



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:

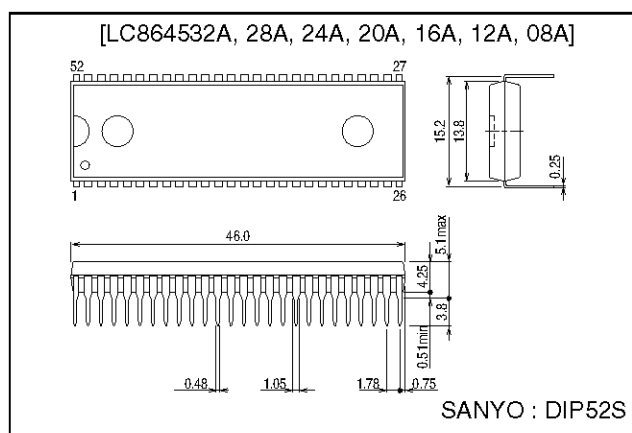
- CPU : Operable at a minimum bus cycle time of 0.5 μ s
- On-chip ROM maximum capacity : 32K bytes (LC864532A)
- On-chip RAM capacity : 256 bytes
- CRT display RAM : 160×9 bits
- On-Screen Display controller
Kanji (Chinese character) displaying available
- 16-bit timer/counter
- 16-bit timer/PWM
- 4-channel $\times$ 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 $\times$ 8 bits | LC864516A | 16384 $\times$ 8 bits |
| | LC864528A | 28672 $\times$ 8 bits | LC864512A | 12288 $\times$ 8 bits |
| | LC864524A | 24576 $\times$ 8 bits | LC864508A | 8192 $\times$ 8 bits |
| | LC864520A | 20480 $\times$ 8 bits | | |

- (2) Random Access Memory (RAM) : 256 $\times$ 8 bits
160 $\times$ 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 μ s	1.0 μ s	Ceramic (CF)	12 MHz	4.5 V to 5.5 V
7.5 μ s	15.0 μ s	Internal RC	800 kHz	4.5 V to 5.5 V

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(4) OSD functions

- Screen for display : 34 columns $\times$ 16 rows (at standard character size)
- Display RAM : 160 $\times$ 9 bits (6 columns for control + 34 columns for display) $\times$ 4 rows $\times$ 9 bits
- 252 kinds of user specified characters
252 kinds 12 $\times$ 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. $\times$ Vert. = (1 $\times$ 1), (1 $\times$ 2), (2 $\times$ 2), (2 $\times$ 4)
(1.5 $\times$ 1), (1.5 $\times$ 2), (3 $\times$ 2), (3 $\times$ 4)
- Shuttering and scrolling in row unit available
- Horizontal character pitch selectable : 9 to 16 dots
- Polarity of R, G, B, BL output programmable
- Polarity of HS, 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 $\times$ 4-bit A/D converter (converted with program)

(7) D/A converters

- Two 7-bit D/A converters

(8) PWM outputs

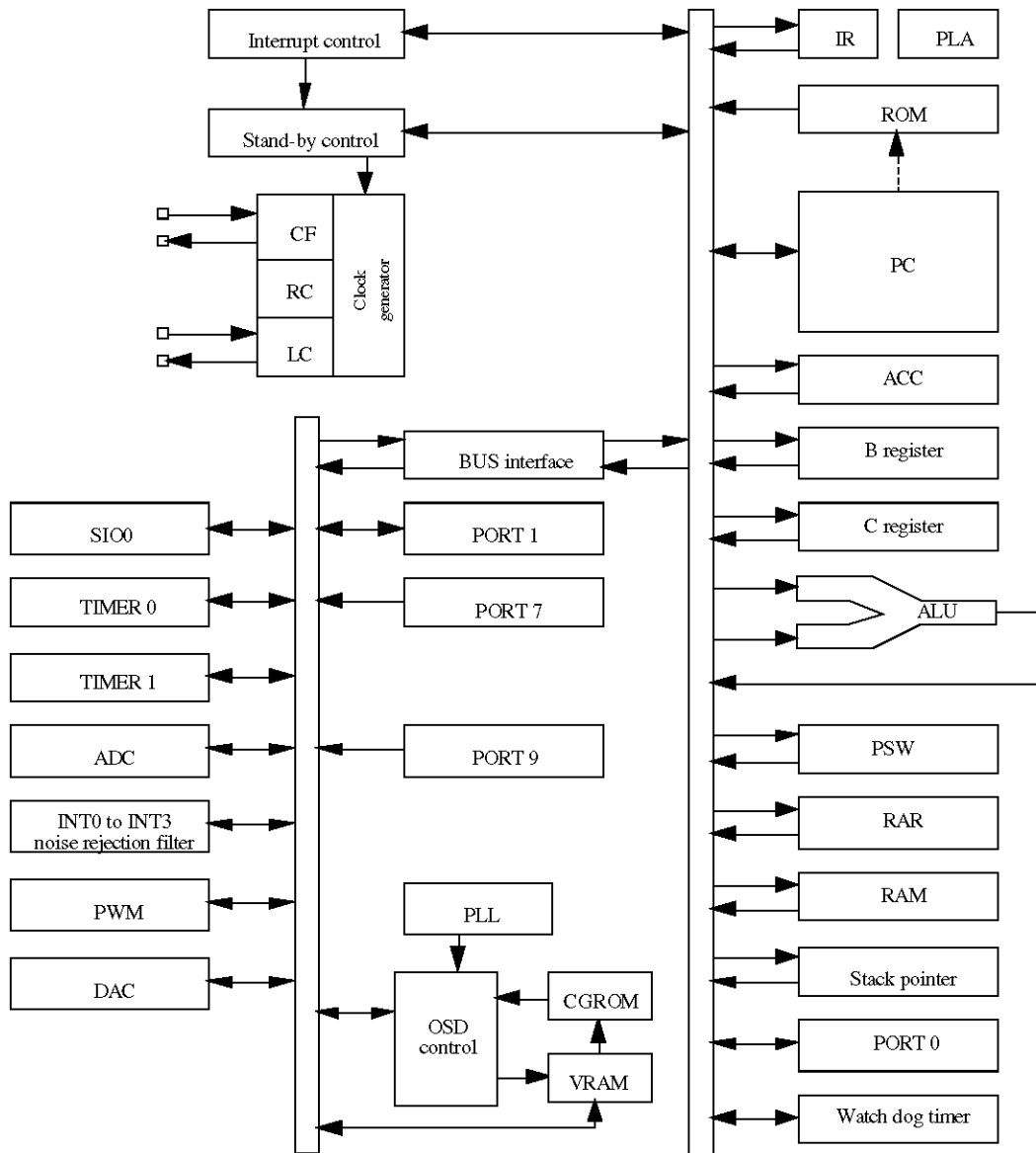
- Ten 7-bit PWMs
- 10-channel $\times$ 7-bit PWM

(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 counterThe 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 $\times$ 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

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
RES	□	17	36	□	PWM5
LC1	□	18	35	□	PWM4
LC2	□	19	34	□	PWM3
FILT	□	20	33	□	PWM2
AVDD	□	21	32	□	PWM1
AVSS	□	22	31	□	PWM0
DA0	□	23	30	□	BL
DA1	□	24	29	□	B
VS	□	25	28	□	G
HS	□	26	27	□	R

Top view

Pin Description

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

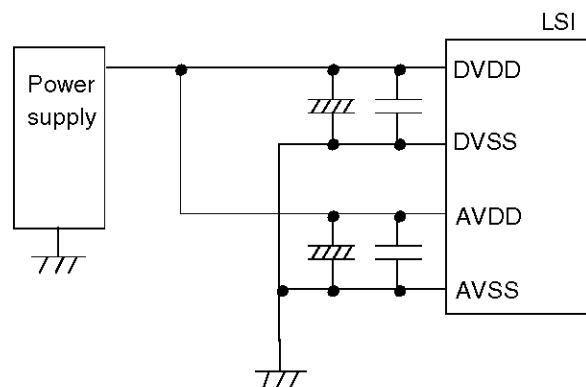
Pin Description Table

Pin name	Pin No.	I/O	Function description							Option																																											
DVSS	9	—	Negative power terminal for digital circuit																																																		
CF1	10	Input	Input terminal for ceramic resonator																																																		
CF2	11	Input	Output terminal for ceramic resonator																																																		
DVDD	12	—	Positive power terminal 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 terminal for analog circuit																																																		
AVSS	22	—	Negative power terminal for analog circuit																																																		
DA0	23	Output	DA0 output / general purpose I/O terminal																																																		
DA1	24	Output	DA1 output / general purpose I/O terminal																																																		
$\overline{\text{VS}}$	25	Input	Vertical synchronization signal input terminal																																																		
$\overline{\text{HS}}$	26	Input	Horizontal synchronization signal input terminal																																																		
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 OSD image signal																																																		
PWM0 to PWM9	31 to 40	Output	PWM0 to 9 output terminal 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 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>							P10	SIO0 data output	P11	SIO0 data input / bus input / output	P12	SIO0 clock input / output	Output format CMOS/Nch-OD (in bit units)																																					
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Port 7 P70 P71 to P73	41 42 to 44	I/O Input	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><td></td><td>Rising</td><td>Falling</td><td>Rising / Falling</td><td>H level</td><td>L level</td><td>Vector</td></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>							P70	INT0 input / HOLD release input / Nch-transistor output for watchdog timer	P71	INT1 input / HOLD release input	P72	INT2 input / timer 0 event input	P73	INT3 input (noise rejection filter attached input) / timer 0 event input		Rising	Falling	Rising / Falling	H level	L level	Vector	INT0	enable	enable	disable	enable	enable	03H	INT1	enable	enable	disable	enable	enable	0BH	INT2	enable	enable	enable	disable	disable	13H	INT3	enable	enable	enable	disable	disable	1BH	Pull-up resistor provided/ not provided (in bit units)
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INT3	enable	enable	enable	disable	disable	1BH																																															
Port 9 P90 to P93	13 to 16	Input	4-bit input port Other function A/D converter input port (4 lines)																																																		

- 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 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 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, VSS = 0 V

Parameter		Symbol	Pins	Conditions	V _{DD} [V]	Ratings			Unit
						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 • $\overline{\text{RES}}$, $\overline{\text{HS}}$, $\overline{\text{VS}}$			−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	mA
High-level output current	Peak output current	I _{OPH} (1)	Ports 0, 1	• Pull-up MOS transistor output • At each pin		−2			
		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	ΣI _{OA} H(1)	Port 1	The total of all pins		−10			
		ΣI _{OA} H(2)	Port 0	The total of all pins		−10			
		ΣI _{OA} H(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				
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		ΣI _{OA} L(1)	Port 0	The total of all pins				40	
		ΣI _{OA} L(2)	Port 1, P70	The total of all pins				40	
		ΣI _{OA} L(3)	R, G, B, BL	The total of all pins				15	
		ΣI _{OA} L(4)	PWM0 to PWM9	The total of all pins				30	
Maximum power dissipation		P _d max	DIP52S	T _a = −30 to +70°C				430	mW
Operating temperature range		T _{opr}				−30		+70	°C
Storage temperature range		T _{stg}				−55		+150	

- * DVSS and AVSS must be supplied the same voltage, VSS. VSS = DVSS = AVSS
 DVDD and AVDD must be supplied the same voltage, VDD. VDD = 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 • HS, VS	Output disable	4.5 to 5.5	0.75V _{DD}		V _{DD}	
	V _{IH} (3)	• P70 port input / interrupt • P71 • 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 • HS, VS • Port 9	Output disable	4.5 to 5.5	V _{SS}		0.25V _{DD}	
	V _{IL} (3)	• P70 port input / interrupt • P71 • 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	

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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	V _{DD} [V]	Ratings			Unit
					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 $\overline{\text{RES}}$ - HS, 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)	$\overline{\text{RES}}$ - HS, 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	R _{pu}	- 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 $\overline{\text{RES}}$ - HS, 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	V _{DD} [V]	Ratings			Unit
							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								
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)								

5. Pulse Input Conditions at Ta = -30°C to +70°C, V_{SS} = 0 V

Parameter	Symbol	Pins	Conditions	V _{DD} [V]	Ratings			Unit
					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)	$\overline{\text{RES}}$	Reset acceptable	4.5 to 5.5	200			μs
	tPIH(5) tPIL(5)	$\overline{\text{HS}}, \overline{\text{VS}}$	Display position controllable Each active edge of HS, 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 Ta = -30°C to +70°C, V_{SS} = 0 V

Parameter	Symbol	Pins	Conditions	V _{DD} [V]	Ratings			Unit
					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 ($\pm 10\%$) and SL characteristics.

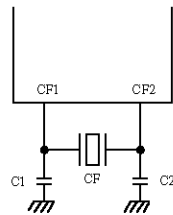
Table 1. Ceramic Resonator Oscillation Guaranteed Constant (main-clock)

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

* See Figures 10 and 11 for the oscillation frequency.

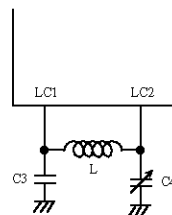
Table 2. LC Oscillation Guaranteed Constant (OSD clock)

- (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 $1/2V_{DD}\pm 10\%$ by the LC oscillation constant 'L' or 'C' to lock the PLL circuit.



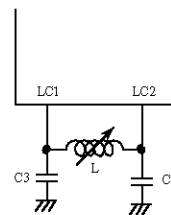
main clock

Figure 1 Ceramic Resonator Oscillation



OSD clock

Figure 2 LC Resonator Oscillation



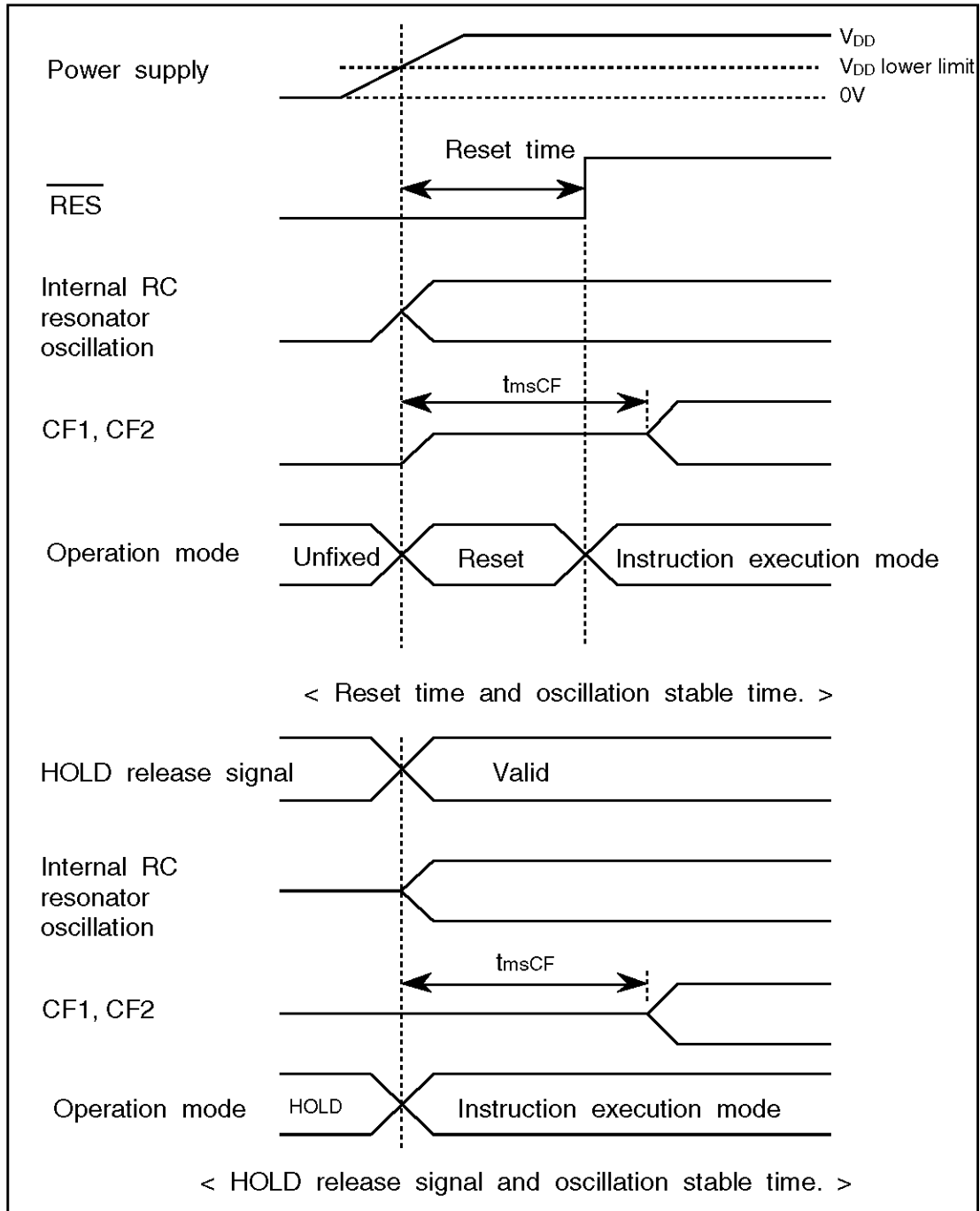


Figure 3 Oscillation Stable Time

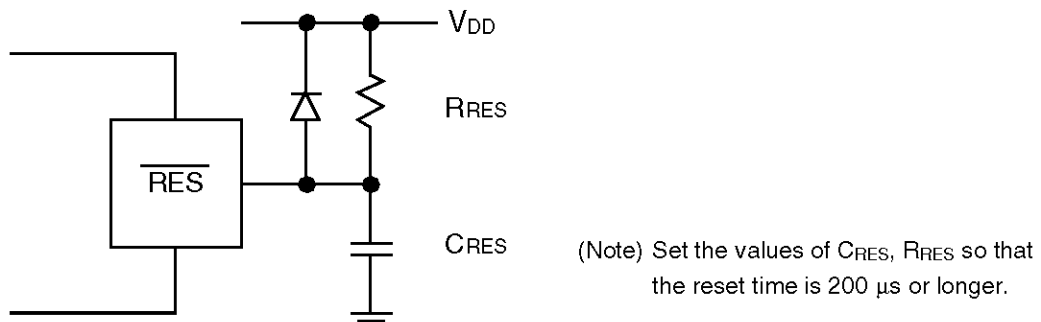


Figure 4 Reset Circuit

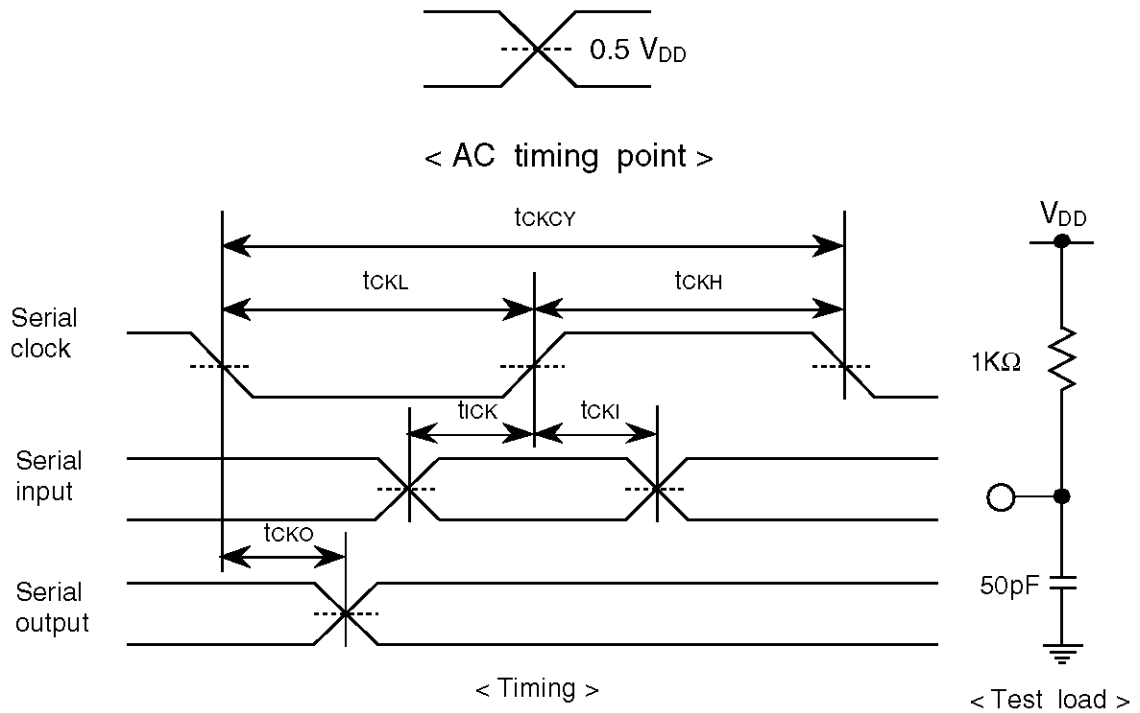


Figure 5 Serial Input/output Test Condition

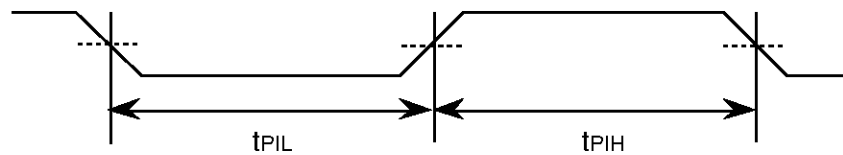


Figure 6 Pulse Input Timing Condition - 1

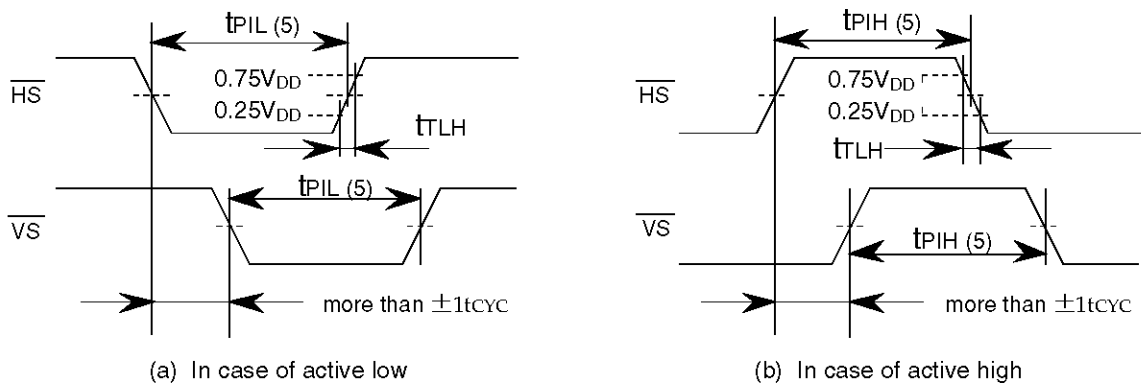


Figure 7 Pulse Input Timing Condition - 2

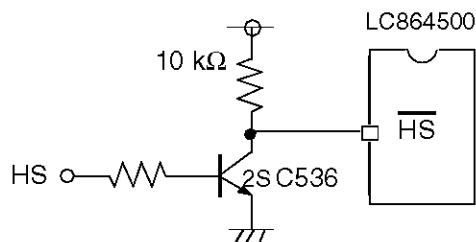


Figure 8 Recommended Interface Circuit

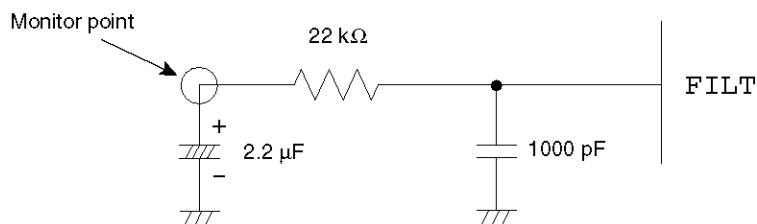


Figure 9 FILT Recommended Circuit

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

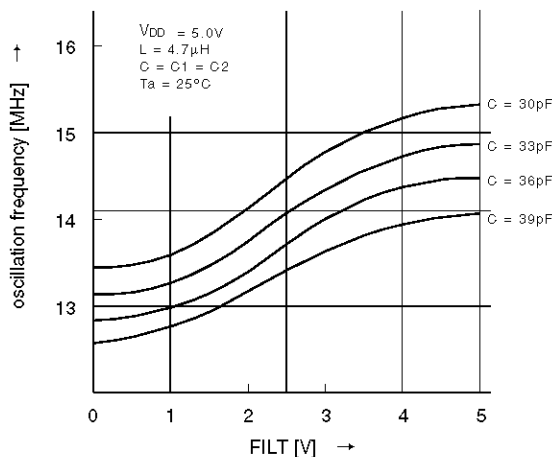


Figure 10 FILT-LC Oscillation Frequency (1)

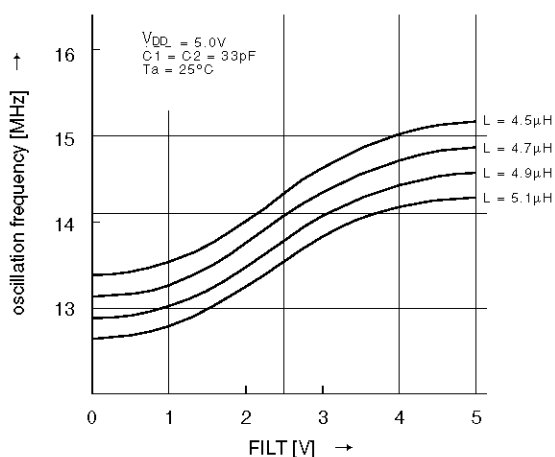


Figure 11 FILT-LC Oscillation Frequency (2)

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