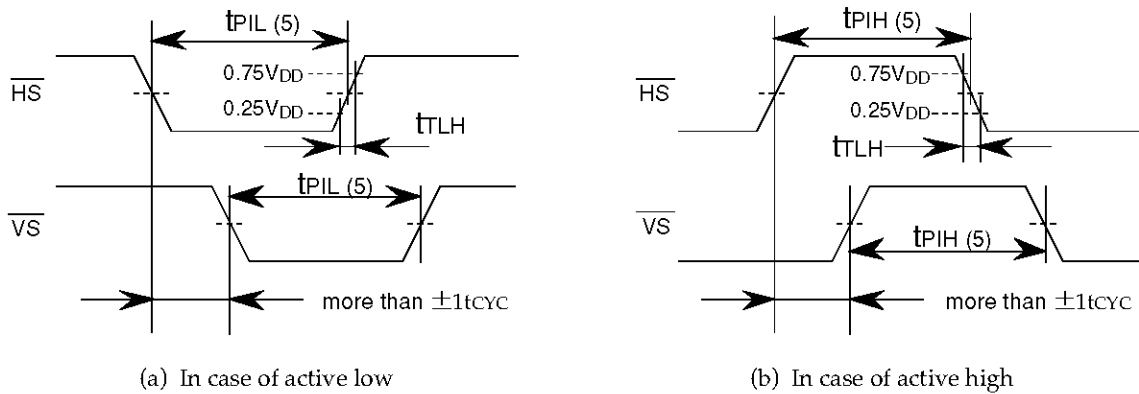


Figure 7 Pulse Input Timing Condition - 2

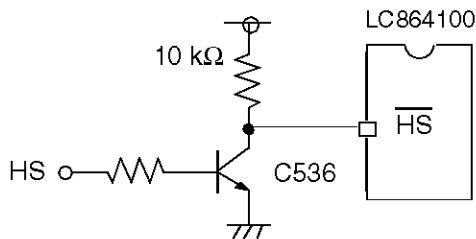


Figure 8 Recommended Interface Circuit

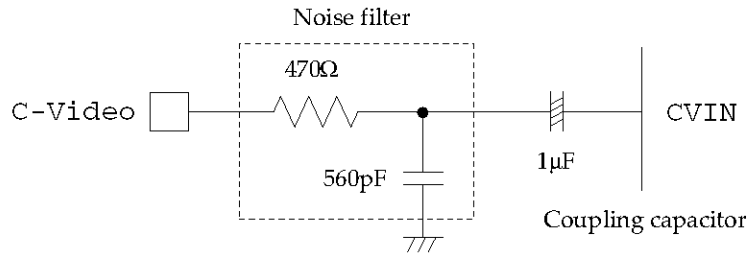


Figure 9 CVIN Recommended Circuit

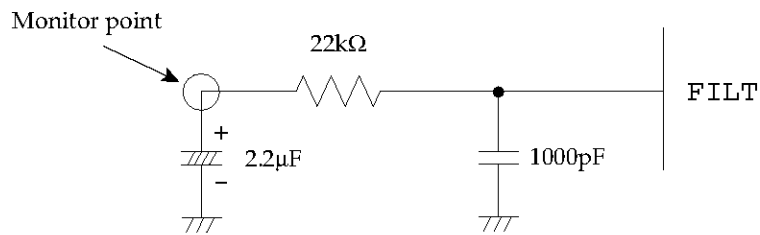


Figure 10 FILT Recommended Circuit

(Note) • Place the parts connected to the FILT terminal as close to the FILT as possible with the shortest pattern length on the board.

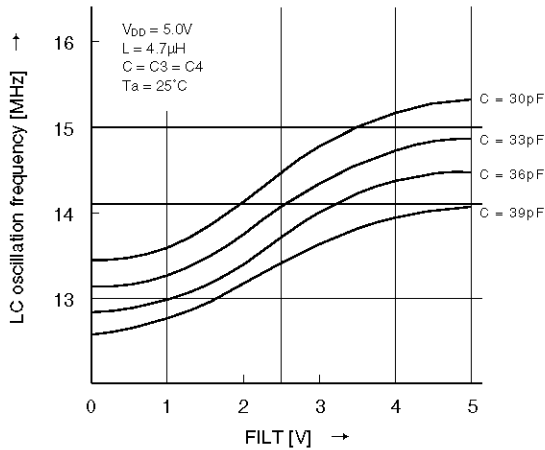


Figure 11 FILT-LC Oscillation Frequency (1)

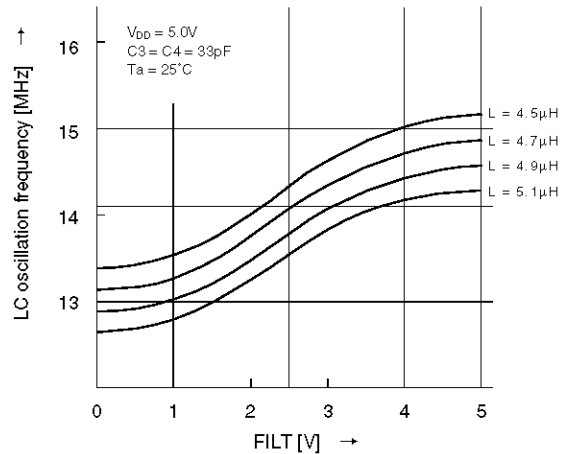


Figure 12 FILT-LC Oscillation Frequency (2)

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