Ordering number: EN 5582

CMOS LSI

LC864532A/28A/24A/20A/16A/12A/08A

8-bit Single Chip Microcontroller

Overview

The LC864532A/28A/24A/20A/16A/12A/08A microcontrollers are 8-bit single chip microcontrollers for the TV controls with the following on-chip functional blocks:

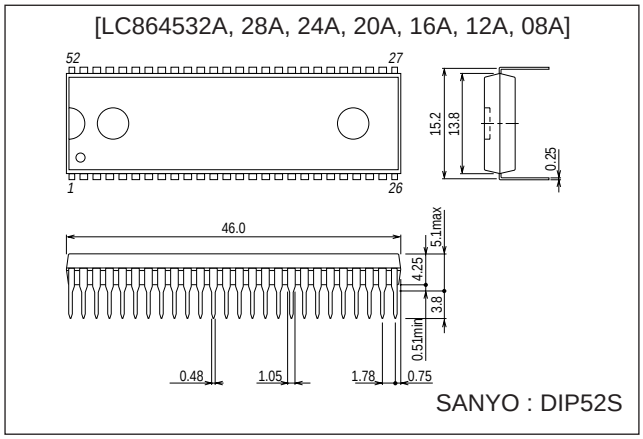
- CPU : Operable at a minimum bus cycle time of 0.5 µs
- On-chip ROM maximum capacity : 32K bytes (LC864532A)
- On-chip RAM capacity : 256 bytes
- CRT display RAM : 160 × 9 bits
- On-Screen Display controller
  Kanji (Chinese character) displaying available
- 16-bit timer/counter
- 16-bit timer/PWM
- 4-channel × 4-bit A/D Converter
- Two 6-bit D/A Converters
- 8-bit synchronous serial-interface circuit

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

Package Dimensions

unit : mm

3128-DIP52S



Feature

(1) Read-Only Memory (ROM) :

LC864532A	32768 × 8 bits	LC864516A	16384 × 8 bits
LC864528A	28672 × 8 bits	LC864512A	12288 × 8 bits
LC864524A	24576 × 8 bits	LC864508A	8192 × 8 bits
LC864520A	20480 × 8 bits		

(2) Random Access Memory (RAM) : 256 × 8 bits
160 × 9 bits (for CRT display)

(3) Bus cycle time / Instruction-cycle time
The LC864532A/28A/24A/20A/16A/12A/08A microcontrollers are constructed 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 (CF)	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

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(4) OSD functions
- Screen for display : 34 columns × 16 rows (at standard character size)
- Display RAM : 160 × 9 bits (6 columns for control + 34 columns for display) × 4 rows × 9 bits
- 252 kinds of user specified characters
  252 kinds 12 × 18 dots
- Various character attributes
  Character colors : 8 colors
  Character background colors : 8 colors
  Fringe / shadow : 8 colors
  Full screen colors : 8 colors
  Fringe / shadow
  Rounding
- Adjacent character attribute data changing available
- Vertical display start line setting in row unit available (row overlapping available)
- Horizontal display start position setting available
- Eight kinds of character 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 $\overline{R}$, $\overline{G}$, $\overline{B}$, BL output programmable
- Polarity of $\overline{HS}$, $\overline{VS}$ input programmable

(5) Ports
- Input/output ports : 2 ports (16 lines)
  Input/output port programmable in nibble units : 1 port (8 lines)
  (when the N-ch open drain output is selected, the data in a bit can be inputted)
  Input/output port programmable in bit units : 1 port (8 lines)
- Input ports : 2 ports (8 lines)

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

(7) D/A converters
- Two 7-bit D/A converters

(8) PWM outputs
- Ten 7-bit PWMs
- 10-channel × 7-bit PWM

(9) 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 with a programmable prescaler
  Mode 1 : 8-bit timer with a programmable prescaler + 8-bit PWM
  Mode 2 : 16-bit timer with a programmable prescaler
  Mode 3 : Variable-bit PWM (9 to 16 bits)
  In Mode 0 and Mode 1, the resolution of Timer and PWM is 1 tCYC.
  In Mode 2 and Mode 3, the resolution of Timer and PWM selectable : 1 tCYC or 1/2 tCYC by program.

(10) Remote control receiver circuit (shares with the P73/INT3/T0IN pin)
- Noise rejection function
- Polarity switching

(11) Watchdog timer
External RC circuit is required
Interrupt or system reset is selectable.

(12) Interrupts
- 12-source 9-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. Vertical synchronous signal interrupt ($\overline{\text{VS}}$) , End of display row
9. 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 interrupts from 3 to 10 listed above. For the external interrupt INT0 and INT1, high or the highest priority can be set.

(13) Sub-routine stack level
- A maximum of 128 levels (Sets the stack inside a RAM.)

(14) Multiplication/division instruction
- 16 bits × 8 bits (7 instruction cycle times)
- 16 bits / 8 bits (7 instruction cycle times)

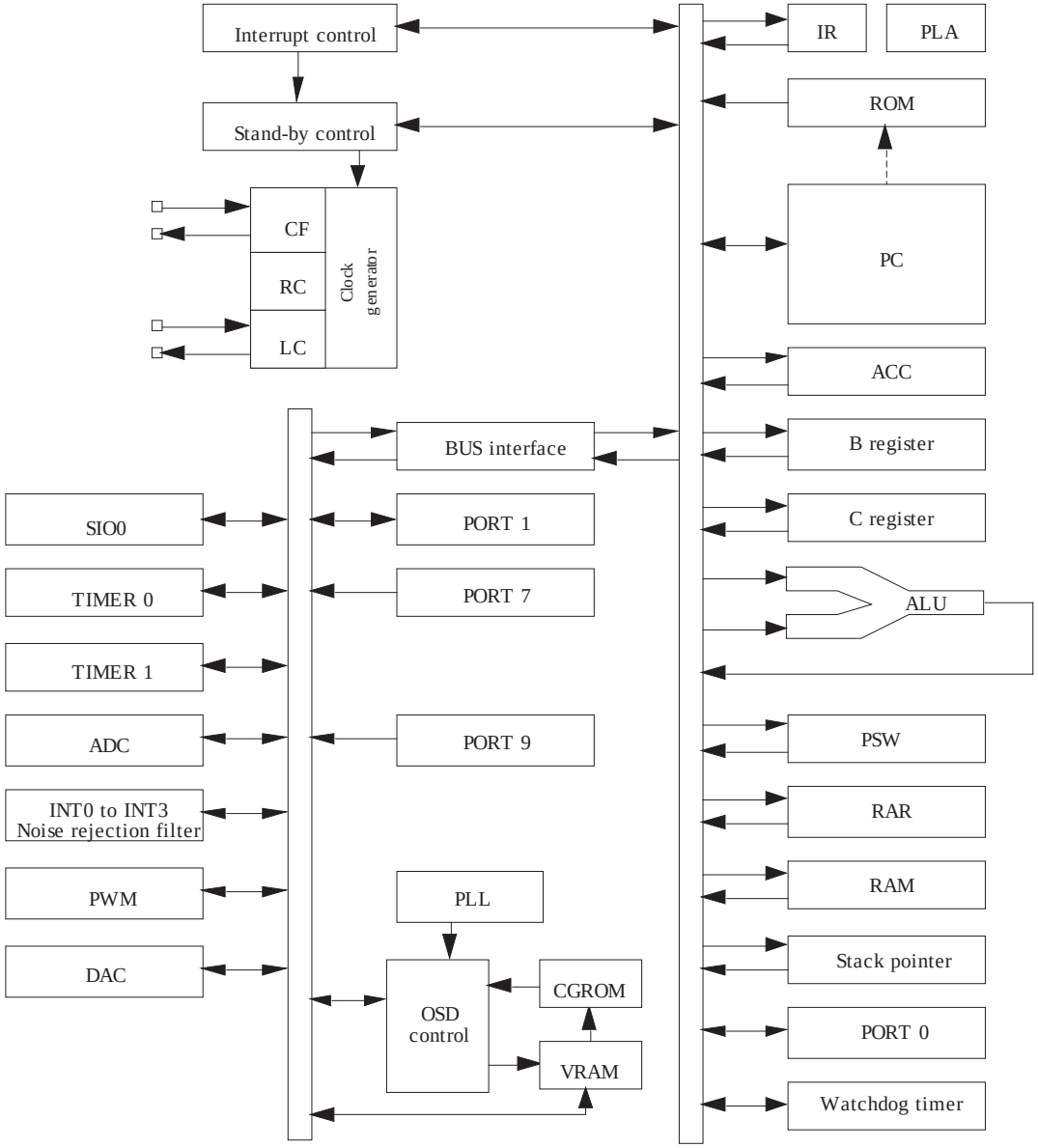
(15) 3 oscillation circuits
- On-chip RC oscillation circuit for the system clock
- On-chip CF oscillation circuit for the system clock
- On-chip LC oscillation circuit for the CRT synchronization

(16) 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 pin ($\overline{\text{RES}}$) to low level.
  • Feed the selected level to either P70/INT0 or P71/INT1.
  • Feed the Port0 interrupt condition.

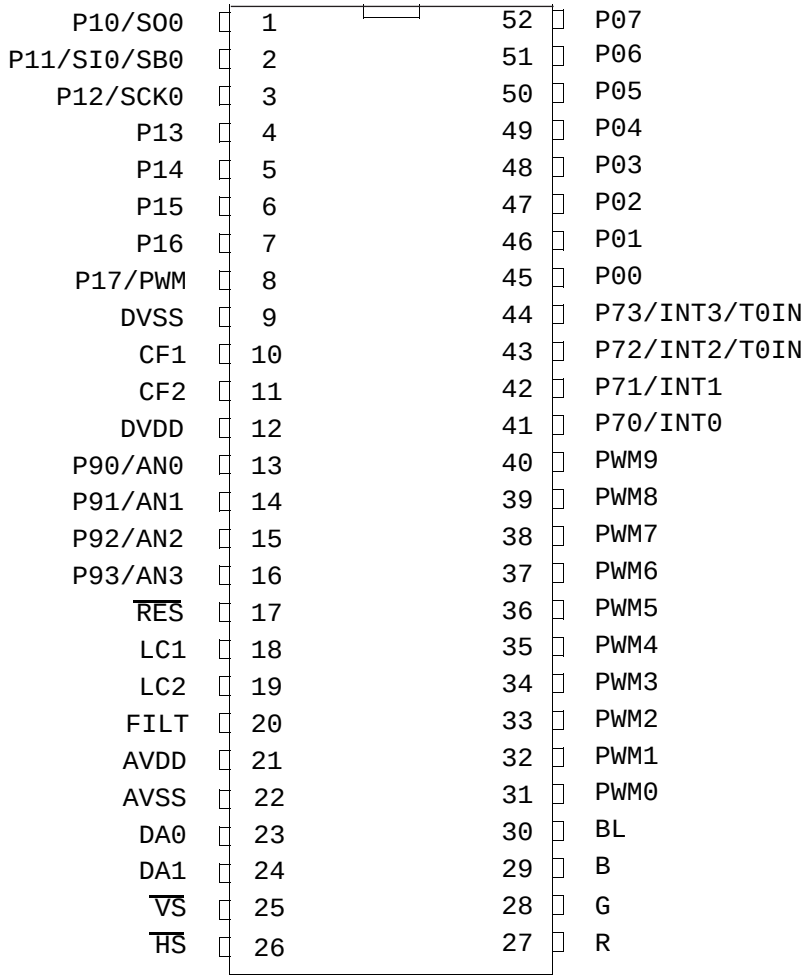
(17) Factory shipments
DIP52S

(18) Development Tools
- Evaluation (EVA) chip : LC866098
- EPROM with a window : LC86E4564
- One time ROM version : LC86P4564
- Emulator : EVA86000 (Main) + ECB864500 (Evaluation board) + POD864500 (Pod)

System Block Diagram



Pin Assignment



Top view

Pin Description

- Port option is able to be specified by a bit unit.

Pin Description Table

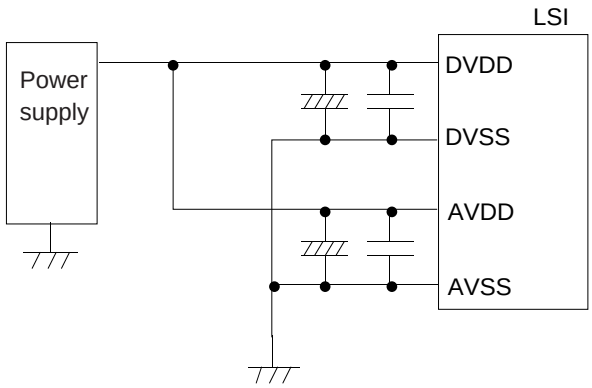
<table>
<tr><th>Pin name</th><th>Pin No.</th><th>I/O</th><th>Function description</th><th>Option</th></tr>
<tr><td>DVSS</td><td>9</td><td>—</td><td>Negative power terminal for digital circuit</td><td></td></tr>
<tr><td>CF1</td><td>10</td><td>Input</td><td>Input terminal for ceramic resonator</td><td></td></tr>
<tr><td>CF2</td><td>11</td><td>Input</td><td>Output terminal for ceramic resonator</td><td></td></tr>
<tr><td>DVDD</td><td>12</td><td>—</td><td>Positive power terminal for digital circuit</td><td></td></tr>
<tr><td>$\overline{\text{RES}}$</td><td>17</td><td>Input</td><td>Reset terminal</td><td></td></tr>
<tr><td>LC1</td><td>18</td><td>Input</td><td>LC oscillation circuit input terminal</td><td></td></tr>
<tr><td>LC2</td><td>19</td><td>Output</td><td>LC oscillation circuit output terminal</td><td></td></tr>
<tr><td>FILT</td><td>20</td><td>Output</td><td>Filter terminal for PLL</td><td></td></tr>
<tr><td>AVDD</td><td>21</td><td>—</td><td>Positive power terminal for analog circuit</td><td></td></tr>
<tr><td>AVSS</td><td>22</td><td>—</td><td>Negative power terminal for analog circuit</td><td></td></tr>
<tr><td>DA0</td><td>23</td><td>Output</td><td>DA0 output / general purpose I/O terminal</td><td></td></tr>
<tr><td>DA1</td><td>24</td><td>Output</td><td>DA1 output / general purpose I/O terminal</td><td></td></tr>
<tr><td>$\overline{\text{VS}}$</td><td>25</td><td>Input</td><td>Vertical synchronization signal input terminal</td><td></td></tr>
<tr><td>$\overline{\text{HS}}$</td><td>26</td><td>Input</td><td>Horizontal synchronization signal input terminal</td><td></td></tr>
<tr><td>R</td><td>27</td><td>Output</td><td>Red (R) output terminal of RGB image output</td><td></td></tr>
<tr><td>G</td><td>28</td><td>Output</td><td>Green (G) output terminal of RGB image output</td><td></td></tr>
<tr><td>B</td><td>29</td><td>Output</td><td>Blue (B) output terminal of RGB image output</td><td></td></tr>
<tr><td>BL</td><td>30</td><td>Output</td><td>Fast blanking control signal
Switch TV image signal and OSD image signal</td><td></td></tr>
<tr><td>PWM0
to PWM9</td><td>31 to 40</td><td>Output</td><td>PWM0 to 9 output terminal
15 V withstand</td><td></td></tr>
<tr><td>Port 0
P00 to P07</td><td>45 to 52</td><td>I/O</td><td>8-bit Input/output port
Input/output can be specified in nibble units
HOLD release input
Interrupt input</td><td>Pull-up resistor provided/ not provided (in bit units)
Output format CMOS/Nch-OD (in bit units)</td></tr>
<tr><td>Port 1
P10 to P17</td><td>1 to 8</td><td>I/O</td><td>8-bit Input/output port
Input/output can be specified in bit units
Other functions
<table>
<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>
</table></td><td>Output format CMOS/Nch-OD (in bit units)</td></tr>
<tr><td>Port 7
P70
P71 to P73</td><td>41
42 to 44</td><td>I/O
Input</td><td>4-bit input port
Other functions
<table>
<tr><td>P70</td><td>INT0 input / HOLD release input / Nch-transistor output for watchdog timer</td></tr>
<tr><td>P71</td><td>INT1 input / HOLD release input</td></tr>
<tr><td>P72</td><td>INT2 input / timer 0 event input</td></tr>
<tr><td>P73</td><td>INT3 input (noise rejection filter attached input) / timer 0 event input</td></tr>
</table>
Interrupt receiver format vector address
<table>
<tr><th></th><th>Rising</th><th>Falling</th><th>Rising / Falling</th><th>H level</th><th>L level</th><th>Vector</th></tr>
<tr><td>INT0</td><td>enable</td><td>enable</td><td>disable</td><td>enable</td><td>enable</td><td>03H</td></tr>
<tr><td>INT1</td><td>enable</td><td>enable</td><td>disable</td><td>enable</td><td>enable</td><td>0BH</td></tr>
<tr><td>INT2</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td><td>13H</td></tr>
<tr><td>INT3</td><td>enable</td><td>enable</td><td>enable</td><td>disable</td><td>disable</td><td>1BH</td></tr>
</table></td><td>Pull-up resistor provided/ not provided (in bit units)</td></tr>
<tr><td>Port 9
P90 to P93</td><td>13 to 16</td><td>Input</td><td>4-bit input port
Other function
A/D converter input port (4 lines)</td><td></td></tr>
</table>

- Any port option can be selected in bit units.
- Port 0 portion : Pull-up resistor is provided when CMOS output is selected.
  The pull-up resister is not provided when N-ch Open Drain is selected.
- Port 1 option : Programmable pull-up resister 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 terminals for built-in analog circuit. DVDD and DVSS are the power terminals for built-in digital circuit. Connect them like the following figure to reduce the mutual noise influence.



Specifications

1. Absolute Maximum Ratings at Ta = 25°C, V_{SS} = 0 V

Parameter		Symbol	Pins	Conditions		Ratings			Unit
					V_{DD} [V]	min	typ	max	
Supply voltage		V_{DD} max	DVDD, AVDD	DVDD = AVDD		–0.3		+7.0	V
Input voltage		V_I(1)	• P71, 72, 73 • Port 9 • $\overline{RES}$, $\overline{HS}$, $\overline{VS}$			–0.3		V_{DD}+0.3	
Output voltage		V_O(1)	R, G, B, BL, FILT			–0.3		V_{DD}+0.3	
		V_O(2)	PWM0 to PWM9			–0.3		+15	
Input/output voltage		V_{IO}(1)	Ports 0, 1, P70 DA0, 1			–0.3		V_{DD}+0.3	
High-level output current	Peak output current	I_{OPH}(1)	Ports 0, 1	• Pull-up MOS transistor output • At each pin		–2			mA
		I_{OPH}(2)	Ports 0, 1 DA0, 1	• CMOS output • At each pin		–4			
		I_{OPH}(3)	R, G, B, BL	• CMOS output • At each pin		–5			
	Total output current	$\sum I_{OAH}$(1)	Port 1	The total of all pins		–10			
		$\sum I_{OAH}$(2)	Port 0	The total of all pins		–10			
		$\sum I_{OAH}$(3)	R, G, B, BL	The total of all pins		–15			
Low-level output current	Peak output current	I_{OPL}(1)	Ports 0, 1 DA0, 1	At each pin				20	
		I_{OPL}(2)	P70	At each pin				30	
		I_{OPL}(3)	• R, G, B, BL • PWM0 to PWM9	At each pin				5	
	Total output current	$\sum I_{OAL}$(1)	Port 0	The total of all pins				40	
		$\sum I_{OAL}$(2)	Port 1, P70	The total of all pins				40	
		$\sum I_{OAL}$(3)	R, G, B, BL	The total of all pins				15	
		$\sum I_{OAL}$(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, V_{SS}. V_{SS} = DVSS = AVSS
DVDD and AVDD must be supplied the same voltage, V_{DD}. V_{DD} = DVDD = AVDD

2. Recommended Operating Range at Ta = –30°C to +70°C, V_{SS} = 0 V

Parameter	Symbol	Pins	Conditions		Ratings			Unit
				V_{DD} [V]	min	typ	max	
Operating voltage range	V_{DD}	DVDD, AVDD	0.98 µs ≤ tCYC tCYC ≤ 1.02 µs		4.5		5.5	V
Hold voltage	V_{HD}	DVDD, AVDD	RAMs and the registers hold data at HOLD mode.		2.0		5.5	
Input high voltage	V_{IH}(1)	Port 0 (Schmitt)	Output disable	4.5 to 5.5	0.6V_{DD}		V_{DD}	
	V_{IH}(2)	• Port 1 (Schmitt) • P72, 73 • $\overline{HS}$, $\overline{VS}$	Output disable	4.5 to 5.5	0.75V_{DD}		V_{DD}	
	V_{IH}(3)	• P70 port input / interrupt • P71 • $\overline{RES}$ (Schmitt)	Output N-channel transistor OFF	4.5 to 5.5	0.75V_{DD}		V_{DD}	
	V_{IH}(4)	P70 Watchdog timer input	Output N-channel transistor OFF	4.5 to 5.5	V_{DD}–0.5		V_{DD}	
	V_{IH}(5)	Port 9 DA0, 1 port input		4.5 to 5.5	0.7V_{DD}		V_{DD}	
Input low voltage	V_{IL}(1)	Port 0 (Schmitt)	Output disable	4.5 to 5.5	V_{SS}		0.2V_{DD}	
	V_{IL}(2)	• Port 1 (Schmitt) • P72, 73 • $\overline{HS}$, $\overline{VS}$ • Port 9	Output disable	4.5 to 5.5	V_{SS}		0.25V_{DD}	
	V_{IL}(3)	• P70 port input / interrupt • P71 • $\overline{RES}$ (Schmitt)	N-channel transistor OFF	4.5 to 5.5	V_{SS}		0.25V_{DD}	
	V_{IL}(4)	P70 Watchdog timer input	N-channel transistor OFF	4.5 to 5.5	V_{SS}		0.6V_{DD}	
	V_{IL}(5)	Port 9 DA0, 1 port input		4.5 to 5.5	V_{SS}		0.3V_{DD}	
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	

Parameter	Symbol	Pins	Conditions		Ratings			Unit
				V_{DD} [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	0.8	2.0	
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 : Refer to Table 1 and Table 2 for the oscillation constant.

Note 2 : The oscillation stable time is a period necessary for the oscillation to be stable after the power first applied, the HOLD mode released and the main-clock oscillation stop instruction released.
Refer to the Figure 3 for details.

3. Electrical Characteristics at Ta = –30°C to +70°C, V_{SS} = 0 V

Parameter	Symbol	Pins	Conditions		Ratings			Unit
				V_{DD} [V]	min	typ	max	
Input high-level current	I_{IH}(1)	• Port 1 DA0, 1 • Port 0 without pull-up MOS transistor.	• Output disable • Pull-up MOS transistor OFF • $V_{IN} = V_{DD}$ (including the off-leak current of the output transistor)	4.5 to 5.5			1	µA
	I_{IH}(2)	• Port 7 without pull-up MOS transistor. • Port 9 • $\overline{RES}$ • $\overline{HS}$, $\overline{VS}$	$V_{IN} = V_{DD}$	4.5 to 5.5			1	
Input low-level current	I_{IL}(1)	• Port 1 DA0, 1 • Port 0 without pull-up MOS transistor.	• Output disable • Pull-up MOS transistor OFF • $V_{IN} = V_{SS}$ (including the off-leak current of the output transistor)	4.5 to 5.5	–1			
	I_{IL}(2)	• Port 7 without pull-up MOS transistor. • Port 9	$V_{IN} = V_{SS}$	4.5 to 5.5	–1			
	I_{IL}(3)	• $\overline{RES}$ • $\overline{HS}$, $\overline{VS}$	$V_{IN} = V_{SS}$	4.5 to 5.5	–1			
Output high-level voltage	V_{OH}(1)	CMOS output of ports 0, 1 DA0, 1	I_{OH} = –1.0 mA	4.5 to 5.5	V_{DD}–1			V
	V_{OH}(2)	R, G, B, BL	I_{OH} = –0.1 mA	4.5 to 5.5	V_{DD}–0.5			
Output low-level voltage	V_{OL}(1)	Ports 0,1	I_{OL} = 10 mA	4.5 to 5.5			1.5	
	V_{OL}(2)	Ports 0,1 DA0,1	• I_{OL} = 1.6 mA • The total current of the ports 0, 1 is 40 mA or less.	4.5 to 5.5			0.4	
	V_{OL}(3)	• R, G, B, BL • PWM0 to PWM9	• I_{OL} = 3.0 mA • The current of any unmeasured pin is 3 mA or less.	4.5 to 5.5			0.4	
	V_{OL}(4)	P70	I_{OL} = 1 mA	4.5 to 5.5			0.4	
Pull-up MOS transistor resistance	Rpu	• Ports 0, 1 • Port 7	$V_{OH} = 0.9V_{DD}$	4.5 to 5.5	13	38	80	kΩ
Output off-leakage current	I_{OFF}	PWM0 to PWM9	V_{OUT} = 13.5 V	4.5 to 5.5			5	µA
Hysteresis voltage	V_{HIS}	• Ports 0, 1 • Port 7 • $\overline{RES}$ • $\overline{HS}$, $\overline{VS}$	Output disable	4.5 to 5.5		$0.1V_{DD}$		V
Pin capacitance	CP	All pins	• f = 1 MHz • Unmeasured input pins are set to V_{SS} level. • Ta = 25°C	4.5 to 5.5		10		pF

4. Serial Input/Output Characteristics at Ta = –30°C to +70°C, V_{SS} = 0 V

Parameter			Symbol	Pins	Conditions	Ratings				Unit
						V_{DD} [V]	min	typ	max	
Serial clock	Input clock	Cycle	tCKCY(1)	• SCK0 • SCLK0	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)	• SCK0 • SCLK0	• Use a pull-up resistor (1 kΩ) during open drain output. • Refer to Figure 5.	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	• Data set-up to SCK0 rising • Data hold from SCK0 rising • Refer to Figure 5.	4.5 to 5.5	0.1			µs
	Data hold time		tCKI			4.5 to 5.5	0.1			
Serial output	Output delay time (Serial clock is external clock)		tCKO(1)	SO0	• Use a pull-up resistor (1kΩ) during open drain output. • Data set-up to SCK0 falling • Data hold from SCK0 falling • Refer to Figure 5.	4.5 to 5.5			7/12tCYC +0.2	µs
	Output delay time (Serial clock is internal clock)		tCKO(2)			4.5 to 5.5			1/3tCYC +0.2	

5. Pulse Input Conditions at Ta = –30°C to +70°C, V_{SS} = 0 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 clock is set to 1/1)	• Interrupt acceptable • Timer0-countable	4.5 to 5.5	2			
	tPIH(3) tPIL(3)	INT3/T0IN (The noise rejection clock is set to 1/16)	• Interrupt acceptable • Timer0-countable	4.5 to 5.5	32			
	tPIL(4)	$\overline{RES}$	Reset acceptable	4.5 to 5.5	200			µs
	tPIH(5) tPIL(5)	$\overline{HS}$, $\overline{VS}$	Display position controllable Each active edge of $\overline{HS}$, $\overline{VS}$ must be more than 1tCYC. Refer to Figure 7.	4.5 to 5.5	10			tCYC
Rising/falling time	tTHL tTLH	$\overline{HS}$	Refer to Figure 7.	4.5 to 5.5			500	ns
Horizontal pull-in range	FH	$\overline{HS}$	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 Ta = –30°C to +70°C, V_{SS} = 0 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		±1/4	±1/2	LSB
Conversion time	tCAD	From Vref selection to when the result is produced	1 bit conversion time = 2tCYC	4.5 to 5.5			1.96	µs
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	µA
	I_{AINL}		V_{AIN} = V_{SS}	4.5 to 5.5	–1			

Note 3 : Absolute precision excepts quantizing error (±1/2 LSB).

7. D/A Converter Characteristics at Ta = –30°C to +70°C, V_{SS} = 0 V

Parameter	Symbol	Pins	Conditions		Ratings			Unit
				V_{DD} [V]	min	typ	max	
Resolution	NDA			4.5 to 5.5		7		bit
Absolute precision	ETDA		7 bits mode (Note 4)	4.5 to 5.5		±1.5	±3	LSB
Settling time	tSDA		(Note 5)	4.5 to 5.5		1.0		µs
Analog input voltage range	VAOUT	DA0 to DA1		4.5 to 5.5	V_{SS}		V_{DD}	V
Output register	RODA		(Note 6)	4.5 to 5.5	1.7	4	7	kΩ

Note 4 : Absolute precision excepts quantizing error (±1/2 LSB).
Note 5 : Settling time refers to the time from when the D/A conversion instruction is executed to when the analog voltage output corresponding to the digital on the specific port is generated. (No load)
Note 6 : D/A data = 80H

8. Current Drain Characteristics at Ta = –30°C to +70°C , V_{SS} = 0 V

Parameter	Symbol	Pins	Conditions		Ratings			Unit
				V_{DD} [V]	min	typ	max	
Current drain during basic operation (Note 7)	I_{DDOP}(1)	DVDD, AVDD	• FmCF = 12 MHz Ceramic resonator oscillation • FmLC = 14.11 MHz LC oscillation • System clock : CF oscillation • Internal RC oscillation stops	4.5 to 5.5		16	28	mA
Current drain in HALT mode (Note 7)	I_{DDHALT}(1)	DVDD, AVDD	• HALT mode • FmCF = 12 MHz Ceramic resonator oscillation • FmLC = 0 Hz (oscillation stops) • System clock : CF oscillation • Internal RC oscillation stops.	4.5 to 5.5		5	10	mA
	I_{DDHALT}(2)	DVDD, AVDD	• HALT mode • FmCF = 0 MHz (oscillation stops) • FmLC = 0 Hz (oscillation stops) • System clock : Internal RC	4.5 to 5.5		400	800	µA
Current drain in HOLD mode (Note 7)	I_{DDHOLD}(1)	DVDD, AVDD	• HOLD mode • All oscillation stops.	4.5 to 5.5		0.05	20	µA
	I_{DDHOLD}(2)							

Note 7 : The currents of the output transistors and the pull-up MOS transistors are ignored.

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	22 pF	22 pF

* Both C1 and C2 must use a K rank (±10%) and SL characteristics.

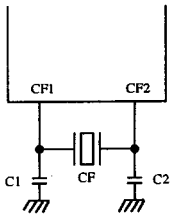
Table 1. Ceramic Resonator Oscillation Guaranteed Constant (main-clock)

Oscillation type	L	C3	C4
14.11 MHz LC oscillation	4.7 µH	33 pF	45 pF (Trimmer)
	4.7 µH±10% (Variable)	33 pF	33 pF

* See Figures 10 and 11 for the oscillation frequency.

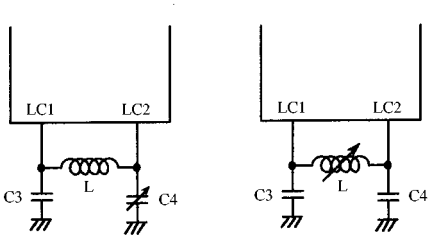
Table 2. LC Oscillation Guaranteed Constant (OSD clock)

(Notes) • Since the circuit pattern affects 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 herein, we provide no guarantee for the characteristics.
• Adjust the voltage of monitor point in Figure 10 to $1/2V_{DD}$±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

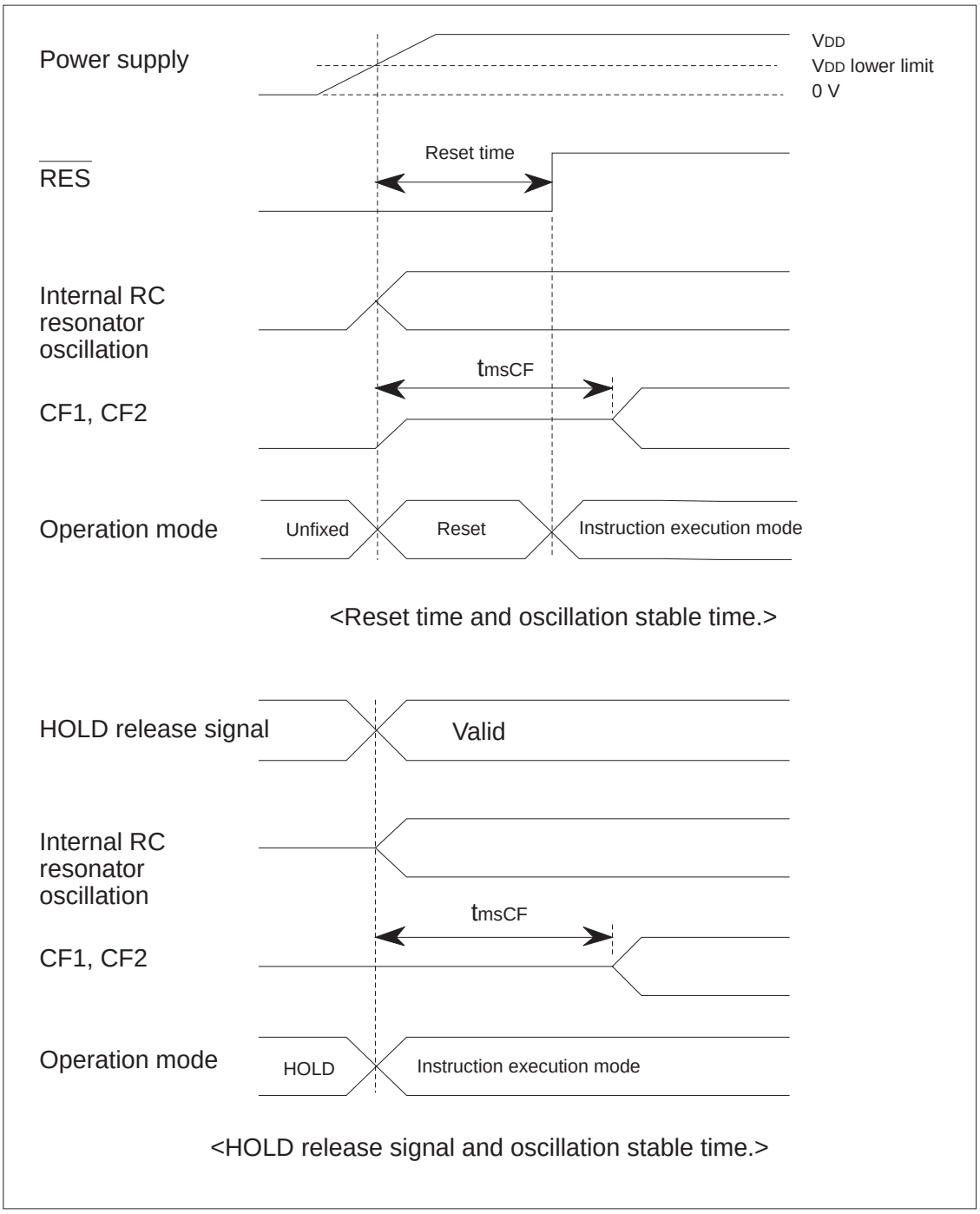
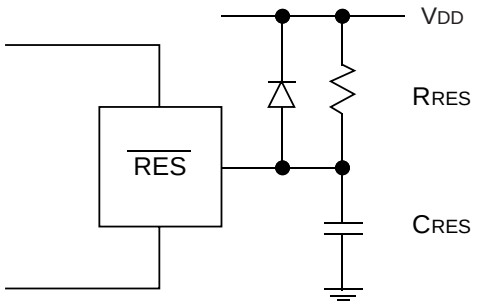


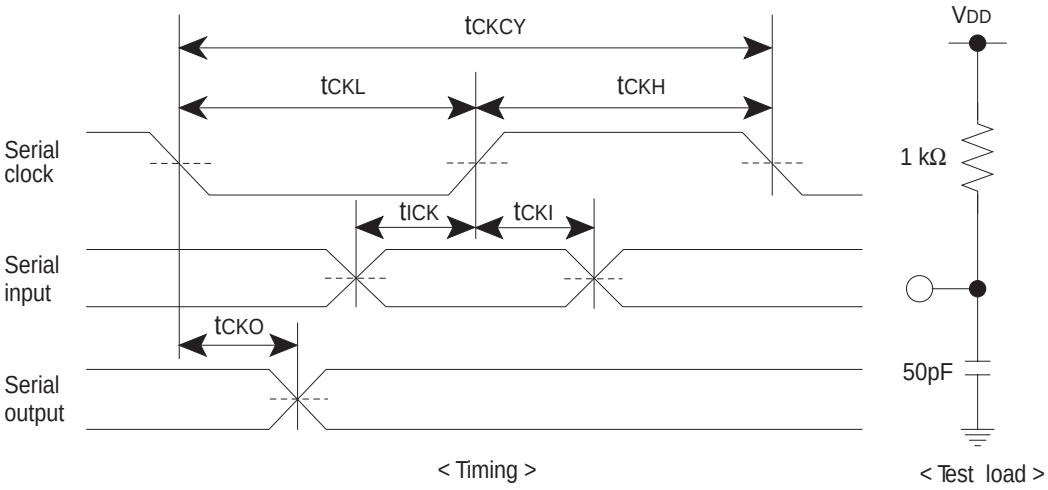
Figure 3 Oscillation Stable Time



(Note) Set the values of C_{RES}, R_{RES} so that the reset time is 200 μs or longer.

Figure 4 Reset Circuit

< AC timing point >



< Timing > < Test load >

Figure 5 Serial Input/output Test Condition

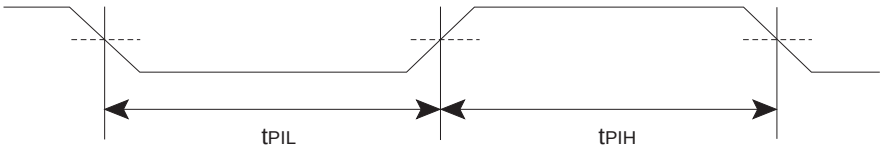
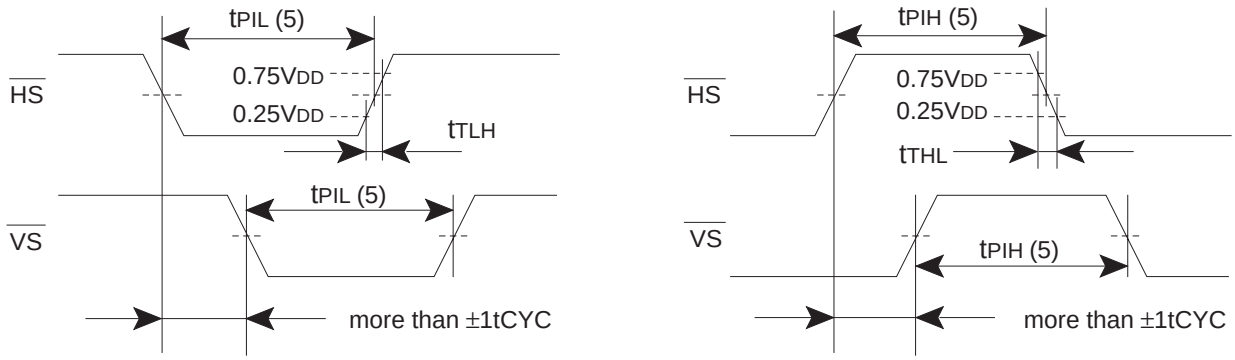


Figure 6 Pulse Input Timing Condition - 1



(a) In case of active low (b) In case of active high

Figure 7 Pulse Input Timing Condition - 2

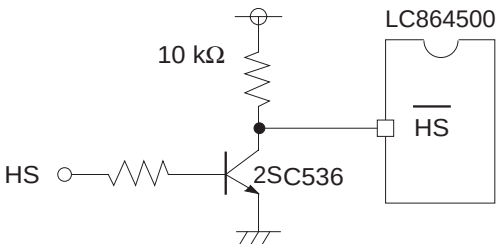


Figure 8 Recommended Interface Circuit

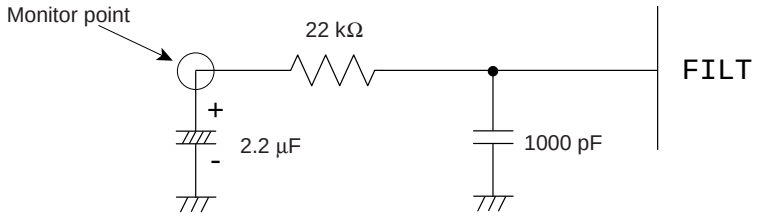


Figure 9 FILT Recommended Circuit

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

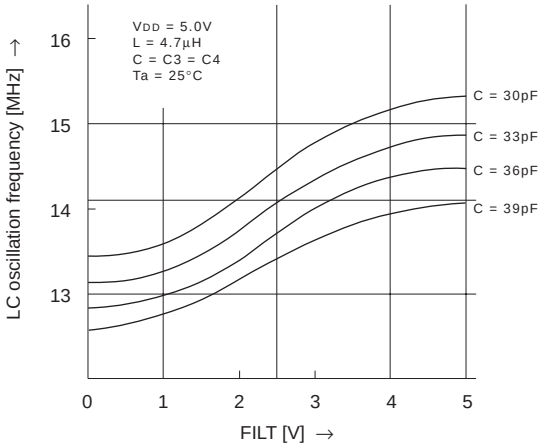


Figure 10 FILT-LC Oscillation Frequency (1)

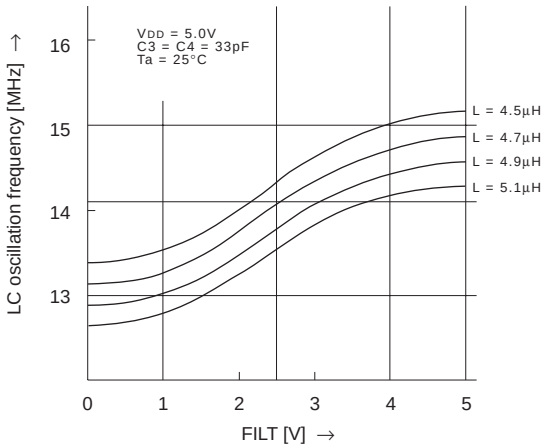


Figure 11 FILT-LC Oscillation Frequency (2)

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