LCD Controller IC

KS3224-LD29

Hardware Manual

07/01/2011 First Edition

KS3224-LD29

KS-R8TPC

(Note) Silk screen print in the above picture is a composite. The actual print may differ.

● Introduction ●

First of all, thank you for having purchased our LCD controller IC (KS3224-LD29) and the touch panel controller IC (KS-R8TPC) (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.

Table of Contents

1. Composition of the LCD Controller IC and the Touch Panel Controller

1) KS3224-LD29 (LCD controller IC)
   KS3224-LD29 can control the following LCD: color QVGA TFT LCD "LMTM057QVGNCA series" (manufacturer: DENSITRON), color QVGA TFT LCD "GVTQ57NPAD series" (manufacturer: SGD).
2) KS-R8TPC (Touch panel controller)
   KS-R8TPC is a CPU device with 2 channels, 8-bit A/D conversion (manufacturer: Renesas, model: R5F211B4SP).
   (Manufacturer of the CPU and product number may change without notice.)

LCD display and touch panel control become possible by using the above set of two. Additionally, display is also possible using only the LCD controller IC.

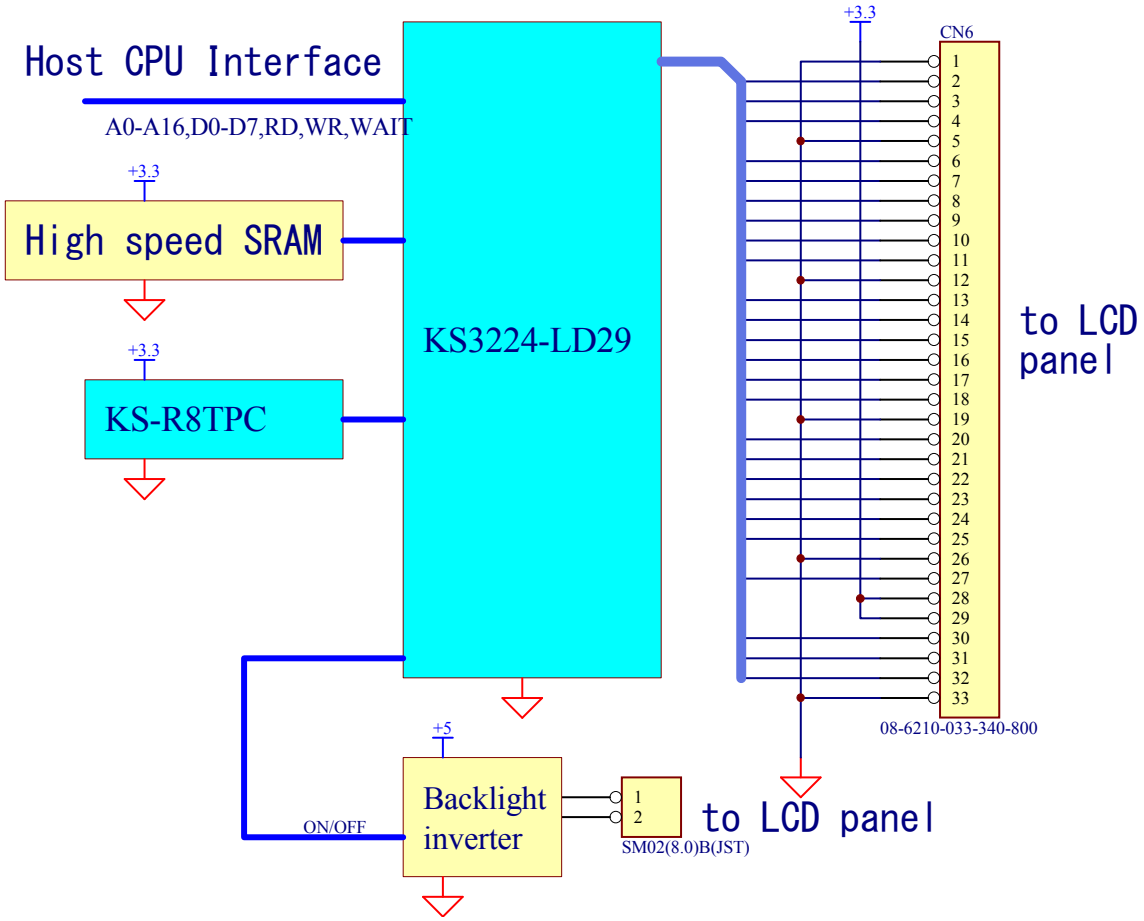
2. Overview and Features of the Product

KS3224-LD29 is an LCD controller developed for embedded systems, with the following characteristics.

1) It is low cost, as it is for embedded systems.
2) 64-color display is possible.
3) Dot number is 320×240 dots.
4) There is an automatic switch display function per dot, which decreases the load on the CPU.
5) There is a Hard Fill function that fills in a page immediately in a specified color.
6) Design is easy with only knowledge of the Host-CPU. LCD expertise is not necessary.
7) Two external analog signals are automatically obtained in 8-bit. Therefore, the temperature sensor and the touch panel can be connected by minimum circuit configuration.
8) The Host-CPU is most compatible with the H8 Host-CPU (Hitachi) and SH Host-CPU. (Interface with 3.3V Host-CPU is possible.)
9) The circuit design is extremely simple. Refer also to the attached circuits.
10) Due to the direct connection to the address bus, the LCD controller appears to be SRAM from the Host-CPU.
11) It is simpler and lower cost than Kenic system's other controllers, as the frame buffer is one page.

The outline framework for the LCD controller IC is as follows. The customer only needs to prepare a high-speed SRAM circuit in order to complete the LCD controller. In this Manual, we have provided the reference circuits as examples. (However, operation of these circuits is not guaranteed. Be aware that the circuit may not operate due to certain circumstances and conditions.)

Schematic configuration diagram of each LCD controller IC



The following table indicates pin assignments (list of pin numbers and signal names) for the LCD controller IC.

Table 1) KS3224-LD29

Pin No	Pin Name	Interface	Pin No	Pin Name	Interface
1	RD	Generic Host-CPU	51	CPUDATA	KS-R8TPC
2	D7	Generic Host-CPU data bus	52	CPULOAD	KS-R8TPC
3	D6		53	MA16	High speed SRAM address bus
4	D5		54	MA15	
5	D4		55	MA14	
6	D3		56	MA13	
7	D2		57	MA12	
8	D1		58	MA11	
9	D0		59	MA10	
10	VCCIO3	+3.3V	60	VCCIO1	+3.3V
11	MD7	Generic Host-CPU data bus	61	MA9	High speed SRAM address bus
12	GNDIO3	0V	62	GNDIO1	0V
13	MD6	Generic Host-CPU data bus	63	MA8	High speed SRAM address bus
14	RESET	Reset circuit	64	MA7	
15	MD5	Generic Host-CPU data bus	65	MA6	
16	MD4		66	MA5	
17	MD3		67	MA4	
18	MD2		68	MA3	
19	MD1		69	MA2	
20	MD0		70	MA1	
21	MWE	High speed SRAM	71	MA0	
22	MOE	High speed SRAM	72	A16	Generic Host-CPU address bus
23	ENAB	To LCD panel	73	A15	
24	VCCIO3	+3.3V	74	VCCIO1	+3.3V
25	GNDIO3	0V	75	GNDIO1	0V
26	TMS	Signal for configuration	76	A14	Generic Host-CPU address bus
27	Vsync	To LCD panel	77	A13	
28	TCK	Signal for configuration 4.7kΩ pull-down	78	A12	
29	VCCIO2	+3.3V	79	A11	
30	GNDIO2	0V	80	VCCIO0	+3.3V
31	TDO	Signal for configuration	81	GNDIO0	0V
32	Hsync	To LCD panel	82	A10	Generic Host-CPU address bus
33	TDI	Signal for configuration	83	A9	
34	CLK	To LCD panel	84	GND	0V
35	VCC	+3.3V	85	A8	Generic Host-CPU address bus
36	CLKI	Clock 49.0909MHz	86	A7	
37	BLEN	Backlight control signals	87	A6	
38	U/L	To LCD panel	88	VCCAUX	+3.3V
39	R/L		89	A5	Generic Host-CPU address bus
40	GND	0V	90	VCC	+3.3V
41	VCCIO2	+3.3V	91	A4	Generic Host-CPU address bus
42	GNDIO2	0V	92	VCCIO0	+3.3V
43	B1	To LCD panel	93	GNDIO0	0V
44	B0		94	A3	Generic Host-CPU address bus
45	G1		95	A2	

46	G0		96	A1	
47	R1		97	A0	
48	SLEEPN	Pull-up register	98	WAIT	Generic Host-CPU
49	R0	To LCD panel	99	SEL	Generic Host-CPU
50	CPUCLK	KS-R8TPC	100	WR	Generic Host-CPU

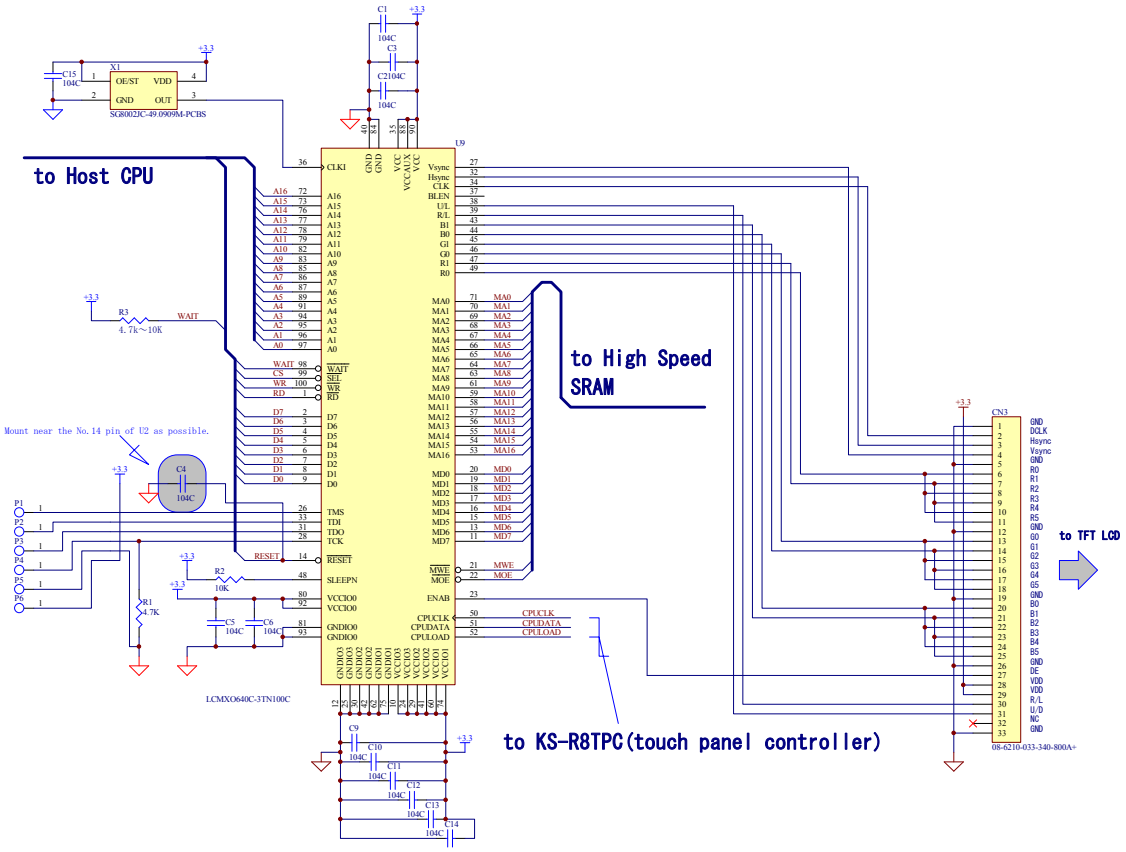
The following table indicates pin assignments (list of pin numbers and signal names) for the touch panel controller IC.

Table 2) KS-R8TPC

1	P3-5	YD	11	P1-6	YOUT
2	P3-7	CPULOAD	12	P1-5	CPUDATA
3	RESET	Reset IC etc.	13	P1-4	CPUCLK
4	XOUT/P4-7	Clock 10MHz	14	P1-3	XIN
5	VSS/AVSS	GND	15	P1-2	LED etc.
6	XIN/P4-6	Clock 10MHz	16	AVCC/VREF	+3.3V
7	VCC	+3.3V	17	P1-1	Touch panel input YU
8	MODE	Pull-up	18	P1-0	Touch panel input XL
9	P4-5	Pull-up	19	P3-3	XOUT
10	P1-7	YIN	20	P3-4	XD

【Reference Circuits】

(1)Reference Circuit Diagram of the LCD Controller IC Area



(Connection and Precautions)

- Quartz Module

  Although the quartz module contains the SG8002 (EPSON); any product with a clock speed of 49.0909MHz can be used.

- CPU Bus

  Connect to H8 Host-CPU (Hitachi), SH Host-CPU, etc. Always pull up with a resistance of 4.7k~10k for the WAIT signal.

・ Reset Signal

The LCD controller provides RESET# input pins for the LCD controller. The internal circuit is reset by ACTIVE LOW. Connect the reset signal used by the CPU, etc. Additionally, if there is noise on the reset signal line, mount a capacitor with the capacity of about 104 near the RESET# input pin, in order to prevent inadvertent resets.

・ Connection to the High Speed SRAM

Refer to "(2) Reference Circuit of the High Speed SRAM" below.

・ Connection to the Touch Panel Controller (KS-R8TPC)

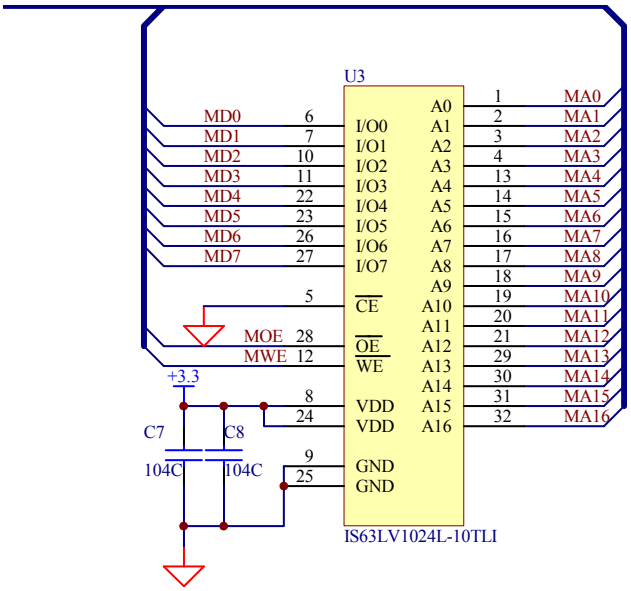
Connect control signals (CPUCLK, CPUDATA, CPULOAD) as shown in "(3) Connection Example to KS-R8TPC" below.

When using the LCD controller only, use with the open state.

・ Arrangement of the Bypass Capacitor

Be particularly careful about the arrangement of the bypass capacitor. When a four- layer board is impossible, bring as close to the LSI VCC pin as possible.

(2) Reference Circuit of the High Speed SRAM



(Precautions)

Be careful with the connection of the bypass capacitor; place near the VCC. Additionally, for the pattern length, make sure the distance from the LCD controller IC is under 10cm (under 5cm is recommended). The high speed SRAM is compatible with 12nS products, but use one that is 10nS and under where possible.

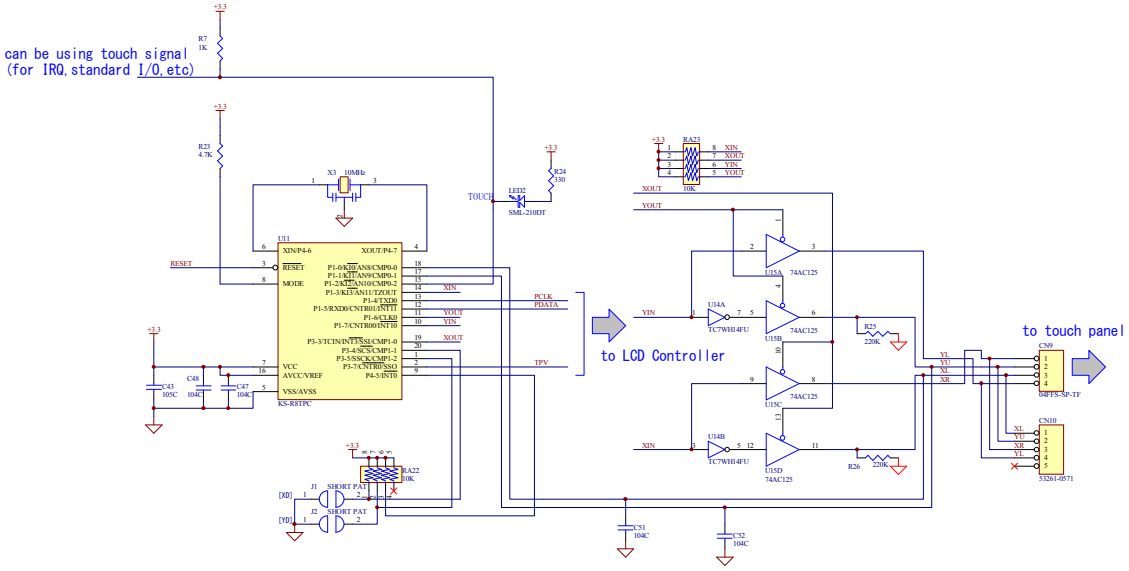
(3) Connection Example to KS-R8TPC and the Touch Panel

Compatible Touch Panels

(1) G22-6D (Gunze)

(2) ATP-057 (DMC)

(3) Others (Most analog touch panels are supported.)



(Connection and Precautions)

- Connection to LCD controller IC

  Connect the control signals (CPUCLK, CPUDATA, CPULOAD) as shown in "(1) Reference Circuit Diagram of the LCD Controller IC Area" above.

- Reset signal

  The touch panel controller internals are initialized by ACTIVE LOW.

- Jumper XD and YD

  When shorting jumper XD, the X axis data of the touch panel is reversed. When shorting jumper YD, the Y axis data of the touch panel is reversed.

  With this setting, it is possible to match the display orientation and the touch panel data orientation.

- Other

  When the touch panel is pressed, the TOUCH signal outputs a low signal. The LED can be turned on, and, by connecting to the CPU's IRQ interrupt port, pressing of the touch panel can be detected by interruption.

3. Electrical Characteristics and Specifications

1) KS3224-LD29

● Maximum Ratings

Item	Sign	Rating	Units
Power supply voltage	V_{CC}	-0.5～3.75	V
Power supply voltage	VCC AUX	-0.5～3.75	V
Output power supply voltage	VCC IO	-0.5～3.75	V
Added I/O tri-state voltage		-0.5～3.75	V
Added input exclusive pin voltage		-0.5～4.25	V
Storage temperature	T_{STG}	-65～+150	℃
Junction temperature	T_j	+125	℃

● Recommended Operating Conditions

Item	Sign	Min.	Max.	Units
Internal core power supply voltage	V_{CC}	1.71	3.465	V
Auxiliary power supply voltage	VCC AUX	3.135	3.465	V
I/O driver power supply voltage	VCC IO	3.135	3.465	V
Junction temperature	T_j	0	85	℃
Ambient Operating temperature	Ta	0	70	℃

The LCD controller contains a built-in core power supply.

Therefore, it can operate at 3.3V single supply.

● DC Standard

Item	Sign	Min.	Max.	Units
Input Hi voltage	V_{IH}	2.0	3.6	V
Input Low voltage	V_{IL}	-0.3	0.8	V
Output Hi voltage	V_{OH}	VCCIO -0.4		V
Output Low voltage	V_{OL}		0.4	V

● Approximate Current and Power Consumption

LCD Controller		KS3224-LD29		
Item	Sign	Standard	Max	Units
Approximate power consumption	POWER	132	287	mW
Approximate current consumption	ICC	40	87	mA

● Refresh Rate

LCD Controller		KS3224-LD29	
Item	Sign	Standard	Units
Refresh rate		57	Hz

2) KS-R8TPC

● Maximum Ratings

Item	Sign	Rating	Units
Power supply voltage	V_{CC}	-0.3～6.5	V
Analog power supply voltage	AV_{CC}	-0.3～6.5	V
Input voltage	V_{IN}	-0.3～V_{CC}+0.3	V
Operating temperature	T_{OPR}	-20～85	℃
Storage temperature	T_{STG}	-65～150	℃

● Recommended Operating Conditions

Item	Sign	Min.	Standard	Max.	Units
Power supply voltage	V_{CC}	2.7	—	5.5	V
Analog power supply voltage	AV_{CC}		Vcc=Avcc		V

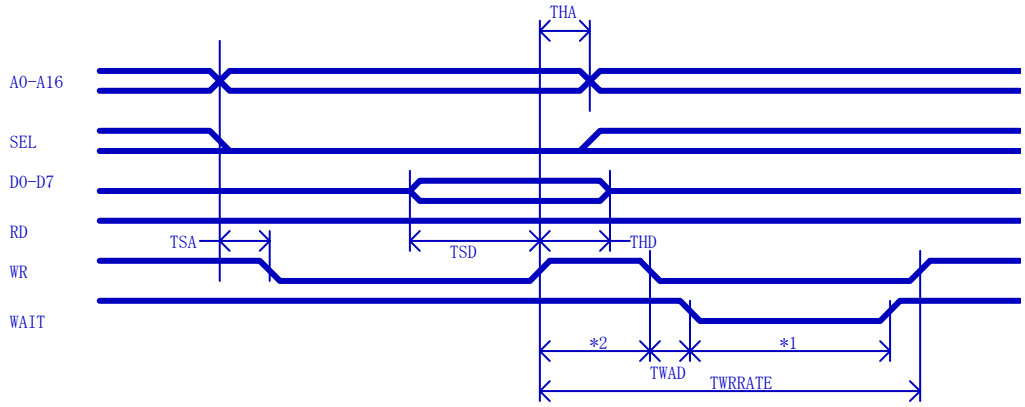
$AV_{CC}=V_{CC}$

● DC Standard

Item	Sign	Min.	Max.	Units
Input Hi voltage	V_{IH}	0.8 V_{CC}	V_{CC}	V
Input Low voltage	V_{IL}	0	0.2 V_{CC}	V
Output Hi voltage	V_{OH}	V_{CC}-0.5	V_{CC}	V
Output Low voltage	V_{OL}		0.5	V

For more details, refer to the CPU device data sheet (Manufacturer: Renesas).
The data sheet can be downloaded from the manufacturer's website.

1) Write Cycle for the LCD Controller Host-CPU Interface

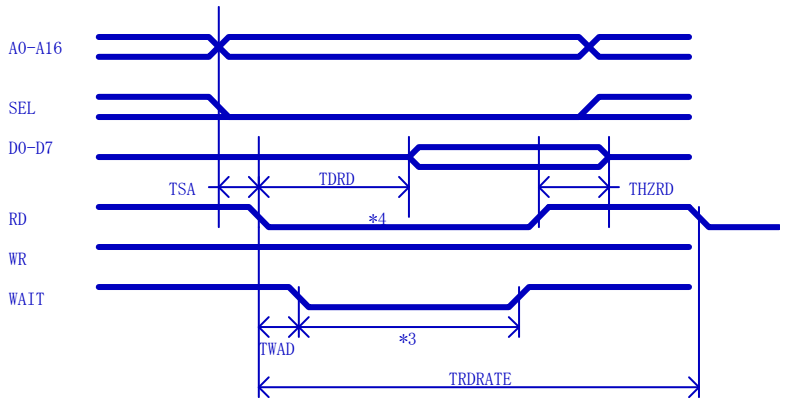


LCD Controller		KS3224-LD29		
Sign	Item	Min.	Max.	Unit
TSA	Address setup	10	–	ns
THA	Address hold	10	–	ns
TSD	Data setup	5	–	ns
THD	Data hold	10	–	ns
TWAD	WAIT output delay	–	11	ns
*1	WAIT width	–	132	ns
*2	Write interval	150	–	ns
TWRRATE	Write rate	155	–	ns

*1 WAIT is triggered when the next data write occurs within the “WAIT width” following the first data.

*2 WAIT signal can be ignored when writing at intervals the same or longer than the “write interval” value.

2) Read Cycle for the LCD Controller Host-CPU Interface



LCD Controller		KS3224-LD29		
Sign	Item	Min.	Max.	Unit
TSA	Address setup	10	—	ns
TDRD	Read access	—	235	ns
THZRD	The time indicates that data output comes to Hi impedance from the reactive of read.	—	10	ns
TWAD	WAIT output delay	—	13	ns
*3	WAIT width	—	260	ns
*4	RD pulse width	260	—	ns
TRDRATE	Read rate	332	—	ns

*3 As the WAIT signal is always sent when the RD pulse is under “WAIT width”, connect the WAIT signal to the CPU, when using.

*4 WAIT signal can be ignored when the RD pulse of the CPU is the same or longer than the “RD pulse width”.

4. Address Map

【KS3224-LD29】

5. Dot Composition of the Screen

Dot composition of the screen is as follows.

(0, 0)=0000H, (1, 0)=0001H …	…	(319, 0)=013F
(0, 1)=0200H, (1, 1)=0201H …	…	(319, 1)=033F
(0, 2)=0400H, (1, 2)=0401H …	…	(319, 2)=053F
(0, 239)=1DE00H, (1, 239)=1DE01H …	…	(319, 239)=1DF3F

Each dot corresponds completely to each bit.
For this LCD controller, the next address 0140H after the end of the first line (319, 0) = 013FH corresponds to (320, 0) and not (0, 1), and continues to (511, 0) =01FFH. Therefore, the frame buffer exists from (0, 0) to (511, 239). However, the displayable area is limited to the range from (0, 0) to (319, 239).

6. Displayed Data

The display data to be written to each frame buffer consists of the color specification bit and control bit.

Bit	7	6	5	4	3	2	1	0
Name	M1	M0	R1	R0	G1	G0	B1	B0
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Initial value	-	-	-	-	-	-	-	-

(Caution) Initial value is indefinite.

Dot Control Bit　bits 7~6

M1	M0	Explanation
0	0	Normal display.
0	1	Inactive setting.
1	0	Blink 1.
1	1	Blink 2.

(Caution) These M1 and M0 bits function as part of a set with control register 1 (DCR).

Color Register　bits 5~4

R1	R0	Explanation
0	0	When the combination of R1 and R0 is “0, 0”, the brightness for red is zero, and when the combination of R1 and R0 is “1, 1”, the brightness is at a maximum.
0	1	
1	0	
1	1	

Color Register　bits 3~2

G1	G0	Explanation
0	0	When the combination of G1 and G0 is “0, 0”, the brightness for green is zero, and when the combination of G1 and G0 is “1, 1”, the brightness is at a maximum.
0	1	
1	0	
1	1	

Color Register　bits 1~0

B1	B0	Explanation
0	0	When the combination of B1 and B0 is “0, 0”, the brightness for green is zero, and when the combination of B1 and B0 is “1, 1”, the brightness is at a maximum.
0	1	
1	0	
1	1	

7. About the Registers

(1) Control Register 3 (DCR3)

Address 1FFFBH (Write side)

Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	-	U/D	L/R	BLEN
R/W	-	-	-	-	-	W	W	W
Initial value	-	-	-	-	-	1	0	1

DCR3 performs display control for the LCD.

Bit 2, 1 Control the display orientation. When looking at the LCD with the I/F cable coming out from the left, the display orientations are as below.

U/D	L/R	Explanation
1	0	Normal display.
1	1	Horizontally flipped.
0	1	180 degree rotation
0	0	Vertically flipped.

U/D=1, L/R=0	U/D=1, R/L=1	U/D=0, R/L=1	U/D=0, R/L=0
			

Bit 0 Controls ON/OFF for the backlight by BLEN output (No. 37 pin). The relation between the register setting values and the BLEN outputs are as follows.

Register Setting Value BLEN	BLEN output	Explanation
0	1	BLEN output reverses the register setting.
1	0	

(2) Control Register 1 (DCR1)

Read and write have different meanings for the register.

Address 1FFFCH (Write side)

Bit	7	6	5	4	3	2	1	0
Name	DOFF	BLK2	BLK1	—	—	—	—	—
R/W	W	W	W	W	W	W	W	W
Initial value	0	0	0	—	-	-	-	-

DCR1 controls Blink 1 and 2, and also controls display ON/OFF.

Bit 7

DOFF	Explanation
0	Display ON.
1	Display OFF.

When this bit is set to "1", LCD data output becomes "0" and the screen turns black.

Bits 6~5

BLK2	BLK1	Explanation
0	0	Blink 1, 2 inactive.
0	1	Blink 1 active; Blink 2 inactive.
1	0	Blink 1 inactive; Blink 2 active.
1	1	Blink 1, 2 active.

Bits 4~0 are write inactive bits.

Address 1FFFCH (ADX) (Read)

Bit	7	6	5	4	3	2	1	0
Name	ADB7	ADB6	ADB5	ADB4	ADB3	ADB2	ADB1	ADB0
R/W	R	R	R	R	R	R	R	R
Initial value	-	-	-	-	-	-	-	-

KS-R8TPC has an 8-bit A/D conversion function, and this conversion result is received by the LCD controller IC and housed to the register automatically. Sampling speed is continuously performed at around 5mS~8mS, and can always be read from the above register. With this

function, analog sensor interfaces such as an analog joystick or analog touch panel are possible without excessive hardware.

(3) Control Register 2 (DCR2)

The register is read-only.

Address 1FFFDH (ADY)

Bit	7	6	5	4	3	2	1	0
Name	ADB7	ADB6	ADB5	ADB4	ADB3	ADB2	ADB1	ADB0
R/W	R	R	R	R	R	R	R	R
Initial value	-	-	-	-	-	-	-	-

The function of this register is like Control Register 1 and can also read A/D conversion results.

(4) Data Register for Hard Fill (CFDR)

Address 1FFFEH

Bit	7	6	5	4	3	2	1	0
Name	M1	M0	R1	R0	G1	G0	B1	B0
R/W	W	W	W	W	W	W	W	W
Initial value	0	0	0	0	0	0	0	0

This is the same as the data for drawing. By storing this data to the register, the register can quickly fill one page worth of the frame buffer with the same data.

(5) Hard Fill Command Register (CFCR)

Address 1FFFFH

Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	-	-	-	BUSY
R/W	-	-	-	-	-	-	-	R/W
Initial value	-	-	-	-	-	-	-	0

When writing "0x01" to this register, the data housed in the CFDR is used to fill the whole frame buffer.

While writing, BUSY bit becomes "1".

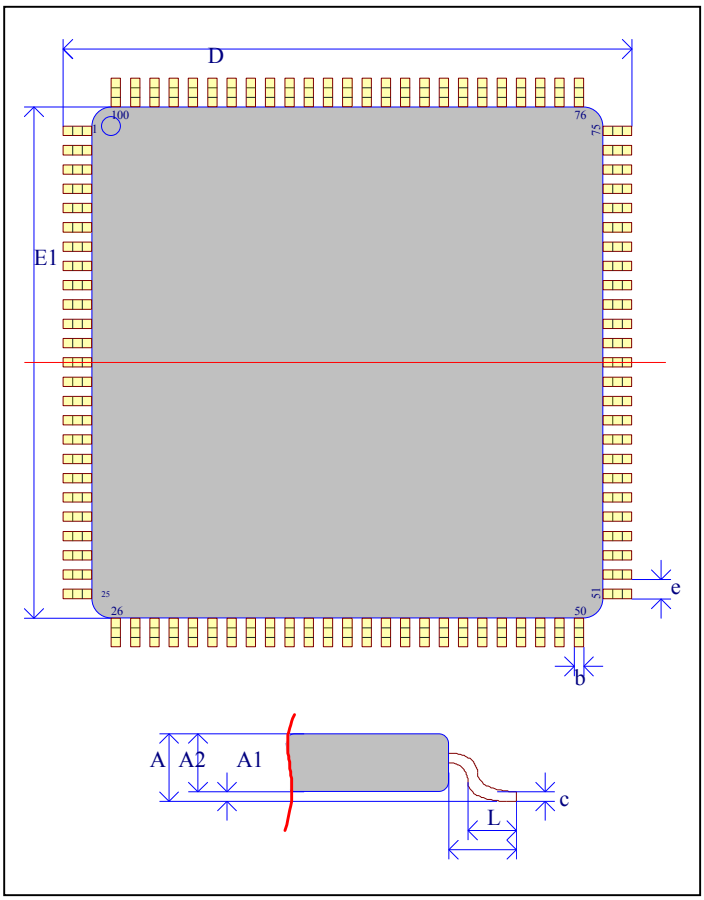
(Caution)

When writing to the frame buffer directly after executing this command, write cannot be performed normally. Wait for at least 32mS or longer, or confirm that bit 0 changes from 1 to 0 before shifting to the next write operation. (Bit 0 is the BUSY bit which outputs 1 directly after a hard clear command is issued, and goes back to 0 when completed.)

8. External Dimensions

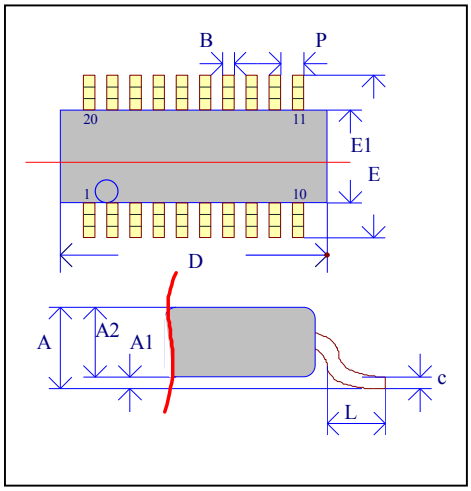
● KS3224-LD29

Sign	MIN(mm)	NOM(mm)	MAX(mm)
A			1.60
A1	0.05		0.15
A2	1.35	1.40	1.45
D	16.00	16.00	16.00
E1	14.00	14.00	14.00
e	0.50	0.50	0.50
b	0.17	0.22	0.27
c	0.09	0.15	0.20
L	0.45	0.60	0.75



● KS-R8TPC

Sign	MIN(mm)	NOM(mm)	MAX(mm)
A			1.45
A1	0	0.1	0.2
A2		1.15	
B	0.17	0.22	0.32
c	0.13	0.15	0.2
D	6.4	6.5	6.6
E1	4.3	4.4	4.5
p	0.53	0.65	0.77
E	6.2	6.4	6.6
L	0.3	0.5	0.7



9. Design Precautions

1) When Powering on

The LCD controller is a type that forwards configuration data from the flash memory inside the device to the SRAM.

After powering on, it starts quickly after disengaging the reset. However, the hard fill starts soon after powering on. When designing software, ensure that it checks the completion of the hard fill in the hard fill register before allowing read-write access.

10. Handling Precautions

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.

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 The recommended ambient conditions for storage are a constant temperature and humidity in the ranges of 5~35℃ and 40~75%, respectively.

④ Avoid storing in areas prone to noxious fumes (in particular, corrosive gases) and high levels of dust.

⑤ 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.

⑥ After taking the Product out of the package, use an antistatic container when storing again.

⑦ When storing, do not directly apply any loads on the Product.

⑧ After an extended period of normal storage (2 years or more), it is recommended to check the solderability and electrical characteristics before use.

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 (100k~100MΩ/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 0.5~1.0MΩ.

(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.

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: 7.5×10^5~10^{12}Ω/sq.)

⑨ Place antistatic mats on storage shelf surfaces.
(Surface resistance: 10^4~10^8Ω/sq., resistance between surface and grounding: 7.5×10^5~10^8Ω/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: 7.5×10^{5}~$10^{10}\Omega$/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 1.0MΩ.

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}~$10^{10}\Omega$)

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.

5) Disposal Precaution

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

11. Operating Condition Precautions

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.

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.

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.

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..

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.

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.

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.

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.

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.

12. Installation Method

The following are the reflow conditions for the LCD controller and touch panel controller. For more details, please make an inquiry to our sales staff.

1) LCD Controller KS3224-LD29

The peak temperature and the peak temperature times for reflow are subject to the following conditions.

- Peak Temperature ・・・ 260℃ (+0/-5℃)
- Peak Temperature Time within 5 ℃ (255℃~260℃) ・・・ 20~40 seconds

2) Touch Panel Controller KS-R8TPC

The peak temperature and the peak temperature times for reflow are subject to the following conditions.

- Peak Temperature ・・・ 260℃ Max.
- Peak Temperature Time within 5 ℃ (255℃~260℃) ・・・ 16 seconds max.