Command-driven LCD Controller IC KS-570CT-I1

Hardware Manual

May 2015, First Edition (Japanese version)

June 2015, First Edition (English version)

KS-570CT-I1

(Note)　Silk screen print in the above picture is a composite.

The actual print may differ.

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● Introduction ●

First of all, thank you for having purchased our command-driven LCD controller IC. (KS-570CT-I1) (the "Product").

This hardware manual (the "Manual") provides an overview of the Product. We hope that you will read the Manual carefully and make use of it for efficient development.
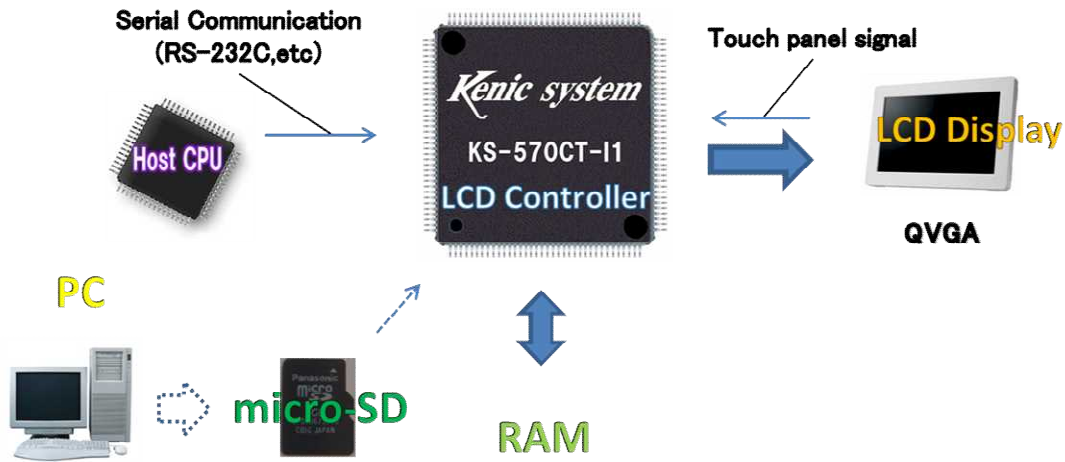
● Important Information ●

1. The Product and this Manual may change without notice.
   Before using the Product, obtain the newest catalog, manual,etc., from the company website.

2. The Product is not designed to be used in systems or devices that can cause death, injury, or serious physical or environmental damage directly due to any malfunction of the Product (life support device, nuclear facility equipment, aircraft, traffic control equipment, various safety devices, etc.). Danger and damage due to the Product being used in the foregoing systems or devices are the sole responsibility of the customer.

3. We assume no responsibility for any damages due to the use or the operation of the Product in a misguided or wrongful way.

4. The usage examples outlined herein are only an explanation of the Product functions. We assume no responsibility for any complaints, accidents, or any disadvantages which may be caused by the use on the basis of the examples outlined in this Manual.

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Contents

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1. Product Features and Overview

KS-570CT-I1 is an LCD controller that allows one to drive such as drawing dots, straight lines, and rectangles with only RS-232C commands.
The controller includes the following features.

1) The LCD controller includes drawing functions. The LCD controller allows a user to easily draw with commands transmitted through RS-232C from the user's microcomputer.
2) The LCD controller includes a touch panel controller (resolution of 10 bits.)
3) The LCD controller allows one to draw a bitmap image on the maximum size of 8,192 bits screen, by connecting to the microSD card.
4) The LCD controller includes the 16-dot font data (the half and full size).
5) The LCD controller enables one to draw the 24-dot font (the half and full size) characters by writing the 24-dot font data in the serial flash memory.
    The 24-dot font data is attached to our starter kit.
6) The display color is 65,536 colors.
7) The display range is 3 pages.

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2. System Configuration Diagram

The system configuration of the KS-570CT-I1 is described by Fig. 2-1 below. The LCD controller is completed with a SRAM that is prepared by a user. Furthermore, by connecting the serial flash memory or microSD card, it is also possible to display an image.
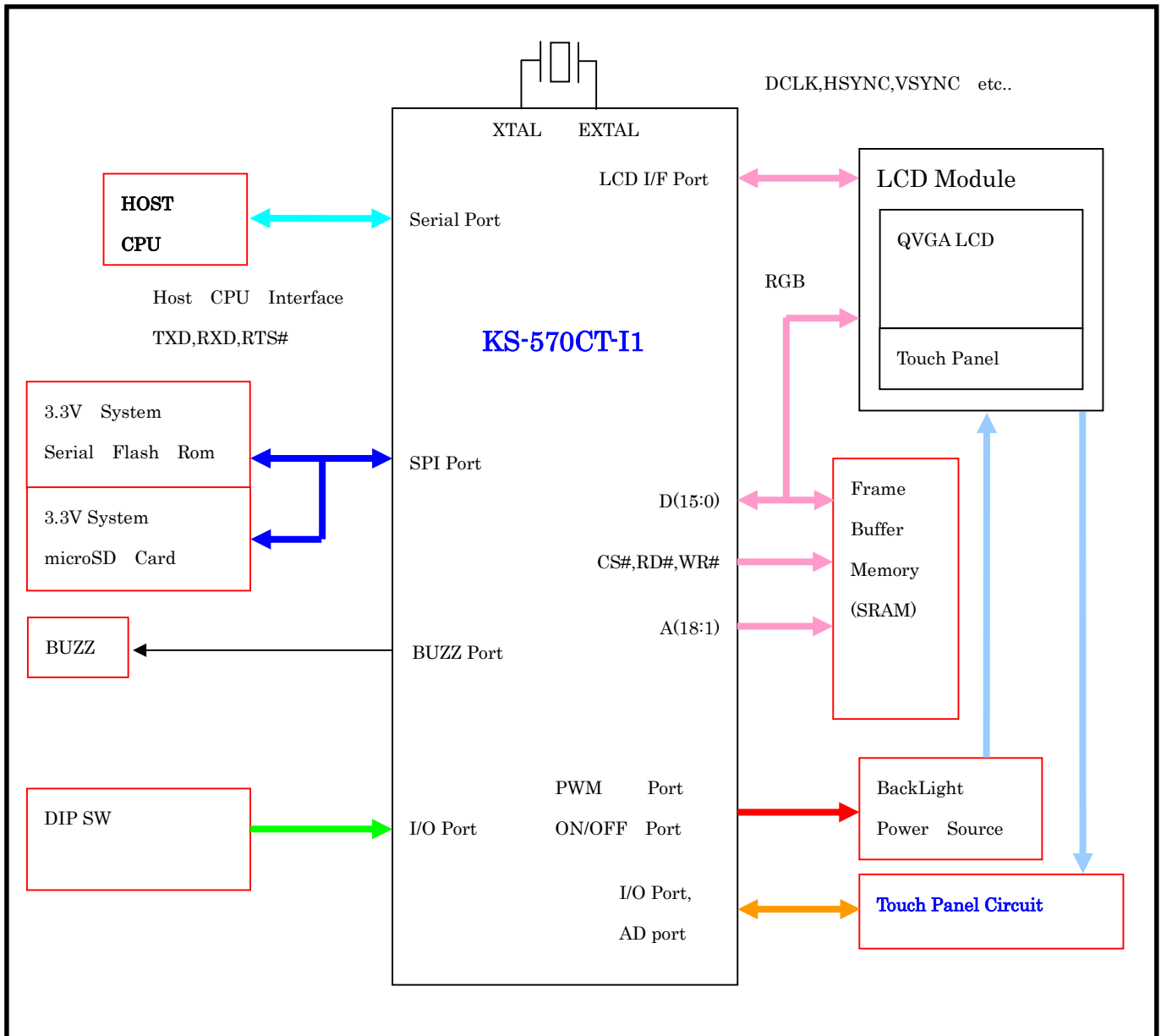

Fig. 2-1 Configuration Diagram

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3. Pins

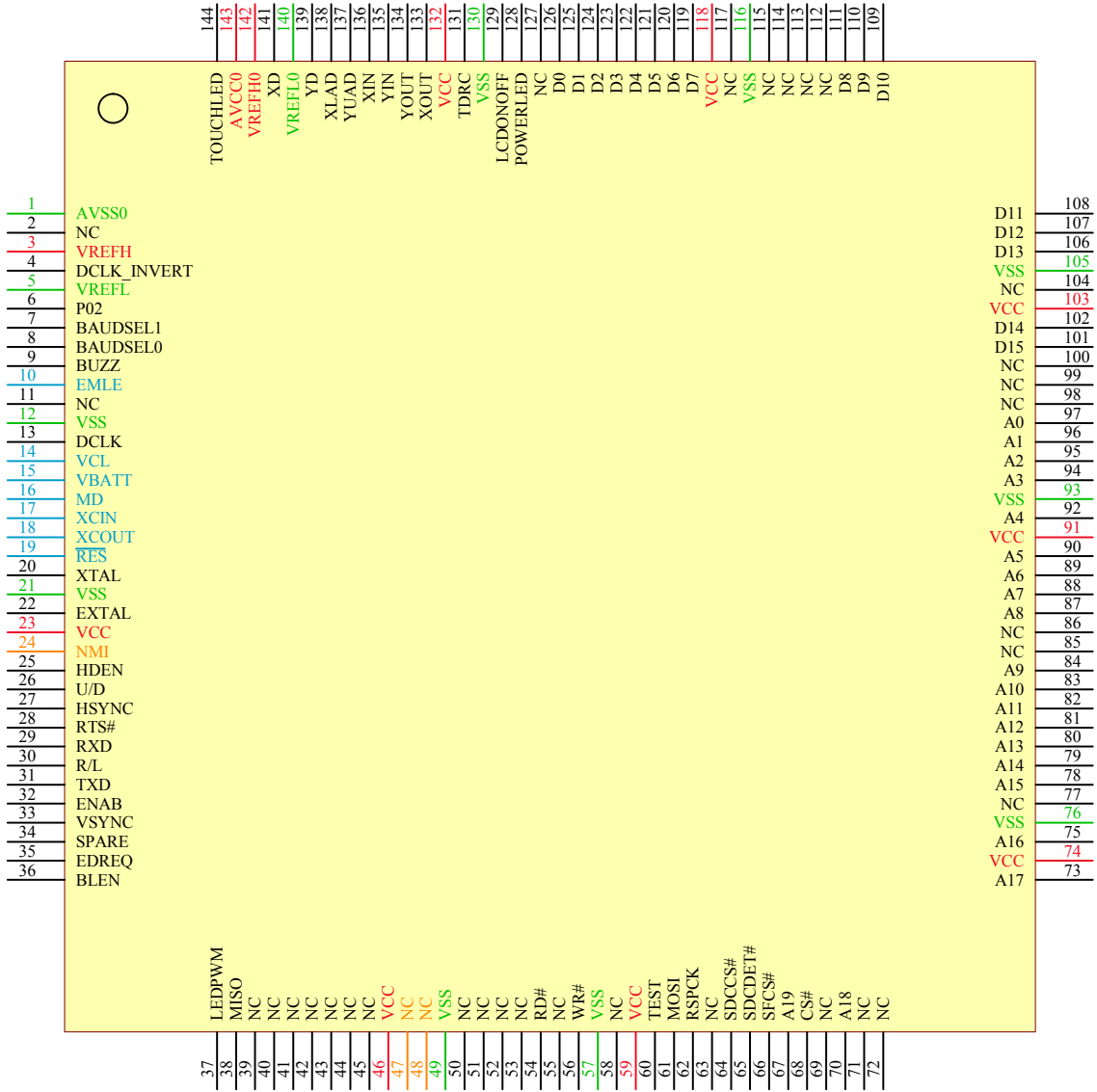Fig.3-1 shows the pin assignment for KS-570CT-I1.

Fig. 3-1 KS-570CT-I1 Pin assignment

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Table 3-1shows the pin assignment table for KS-570CT-I1 (the list of pin numbers and signal names.)

Table 3-1 Pin Assignment Table for KS-570CT-I1 (1/4)

Pin No	Pin Name	I/O	PULL MODE	Drive Capability	5V Tolerant	Schmidt Trigger Input	Interface
1	AVSS0	I	—	—	—	—	0V (for Analog)
2	NC	O	—	—	—	—	No connection
3	VREFH	I	—	—	—	—	+3.3V
4	DCLK_IN VERT	I	Pull-up	—	—	○	For DCLK Inverting setting Dip switch etc.
5	VREFL	I	—	—	—	—	0V
6	P02	I	Pull-up	—	—	○	No connection
7	BAUD SEL1	I	Pull-up	—	—	○	Dip Switch for setting RS-232C baud rates
8	BAUD SEL0	I	Pull-up	—	—	○	
9	BUZZ	O	—	HIGH	—	—	Connected to BUZZ
10	EMLE	I	—	—	—	—	10k Pull-down
11	NC	O	—	—	—	—	No connection
12	VSS	I	—	—	—	—	0V
13	DCLK	O	—	HIGH	—	—	To LCD panel
14	VCL	I	—	—	—	—	Connected to the capacitor of 0.1uF
15	VBATT	I	—	—	—	—	+3.3V
16	MD	I	—	—	—	—	10k Pull-up
17	XCIN	I	—	—	—	—	10k Pull-up
18	XCOUT	O	—	—	—	—	No connection
19	RES#	I	—	—	—	○	10k Pull-up
20	XTAL	O	—	HIGH	—	—	Connected to the crystal oscillator
21	VSS	I	—	—	—	—	0V
22	EXTAL	I	—	—	—	—	Connected to the crystal oscillator
23	VCC	I	—	—	—	—	+3.3V
24	NMI	I	—	—	—	○	10k Pull-up
25	HDEN	O	—	HIGH	—	—	Connected the 35th Pin
26	U/D	O	—	HIGH	—	—	To LCD panel
27	HSYNC	O	—	HIGH	—	—	To LCD panel
28	RTS#	O	—	HIGH	—	—	Serial RTS Output
29	RXD	I	—	—	○	○	Serial Receive Data Input
30	R/L	O	—	Normal	—	—	To LCD panel
31	TXD	O	—	HIGH	—	—	Serial Transmit Data Output
32	ENAB	O	—	HIGH	—	—	To LCD panel
33	VSYNC	O	—	HIGH	—	—	To LCD panel
34	SPARE	I	—	—	—	○	10k Pull-up
35	EDREQ	I	—	—	—	—	Connected the 25th Pin
36	BLEN	O	—	HIGH	—	—	To the LED Backlight I/F part
37	LED PWM	O	—	HIGH	—	—	To the LED Backlight I/F part
38	MISO	I	—	—	○	—	SPI signal: To the Serial Flash Memory, microSD Card
39	NC	O	—	—	—	—	No connection
40	NC	O	—	—	—	—	No connection
41	NC	O	—	—	—	—	No connection

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Table 3-1 Pin Assignment Table for KS-570CT-I1 (2/4)

Pin No	Pin Name	I/O	PULL MODE	Drive Capability	5V Tolerant	Schmidt Trigger Input	Interface
42	NC	O	—	—	—	—	No connection
43	NC	O	—	—	—	—	No connection
44	NC	O	—	—	—	—	No connection
45	NC	O	—	—	—	—	No connection
46	VCC	I	—	—	—	—	+3.3V
47	NC	I/O	—	—	—	—	No connection
48	NC	I/O	—	—	—	—	No connection
49	VSS	I	—	—	—	—	0V
50	NC	O	—	—	—	—	No connection
51	NC	O	—	—	—	—	No connection
52	NC	O	—	—	—	—	No connection
53	NC	O	—	—	—	—	No connection
54	RD#	O	—	Normal	—	—	Frame Buffer Memory Control Signal
55	NC	O	—	—	—	—	No connection
56	WR#	O	—	Normal	—	—	Frame Buffer Memory Control Signal
57	VSS	I	—	—	—	—	0V
58	NC	O	—	—	—	—	No connection
59	VCC	I	—	—	—	—	+3.3V
60	TEST	I	—	—	—	○	10k Pull-down
61	MOSI	O	—	HIGH	—	—	SPI signal: To the Serial Flash Memory, the microSD Card
62	RSPCK	O	—	HIGH	—	—	SPI signal: To the Serial Flash Memory, the microSD Card
63	NC	O	—	—	—	—	No connection
64	SDCCS#	O	—	HIGH	—	—	SPI signal: To the microSD card
65	SDC DET#	I	—	—	—	○	To microSD card
66	SFCS#	O	—	Normal	—	—	SPI signal: To the Serial Flash Memory
67	A19	O	—	Normal	—	—	No connection
68	CS#	O	—	HIGH	—	—	Frame Buffer Memory Control Signal
69	NC	O	—	—	—	—	No connection
70	A18	O	—	Normal	—	—	Frame Buffer Memory Address Bus
71	NC	O	—	—	—	—	No connection
72	NC	O	—	—	—	—	No connection
73	A17	O	—	Normal	—	—	Frame Buffer Memory Address Bus
74	VCC	I	—	—	—	—	+3.3V
75	A16	O	—	Normal	—	—	Frame Buffer Memory Address Bus
76	VSS	I	—	—	—	—	0V
77	NC	O	—	—	—	—	No connection
78	A15	O	—	Normal	—	—	Frame Buffer Memory Address Bus
79	A14	O	—	Normal	—	—	
80	A13	O	—	Normal	—	—	
81	A12	O	—	Normal	—	—	
82	A11	O	—	Normal	—	—	
83	A10	O	—	Normal	—	—	
84	A9	O	—	Normal	—	—	
85	NC	O	—	—	—	—	No connection
86	NC	O	—	—	—	—	No connection
87	A8	O	—	Normal	—	—	Frame Buffer Memory Address Bus
88	A7	O	—	Normal	—	—	
89	A6	O	—	Normal	—	—	

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Table 3-1 Pin Assignment Table for KS-570CT-I1 (3/4)

Pin No	Pin Name	I/O	PULL MODE	Drive Capability	5V Tolerant	Schmidt Trigger Input	Interface
90	A5	O	—	Normal	—	—	Frame Buffer Memory Address Bus
91	VCC	I	—	—	—	—	+3.3V
92	A4	O	—	Normal	—	—	Frame Buffer Memory Address Bus
93	VSS	I	—	—	—	—	0V
94	A3	O	—	Normal	—	—	Frame Buffer Memory Address Bus
95	A2	O	—	Normal	—	—	
96	A1	O	—	Normal	—	—	
97	A0	O	—	Normal	—	—	No connection
98	NC	O	—	—	—	—	No connection
99	NC	O	—	—	—	—	No connection
100	NC	O	—	—	—	—	No connection
101	D15	I/O	—	Normal	—	—	To the Frame Buffer Memory Data Bus, and the LCD
102	D14	I/O	—	Normal	—	—	
103	VCC	I	—	—	—	—	+3.3V
104	NC	O	—	—	—	—	No connection
105	VSS	I	—	—	—	—	0V
106	D13	I/O	—	Normal	—	—	To the Frame Buffer Memory Data Bus, and the LCD
107	D12	I/O	—	Normal	—	—	
108	D11	I/O	—	Normal	—	—	
109	D10	I/O	—	Normal	—	—	
110	D9	I/O	—	Normal	—	—	
111	D8	I/O	—	Normal	—	—	
112	NC	O	—	—	—	—	No connection
113	NC	O	—	—	—	—	No connection
114	NC	O	—	—	—	—	No connection
115	NC	O	—	—	—	—	No connection
116	VSS	I	—	—	—	—	0V
117	NC	O	—	—	—	—	No connection
118	VCC	I	—	—	—	—	+3.3V
119	D7	I/O	—	Normal	—	—	To the Frame Buffer Memory Data Bus, and the LCD
120	D6	I/O	—	Normal	—	—	
121	D5	I/O	—	Normal	—	—	
122	D4	I/O	—	Normal	—	—	
123	D3	I/O	—	Normal	—	—	
124	D2	I/O	—	Normal	—	—	
125	D1	I/O	—	Normal	—	—	
126	D0	I/O	—	Normal	—	—	
127	NC	O	—	—	—	—	No connection
128	POWER LED	O	—	Normal	—	—	LED, and Others
129	LCDON OFF	O	—	Normal	—	—	LCD Power Control
130	VSS	I	—	—	—	—	0V
131	TDRC	O	—	Normal	—	—	To the Touch Panel Control Circuit
132	VCC	I	—	—	—	—	+3.3V
133	XOUT	O	—	Normal	—	—	To the Touch Panel Control Circuit
134	YOUT	O	—	Normal	—	—	

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Table 3-1 Pin Assignment Table for KS-570CT-I1 (4/4)

Pin No	Pin Name	I/O	PULL MODE	Drive Capability	5V Tolerant	Schmidt Trigger Input	Interface
135	YIN	O	—	Normal	—	—	To the Touch Panel Control Circuit
136	XIN	O	—	Normal	—	—	
137	YUAD	I	—	—	—	—	
138	XLAD	I	—	—	—	—	
139	YD	I	Pull-up	—	—	○	Inverting the Touch Panel Data Coordinates
140	VREFL0	I	—	—	—	—	0V (for Analog)
141	XD	I	Pull-up	—	—	○	Inverting the Touch Panel Data Coordinates
142	VREFH0	I	—	—	—	—	+3.3V (for Analog)
143	AVCC0	I	—	—	—	—	+3.3V (for Analog)
144	TOUCH LED	O	—	HIGH	—	—	LED, and Others

(Note 1) Pins that are marked ○ in the 5V tolerant raw are pins that correspond to the 5V tolerant.

(Note 2) Pins that are marked ○ in the column of the Schmidt trigger input are the Schmidt trigger input pins.

Input pins other than those above (except for the power pins), and input/output pins are normal pins.

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4. Electric Characteristics

4-1 Absolute Maximum Rating

Table 4-1 Absolute Maximum Rating

Conditions: VSS=AVSS0=VREFL/VREFL0=0V

Item	Sign	Rated value	Unit
Power supply voltage	VCC	-0.3～+4.6	V
VBATT Power Voltage	V$_{BATT}$	-0.3～+4.6	V
Input Voltage (Except for ports that correspond to the 5V tolerant (Note 1))	Vin	-0.3～VCC+0.3	V
Input Voltage (Ports that correspond to the 5V tolerant (Note 1))	Vin	-0.3～+5.8	V
Reference Power Voltage	VREFH	-0.3～VCC+0.3	V
Analog Power Voltage	AVCC	-0.3～+4.6	V
Analog Input Voltage	XLAD,YUAD	-0.3～VCC+0.3V	V
Operation temperature	Topr	-40～+85	℃
Storage temperature	Tstg	-55～+125	℃

[Precautions] When the LSI is used in excess of its absolute maximum rating, it may be permanently damaged.

(Note 1) The RXD and MISO pins correspond to the 5V tolerant.

4-2 Recommended Operating Conditions

Table 4-2　Recommended Operating Conditions

Item	Sign	Rated value	Unit
Power supply voltage	VCC	2.7～3.6	V
VBATT Power Voltage	V$_{BATT}$	2.7～3.6	V
Reference Power Voltage	VREFH0	2.7～AVCC0	V
Reference Power Voltage	VREFH	2.7～3.6	V
Analog Power Voltage	AVCC0	2.7～3.6	V

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4-3 DC Characteristics

Table 4-3 DC Characteristics (1)

Conditions: VCC=AVCC0=VREFH=VBATT=2.7 - 3.6V, VREFH0=2.7V - AVCC0,

VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item		Sign	min	typ	max	Unit
Schmidt Trigger Input Voltage	Ports corresponding to 5V Tolerant	V_{IH}	VCC×0.8	—	5.8	V
		V_{IL}	-0.3	—	VCC×0.2	V
		ΔV_T	VCC×0.06	—	—	V
	Ports except for ports corresponding to 5V Tolerant Other Input Pins	V_{IH}	VCC×0.8	—	VCC+0.3	V
		V_{IL}	-0.3	—	VCC×0.2	V
		ΔV_T	VCC×0.06	—	—	V
Input High Level Voltage (Normal Input or Input/Output Pins)	MD pin, EMLE	V_{IH}	VCC×0.9	—	VCC+0.3	V
	EXTAL,MISO,EDREQ		VCC×0.8	—	VCC+0.3	V
	XCIN		—	—	VCC+0.3	V
	D0~D15		VCC×0.7	—	VCC+0.3	V
Input Low Level Voltage (Normal Input or Input/Output Pins)	MD pin, EMLE	V_{IL}	-0.3	—	VCC×0.1	V
	EXTAL,MISO,EDREQ		-0.3	—	VCC×0.2	V
	XCIN		-0.3	—	—	V
	D0~D15		-0.3	—	VCC×0.3	V

Table 4-4 DC Characteristics (2)

Conditions: VCC=AVCC0=VREFH=VBATT =2.7 - 3.6V, VREFH0=2.7V - AVCC0,

VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item		Sign	min	typ	max	Unit
Output High Level Voltage	$I_{OH}=-1mA$	V_{OH}	VCC-0.5	—	—	V
Output Low Level Voltage	$I_{OL}=1mA$	V_{OL}	—	—	0.5	V

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Table 4-5 Allowable Output Current

Conditions: VCC=AVCC0=VREFH=VBATT =2.7 - 3.6V, VREFH0=2.7V - AVCC0,

VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item	Drive	Sign	min	typ	max	Unit
Output Low Level Allowable Current	Normal Drive	I_{OL}	—	—	2.0	mA
(Average Current Value per Pin)	High Drive	I_{OL}	—	—	3.8	mA
Output Low Level Allowable Current	Normal Drive	I_{OL}	—	—	4.0	mA
(Maximum Current Value per Pin)	High Drive	I_{OL}	—	—	7.6	mA
Output Low Level Allowable Current	Normal Drive	I_{OH}	—	—	-2.0	mA
(Average Current Value per Pin)	High Drive	I_{OH}	—	—	-3.8	mA
Output Low Level Allowable Current	Normal Drive	I_{OH}	—	—	-4.0	mA
(Maximum Current Value per Pin)	High Drive	I_{OH}	—	—	-7.6	mA

4-4　Consumption Current

Table 4-6 Consumption Current

Conditions: VCC=AVCC0=VREFH=VBATT =2.7 - 3.6V, VREFH0=2.7V - AVCC0,

VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item	Sign	min	typ	max	Unit
Normal operation	I_{CC}	—	50	100	mA
Low power consumption		—	22	200	μA
Analog Power Current	I_{AVCC0}	—	2.3	3.2	mA
	I_{VREFH}	—	1.0	1.65	mA
Reference Power Current	I_{VREFH0}	—	0.6	0.7	mA

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4-5　AC Characteristics

4-5-1　Reset Timing

Table 4-7 Reset Timing

Conditions: VCC=AVCC0=VREFH=VBATT=2.7 - 3.6V, VREFH0=2.7V - AVCC0,
　　　　　VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item		Sign	min	typ	max	Unit	Note
RES#　Pulse Width	When the power is turned on	t_{RESWP}	2	—	—	ms	Fig. 4-1
	Except for the above	t_{RESW}	200	—	—	µs	Fig. 4-2
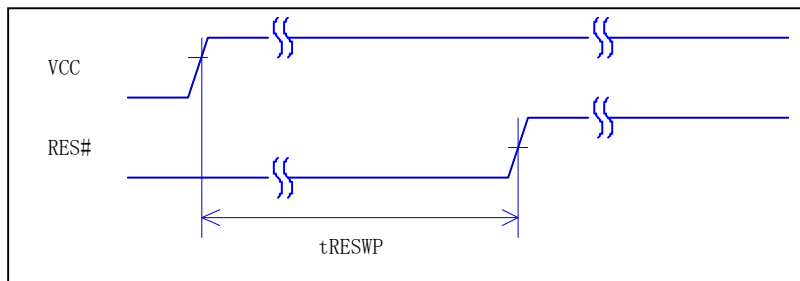
Fig. 4-1 Reset Input Timing when the power is turned on
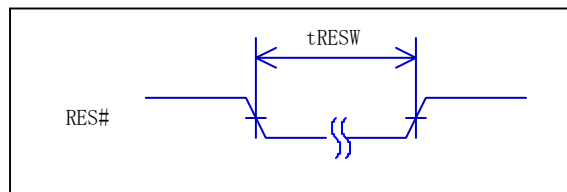
Fig. 4-2 Reset Input Timing

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4-5-2　SPI Timing

Table 4-8 SPI Timing

Conditions: VCC=AVCC0=VREFH=VBATT=2.7 - 3.6V, VREFH0=2.7V - AVCC0,
VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item		Sign	min	typ	max	Unit	Condition
RSPCK Clock Cycle		t_{SPcyc}	—	12	—	MHz	Fig. 4-3 C=30pF
			—	83.33	—	ns	
RSPCK Clock High Level Pulse Width		t_{SPCKWH}	33.67	—	—	ns	
RSPCK Clock Low Level Pulse Width		t_{SPCKWL}	33.67	—	—	ns	
RSPCK Clock Rise/Fall Time		t_{SPCKr}、t_{SPCKf}	—	—	5	ns	
Data Input Set-up Time	VCC≧3.0V	t_{SU}	15	—	—	Fig. 4-4 C=30pF	図 4-4 C=30pF
	VCC<3.0V		20	—	—		
Data Input Hold Time		t_H	0	—	—	ns	
SFCS# Set-up Time		t_{LEAD}	1	—	—	us	
SFCS# Hold Time		t_{LAG}	1	—	—	us	
Data Output Delay Time		t_{OD}	—	—	18	ns	
Data Output Hold Time		t_{OH}	0	—	—	ns	
Continuous Transmission Delay Time		t_{TD}	200	—	—	ns	
MOSI Rise/Fall Time		t_{DR}、t_{Df}	—	—	5	ns	
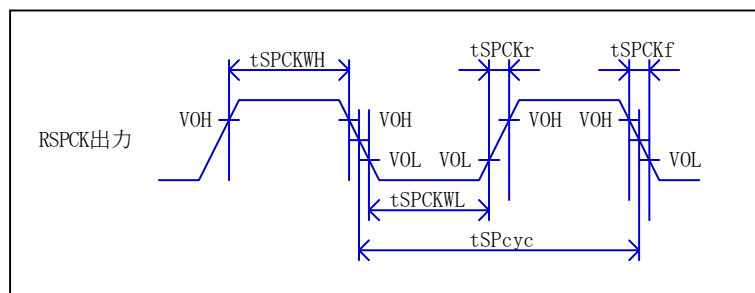
Fig. 4-3 SPI Clock Timing

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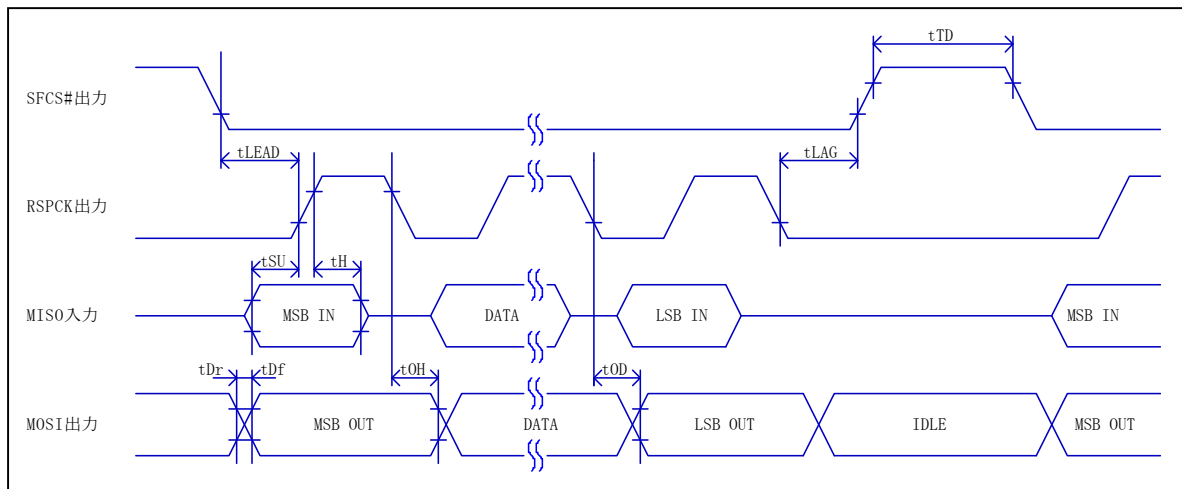
Fig. 4-4 SPI Timing (SPI Mode: Mode 0)

4-6　Power On Reset Circuit, Voltage Detection Circuit Characteristics

Table 4-9 Power On Reset Circuit, Voltage Detection Circuit Characteristics
Conditions: VCC=AVCC0=VREFH=VBATT=2.7 - 3.6V, VREFH0=2.7V - AVCC0,
　　　　VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item		Sign	min	typ	max	Unit	Condition
Voltage Detection Level	Power On Reset (POR)	V_{POR}	2.5	2.6	2.7	V	Fig. 4-5
	Voltage Detection Circuit (LVD0)	V_{det0}	2.7	2.80	2.9	V	Fig. 4-6
Internal Reset Time	Power On Reset Time	t_{POR}	—	4.6	—	ms	Fig. 4-5
	LVD0 Reset Time	t_{LVD0}	—	4.6	—	ms	Fig. 4-6
Minimum VCC Drop Time		t_{VOFF}	200	—	—	µs	Fig. 4-5, Fig. 4-6
Response Delay Time		t_{det}	—	—	200	µs	Fig. 4-5, Fig. 4-6

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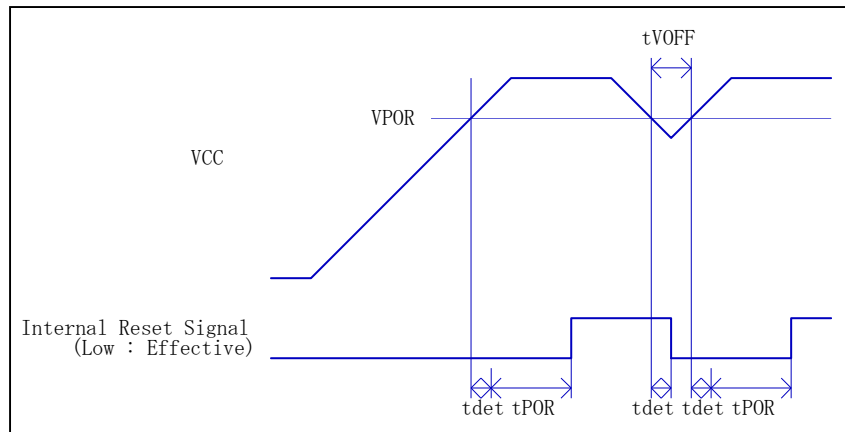
Fig. 4-5 Power On Reset Timing
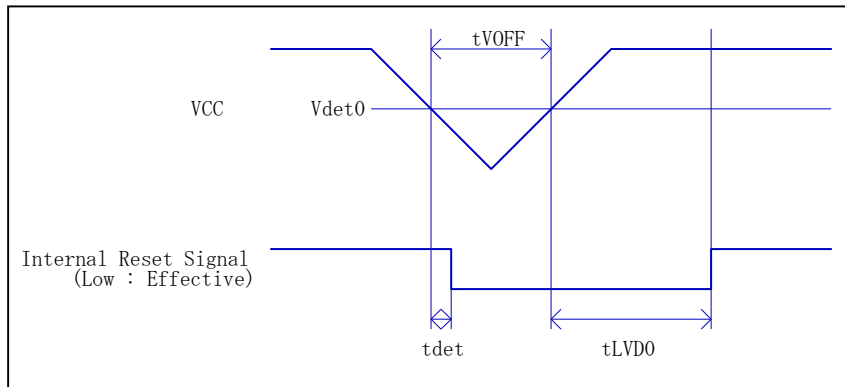
Fig. 4-6 Voltage Detection Circuit Timing (Vdet0)

4-7 Start-up Time of LCD Controller

Table 4-10 LCD Controller Start-up Time

Conditions: VCC=AVCC0=VREFH=VBATT=2.7 - 3.6V, VREFH0=2.7V - AVCC0,

VSS=AVSS0= VREFL/VREFL0=0V, Ta=Topr

Item	Sign	min	typ	max	Unit	Note
Start-up Time of LCD Controller	$t_{INITIAL}$	450	—	660	ms	Fig. 4-7

（Note） When the microSD card is not used, Start-up time is minimum value.

When the microSD card is used, Start-up time is miximum value.

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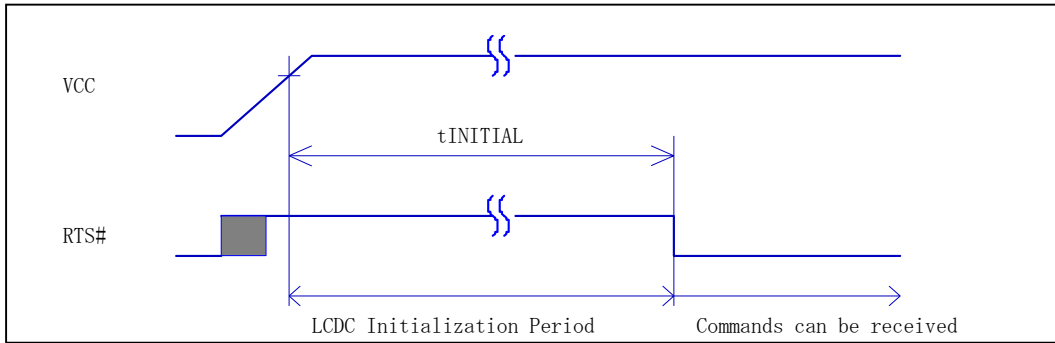
Fig. 4-7 LCD Controller Start-up Time

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5. Clock

5-1 Overview

The LCD controller includes a clock oscillation circuit.

The input/output pins of the clock oscillation circuit are shown in Table 5-1.

Table 5-1 Input/Output Pins of Clock Oscillation Circuit

Pin Name	Input/Output	Function
XTAL	Output	These are the crystal oscillator pins of the main clock
EXTAL	Input	oscillation circuit.
XCIN	Input	These are the crystal oscillator pins of the sub clock
XCOUT	Output	oscillation circuit. The LCD controller is not used.

5-2 Main Clock Oscillator

Connect the crystal oscillator with an oscillation frequency of 12MHz to the main clock oscillator.

The example of connection when connecting the crystal oscillator is shown in Fig. 5-1.

Insert a damping resistance (Rd) if necessary. The resistance value varies with an oscillator and an oscillation drive capability. Thus, set a value that is recommended by the oscillator manufacturer. In addition, when additional external feedback resistance (Rf) is required by the oscillation manufacturer, insert the resistance Rf between the EXTAL and the XTAL.
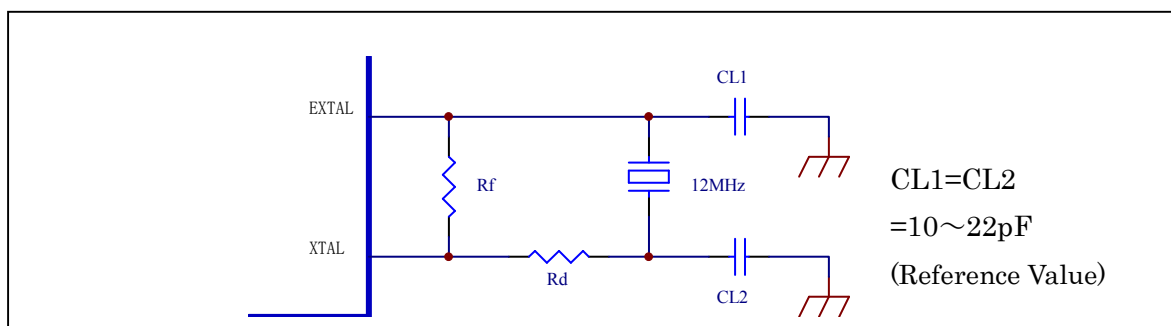

Fig. 5-1 Example of Connection for Crystal Oscillator

Table 5-2 Damping Resistance Rd (Reference Value)

Frequency of Crystal Oscillator [MHz]	12
Rd [Ω]	0

The equivalent circuit of the crystal oscillator is shown in Fig. 5-2. Use a crystal oscillator with the characteristics as those shown in Table 5-3.

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However, the characteristics are just a reference value. Even if the characteristics are not satisfied, there is no problem when the connection circuit including the substrate is matched.
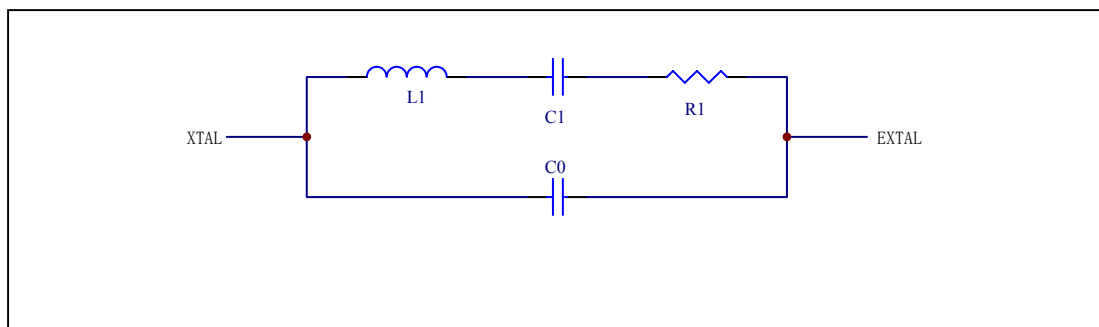

Fig. 5-2   Equivalent Circuit for Crystal Oscillator

Table 5-3 Characteristics of Crystal Oscillator (reference values)

Frequency [MHz]	12
R1max ［Ω］	60
C0max[pF]	7

5-3   Sub Clock Oscillator

The LCD controller has not used a sub clock oscillator.

Connect (pull down) the XCIN pin by means of a resistance (4.7kΩ〜10kΩ) to the VSS (GND), as shown in Fig. 5-3. Open the XCOUT pin.
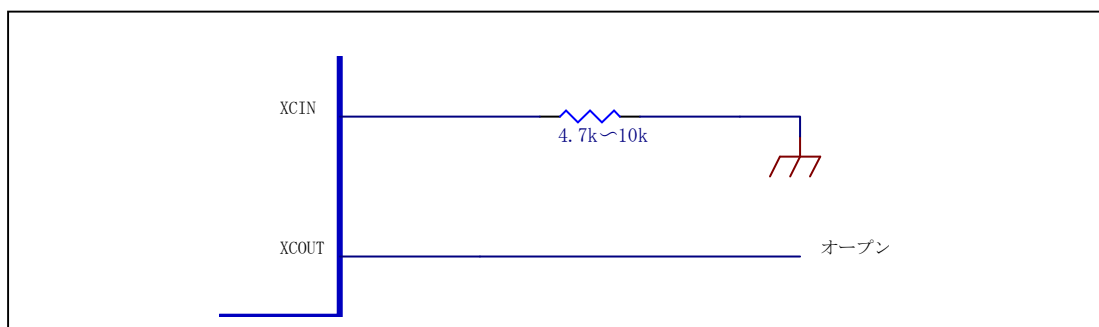

Fig. 5-3 Pin Treatment of Sub Clock Oscillator

5-4   Precautions for Use

5-4-1   Precautions for Crystal Oscillator

Characteristics for the oscillator have a close relationship with the board that is designed by a user. Then, the user shall sufficiently evaluate them and then use the

Kenic system

oscillator by reference to the example of connection that is described in this chapter. The circuit constants of the oscillator vary with the stray capacitance in the packaging circuit. Thus, the user should check with the oscillator manufacturer to determine the matching conditions. Make sure that the voltage that is applied to the oscillator pins does not exceed the maximum rating.

5-4-2   Precautions for Board Design

Arrange the oscillator and the capacitor at the nearest locations of the oscillator pins. Do not arrange signal lines close to the oscillator circuit, as shown in Fig. 5-4. The electromagnetic induction that is generated by the close arrangement above may interfere with the normal oscillation.
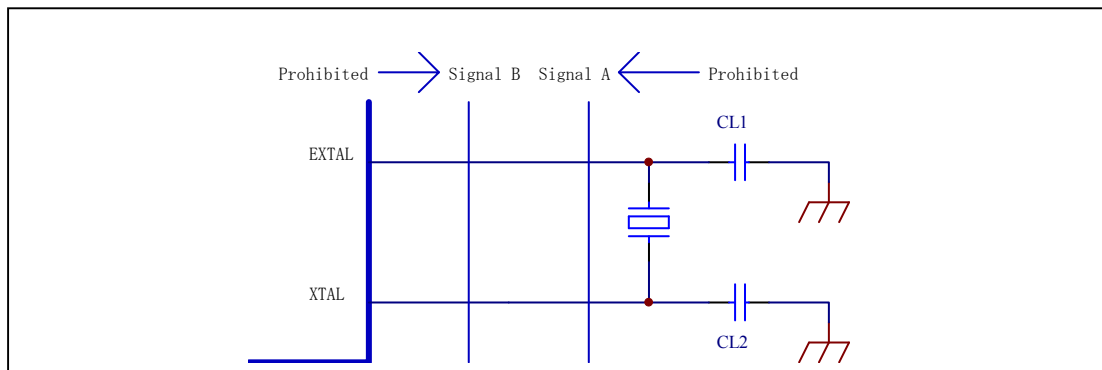

Fig. 5-4 Precautions for Board Design of Oscillation Circuit

5-4-3   Oscillation Stability Time

Set the oscillator stability time of the crystal oscillator at 20 msec or less. (the oscillation stability time between the application of a voltage to the crystal oscillator and the stabilization of amplitude).

5-5   Reference Circuit

For the oscillator circuits and constants of the crystal oscillator that are evaluated with our board, refer to "23. Reference Circuit Diagram."

The manufacturer and type of the crystal oscillators that are used in our boards are described in Table 5-4.

Table 5-4 Manufacturer and Type of Crystal Oscillators

Manufacturer	Type
Nihon Dempa Kogyo	NX3225GA-12.000M-STD-CRG-2

Kenic system

6. Reset

6-1 Overview

There are Resets by RES# Pin, Power On Reset, and Voltage Monitor 0 (zero) Reset.

The names and causes of Resets are shown in Table 6-1.

Table 6-1 Names and Causes of Resets

Name of Reset	Cause
RES# Pin Reset	The input voltage of RES# pin is Low.
Power On Reset	VCC increases (Monitor voltage: VPOR) (Note 1)
Voltage Monitor 0 (zero) Reset	VCC decreases (Monitor voltage: Vdet0) (Note 1)

(Note 1) For the Monitor voltages (VPOR, Vdet0), refer to "4. Electric characteristics."

The input/output pins for the reset are shown in Table 6-2

Table 6-2 Input/Output Pins for Reset

Pin Name	Input/Output	Function
RES#	Input	Reset Pin

6-2 RES# Pin Reset

This is Reset by the RES# Pin.

When the RES# pin is Low, the LCD controller ceases the operation and enters the reset condition.

For the reset timing, refer to "4. Electric Characteristics."

6-3 Power On Reset and Voltage Monitor 0 (zero) Reset

The power on reset is an internal reset by the power on reset circuit.

When turning the power on under the condition that the RES# pin is set to High, the power on reset is activated. When the power voltage VCC exceeds the monitor voltage VPOR, the internal reset is released after the power on reset time. Then, the LCD controller begins its operation.

When performing the power on reset, pull up the RES# pins with a resistance of 4.7kΩ - 10kΩ, as shown in Fig. 6-1.

The voltage monitor 0 (zero) reset is an internal reset by the power monitor circuit. When the VCC is Vdet0 or lower, the LCD controller enters the reset condition. When the VCC exceeds the Vdet0, the reset of the LCD controller is released after the LVD0 reset time (tLVD0.)

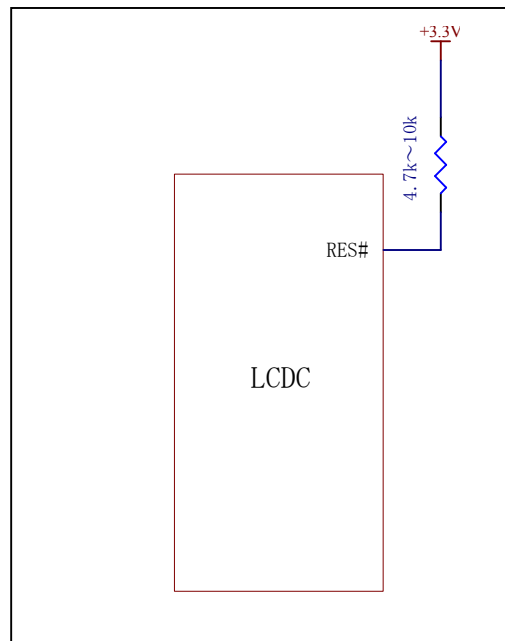An example of operation of the power on reset and the voltage monitor 0 reset is

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shown in Fig. 6-2.

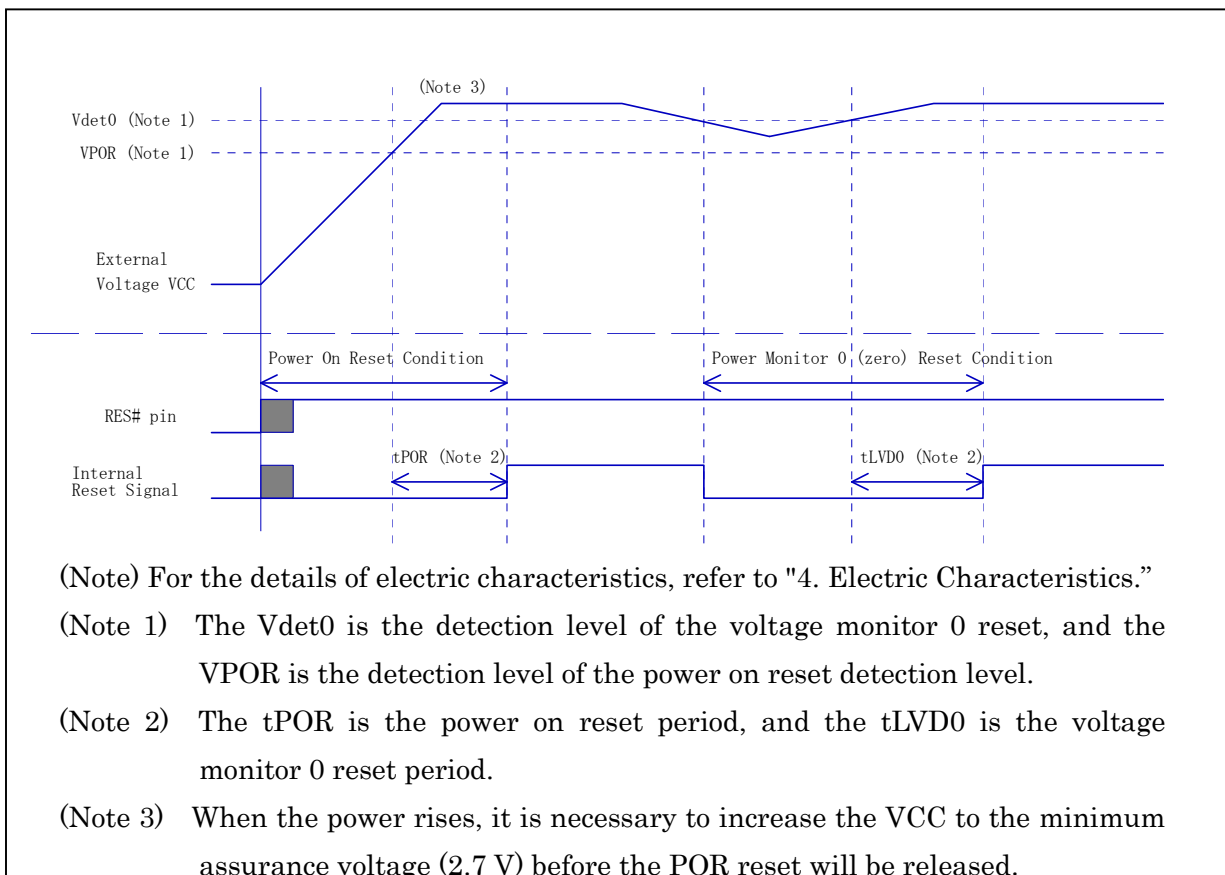
Fig. 6-1 Circuit when the Power On Reset is performed

(Note) For the details of electric characteristics, refer to "4. Electric Characteristics."

(Note 1)   The Vdet0 is the detection level of the voltage monitor 0 reset, and the VPOR is the detection level of the power on reset detection level.

(Note 2)   The tPOR is the power on reset period, and the tLVD0 is the voltage monitor 0 reset period.

(Note 3)   When the power rises, it is necessary to increase the VCC to the minimum assurance voltage (2.7 V) before the POR reset will be released.

Fig. 6-2 Power On Reset and Voltage Monitor 0 Reset

Kenic system

6-4 Reference Circuit

Refer to "23 Reference Circuit Diagrams" that describes the reset reference circuits by the power on reset.

Kenic system

7. Serial Communication Interface (SCI)

7-1   Overview

The LCD controller includes one channel of asynchronous serial communication interface (hereinafter called SCI).

The input/output pins for the SCI are shown in Table 7-1.

Table 7-1 SCI Input/Output Pins

Pin Name	Input/Output	Function
RXD	Input	SCI Receive Data Input Pin
TXD	Output	SCI Transmission Data Output Pin
RTS#	Output	SCI Transmission Request Output Pin
BAUDSEL1	Input	SCI Baud Rate Selection Pins
BAUDSEL0	Input	

7-2   Communication spetifications

7-2-1   Communication specifications

The SCI communication specifications are shown in Fig. 7-2.

Table 7-2 SCI Communication Specifications

Item	Specifications
Baud Rate	Selectable from among 9600, 19200, 38400, and 115200 bps
Data Length	8 bits
Stop Bit	1 bit
Parity	Not provided
Hardware Control	RTS Control

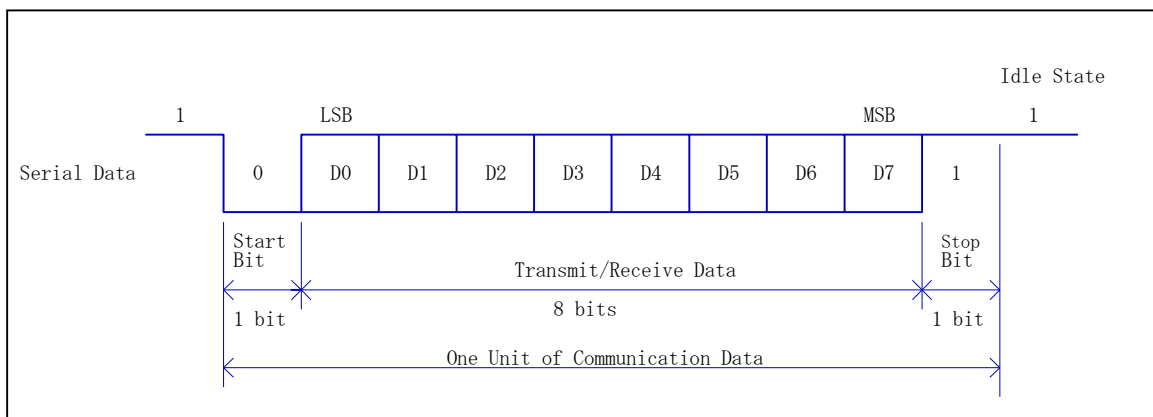The data format of the asynchronous serial communication is shown in Fig. 7-1.

Fig. 7-1 Data Format of Asynchronous Serial Communication

Kenic system

7-2-2　Baud Rate Selection

The Baud Rates can be selected from among 9600, 19200, 38400, and 115200bps by connecting the BAUDSEL1 and BAUDSEL0 pins to the DIP switches.

The relationship between the BAUDSEL1 and BAUDSEL0 pins and the Baud Rates is shown in table 7-3.

Table 7-3 Relationship between BAUDSEL1 and BAUDSEL0 pins and Baud Rates

BAUDSEL1 Pin	BAUDSEL0 Pin	Baud Rate [bps]
LOW	LOW	9600
LOW	HIGH	19200
HIGH	LOW	38400
HIGH	HIGH	115200

The BAUDSEL1 and BAUDSEL0 pins are pulled up in the LCD controller. When setting the above pins to HIGH, these pins may be open.

These pin conditions are checked only when the power is turned on. Thus, when the baud rate is changed, the power should be restarted or reset again.

7-3　Receive Buffer and RTS# Control

The LCD controller includes receive buffers of 512 bytes. The receive buffers are ring buffers.

When the receive data that is stored in the receive buffer is not been processed, or if the pointer has passed through the buffer, the unprocessed data may have been overwritten.

To prevent the above, the LCD controller includes the RTS# output pin.

The relationship between the output condition of the RTS# output pin and the receive feasibility is shown in Table 7-4.

Table 7-4 Output Condition of RTS# Output Pin and Receive Feasibility

Output Condition of RTS# Output Pin	Receive Feasibility
HIGH	Reception unable
LOW	Reception enable

When commands are received continually during the drawing process, if the pointer has passed through the buffer, the received, but unprocessed data may have been overwritten. Thus, connect the RTS# pin of the LCD controller to the CTS# pin of the user's microcomputer, and then use the Controller.

Kenic system

7-4 Precautions for Use

The pins related to the SCI are the input ports during the reset process. During the reset process, signals are unstable. Thus, pull up signals with a resistance (4.7kΩ - 10kΩ), as shown in Fig. 7-2.
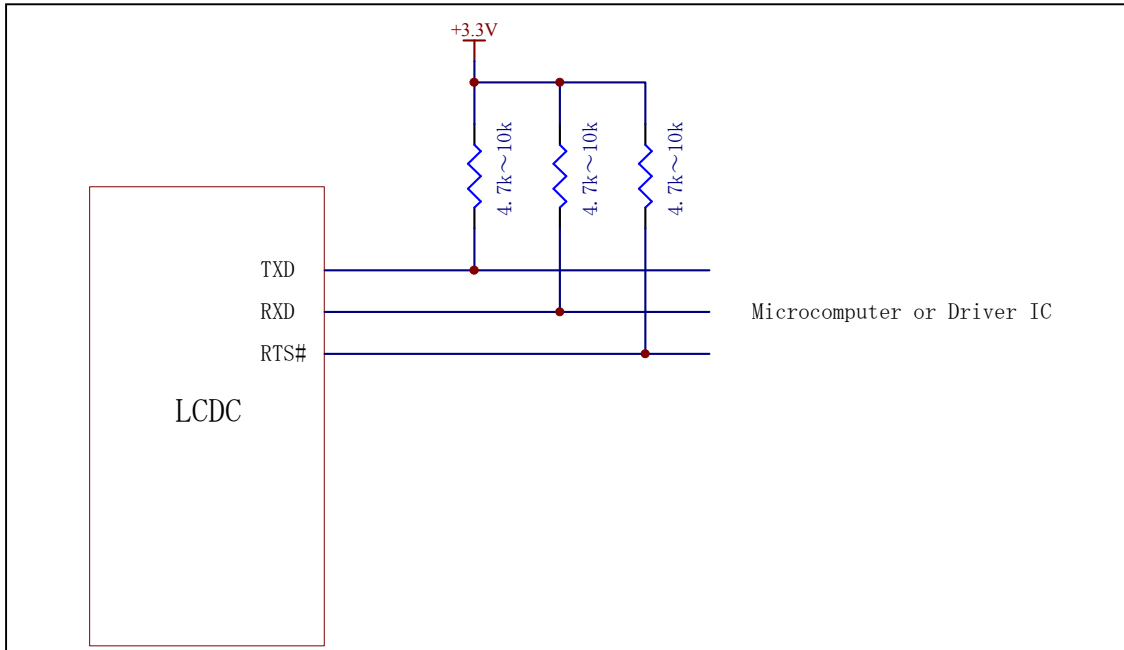

Fig. 7-2 Pull-up Processing of SCI Signals

7-5 Reference Circuit

Refer to "23. Reference Circuit Diagrams" that describes the reference circuits when the driver IC is not used.

Kenic system

8. Frame Buffer Memory

8-1 Overview

The LCD controller includes an external bus controller, which allows one to connect a frame buffer memory (SRAM) on a maximum capacity of 256K words, 16 bits.

The input/output pins for the external bus are shown in Table 8-1.

Table 8-1 Input/Output Pins for External Bus

Pin Name	Input/Output	Function
A18～A1	Output	Address Output Pins
D15～D0	Input/Output	Data Input/Output Pins LCD RGB Signals
CS#	Output	Chip Select Output Pin
RD#	Output	Read Output Pin
WR#	Output	Write Output Pin
EDREQ	Input	LCD Display Data Transfer Request Input Pin
HDEN	Output	LCD Display Period Output Pin

8-2 Frame Buffer Memory Access

The access to the frame buffer memory is shown in Fig. 8-1.

During the veridical display, the read access is started by the LCD display period output signal (output from the HDEN pin) and the data is read from the frame buffer memory. The data that is output on the data bus is the RGB signals of the LCD. During the vertical display, the drawing data cannot be written in the frame buffer memory. The drawing data is written in the frame buffer memory with commands for drawing during the non-vertical display. If the drawing data cannot be written during the non-vertical display due to image size, the remaining data will be written during the non-vertical display of the next frame.
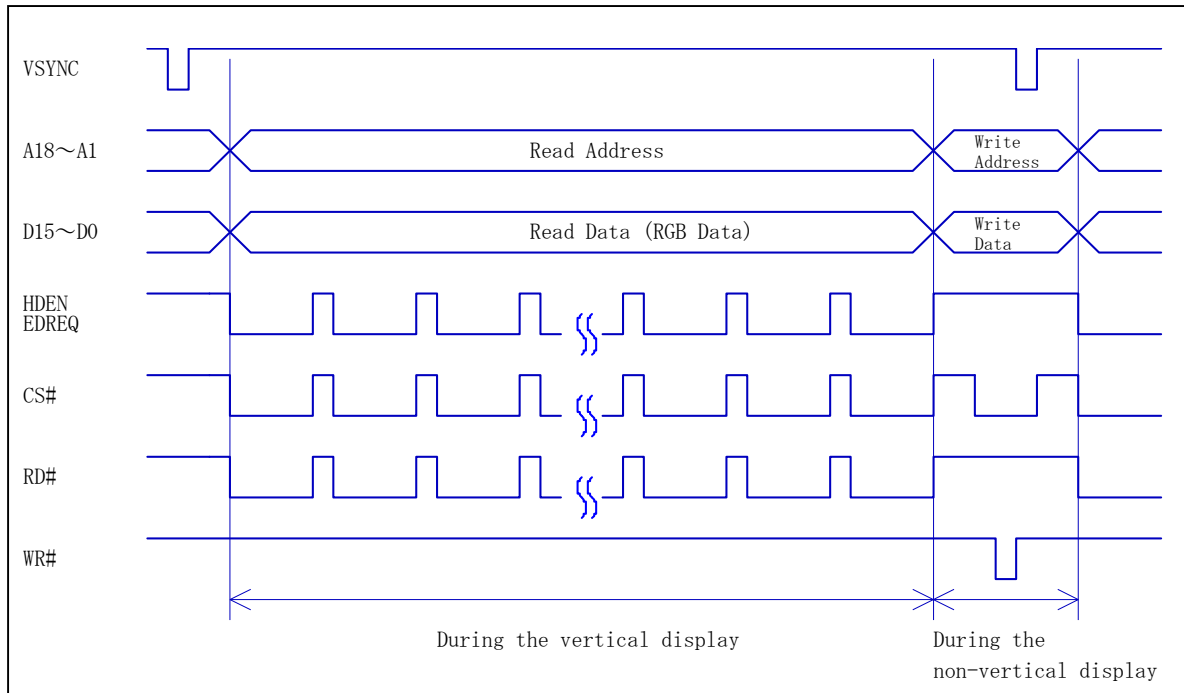
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Fig. 8-1 Access of Frame Buffer Memory

8-3 Connection

The connection diagram between the LCD controller and the frame buffer memory is shown in Fig. 8-2.

Connect the address signal of the LCD to the address pins of the buffer memory, in order from A1, because of the data bus width has 16 bits. The LCD controller includes the pins of A19 and A0. Open these pins.

Connect the data bus to the D15 − D0 pins and the RGB pins of the LCD. For the connection to the LCD, refer to "9 LCD Interface."

For the CS#, RD#, and WR# signals, connect the CE#, OE#, and WE# of the frame buffer memory. These pins are input ports during the reset process. During the reset process, signals are unstable and thus, malfunctions such as writing and/or outputting of unnecessary data may occur. Pull up the signals with resistance (4.7kΩ - 10kΩ), as shown in Fig. 8-2.

Connect the HDEN pin and the EDREQ pin. Make sure that, if these pins are not connected, the RGB signals will not be outputted to the LCD during the vertical display.
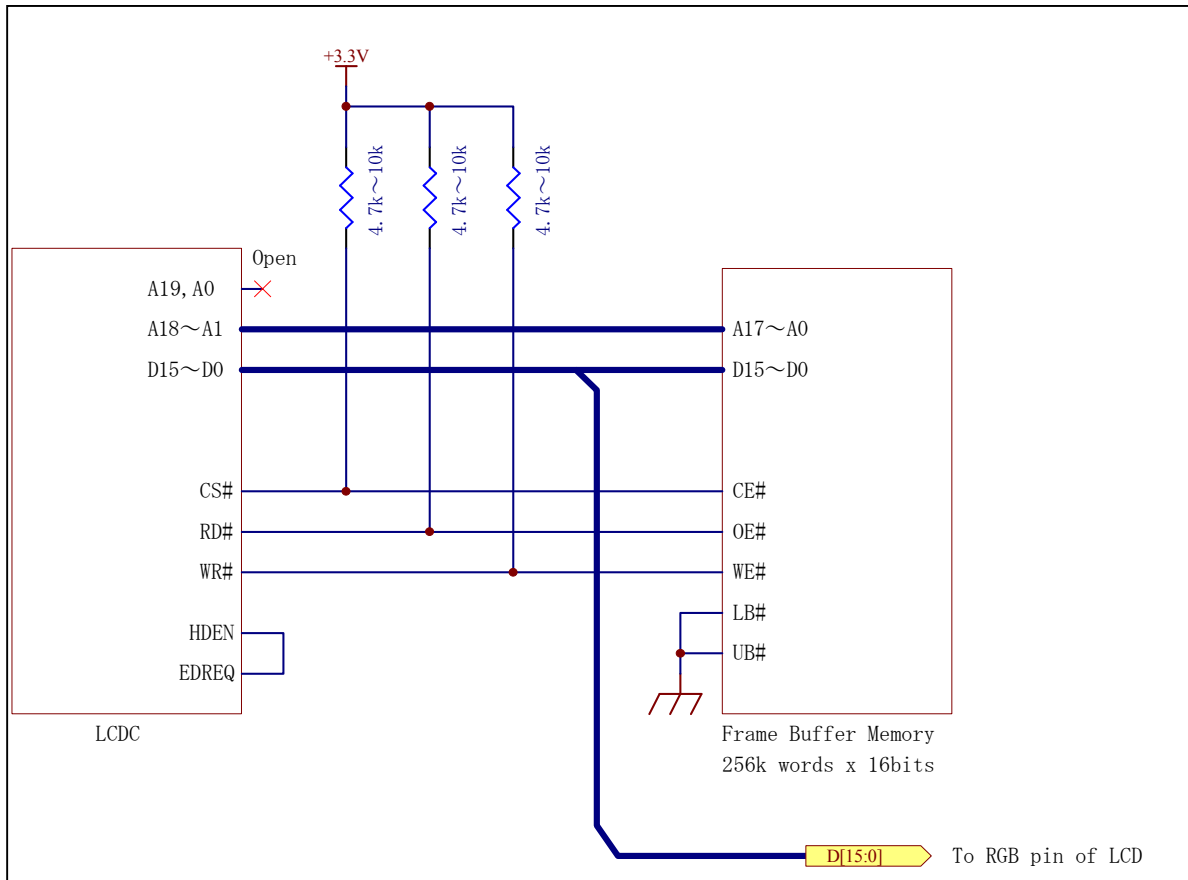
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Fig. 8-2 Connection Diagram of Frame Buffer Memory

8-4 Memory Map

The memory map of the buffer memory is shown in Fig. 8-3.

The LCD controller is configured with three pages. One page of them is allocated to QVGA display area.

The pages can be selected as a display or a write page by commands.

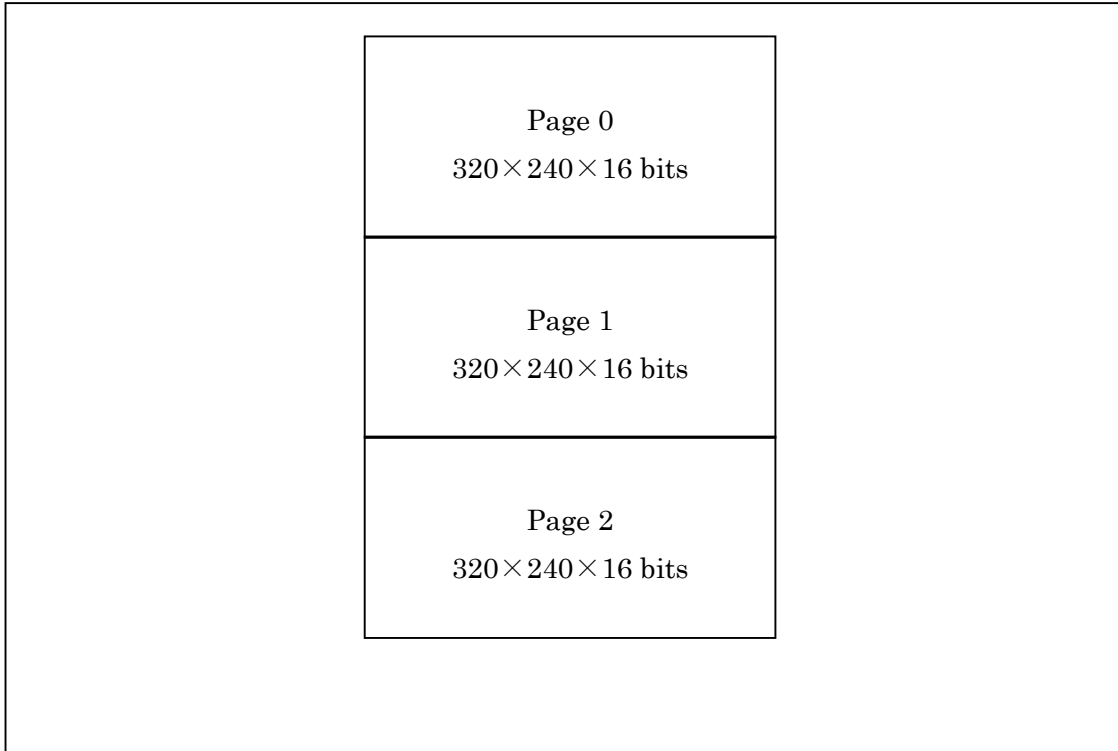For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

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Fig. 8-3 Memory Map of Frame Buffer Memory

8-5　Precautions for Use

8-5-1　Selection of Frame Buffer Memory

Use the buffer memory of a high speed SRAM (a speed of 10 nsec.).
The manufacturer and type of the high speed SRAM we recommend are shown in Table 8-2.

Table 8-2 Manufacturer and Type of High Speed SRAM

Manufacturer	Type	Specifications
Lyontek	LY61L25616AML-10I	256k×16 bit, 10ns
ISSI	IS61WV25616BLL-10TLI	256k×16 bit, 10ns

When using a high speed SRAM that is not listed in Table 8-2, select a high speed SRAM that has equivalent specifications to the SRAM in Table 8-2.

8-5-2　Precautions for Board Design

Arrange the signal lines between the LCD controller and the frame buffer memory with a minimum length.

Kenic system

8-6　Reference Circuit

Refer to "23. Reference Circuit Diagrams" that describes the reference circuits when LY61L25616AML-10I (Lyontek) is connected.

Kenic system

9. LCD Interface

9-1 Overview

The LCD controller allows one to output the LCD synchronization signal and control signals for the LCD.

The output pins for the LCD interface are shown in Table 9-1.

Table 9-1 Output Pins for LCD Interface

Pin Name	Input/Output	Function
DCLK	Output	Dot Clock Output Pin
HSYNC	Output	Horizontal Synchronization Signal Output Pin
VSYNC	Output	Vertical Synchronization Signal Output Pin
ENAB	Output	Data Enabling Output Pin
R/L	Output	Horizontal Inverse Signal Output
U/D	Output	Vertical Inverse Signal Output
DCLK_INVERT	Input	DCLK Inverse Input

9-2 Connection

The connection diagram between the LCD controller and the LCD is shown in Fig. 9-1.

There are LCDs without the ENAB signal and LCDs with only an ENAB signal that is a synchronization signal. Connect between the LCDC and the LCD with a connection method suited to the LCD that is used.

The LCD controller does not include the RGB output Pins. As explained in "8. Frame Buffer Memory", the RGB data is outputted to the data busses of D15 – D0 during the vertical display. Connect the data busses of D15 – D0 to the RGB signals of the LCD, as shown in Fig. 9-1.

The LCD controller includes the R/L terminals (a horizontally inverted signal output) and the U/D terminals (a vertically inverted signal output). The indication direction in the LCD can be changed by connecting the R/L and U/D terminals on the LCD side. The output logical values of the R/L and U/D terminals can be set by commands. For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual." The state of these terminals' initial output logic values are shown in Table 9-2.

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Table 9-2 Initial Output Logic Values of R/L and U/D Terminals

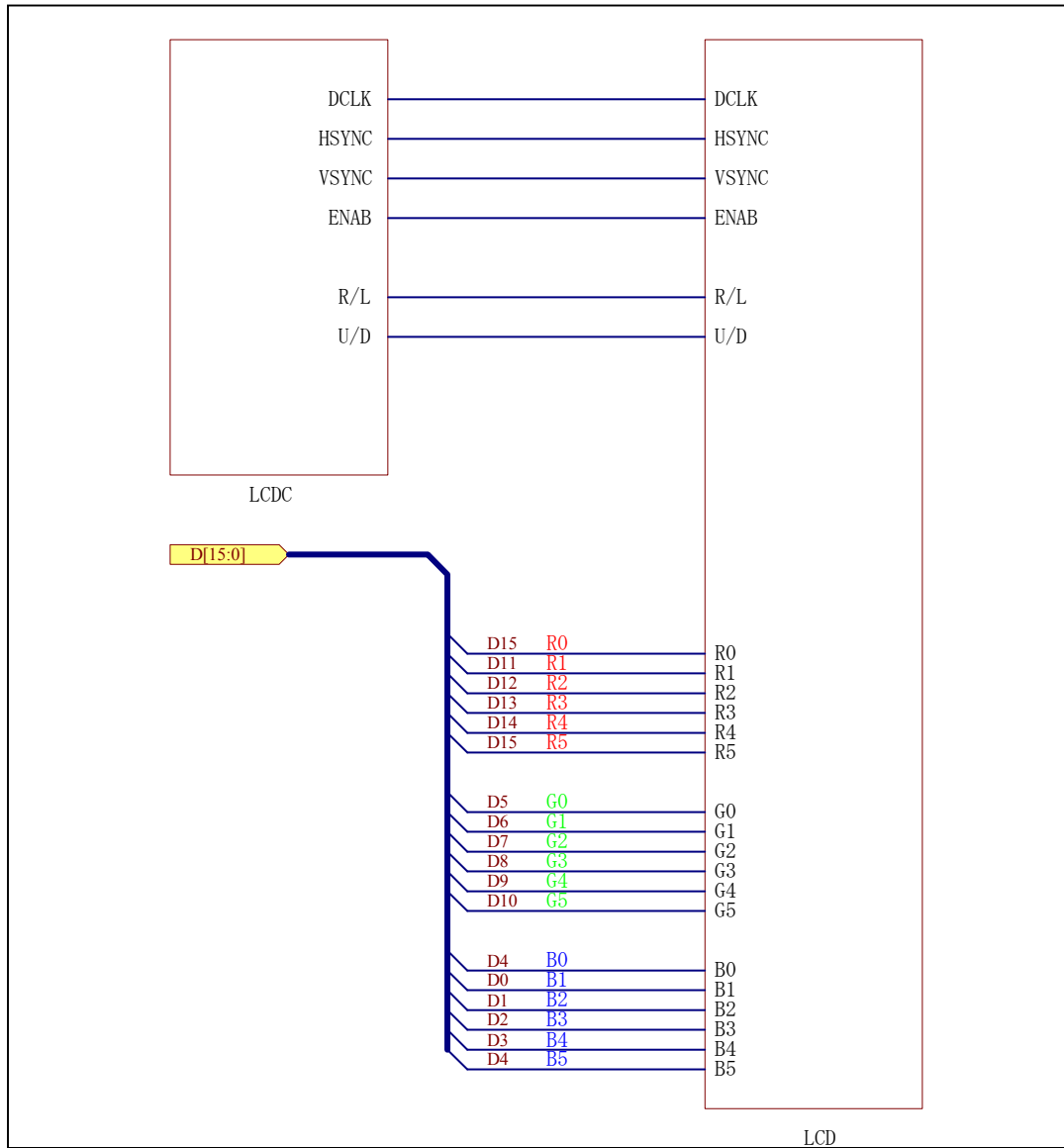| Terminal Name	Initial Output Logic Value
R/L terminals	LOW Output
U/D Terminals	HIGH Output

Fig. 9-1 Connection of LCD

9-3　Object LCD

LCDs whose operations have been checked by this LCD controller are described on our web site. Refer to the site.

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9-4　DCLK Polarity Reversing Function

The LCD controller includes a function that reverses the polarity of the DCLK output signal. The polarity is reversed by the DVLK_INVERT input terminals.

The relationship of the input logic values of the DCLK_INVERT input terminals to the polarities of the DCLK_INVERT output signals is shown in Table 9-3.

Table 9-3 Relationship of Input Logic

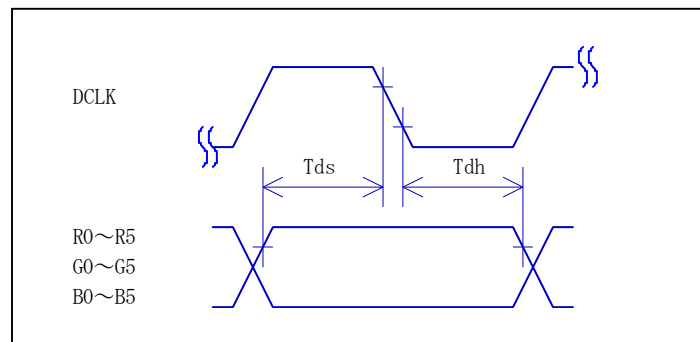| DCLK_INVERT Input Terminal	Polarity of DCLK_INVERT Output Signal	Remarks
HIGH or Open	Falling	Fig. 9-2
LOW	Rising	Fig. 9-3

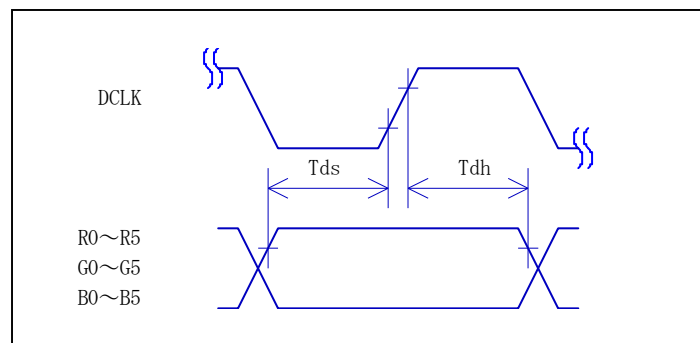Fig 9-2 Falling Polarity of DCLK Output Signal

Fig. 9-3 Rising Polarity of DCLK Output Signal

9-5　Reference Circuit

Refer to "23. Reference Circuit Diagrams" that describes the reference circuits when the following LCD is connected.

・ Kyocera　　　　TCG057QVLCS-H50
・ Kyocera　　　　TCG057QVLCA-G00
・ DENSITRON　　LMTM057QVGNCA-4R

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10. SPI Interface

10-1 Overview

The LCD controller includes one channel of serial peripheral interface (hereinafter called SPI).

The SPI is used for communication between the LCD controller, and the serial flash memory and/or the micro SD card. The LCD controller is a master side.

The input/output pin for SPI is shown in Table 10-1.

Table 10-1 SPI Input/Output Pins

Pin Name	Input/Output	Function
RSPCK	Output	Clock Output Pin
MOSI	Output	Master Data Output Pin
MISO	Input	Master Data Input Pin
SDCCS#	Output	microSD Card Selecting Output Pin
SFCS#	Output	Serial Flash Memory Selecting Output Pin

10-2 Communication Specifications

The SPI communication specifications are shown in Fig. 10-2.

Table 10-2 SPI Communication Specifications

Item	Specifications
Transfer Rate	12Mbps (Note 1)
Communication Activity Mode	Full-duplex Synchronous Serial Communication
SPI Mode	Mode 0

(Note 1) Only during initialization of the microSD card, the transfer rate is 400 kbps.

10-3 Connection

The connection diagram between the LCD controller, and the serial flash memory and/or the micro SD card is shown in Fig. 10-1. Pull down the RSPCK with a register of 100kΩ. Pull up with a resister of 47kΩ for signals except for the RSPCK.

When the LCD controller is not connected to the serial flash memory and the microSD card, treat each Pin, as shown in Table 10-3.

Kenic system
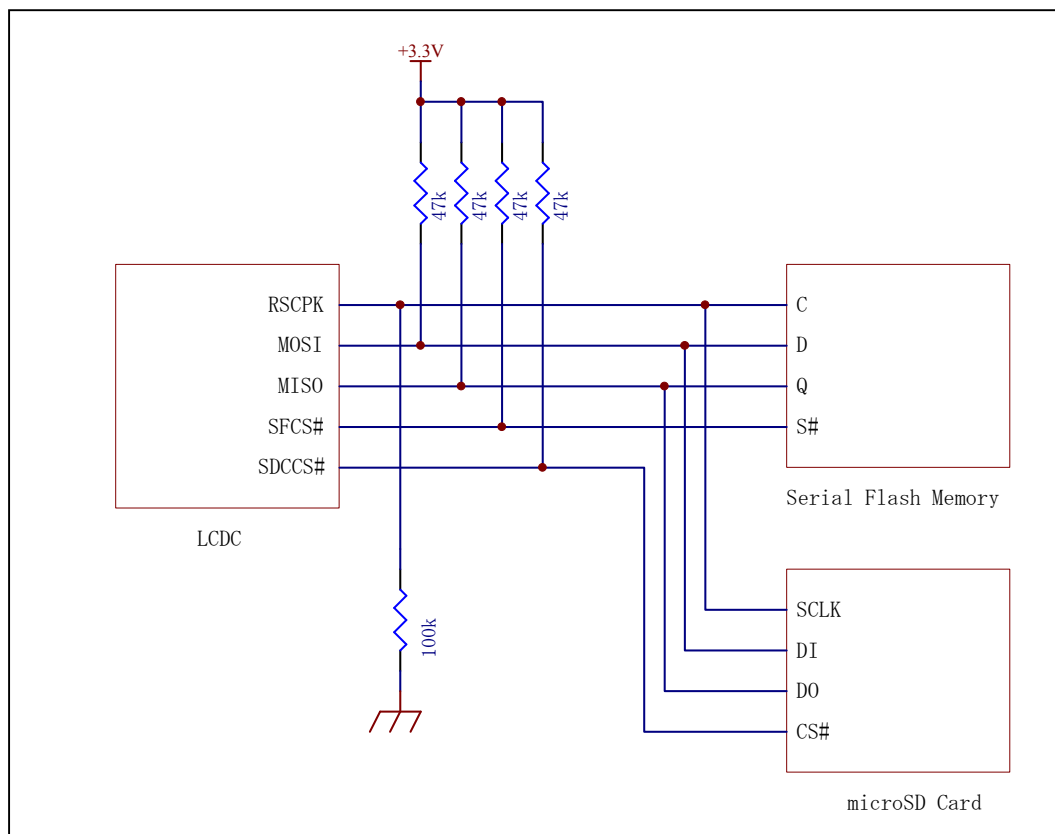
Fig. 10-1 SPI Connection

Table 10-3 Pin treatment when the LCD controller is not connected

to the serial flash memory and the microSD card

Pin Name	Input/Output	Pin Treatment
RSPCK	Output	Pull-up　(4.7kΩ～10kΩ)
MOSI	Output	Pull-up　(4.7kΩ～10kΩ)
MISO	Input	Pull-up　(4.7kΩ～10kΩ)
SDCCS#	Output	Open
SFCS#	Output	Open

10-4　Reference Circuit

Refer to "23. Reference Circuit Diagrams" that describes the reference circuits when
the LCD controller is not connected to the serial flash memory and the microSD card.
For Starter Kit users, refer to the circuit diagrams attached to the Starter Kit that
describes the connection circuit for the serial flash memory and the microSD card.

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11. Serial Flash Memory

11-1 Overview

The LCD controller includes a font drawing function and an image data drawing function. When using these functions, it is necessary to connect the serial flash memory to the LCD controller and to write the font data or the image data in the memory.

However, the LCD controller includes the 16-dot font data for the font image function. When drawing the 24-dot font characters, it needs the serial flash memory.

11-2 Memory Map

The memory map of the serial flash memory is shown in Fig. 11-1.


```
0x00000000      ┌─────────────────────┐
                │     24-dot font     │
                │     Data area       │
                │   About 1.5Mbyte    │
0x0017FFFF      ├─────────────────────┤
0x00180000      │                     │
                │                     │
                │                     │
                │  The image data area│
                │    About 6Mbyte     │
                │                     │
                │                     │
0x007FFFFF      └─────────────────────┘
```
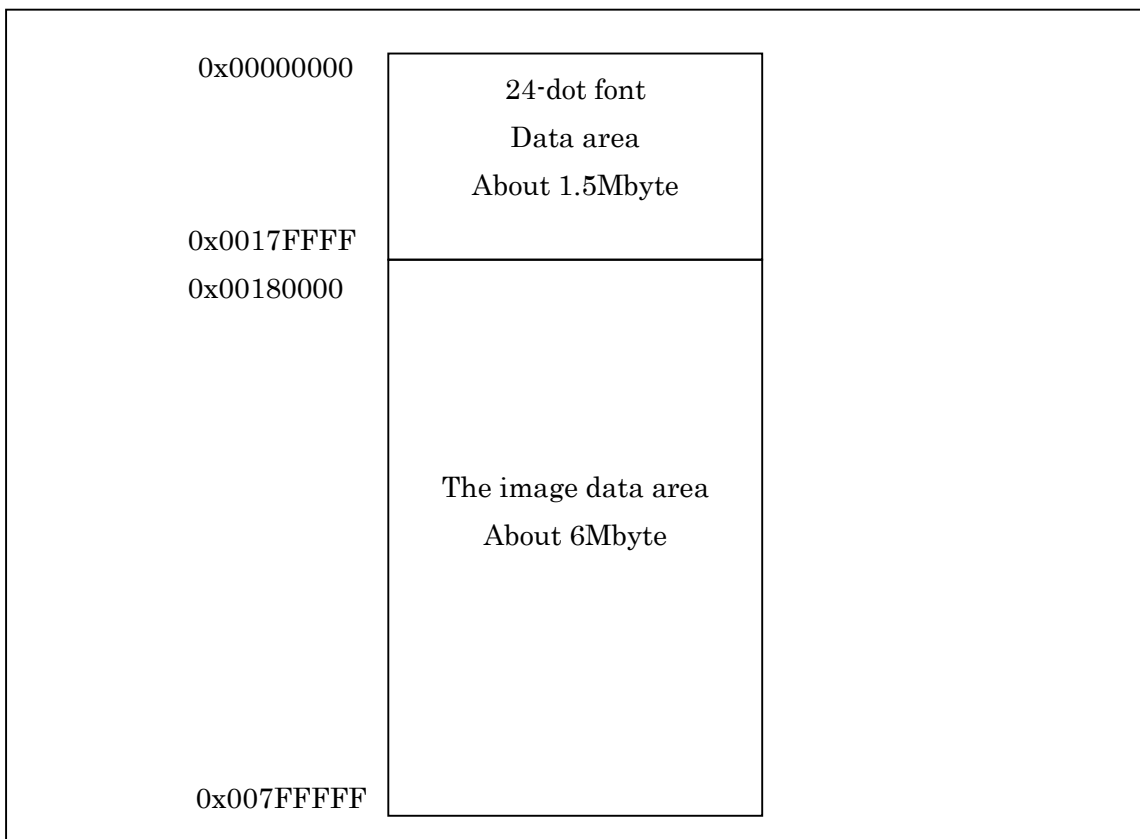
Fig. 11-1 Memory Map of Serial Flash Memory

The image data area is divided into the image data index area and the image data storage area, as shown in Fig. 11-2.
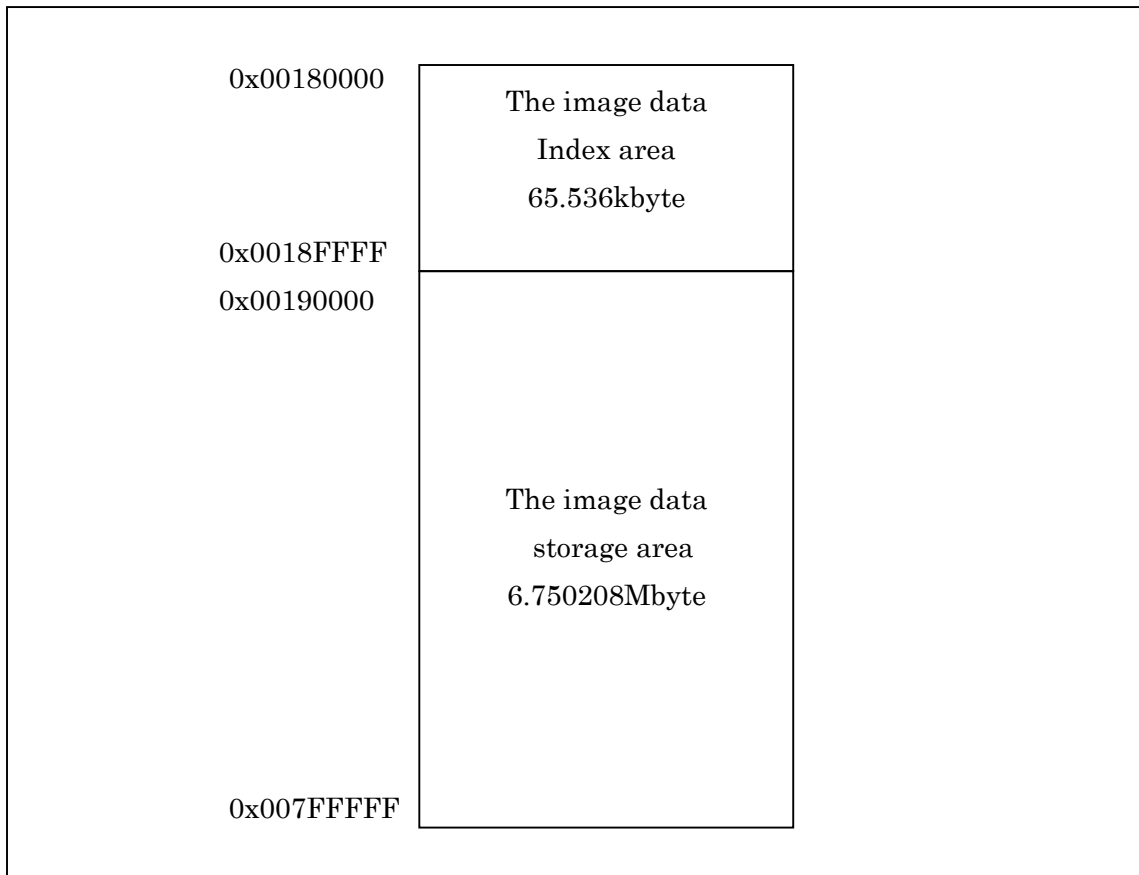
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```
0x00180000    ┌─────────────────┐
              │  The image data  │
              │   Index area     │
              │  65.536kbyte     │
0x0018FFFF    │                  │
0x00190000    ├─────────────────┤
              │                  │
              │                  │
              │                  │
              │  The image data  │
              │   storage area   │
              │  6.750208Mbyte   │
              │                  │
0x007FFFFF    └─────────────────┘
```

Fig. 11-2 Image Data Area

The following information is stored in the image data index area.

①Image data width (2 bytes)

②Image data height (2 bytes)

③Starting address of Image data location (4 bytes)

The image data (color information) is stored in the image data storage area.

The size of the image data index area is 65,536 Kbytes. This enables one to write image data on a maximum of 8,192 in the serial flash memory. However, the size of the image data may reduce the number of screens that can be written in the memory. For example, in the case of a QVGA size image,

the data for 1 (one) image is 320 x 240 x 2 bytes=153.6Kbytes.

The number of image data that are written in the image data area is
6.750208Mbytes/153.6 Kbytes≒43 screens.

In reverse, in the case of an image size of 20 x 20,

　one image data is 20×20×2=800 bytes.

The number of image data that can be written in the image data area is
6.750208Mbytes/800 Kbytes≒8,437 screens.

However, the image data index area can store only information of 8,192 image data
size at most. In this case, the maximum number of screens that can be written is
8,192.
The number of images that can be stored in the serial flash memory varies with the
size of the image data prepared by a user. Be aware of the number of images.

11-3　Precautions for Use

11-3-1　Selection of Serial Flash Memory

For the serial flash memory, use the serial flash memory manufactured by the
specified manufacturer shown in Table 11-1.

Table 11-1 Manufacturer and Type of Serial Flash Memory

Manufacturer	Type	Specifications
Micron　Technology	M25P64-VMF6P	Capacity 64Mbit

Contact us when a serial flash memory that is not listed in Table 11-1 is used. We
will check to determine whether the data sheet of a serial flash memory that is sent
by a user conforms to our requirements. Select a flash memory of 64 Mbit in capacity.

Kenic system

11-3-2　Timeout of Serial Flash Memory

For the following processes of the serial flash memory, time required to complete the processing varies with manufacturer and memory capacity.

　・Writing a status register
　・Writing a page
　・Sector erasing
　・Chip (bulk) erasing

Timeout is invalid by default in the LCD controller, which waits until the above process is completed.

Enabling timeout by a command allows one to end the processing without waiting for the completion of operations when the process is not completed, although the timeout time that is shown in Table 11-2 has been passed over. For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

Table 11-2 Timeout Time

Process Description	Timeout Time	Unit
Writing a status register	30	msec
Writing a page	10	msec
Sector erasing, Chip (bulk) erasing	320	sec

Kenic system

12. Touch Panel

12-1 Overview

The LCD controller includes a touch panel controller.

The input/output Pins for the touch panels are shown in Table 12-1.

Table 12-1 Input/Output Pins related Touch Panel

Pin Name	Input/Output	Function
AVCC0	Input	Analog Power Pin of A/D Converter
AVSS0	Input	Analog Ground Pin of A/D Converter
VREFH0	Input	Reference Power Pin of A/D Converter
VREFL0	Input	Reference Power Ground Pin of A/D Converter
XOUT	Output	X-axis Voltage Applying Enabling Output Pin
YOUT	Output	Y-axis Voltage Applying Enabling Output Pin
XIN	Output	X-axis Voltage Applying Signal Output Pin
YIN	Output	Y-axis Voltage Applying Signal Output Pin
TDRC	Output	Touch Panel Detection Resistance Control Output Signal
TOUCHLED	Output	Touch Panel Pressing Detection Output Signal
XLAD	Input	Y-position Detection Voltage Analog Input Pin
YUAD	Input	X-position Detection Voltage Analog Input Pin
XD	Input	X-direction AD Value Inverted Input Pin
YD	Input	Y-direction AD Value Inverted Input Pin

12-2 Specifications

The specifications of the touch panel controller are shown in Fig. 12-2.

Table 12-2 Specifications of Touch Panel Controller

Item	Specifications
Corresponding Touch Panel	Four-wire Resistive Type
Touch Panel Data Resolution	10 bits
Others	X-direction AD Value, Y-direction AD Value Inverted

12-3 Connection

An example of the touch panel connection is shown in Fig. 12-1.

The XD and the YD pins are pulled up in the LCD controller. Thus, the external pull-up resistances are not needed.

When the touch panel is not used, each pin is treated, as shown in Table 12-3.

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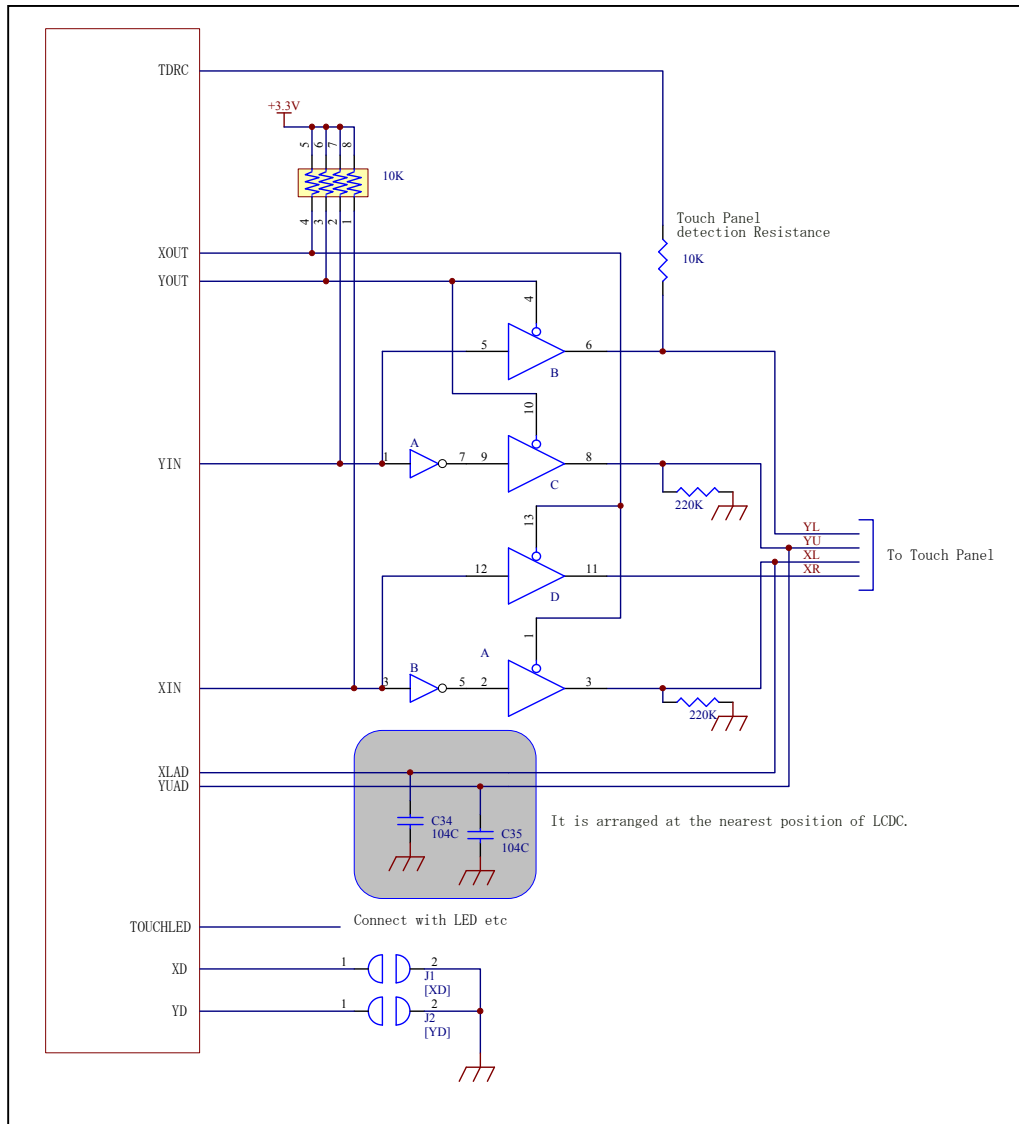
Fig. 12-1 Touch Panel Connection Example

Table 12-3 Pin Treatment when the touch panel is not used

Pin Name	I/O	Pin Treatment
XOUT	Output	Open
YOUT	Output	Open
XIN	Output	Open
YIN	Output	Open
TDRC	Output	Open
TOUCHLED	Output	Open
XLAD	Input	Pull-down（4.7kΩ～10kΩ）
YLAD	Input	Pull-down（4.7kΩ～10kΩ）
XD	Input	Open (Internal Pull up)
YD	Input	Open (Internal Pull up)

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12-4 Touch Panel Data Returning Mode

The LCD controller includes the following touch panel data returning modes.

    ① 1 (one) Data Returning

    ② Automatic continuous returning

    ③ Continuous returning while pressing the touch panel

    ④ Returning only when the touch panel is being pressed

    ⑤ Returning only when the touch panel is released

    ⑥ Returning both data when the touch panel is pressed and when it is released

These modes are selected by commands. For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

12-4-1 1 (one) Data Returning

The mode is for returning the touch panel data once, (the event data, the X-direction AD value and the Y-direction AD value) when a command is received. The operation is shown in Fig. 12-2.

If the touch panel is not pressed when the command is received, the event data, the X-direction AD value, and the Y-direction AD value are 0 (zero) and then these data are returned. If the touch panel is pressed when the command is received, the event data is 1, and the X-direction AD value and the Y-direction AD value are the data of a position where the touch panel is pressed. Then, the data are returned.
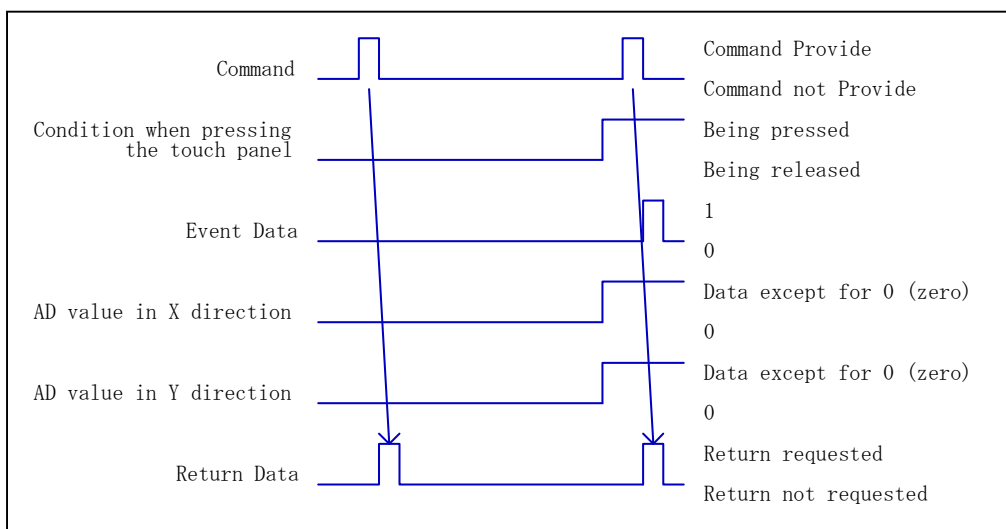

Fig. 12-2　1 (one) Data Returning Operation

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12-4-2　Automatic, Continuous Returning

The mode is for returning the touch panel data continuously at a constant frequency from a time when the command has been received. (the event data, the X-direction AD value and the Y-direction AD value). The operation is shown in Fig. 12-3.

First, the data of a condition when the command has been received is returned. Subsequently, the touch panel data is returned automatically at the frequency of the touch panel data returning interval.

The touch panel data returning interval is 50 msec by default. This value can be changed by commands. For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

When drawing commands or other commands are transmitted while returning the touch panel data, the touch panel data returning interval is increased by the process time for the command.

When stopping the automatic continuous returning, set to the 1 (one) data returning mode.
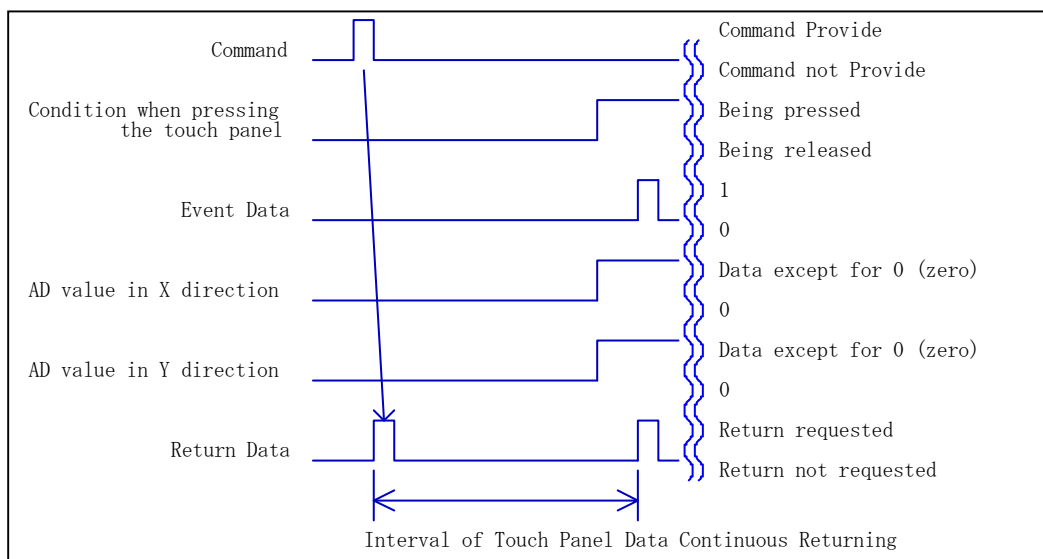
Fig. 12-3 Automatic Continuous Returning Operation

12-4-3　Continuous Returning While Pressing the Touch Panel

The mode is for returning, continuously at a constant frequency, the touch panel data (the event data, the X-direction AD value and the Y-direction AD value) only during the touch panel is being pressed. The operation is shown in Fig. 12-4.

When the command is received, the data returning is stopped.

When the touch panel is pressed, the data return is initiated. Subsequently, the touch panel data is returned automatically at the frequency of the touch panel data

returning interval while the touch panel is being pressed.

When drawing commands and/or other commands are transmitted while returning the touch panel data, the touch panel data returning interval is increased by the process time for the command.

When the touch panel is released, the X-direction AD value and the Y-direction AD value when the touch panel is released are returned and then the returning operation is stopped. If the touch panel is pressed again, the retuning operation is performed in the same manner.

When stopping the operation mode, set to the 1 (one) data returning mode.
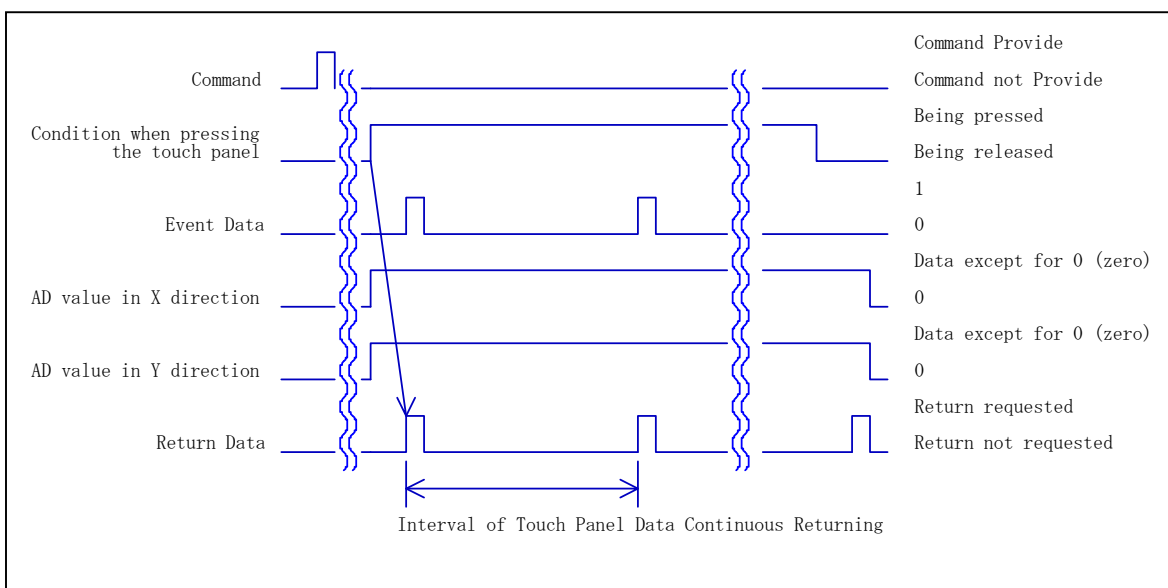
Fig. 12-4 Continuous Returning Operation while Touch Panel is being pressed

12-4-4　Returning only while the touch panel is being pressed

When the touch panel is pressed, the data is returned only once. The operation is shown in Fig. 12-5.

When the command is received, the data return is stopped. When the touch panel is pressed, the data is returned only once. When releasing the touch panel and pressing it again, the data is returned only once. Subsequently, this operation is repeated. When stopping the operation mode, set to the 1 (one) data returning mode.

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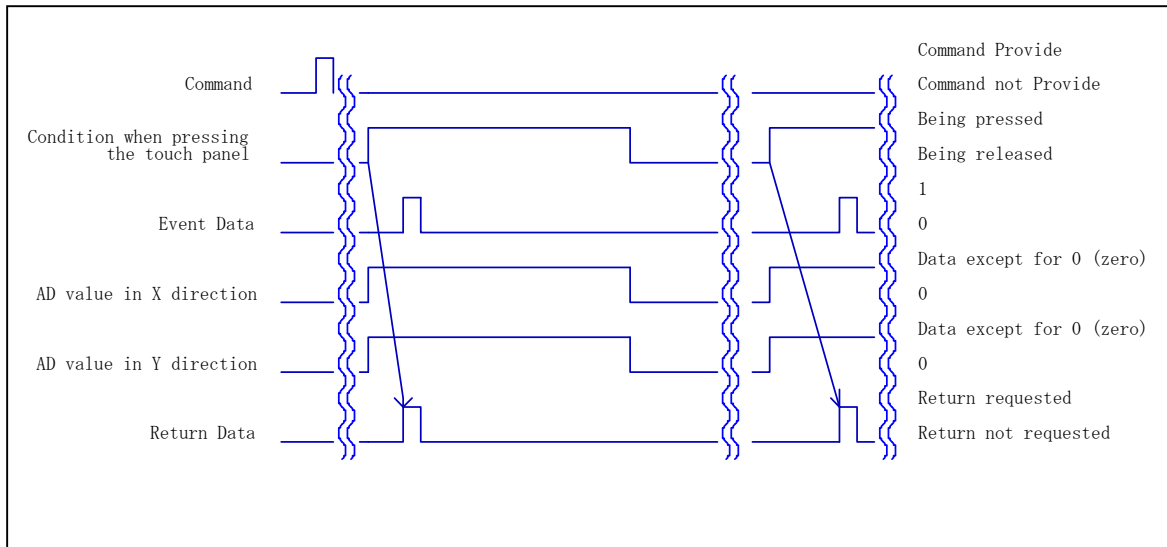
Fig. 12-5 Continuous Returning Operation only when Touch Panel is pressed

12-4-5 Returning only when the touch panel is released

When the touch panel is released, the data is returned only once. The operation is shown in Fig. 12-6.

When the command is received, the data return is stopped. If the touch panel is released after it is pressed, that data is returned only once. When the touch panel is pressed and then released again, the data is returned only once. Subsequently, this operation is repeated. When stopping the operation mode, set to the 1 (one) data returning mode.
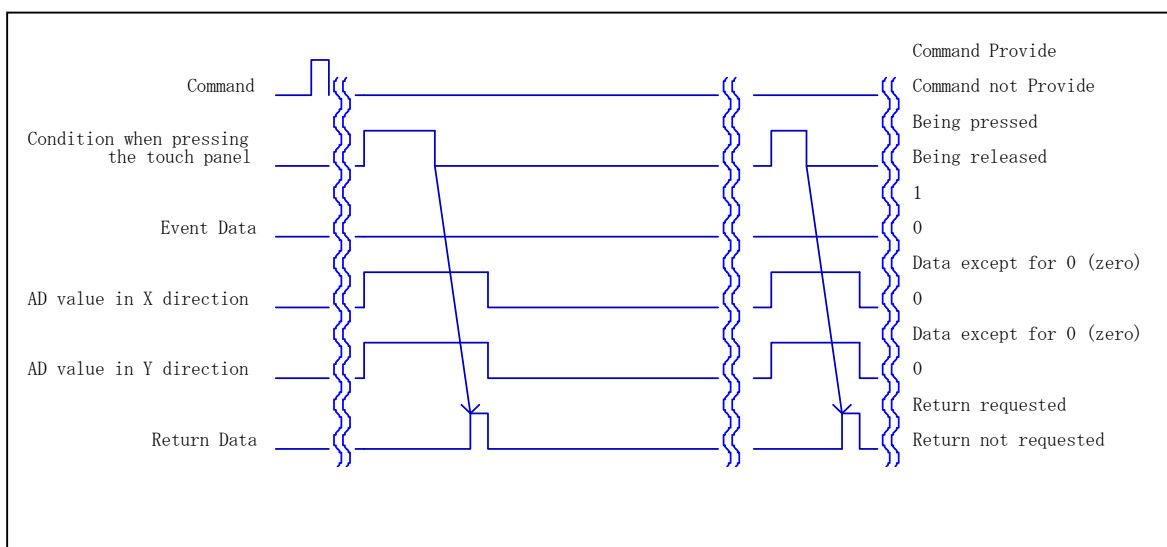
Fig. 12-6 Returning Operation only when Touch Panel is released

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12-4-6　Returning both data when the touch panel is pressed and when it is released

When the touch panel is pressed and when it is released, both data are returned. The operation is shown in Fig. 12-7.

When the command is received, the data return is stopped. When the touch panel is pressed, the data is returned. Subsequently, the data has been returned until a finger is released from the touch panel. When the finger is released from the touch panel, the data is returned. After this, the data will be been returned until the touch panel is pressed again. Subsequently, this operation is repeated. When stopping the operation mode, set to the 1 (one) data returning mode.
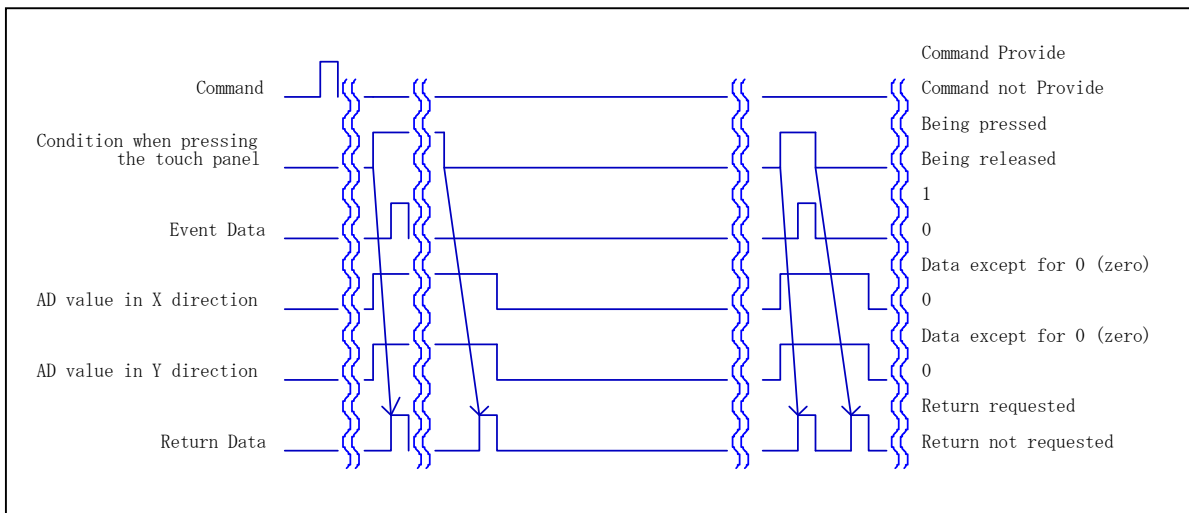
Fig. 12-7 Returning Operation of both data when the touch panel is pressed and when it is released

12-5　TOUCHLED signal output

The TOUCHLED signal output is held at HIGH while the touch panel is being pressed, as shown in Fig. 12-8.
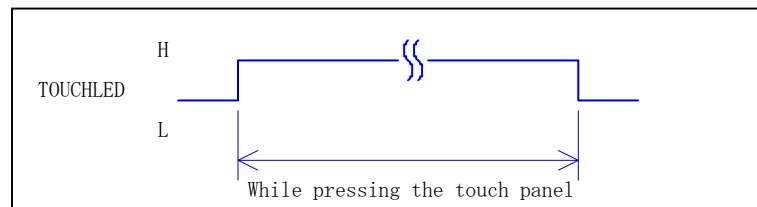
Fig. 12-8 TOUCHLED Signal Output

Kenic system

12-6 AD value in the X direction, and AD value in the Y direction inverting

The X-direction AD value and the Y-direction AD value can be inverted with the XD pin and the YD-pin.

The conditions of the XD and the YD pins and the conditions of the AD value in the X direction and the AD value in the Y direction are described in Table 12-4.

Table 12-4 Conditions of XD and YD pins and conditions of
X-direction and Y-direction AD values

XD Pin	YD Pin	AD value in X direction	AD value in Y direction
H or Open	H or Open	Normal	Normal
L	L	Inversion	Inversion

The conditions described in Table 12-4 are shown in Fig. 12-9 and 12-10.
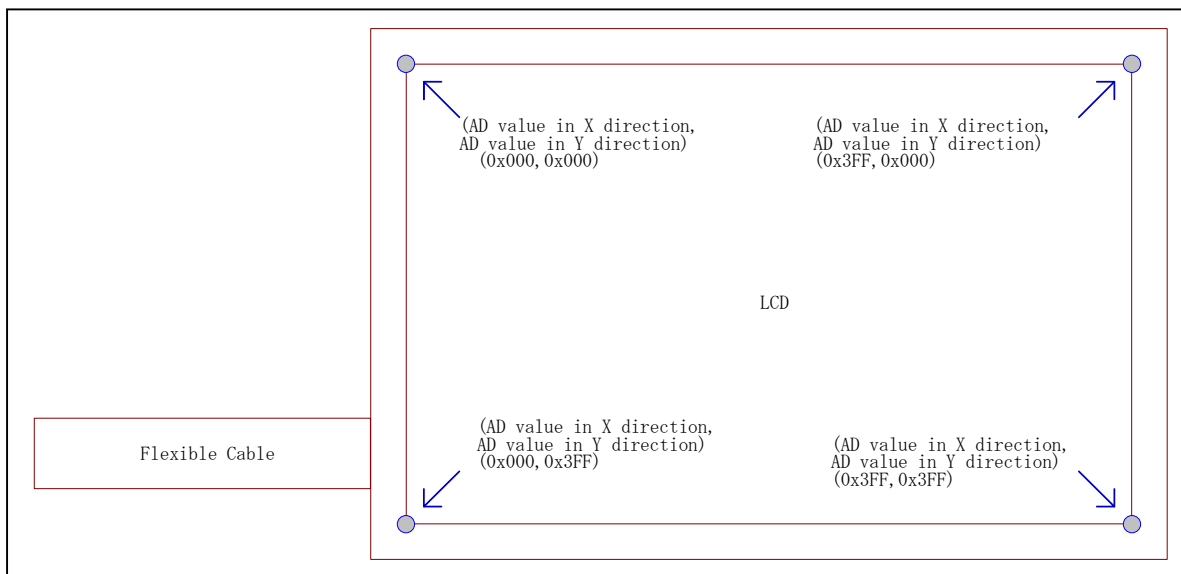
Fig. 12-9 When both XD and YD pin are open or HIGH

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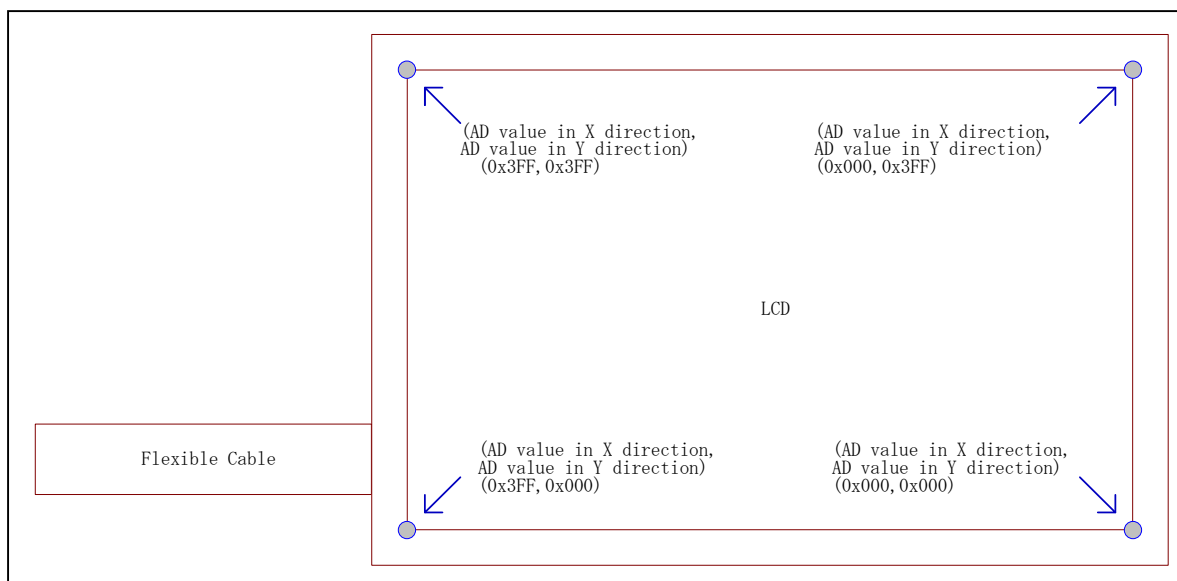
Fig. 12-10 When both XD and YD pin are LOW

12-7　Precautions for Use

12-7-1　Data

The AD value in the X-direction and the AD value in the Y-direction that are returned from the LCD controller are AD converted data.

Thus, the dot-coordinates conversion should be conducted on the user microcomputer side.

12-7-2　Setting range of analog power pin and others

Using the LSI at a voltage exceeding the following voltage setting range may adversely affect its reliability.

・Setting the range of analog input voltage

The voltage that is applied to the analog input pins (the XLAD and the YUAD) should be within the range of $VREFL0 \leqq VAN \leqq VREFH0$.

・Relationship with each power pin (AVCC0－AVSS0, VREFH0－VREFL0, VCC－VSS)

These relationship should be AVCC0=VCC and AVSS0=VSS.

When the touch panel is unused, the relationship should be

VREFH0=AVCC0=VCC, and VREFL0=AVSS0=VSS.

・Setting the range of VREFH0

The setting should be VREFH0=AVCC0.

Kenic system

12-7-3   Precautions for Board Design

When designing the board, signal lines of digital circuits and signal lines of analog circuits (XLAD and YUAD) should not be crossed or come close in the enable range. The analog signals with noise adversely affect the accuracy of the AD converted values.

To reduce the noise, connect the analog pin (the XLAD and YUAD pin) through a capacitor of 0.1uF.

For the AVCC0, AVSS0, VREFH0, and VREFL0, connect by means of the resistance of 0Ω from the VCC and VSS respectively, as shown in Fig. 12-11. In addition, connect capacitors of 10uF and 0.1uF between each power.
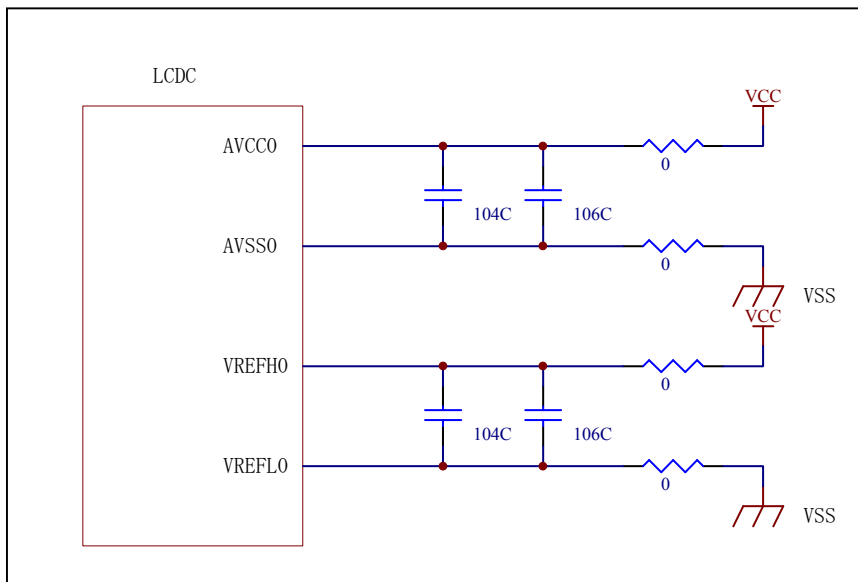
Fig. 12-11 Pin Treatment of Analog Power

12-8   Reference Circuit

Refer to "23 Reference Circuit Diagrams" that describes the reference circuits of the touch panel.

Kenic system

13. LED Backlight

13-1   Overview

The LCD controller includes the PWM output pin for LED backlight dimming and the backlight ON/OFF output pin.

The output pins for the LED backlight are shown in Table 13-1.

Table 13-1 Input/Output Pins for LED Backlight

Pin Name	Input/Output	Function
BLEN	Output	Backlight ON/OFF Output Pin
LEDPWM	Output	PWM Output Pin for Backlight Diming

13-2   Backlight ON/OFF Output

After releasing the reset and initializing the LCD controller, the backlight ON/OFF output is LOW output (for the detailed timing, refer to "18 Power Supply Sequence and Power Conservation".)

Switching the HIGH/LOW of the output is performed by commands. For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

13-3   PWM output

After the release of the reset and the initialization of the LCD controller, the PWM output is HIGH output with a frequency of 200Hz and an ON DUTY 100% (for the detailed timing, refer to "18 Power Supply Sequence and Power Conservation."

The PWM frequency can be selected from among each 100 Hz unit in the range of 100 Hz – 1000 Hz, and 100 kHz. The ON DUTY can be set in increments of 1% in the range of 0% - 100%.

Setting the PWM frequency and the ON DUTY can be performed by commands. For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

13-4   Reference Circuit

Refer to "23. Reference Circuit Diagrams" that describes the reference circuits of the LED backlight I/F circuit.

Kenic system

14. Buzzer

14-1 Overview

The LCD controller includes the output pin for the buzzer control.

The output pins for the buzzer are shown in Table 14-1.

Table 14-1 Input/Output Pins for Buzzer

Pin Name	Input/Output	Function
BUZZ	Output	Buzzer ON/OFF Output Pin

14-2 BUZZ output

After the release of the reset, the BUZZ pin is the LOW output.

The BUZZ pin output can be selected from the toggle output or switching to the LOW output automatically from the HIGH output for a fixed period of time.

In the case of the toggle output, the output is held at HIGH between the ON command by the former command and the OFF command by the later command, as shown in Fig. 14-1.

In the case of HIGH output for a fixed period of time, the output is held at HIGH by the former command and switches to LOW automatically after the fixed period of time that is set by the command, as shown in Fig. 14-2.
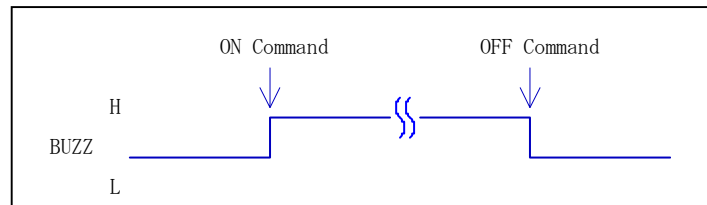
Fig. 14-1 Toggle Control
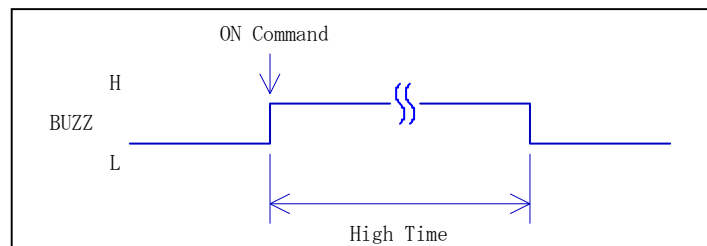
Fig. 14-2 Fixed Period Time Control

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

Kenic system

14-3 Reference Circuit

Refer to "23. Reference Circuit Diagrams" that describes the buzzer reference circuits.

15. Treatment for Power Pins, Unused Pin and Other Pins

15-1 Power pin treatment

The power pin is treated, as shown in Table 15-1. For these pin treatments, refer to "23. Reference Circuits."

Table 15-1 Power pin treatment

Pin Name	Pin Treatment	Notes
VCC	Connects to the +3.3V.	Insert capacitors of 0.1uF between VCC-VSS, VREFH-VREFL, and VBATT-VSS.
VREFH		
VBATT		
VSS	Connects to the GND.	
VREFL		

(Note) For the pin treatment of the AVCC0 and the VREFL0 pin, refer to "12. Touch Panel."

15-2 Treatment for unused pin and other pins

The unused pin and other pins are treated, as shown in Table 15-2. For these pin treatments, refer to "23. Reference Circuits."

Table 15-2 Treatment for unused pin and other pins

Pin Name	Pin Treatment	Notes
NC	Open	
P02	Open	Pulls up in the LCD controller
EMLE	Pulls down with a resistance of 10kΩ.	
VCL	Connects VSS by means of a capacitor of 0.1uF.	Arrange the capacitor closed to the pin.
MD	Pulls up with a resistance of 10kΩ.	
XCOUT	Open	
NMI	Pulls up with a resistance of 10kΩ.	
SPARE	Pulls up with a resistance of 10kΩ.	
TEST	Pulls down with a resistance of 10kΩ.	
SDCDET#	Pulls up with a resistance of 10kΩ.	When not using the microSD
A19	Open	
A0	Open	

Kenic system

16. Font Data

16-1　16-dot font data

The LCD controller includes 8 x 16 dot (half-size) font data (including half-size Kana characters) and 16 x 16 dot (full-size) font data (JIS 1st level and 2nd level.)

Specify the 8 x 16 dot (half-size) font data with an ANK code and 16 x 16 dot (full-size) with an Shift-JIS code.

16-2　24-dot font data

The LCD controller does not include the 24-dot font data. When drawing the 24-dot font characters, it is necessary to connect the LCD controller to the serial flash memory and to write the 24-dot font data in the serial flash memory.

For more detail, refer to "Starter Kit Manual."

Kenic system

17. Drawing Functions and Drawing Colors

Each drawing function and drawing color is described below.

17-1 Drawing functions

The drawing functions are described below.

17-1-1 Dot drawing function

This function is for drawing dots on the screen.

This function allows one to specify coordinates (X, Y) and a drawing color and to draw a dot with commands.

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

17-1-2 Line drawing function

This function is for drawing lines (straight lines) on the screen.

This function allows one to specify coordinates (X1, Y1) of a starting point, coordinates (X2, Y2) of an ending point, and a drawing color and to draw a rectangle with commands.

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

17-1-3 Rectangle drawing function

This function is for drawing a rectangle (frames or fills) on the screen.

This function allows one to specify coordinates (X1, Y1) of a starting point, coordinates (X2, Y2) of an ending point, and a drawing color and to draw a rectangle with commands.

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

17-1-4 Circle and cylinder drawing function

This function is for drawing circles and cylinders ((longitudinal cylinders or horizontal cylinders) on the screen.

This function allows one to specify coordinates (X1, Y1) of a center point, an X-radius, a Y-radius, a height of a cylinder, a frame color and a fill color, and to draw a circle or a cylinder with commands.

For more detail of the commands, refer to "Command-driven LCD Controller IC

Command Manual."

17-1-5　Character drawing function

This function is for drawing characters on the screen.

This function allows one to specify a font type, a font size, coordinates (X, Y) of a starting point, a character color, a background color, and a character string and draw a character with commands.

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

17-1-6　7-segment character drawing

This function is for drawing 7-segment characters on the screen.

This function allows one to specify display digits, coordinates (X, Y) of a starting point, a character color, a background color, and a character string and to draw a character with commands.

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

17-2　Drawing color

The drawing color is represented with the RGB565 format, as shown in Fig. 17-1.

High order bytes

Bit	15	14	13	12	11	10	9	8
Name	R4	R3	R2	R1	R0	G5	G4	G3

Lower order bytes

Bit	7	6	5	4	3	2	1	0
Name	G2	G1	G0	B4	B3	B2	B1	B0

Fig. 17-1 RGB565 Format

Kenic system

18. Power Supply Sequence and Power Conservation

18-1 Power supply sequence

The power supply sequence of the LCD controller is shown in Fig. 18-1.

The flow of the power supply is described below.

- Turn on the power.
- Release the reset of the LCD controller.
- Switch the POWERLED signal from LOW to HIGH to start the LCD controller.
- After about 100 msec, switch the LCDONOFF signal from LOW to HIGH to turn the LCD power ON.
- After about 40msec, start outputting the LCD synchronization signal.
- After about 14 – 15 frames, switch the BELN signal to LOW and the LEDPWM signal to HIGH and light the backlight.
- Switch the RTS# signal from HIGH to LOW to enter a command reception state.

For the time between the power turning ON to the LOW state of the RTS# (the time until the LCD controller is in the command reception condition), refer to "4-7 Start up Time of LCD Controller."

(Note 1) The time required to switch the LCDONOFF to HIGH and shift the +3.3VLCD to +3.3 V should be within 10 msec.

(Note 2) The time required to turn the backlight ON and shift the RTS# to LOW when the microSD card is not connected is different when the microSD card is connected.
When the microSD card is not connected, the RTS# will shift to LOW immediately after turning the backlight ON. When the microSD is connected, the time required to turn the backlight ON and shift the RTS# to LOW needs a maximum of 210 msec due to the initialization of the microSD.

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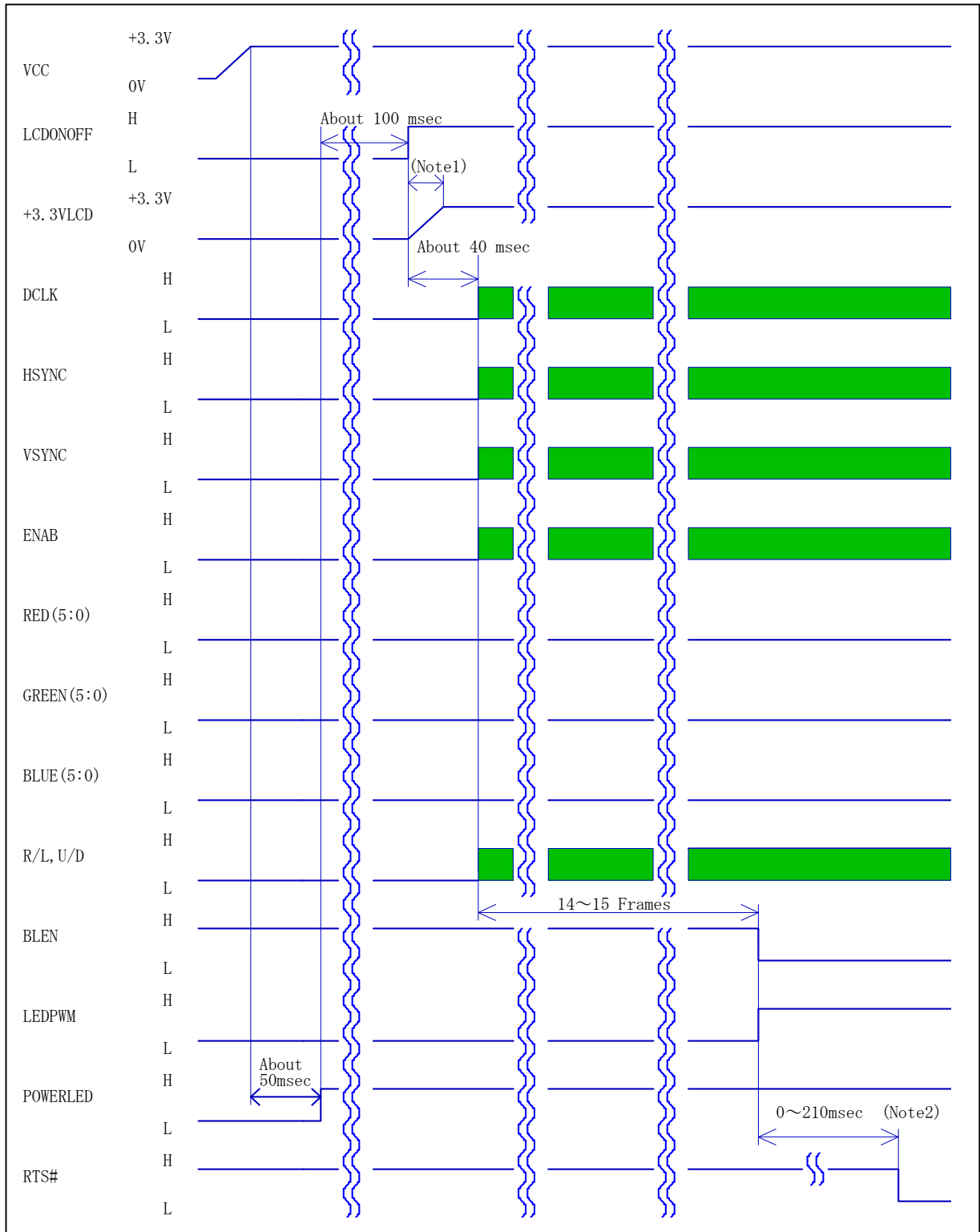
Fig. 18-1 Power Supply Sequence

Kenic system

18-2　Power conservation

18-2-1　Description for power conservation

The LCD controller includes the power conservation function. This function allows one to shift to a power conservation condition.

For more detail of the commands, refer to "Command-driven LCD Controller IC Command Manual."

The input/output pins for the power conservation is shown in Table 18-1.

Table 18-1 Input/Output Pins for Power Conservation

Pin Name	Input/Output	Function
LCDONOFF	Output	LCD Power ON/OFF Control Output Pin
POWERLED	Output	LCD Status Output Pin
RXD	Input	Power Conservation Releasing Pin (Note 1)
XLAD	Input	Power Conservation Releasing Pin (Note 2)

(Note 1) This pin normally functions as the receive data input pin of the SCI. However, it is the power conservation releasing input pin during the power conservation.

(Note 2) This pin normally functions as the Y-position detection voltage analog input pin of the touch panel. However, it is the power conservation releasing input pin during the power conservation.

The POWERLED pin is the output pin for the status condition of the LCD controller, as shown in Table 18-2.

Table 18-2 POWERLED Pin Output

POWERLED Pin Output	LCD Controller Condition
HIGH	Active
LOW	Low Power Consumption Condition

Kenic system

18-2-2　Example of Connection

The connection example when using the power conservation is shown in Fig. 18-2.

(Note 1) For the example of connection for these signals, refer to "7. Serial Communication Interface (SCI)" and "12. Touch Panel."

(Note 2) When the POWERLED signal is connected to the port of the microcomputer, pull down with a resistance of 100kΩ.
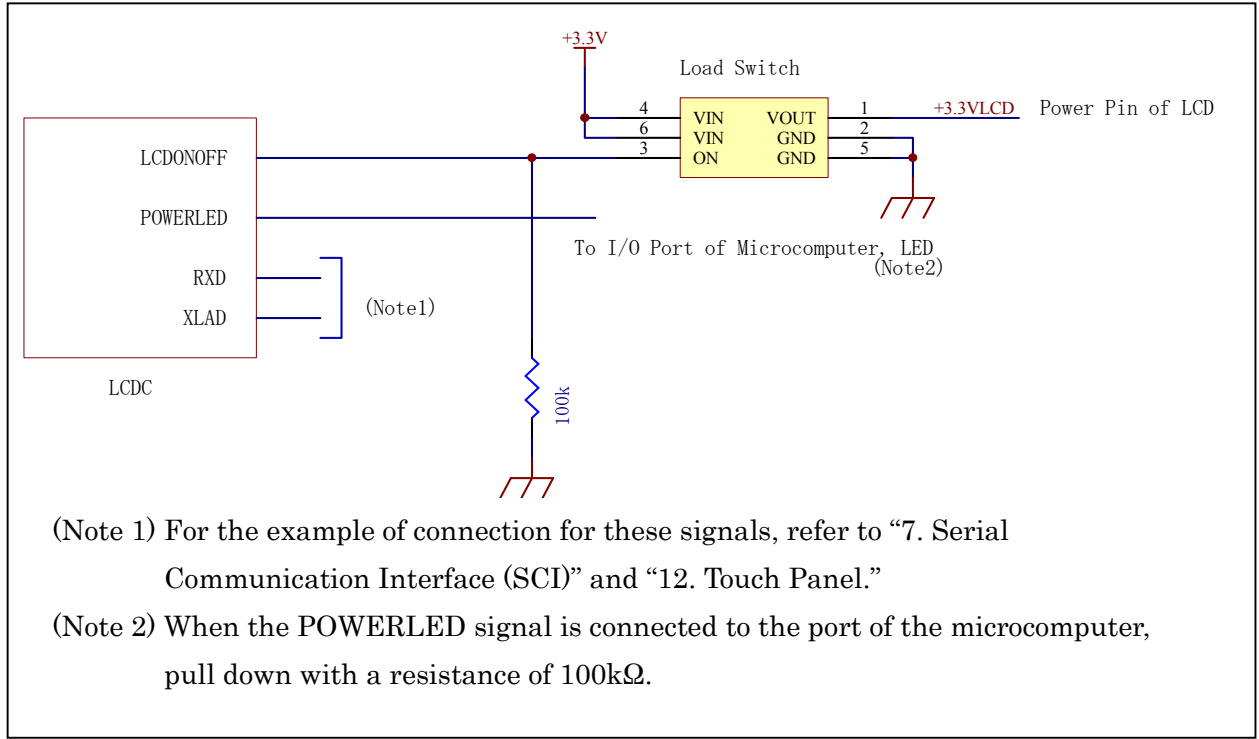
Fig. 18-2 Example of Connection when using Power Conservation

When the power conservation function is not used, open the LCDONOFF pin and the POWERLED pin. In addition, directly connect the LCD power to the +3.3 VLCD (refer to "23. Reference Circuits").

Kenic system

18-2-3　Shifting from the active condition to the low power consumption

The operation from the normal operation to the low power consumption is shown in Fig. 18-3.

The flow of shifting to the low power consumption is described below.

・ Receive the command of the low power consumption shifting (E.)
・ The LCD Controller closes the serial port (switches the RTS# signal to HIGH and holds the reception unable condition), stops the touch panel operation, and stops the buzzer.
・ Reset all area of the frame buffer memory to 0 (zero.)
・ Turn the backlight to OFF.
・ After 270 msec, switch the LCD synchronization signal and outputs LOW.
・ After switching the POWERLED to LOW, shift to the low power consumption.

When the ACK is enabled by the presence/absence (R) command, return the ACK before closing the serial port.

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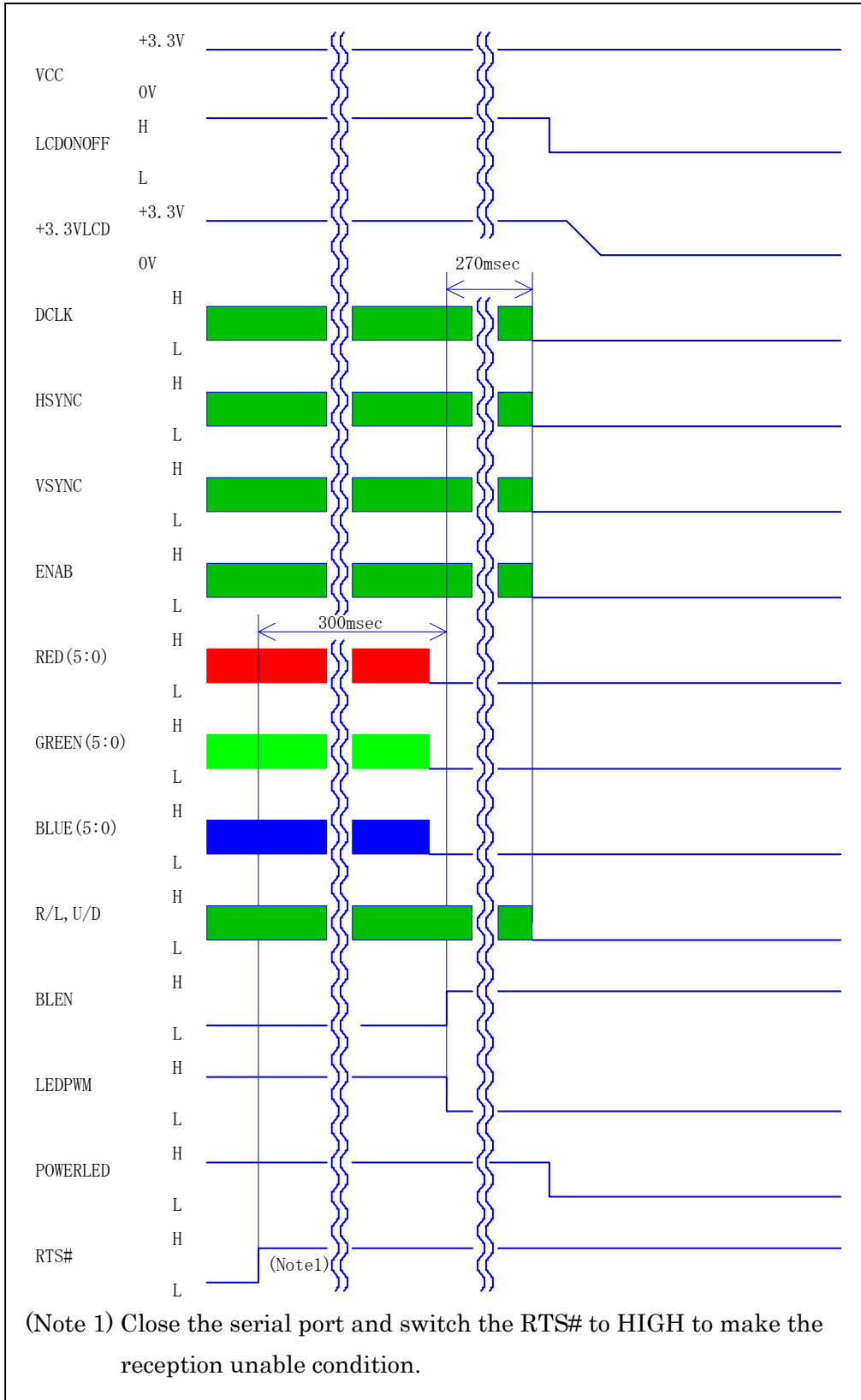
Fig. 18-3 Shifting from Active Condition to Low Power Consumption

The figure shows a timing diagram with the following signals:

- VCC (+3.3V / 0V)
- LCDONOFF (H / L)
- +3.3VLCD (+3.3V / 0V)
- DCLK (H / L)
- HSYNC (H / L)
- VSYNC (H / L)
- ENAB (H / L)
- RED(5:0) (H / L)
- GREEN(5:0) (H / L)
- BLUE(5:0) (H / L)
- R/L, U/D (H / L)
- BLEN (H / L)
- LEDPWM (H / L)
- POWERLED (H / L)
- RTS# (H / L)

Timing markers: 270msec, 300msec

(Note 1) Close the serial port and switch the RTS# to HIGH to make the
reception unable condition.

Kenic system

18-2-4 Returning from the low power consumption to the normal condition

The process that returns from the low power consumption condition to the normal condition is described below.

① Transmit the low power consumption shifting (E) command from the microcomputer.

② Press the touch panel.

When transmitting the low power consumption shifting (E) command from the microcomputer under the low power consumption, the LCD controller returns from the low power consumption and shifts to the normal condition. The LCD controller switches the RTS# signal to HIGH to make the reception unable condition during the low power consumption. When transmitting the command to return, ignore the RTS# signal. At that time, since the command transmitted from the microcomputer is discarded, the LCD controller will not shift to the low power consumption mode again.

By pressing the touch panel under the low power consumption, the LCD controller returns from the low power consumption to the normal condition.

The operation from the low power consumption to the normal operation condition is shown in Fig. 18-4.

The flow of returning to the normal condition is described below.

・ A request to release the low power consumption produces the internal reset.

・ When the internal reset is released, the POWERLED signal is switched from LOW to HIGH to start the returning operation.

・ The subsequent operations are same as that of the power supply sequence.

(Note 1) The time required to switch the LCDONOFF to HIGH and shift the +3.3VLCD to +3.3 V should be within 10 msec.

(Note 2) The time required to turn the backlight ON and shift the RTS# to LOW when the microSD card is not connected is different when the microSD card is connected.

When the microSD card is not connected, the RTS# will shift to LOW immediately after turning the backlight ON. When the microSD is connected, the time required to turn the backlight ON and shift the RTS# to LOW needs a maximum of 10 msec due to the initialization of the microSD (The time is

Kenic system

shorter when the power is turned ON because the initialization has been completed when the power is turned ON).

Kenic system
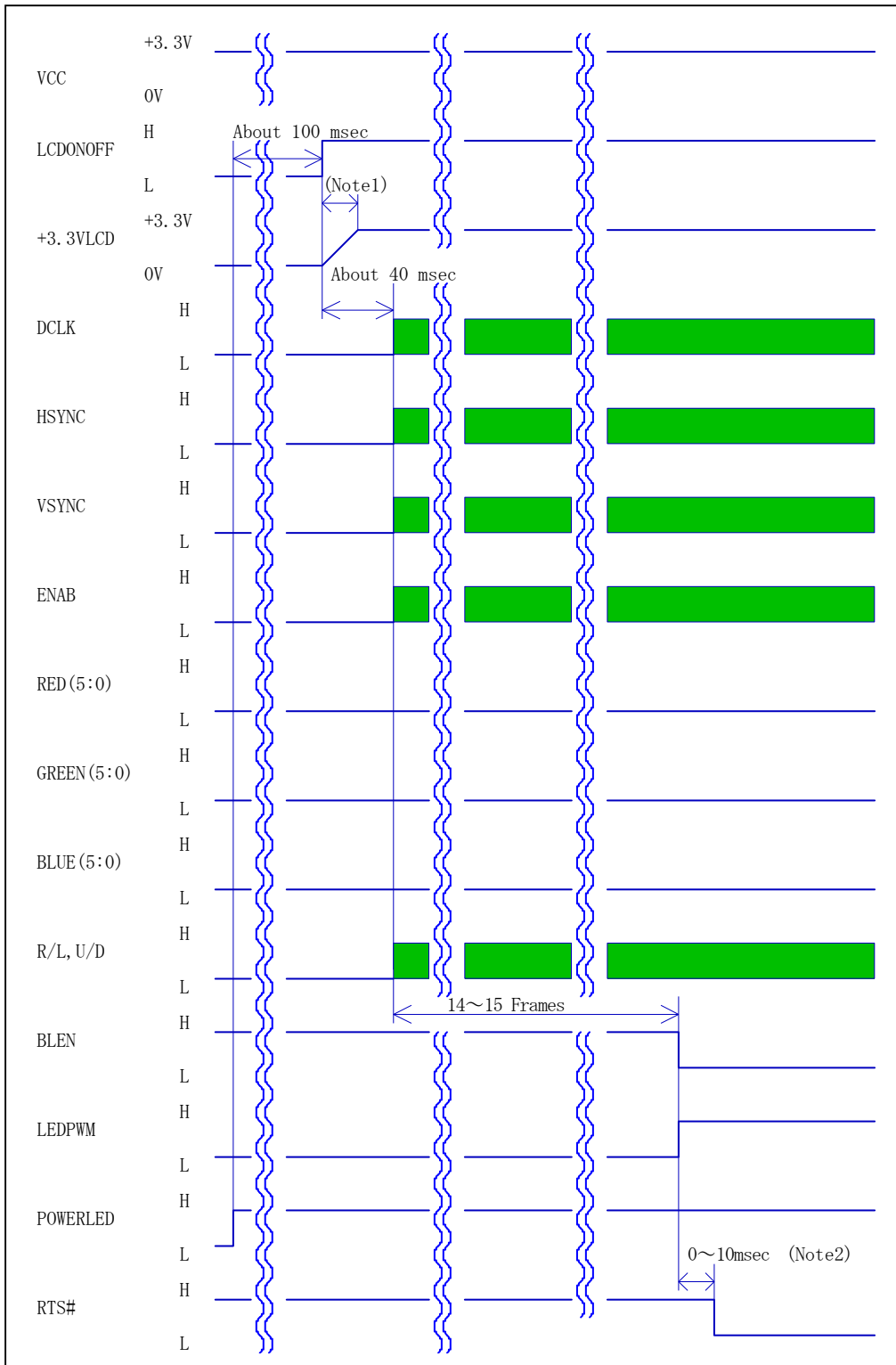
Fig. 18-4 Returning from Low Power Consumption to Normal Condition

Kenic system

18-2-5 Pin conditions during power conservation

Each pin condition during power conservation is shown in Table 18-3.

Table 18-3 Each Pin Condition during Power Conservation

Pin Name	Input/Output	Output value	Notes
DCLK	Output	LOW	
HDEN	Output	LOW	
HSYNC	Output	LOW	
VSYNC	Output	LOW	
ENAB	Output	LOW	
R/L	Output	LOW	
U/D	Output	LOW	
TXD	Output	HIGH	
RTS#	Output	HIGH	
BLEN	Output	HIGH	
LEDPWM	Output	LOW	
XOUT	Output	HIGH	
YOUT	Output	HIGH	
XIN	Output	HIGH	
YIN	Output	HIGH	
TDRC	Output	HIGH	
TOUCHLED	Output	LOW	
A19～A0	Output	LOW	
CS#,RD#,WR#	Output	HIGH	
D15～D0	Output	LOW	
RSPCK	Output	LOW	
MOSI	Output	HIGH	
SDCCS#	Output	HIGH	
SFCS#	Output	HIGH	
BUZZ	Output	LOW	
LCDONOFF	Output	LOW	
POWERLED	Output	LOW	

Pins that are not listed in Table 18-3 are held at the conditions before shifting to the low power consumption.

Kenic system

18-2-6　Precautions for Use

The LCD controller initializes the frame buffer memory with 0 (zero) when returning　from low power consumption. Thus, after the return from the low power consumption, transmit the command from the HOST microcomputer to redraw the screen.

Also, the parameters that are shown in Table 18-4 are initialized to default values. After the return from the low power consumption, transmit the command from the HOST microcomputer to return the condition before shifting to the low power consumption.

Table 18-4 Each Parameter Condition after Return from Low Power Consumption

Parameter	Default value
Display Page	Page 0
Writing Page	Page 0
Returning touch panel data	1 (one) Data Returning
Interval between continuous returns of touch panel data	50 msec
R/L Output	LOW
U/D Output	HIGH
BLEN Output	LOW
PWM Frequency	200Hz
PWM ON DUTY	100%
Presence/Absence of Checksum	Absence
ACK enabled/disabled	Disabled
Timeout of Serial Flash Memory	Timeout disabled

Kenic system

19. Outline Dimension
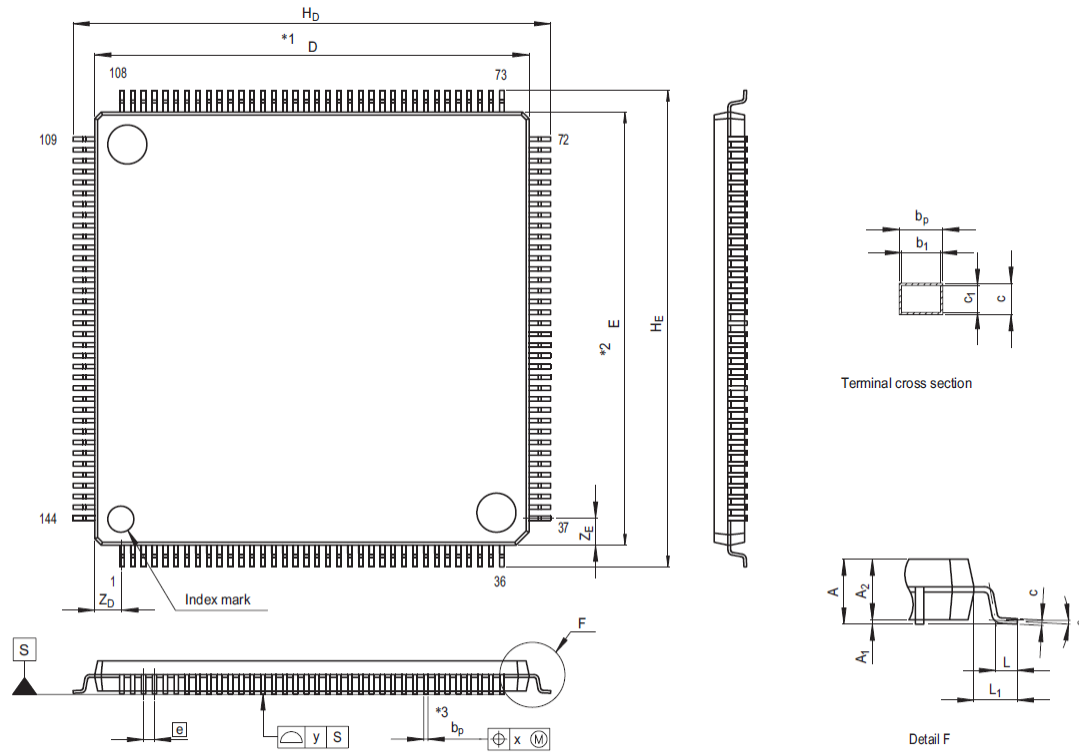
Sign	Dimension [mm]		
	Min	Nom	Max
D	19.9	20.0	20.1
E	19.9	20.0	20.1
A_2	-	1.4	-
H_D	21.8	22.0	22.2
H_E	21.8	22.0	22.2
A	-	-	1.7
A_1	0.05	0.1	0.15
b_p	0.17	0.22	0.27
b_1	-	0.20	-
c	0.09	0.145	0.20
c_1	-	0.125	-
θ	0°	-	8°
e	-	0.5	-
x	-	-	0.08
y	-	-	0.10
Z_D	-	1.25	-
Z_E	-	1.25	-
L	0.35	0.5	0.65
L_1	-	1.0	-

Terminal cross section

Detail F

(Note 1) * 1, * 2 ... resin remaining is not included.

(Note 2) * 3 ... tie bars rest are not included.

Kenic system

20. Handling Precautions

Please be careful about the following point enough in handling.

20-1 Transport

Handle the Product and the packaging carefully. Do not throw or drop, as this can cause damage to the Product. When transporting, avoid mechanical vibration and shock as much as possible.

Moreover, avoid the Product getting wet during times of rain and snow, as it has a negative influence on the effectiveness of the antistatic materials (magazine, etc.) and the main Product itself.

20-2 Storage

① Avoid storing in areas at risk of water leakage and direct sunlight (be particularly careful during times of rain and snow.)

② Do not stack packaging boxes upside down or sideways.

③ Avoid storing in areas prone to noxious fumes (in particular, corrosive gases) and high levels of dust.

④ Sudden temperature changes during storage result in condensation, causing the oxidation of leads and corrosion, and thus the deterioration of solder wettability. Store in areas not subject to frequent changes in temperature.

⑤ After taking the Product out of the package, use an antistatic container when storing again.

⑥ When storing, do not directly apply any loads on the Product.

⑦ The storage period of the moisture-proof packaging before opening is a maximum of 2 (two) years under conditions of 5 - 35℃ and 85%RH or less. When 2 (two) or more years have passed, we recommend that the soldering condition and electric characteristics should be checked before using.

To avoid moisture absorption after opening the moisture-proof packaging, store under the following conditions.

Table 20-1 Storage Conditions after Opening Moisture-proof Packaging

Item	Condition	Notes
Temperature	5～30℃	
Humidity	70%RH or less	
Time	Within 168 hours	Time between opening the packaging and completing the final reflow soldering

Kenic system

20-3　Inspection

(1)　Grounding

①　Properly ground the floor, worktable, conveyor, floor mat, etc. so as to avoid a buildup of static electricity. In particular, always ground the worktable which has direct contact with the device and the antistatic floor mat $(100\text{k}\sim100\text{M}\Omega/\text{cm}^2)$.

②　Always ground the electronic measuring instruments, the jig, and the soldering iron.

③　Workers should wear antistatic work wear, and the worker's body should be grounded using an antistatic wrist strap. The antistatic wrist strap should be grounded at a resistance of about $0.5\sim1.0\text{M}\Omega$.

(2)　Electrical Leakage

Leakage from the electrical inspection equipment and/or the Product-embedded system itself should be avoided to prevent damage to the semiconductors in the device, but above all for the worker's safety. Prior to using the circuit tester, curve tracer, synchroscope, other measuring instruments or other equipment such as the soldering iron that directly comes into contact with the Product, ensure that there is no leakage before grounding.

(3)　Order of Inspection

①　Before inspecting the Product, check for proper grounding and any leakage as described above. Additionally, apply voltage to the Product only after inserting into a jig. When doing so, avoid sudden startups and shut downs of the power supply.

②　After completing inspection of the Product, switch off the applied voltage before removing it from the jig. If removed while powered on, deterioration and/or damage to the Product may occur.

(4)　Electric Shock

During electrical measurement, there is possibility of electric shock from the lead or wiring, the connectors, the envelope, and/or the heat sink. Avoid bodily contact while powered on.

Kenic system

20-4　ESD (Deterioration/Damage from Electrostatic Discharge)

When handling the Product　by itself, ensure that the environment is as static-free as possible, workers wear antistatic clothes, containers that have direct contact with the Product use antistatic material, and that proper grounding is used, with a resistance of 0.5~1.0MΩ.

(1) Management of the Work Environment

　① When humidity decreases, static electricity can build up through friction. The recommended humidity level is 40~60%, after considering moisture absorption caused by the opening of moisture proof product packaging.

　② Ground all equipment and jigs installed within the workspace.

　③ Place and ground conductive mats on the workspace floor to prevent static electricity buildup on the floor (surface resistance 10^4~10^8Ω/sq., resistance between surface and grounding $7.5×10^5$~10^8Ω/sq.).

　④ Place and ground conductive mats (with resistance capability) on the worktable surface to diffuse static electricity (surface resistance: 10^4~10^8Ω/sq. resistance between surface and grounding: $7.5×10^5$~10^8Ω/sq.). Avoid using a metal surface for the worktable that can create a sudden electrostatic discharge with low resistance when the Product comes into direct contact with it.

　⑤ When using automated equipment, be careful of the following points.

　　(a) When picking up the IC package surface by vacuum, use conductive rubber at the pickup's tip to prevent electrostatic buildup.

　　(b) Minimize friction to the IC package surface. When friction can't be avoided due to the system, decrease the friction surface, or use materials with a smaller friction coefficient or electrical resistance, or consider using an ionizer.

　　(c) Use electrostatic dissipation materials for parts that come into contact with the lead pin of the Product.

　　(d) Avoid the Product coming into contact with electrostatically-charged objects (human body, work clothes, etc.).

　　(e) Utilize a tape carrier that uses a low-resistance material in the part where the tape comes into contact.

　　(f) Avoid contact between the jig equipment and the Product during the manufacturing process.

　　(g) For manufacturing processes that cause the package to become

electrostatically charged, use an ionizer to neutralize the charge.

⑥ In the workspace, use a VDT filter to prevent electrostatic buildup on the CRT surface, and avoid switching on and off as much as possible during work. This is to prevent electromagnetic induction to the device.

⑦ Regularly measure the electrostatic potential of the workspace, to ensure that there is no buildup.

⑧ Use antistatic fiber covers on chairs, and ground the chairs to the floor with a grounding chain. (Resistance between chair surface and grounding chain: $7.5 \times 10^5 \sim 10^{12}\Omega$/sq.)

⑨ Place antistatic mats on storage shelf surfaces.
(Surface resistance: $10^4 \sim 10^8\Omega$/sq., resistance between surface and grounding: $7.5 \times 10^5 \sim 10^8\Omega$/sq.)

⑩ For shipping and temporary storage containers for the device (box, jig, bag, etc.), use a container made of electrostatic dissipation or antistatic material.

⑪ As for carts, use electrostatically conductive materials for surfaces that come into contact with the Product packaging, and ground to the floor by using a grounding chain. (Resistance between cart surface and grounding chain: $7.5 \times 10^5 \sim 10^{10}\Omega$/sq.)

⑫ For electrostatically-controlled areas, place a grounding conductor exclusively for static electricity. For this grounding conductor, use a power transmission grounding conductor (class three and above or equivalent) or underground grounding conductor. In addition, it is recommended to separate it from the equipment grounding when feasible.

(2) Work Precautions
　① Workers should wear anti-static clothes and conductive shoes (or heel strap, leg strap).

　② Workers should also wear a wrist strap, grounded with a resistance of about $1.0M\Omega$.

　③ Ground the tip of the soldering iron, and use with a low voltage (6V~24V).

　④ Tweezers have a potential of contacting the Product's pins; as such, use an antistatic type and avoid metal tweezers as much as possible. With low resistance, metal tweezers can cause a sudden discharge from a charged Product. When utilizing vacuum tweezers, use a conductivity adsorption pad on the tip and ground using a grounding conductor exclusively for static electricity. (Resistance: $10^4 \sim 10^{10}\Omega$)

Kenic system

⑤　Do not place the Product and its container near areas with a high electric field (eg. on the CRT, etc.).

⑥　When stacking PCBs with mounted semiconductors, place antistatic boards in between to avoid direct contact. Otherwise, static buildup and discharge may occur.

⑦　When bringing in items into an electrostatically-controlled area (clipboard, etc.), use items made of antistatic material as much as possible.

⑧　When touching the Product directly, wear antistatic gloves or finger cots/stalls. (Resistance: $10^8\Omega$ and under)

⑨　When placing safety covers for equipment near the device, use covers with a resistance of $10^9\Omega$ and under.

⑩　When use of a wrist strap is impossible, and friction to the device is likely, use an ionizer.

20-5　Disposal Precaution

When disposing of the device and the packaging. Please consider the environment and follow all local laws and regulations.

Kenic system

21. Operating Condition Precautions

21-1 Ambient Temperature

As a rule, semiconductors are more sensitive to the temperature than other components. As the various electrical characteristics are limited by operating temperature, determine the temperature environment in advance, and consider derating when designing the device. Furthermore, use of the Product beyond specifications not only means that the electrical characteristics cannot be guaranteed, but can also cause deterioration of the device.

21-2 Ambient Humidity

Molded devices are not perfectly airtight. Therefore, long-term use in highly humid environments can cause deterioration and damage to the semiconductor chips due to moisture penetration.

Moreover, for normal PCBs, highly humid environments can lead to lowered impedance between wirings. Therefore, for systems with high signal source impedance, these substrate leaks and leaks between pins in the Product can cause malfunctions. In such cases, consider humidity-proofing the Product surface. On the other hand, in low humidity, damage due to electrostatic discharge can become a problem, so use within a humidity range of 40~60% when not particularly humidity-proofing.

21-3 Corrosive Gas

Beware that corrosive gas can affect the device and cause deterioration of electrical characteristics.

An example of this is rubber near the device releases sulfuric gas (or condensation in high humidity), resulting in corrosion to leads, crystallization due to chemical reaction between leads and ensuing leakage.

21-4 Radiation/Cosmic rays

Generally, devices are not designed to resist radiation and cosmic rays. Therefore, for space applications and in environments with radiation, it is necessary to design specific protection for these factors.

Kenic system

21-5　Intense Electric Field/Magnetic Field

When the Product is exposed to magnetic fields, abnormal phenomenon (impedance variation and increase of current leaks, etc.) can occur due to polarization of the plastic material and the IC chip internals.

There was also a reported case of malfunction due to the installation of the LSI near the deflection yoke of a television set. In such cases, changing the installation location and/or deploying an electromagnetic shield maybe necessary. In particular, in an alternating magnetic field, a shield is necessary due to the occurrence of electromotive forces.

21-6　Vibration/Impact/Stress

Cannon type devices with a hollow interior and those with a ceramic seal are vulnerable to vibration and shock because internal wire connections are not fixed. However, in actual devices, there have been reports that vibration, shock, or stress to soldered parts and connections leading to the snapping of wires. Therefore, care is necessary in designing equipment with a high vibration rate. It is also known that when stress is applied to the semiconductor chip through the package, a change in internal chip resistance can be caused by the Piezo effect. For analog circuits, be careful of stress to the package, as well. In particular, strong vibration, shock, or stress, can cause cracks in the package or chip.

21-7　Ambient Light (ultraviolet rays, sunlight, fluorescent lights, lamps, etc.)

When semiconductor devices are exposed to light, malfunctions can occur due to striking voltage caused by a photoelectric effect. In particular, devices with a view of the internal chip are affected by this, so the design should not allow ambient light to enter. Care must be taken as devices other than photo semiconductors and EP-ROMs can be affected by this.

21-8　Dust/Oil

Similar to corrosive gas, chemical reactions may occur in the device due to dust or oil. As such, avoid environments where dust and oil can enter the device, since they can affect the device characteristics. Care must be taken in designing optical devices, since, in addition to the above, optical characteristics can be affected.

Kenic system

21-9 Smoke/Fire

Semiconductor devices and modular devices are not fire-resistant, and as such, combustion is possible. In such cases, the device may emit toxic gases.

Therefore, avoid areas with open flames, heated elements, and combustible/flammable objects.

22. Implementation

22-1 Baking (drying) treatment before implementation

In the case of the following conditions, baking (drying) should be treated before implementation.

(1) When baking treatment is required

① When 30% spot on the indicator card has changed to a pink discoloration before opening the moisture-proof packaging

② After opening the moisture-proof packaging, when the storage period has been passed or has not been stored under the specified storage conditions (refer to Table 20-1).

(2) Recommended baking conditions

Treat the baking under the conditions shown in Table 22-1.

Table 22-1 Recommended Baking Conditions

Baking Temperature	Baking Time	Repeated Baking
125℃±5℃	16 – 24 hours	Accumulating Total: within 96 hours

Treat with a heat resistant tray when baking.

Check for the indications of "HEAT PROOF" or a heat resistant temperature of a heat-proof tray before the treatment.

22-2 Reflow Profile

To avoid the moisture absorption again after opening the moisture-proof packaging, conduct reflow implementation within the storage time that is specified (refer to Table 20-1).

When the storage time passed, treat the baking as described in the baking conditions.

(1) Part heat resistance

Air reflow: Package surface temperature= Maximum 260 ℃

Time at 255 ℃ or greater=30 sec or less

Kenic system
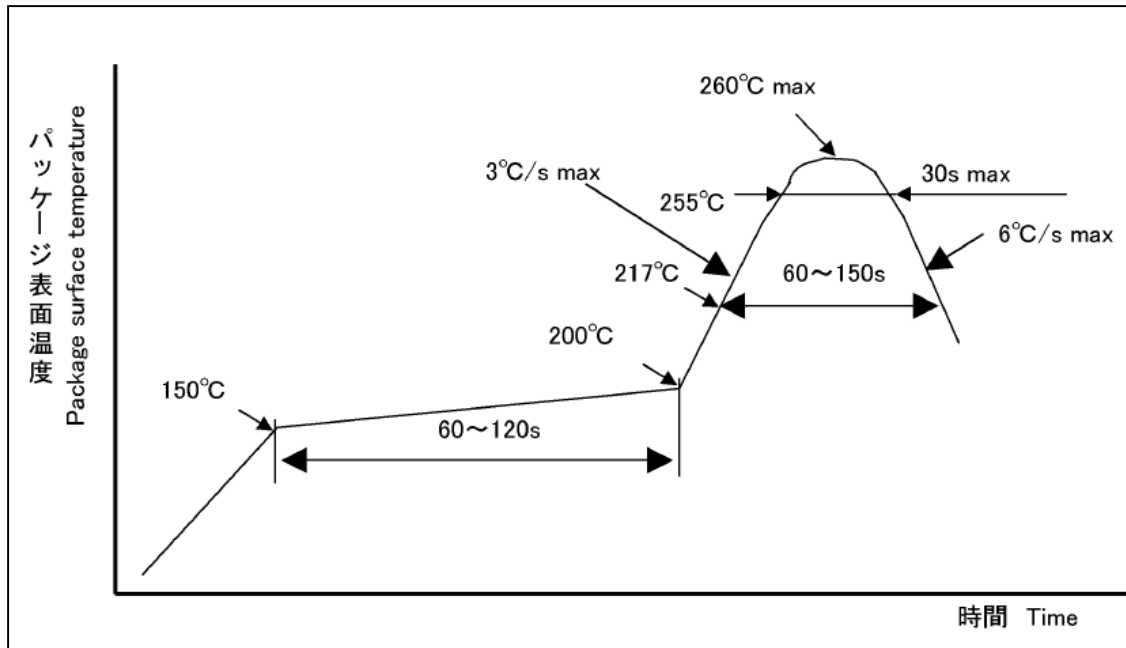
Fig. 22-1 Air Reflow Profile

⑵ Number of reflow times

The number of reflow times is 3 (three) or less within the storage conditions (refer to Table 20-1) after opening the moisture-proof packaging.

Kenic system

22-3　Portion heating method (soldering iron heating method)

This method is fixing the package to a pad portion with a flux and an adhesive, and soldering with a soldering iron. To avoid degradation of reliability by heating, conduct this method at the temperature of a soldering iron that is within 350 ℃, and with the soldering time per pin that is within 3 (three) sec.

22-4　Precautions when implementing a lead-free plating product (Sn plating)

When implementing a lead-free plating product, set a peak temperature by paying attention to the following items when setting the profile of the reflow temperature.

(1) The surface temperature is a heatproof temperature or lower.
(2) The temperature of a lead portion is a melting point of an implementing solder or greater.

Specially, when implementing an Sn plating product, it is necessary to implement at the temperature of 232 ℃ or greater because the melting point of a coating is 232 ℃.

Kenic system

23. Reference Circuits

Refer to the reference circuits on the pages that follow the next page. (However, these circuits will not guarantee the operations. Please do understand that conditions such as patterns may interrupt the operations.)

Kenic system

Frame Buffer Memory Part

LCD I/F and LED Backlight I/F Circuit Part

LCD Controller Part

LCDC
LCDC.Sch

A[1..18]	
D[0..15]	
CS#	
WR#	
RD#	
DCLK	
Hsync	
Vsync	
LCD_ENA	
R/L	
U/D	
BLEN	
LED_PWM	
YUAD	
XLAD	
XIN	
YIN	
YOUT	
XOUT	
XD	
YD	
TDRC	
TOUCHLED	

+5.0V
+3.3V

+5.0V
+3.3V
GND

GND

LCDIFFRAMEMORY
LCDIFFRAMEMORY.Sch

+5.0V
+3.3V

A[1..18]	+5.0V
D[0..15]	
CS#	+3.3V
WR#	
RD#	GND
DCLK	
Hsync	
Vsync	
LCD_ENA	
R/L	
U/D	
BLEN	
LED_PWM	

GND

Touch Panel Circuit Part

TOUCHPANEL
TOUCHPANEL.Sch

+3.3V

	+3.3V
	GND
YUAD	
XLAD	
XIN	
YIN	
YOUT	
XOUT	
XD	
YD	
TDRC	
TOUCHLED	

GND

Kenic system

LCD Controller Part

To Touch Panel Circuit Part

To LCD I/F Connector and Frame Buffer Memory Part

Buzzer Part

Dip Switch for Selecting Serial Baud Rates

KS-570CT-I1

Power Supply and RS232C
Communication Connector

To LCD I/F Connector and Backlight DCDC Part

KS-570CT-01 Power Pin Bypass Capacitor

**pin indicates a Pin Number of KS-570CT-II.

15pin	23pin	46pin	59pin	74pin	91pin	103pin	118pin	132pin	3pin
C19	C20	C21	C22	C23	C24	C25	C26	C27	C9
104C	104C	104C	104C	104C	104C	104C	104C	104C	104C
12pin	21pin	49pin	57pin	76pin	93pin	105pin	116pin	130pin	5pin

To Backlight DCDC Part   To Frame Buffer Memory Part

To Frame Buffer Memory Part

Frame Buffer Memory Part
LCD I/F and Backlight DCDC Part

+3.3V
+5.0V

+3.3V
+5.0V
GND
GND

Frame Buffer Memory Part

LCD I/F Connector

CN3

U4

D0	7	IO0	A0	1	A1
D1	8	IO1	A1	2	A2
D2	9	IO2	A2	3	A3
D3	10	IO3	A3	4	A4
D4	13	IO4	A4	5	A5
D5	14	IO5	A5	18	A6
D6	15	IO6	A6	19	A7
D7	16	IO7	A7	20	A8
D8	29	IO8	A8	21	A9
D9	30	IO9	A9	22	A10
D10	31	IO10	A10	23	A11
D11	32	IO11	A11	24	A12
D12	35	IO12	A12	25	A13
D13	36	IO13	A13	26	A14
D14	37	IO14	A14	27	A15
D15	38	IO15	A15	42	A16
			A16	43	A17
			A17	44	A18

A[1..18]
D[0..15]

+3.3V

11	Vcc
33	Vcc
12	Vss
34	Vss

GND
C29
104C

C28
104C

+3.3V

RA1
10K

LY61L25616AML-10I

GND

28	NC
6	CE
40	UB
39	LB
41	OE
17	WE

WR#
RD#
CS#

DCLK
Hsync
Vsync

1		GND
2	1	CLK
3	2	Hsync
4	3	Vsync
5	4	GND
6	5	R0
7	6	R1
8	7	R2
9	8	R3
10	9	R4
11	10	R5
12	11	GND
13	12	G0
14	13	G1
15	14	G2
16	15	G3
17	16	G4
18	17	G5
19	18	GND
20	19	B0
21	20	B1
22	21	B2
23	22	B3
24	23	B4
25	24	B5
26	25	GND
27	26	ENAB
28	27	VCC
29	28	VCC
30	29	R/L
31	30	U/D
32	31	NC(V/Q)
33	32	GND
	33	

DCLK
Hsync
Vsync

D15 R0
D11 R1
D12 R2
D13 R3
D14 R4
D15 R5

D5 G0
D6 G1
D7 G2
D8 G3
D9 G4
D10 G5

D4 B0
D0 B1
D1 B2
D2 B3
D3 B4
D4 B5

LCD ENA LCD ENA

R/L R/L
U/D U/D

C32
104C
+3.3V
GND

GND R6 0

GND

08-6210-033-340-800A+

To QVGA TFT LCD

R6

The R6 is not normally equipped. The R6 may be equipped
when some LCDs are connected.

LED Backlight I/F Circuit

+3.3V

R10
1k

BLEN BLEN 2

Q4
DTC124XUA

GND

+5.0V

CN6

1	LEDVCC
2	LEDVCC
3	LEDGND
4	LEDGND
5	EN
6	PWM

GND

To LED Backlight Power Supply

53261-0671

LED PWM LED PWM R21
1K

C10
104C

GND

When KSLBC-3 is connected, the C10 is not equipped.
When KSLBC-2 is connected, the C10 is equipped.

Kenic system

Touch Panel Circuit Part

+3.3V
+3.3V

GND
GND

+3.3V

5 6 7 8

RA2
10K

4 3 2 1

XOUT   XOUT

YOUT   YOUT

SN74LVC125ANSR

4

5   6

U7B

Touch Panel detection Resistance

R34
10K   TDRC

SN74LVC125ANSR

10

U6A

YIN   YIN   1   7   9   8

TC7WH14FU(L)   U7C

R36
220K   GND

SN74LVC125ANSR

13

12   11

U7D

YL
YU
XL
XR

CN7
1   XL
2   YU
3   XR
4   YD

04FFS-SP-TF

U7A   SN74LVC125ANSR

1

U6B

XIN   XIN   3   5   2   3

TC7WH14FU(L)

R35   220K   GND

CN8
XR   1
YU   2
XL   3
YL   4
5

53261-0571

XLAD   XLAD
YUAD   YUAD

R7   0

R8   0

C34
104C

C35
104C

GND   GND

It is arranged at the nearest position of KS-570CT-II.

+3.3V   U7E   SN74LVC125ANSR

14

VCC   GND   7

C33   104C   6

U6C

2

TC7WH14FU(L)

U6D

8   VCC   GND   4

TC7WH14FU(L)

C36   104C   GND

1   2   XD   XD

J1
[XD]

1   2   YD   YD

J2
[YD]

GND

JP1: X-Inversion of Analog Data
JP2: Y-Inversion of Analog Data

+3.3V

R25
330

LED2
SML-210DT

Q2

TOUCHLED   TOUCHLED   2

3

1

DTC123JUA   GND

Kenic system