High Reliability & Wide Temperature Range

HITACHI LIQUID CRYSTAL DISPLAY FOR MEASUREMENT EQUIPMENT

Extremely Appropriate for Measurement Equipment, Digital Meter, Car Clock, etc.

Hitachi Liquid Crystal Display for Measurement Equipment has been developed for various kinds of digital measurement equipment by the highest of Hitachi's LCD manufacturing techniques. Comparing with ordinary liquid crystal displays, they are capable to use in a wide temperature range, moreover with extremely high reliability. Also they are simply mounted when LCD is assembled to the equipment, by means of connector pins provided at LCD terminals.
This catalogue establishes maximum rating, electrical characteristics, handling precautions, etc., other than the main advantages and applications.

■ FEATURES

- High reliability for temperature and humidity
- Legible and obvious display owing to indistinguishable electrode forming film
- Wide viewing angle
- Easy to install to the equipment by connector pins at terminal

■ APPLICATIONS

- Termometer • Tester (voltmeter, ammeter, etc.)
- Panel meter • pH meter • Clinical thermometer
- Pulse meter • Tachometer • Water-rate meter
- Odometer • Car clock • Gauge • Micrometer
- The other digital measurement equipments

■ OPTION

Item	Type
Size	• Standard type
Display pattern	• Standard type • Custom-made
Rear polarizer	• Reflective type • Undirectional reflective type • Transmissive type • Transflective type
Color	• Color polarizer • Color polarizer with reflector • Color painting on polarizer
Contact pad	• With connector pin • Without connector pin

■ Hitachi's Liquid Crystal Display for Measurement Equipment

Part Number		External Dimension (Width x Length) (mm)	Number of Connector Pins	Contents of Display			Page
Standard	Extended Temp			Digits	Height of Character	Symbol	
LS022C-C	LS022CH-C	51.5 x 22.0	40	4	8.9	None	8
LS023C-C	LS023CH-C			4 - 1/3	7.6	← ÷	
LS007C-C	LS007CH-C	50.8 x 30.5	40	3 - 1/3	12.7	LO BAT ÷	8
H1331C-C	L1331CH-C					← ÷	9
H1332C-C	H1332CH-C			4 - 1/3	10.2		
H1333C-C	H1333CH-C			4	12.7	None	
LS024C-C	LS024CH-C			5	10.2		
H1335C-C	-	70 x 30	50	6	12.7	None	10
LS060C-C	-		54	4 - 1/3	13.6	Various	
-	LS066CH-C	70 x 38.1	40	3 - 1/3	17.8	LO BAT ÷	10
H1336C-C	H1336CH-C					← ÷	11
H1337C-C	-			4		None	
LS025C-C	-			4 - 1/3	15.2	← ÷	
LS026C-C	LS026CH-C	93.85 x 30.5	68	8	12.7	None	11
LS027C-C	-	93.85 x 38.1	50	6	17.8	None	12
H1338C-C	H1338CH-C	93.85 x 45.72	40	3 - 1/3	25.4	← ÷	12
LS028C-C	-			4		None	
H1339C-C	-			4 - 1/3	20.3	← ÷	

Notes:
(1) Type number for the wider temperature range (-20°C ~ +80°C) uses an H. Example H1338CH-C
(2) Type numbers with -C only are without pins. Example LS007-C
(3) Transflective versions use an E in the part number. Example H1333C-E

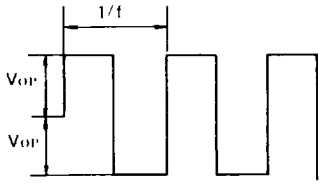
■MAXIMUM RATING

Item	Standard type	Wide temperature range type	Unit
Average residual DC voltage	100	200	mV
Operating temperature	−10 ~ +60	−20 ~ +80	°C
Storage temperature	−20 ~ +60	−30 ~ +85	°C

■ELECTROOPTICAL CHARACTERISTICS

Item			Standard type (−10°C ~ +60°C)			Wide temperature range type (−20°C ~ +80°C)			Unit	Note
			min.	typ.	max.	min.	typ.	max.		
Driving voltage			3.0	5.0	6.0	4.5	5.0	6.0	V	(1)
Driving frequency			–	32	–	50	64	500	Hz	(1)
Threshold voltage		−10°C	–	2.1	2.7	–	3.3 (−20°C)	–	V	(4)
		25°C	–	1.9	2.5	–	3.1	–	V	
Contrast ratio			2	15	–	–	10	–	–	(2)
Response time	Rise time	−20°C	–	–	–	–	620	1200	ms	(5)
		0°C	–	150	300	–	150	350	ms	
		25°C	–	50	100	–	50	120	ms	
	Fall time	−20°C	–	–	–	–	350	700	ms	
		0°C	–	350	700	–	150	300	ms	
		25°C	–	110	250	–	50	120	ms	

(1) Definition of driving voltage and driving frequency



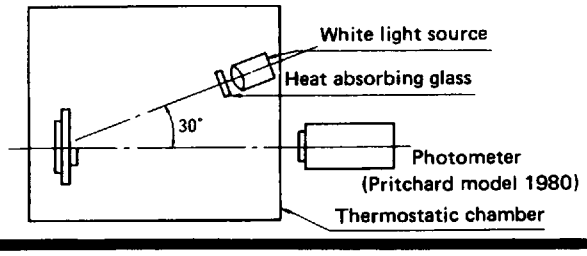
Vop: Driving voltage
f : Driving frequency
Driving voltage
wave form: AC square wave

(2) Definition of contrast ratio

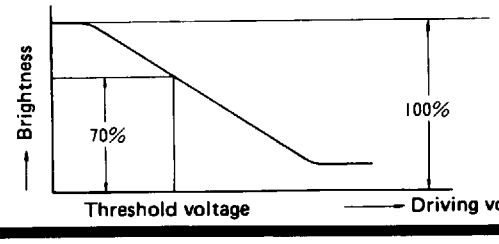
$$\text{Contrast ratio} = \frac{\text{Brightness at 0V driving}}{\text{Brightness at 5V driving}}$$

Temperature : 25°C

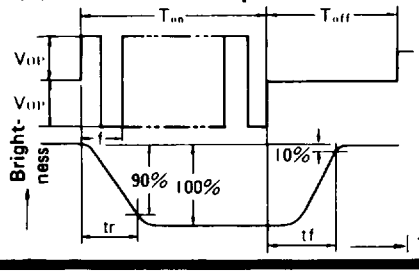
(3) Optical characteristics measuring method



(4) Definition of threshold voltage



(5) Definition of response time



tr: Rise time
tf: Fall time
Vop: 5.0V
f: 32Hz
Ton: ON
Toff: OFF

TYPICAL CIRCUIT DIAGRAMS

For users of Hitachi's liquid crystal display, Hitachi separately prepared the technical explanatory data of the liquid crystal display from the principle of operations till applications. Please put it to use as a reference.

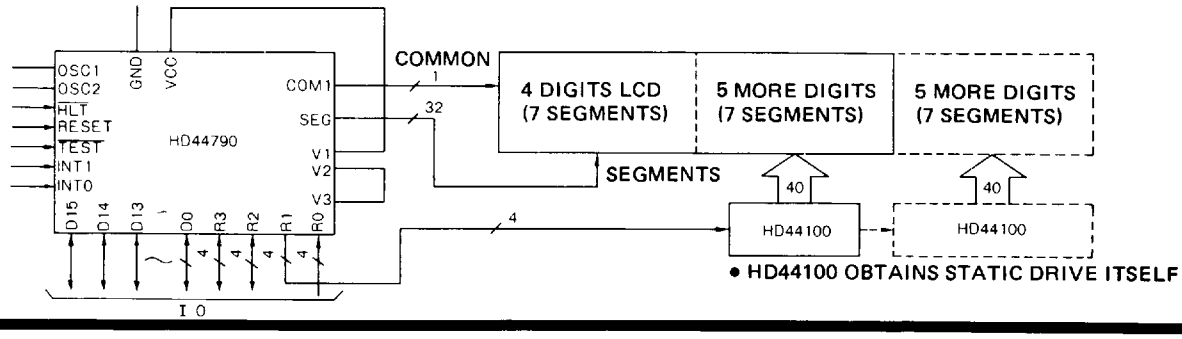
There are two driving systems for liquid crystal display, static driving system and multiplex driving system, Hitachi's liquid crystal display for measurement equipment adopts the static driving system which has outstanding feature in display and reliability.

Concerning with the list of product types shown in the previous page, these liquid crystal displays require the special LSI for each product type to drive them.

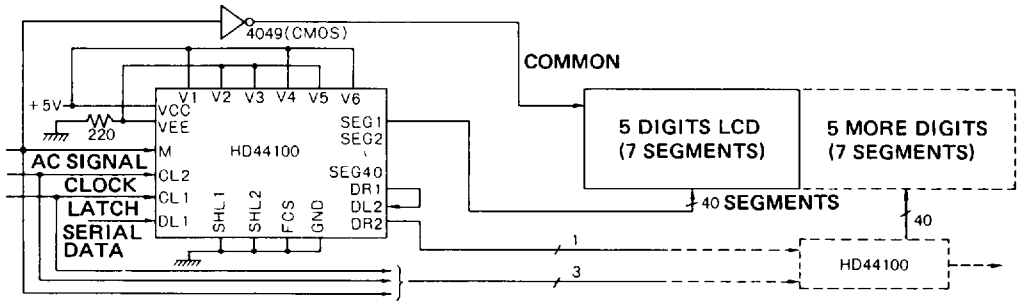
Please refer to the following examples for using the driving LSI. For further details, in case using 4-bit microcomputer (HD44790), since it can extend the driving circuit same as 40-segment driver, all kinds of display are obtained.

■ Driving LSI [Examples]

• 4-BIT MICROCOMPUTER (HD44790)



• 40-SEGMENT DRIVER (HD44100)



■ REFERENCE LSI

Type No.	Maker	Driving method	Output terminal		Display at static drive	Data input	Others
			Common	Segment			
HD44790	Hitachi	1/4 duty	1 ~ 4	32	4 digits	4 bit microcomputer	Static ~ 1/4 duty available
HD44100	Hitachi	1/20 duty	(20)	40	5 digits	Serial	20 common drive available
HMCS45C	Hitachi	Static	–	44	5 digits	4 bit microcomputer	–
HMCS43C	Hitachi	Static	–	32	4 digits	4 bit microcomputer	–
HD14543B	Hitachi	Static	1	7	1 digit	BCD parallel	–

APPEARANCE AND DISPLAY QUALITY OF HITACHI LIQUID CRYSTAL DISPLAY DEVICE

Hitachi pays special attention to improvement in the appearance and display quality of every liquid crystal display device by using strict quality control standards. We have succeeded in producing excellent products with high display quality and uniform products level.

RELIABILITY

Every Hitachi liquid crystal display device is manufactured in a well controlled production system from the purchase of the liquid crystal materials to the completed product.
We are making every effort to secure unparalleled quality through a far-reaching quality control program and service life tests, environmental tests, and mechanical tests, etc. throughout the entire production process.

HANDLING PRECAUTION

Package

1) Do not leave the package in a humid place for a long time, especially where the temperature is more than 35°C. Please preserve and use it within the limited temperature and humidity range.
2) Do not leave the LCD in a bright place for over ten days, although it is sealed by polarizers with wavelength cut of less than 400 nm for its protection. However, do not leave the LCD without a front polarizer in a bright place for more than two hours.
3) Do not drop water or chemicals, etc. on the surface of the display.
4) Handle the front polarizer and reflector with care as it is easily damaged. Do not press or rub them with a glass, a pin or any small, hard object. Take care not to push and drop them because a strong shock may damage them.
5) Since the adhesive used in the front and back polarizers is of organic agents, it may cause a chemical reaction with other kinds of chemicals resulting in their deterioration. Use the designated chemicals (petroleum benzine).
6) Soak a piece of absorbent cotton or chamois leather with the designated chemicals and wipe softly when the surface of display becomes dirty. It is normaly sufficient to wipe the surface of display with a chamois leather so as not to damage the display surface and the outside appearance.
7) Glass has a tendency to break and crack. Handle the edge with care as that part is particularly susceptible to this.
8) Contact terminal (transparent conductive coat) may be damaged by the sharp part of glass, etc. The wire will be severed if the mechanical contact terminal is excessively rubbed. Please bring in contact with the transparent electrode part carefully.
9) Do not touch the surface of display and the part of transparent conductive coated terminal with naked fingers. The LCD will be stained on the surface of display leading to less of insulation between terminals.

Installation

1) Always, fix LCD at the outside of a peripheral part. Take care to apply pressure on the polarizers because a bubble will be generated and the polarizers will come off, damaging the outside appearance. If power is applied between front and back glass substrate on the display with liquid crystal, the life will be shortened and a gap between the LCD will form so that the LCD will not operate.
2) Set a transparent protective board (for example, acrylic board) on a product board in order to protect liquid crystal display and particularly the surface of the polarizer.
3) Avoid heating the terminal part over 70°C as this will weaken the effect of the sealing material.

Handling Notes

1) The useful life is reduced if it is operated at high voltage over the prescribed voltage. Please use the LCD within the prescribed voltage. Particularly, take care not to use the LCD at a high temperature. Moreover, do not use LCD at DC as this will shorten its life and cause an electronic chemical reaction.
2) When operating temperature is below the prescribed one, switching on and off becomes slow. When operating temperature is above that prescribed, the display becomes dark. When operating temperature returns to normal, the display reverts to the former color.
3) Avoid condensation, as electric chemical reactions are likely to occur and the wire may be disconnected when the terminal parts have some condensation. Use LCD below relative humidity equivalent to 40°C and 50% RH.

Storage Method

1) Put the LCD in a vinyl case and seal it so that no air enters from outside. No desiccative needed.
2) Place the LCD well away from the direct rays of the sun or a fluorescent light, etc. and maintain the storage temperature at 0~35°C as far as possible.
3) Wrap each LCD in soft paper, etc. so they are not damaged by the polarizer, in particular. Place and preserve the LCD's in a Hitachi inner packing box.

■ Semi-Custom Options Available

Standard Part Type Number	WTR -20°C ~ +80°C	Transflective	WTR + Transflective
LS022C-C	✓		
LS023C-C	✓		
LS007C-C	✓		✓
H1331C-C	✓	✓	
H1332C-C	✓		
H1333C-C	✓	✓	
LS024C-C	✓	✓	
H1335C-C			✓
LS060C-C			
LS066	LS066CH-C		
H1336C-C	✓		
H1337C-C			
LS025C-C			
LS026C-C	✓		
LS027C-C			
H1338C-C	✓		✓
LS028C-C			
H1339C-C			

NOTE : Minimum order quantity 1Kpcs

Mass Production
H1331C-C
H1331C-E
H1331CH-C
H1332C-C
H1332CH-C
H1333C-C
H1333CH-C
H1335C-C
H1335CH-E
H1336C-C
H1336CH-C
H1337C-C
H1338C-C
H1338CH-C
H1338CH-E
H1339C-C
LS007C-C
LS007CH-C
LS007CH-E
LS022C-C
LS022CH-C
LS023C-C
LS023CH-C
LS024C-C
LS024C-E
LS024CH-C
LS025C-C
LS026C-C
LS026CH-C
LS027C-C
LS028C-C
LS060C-C
LS066CH-C

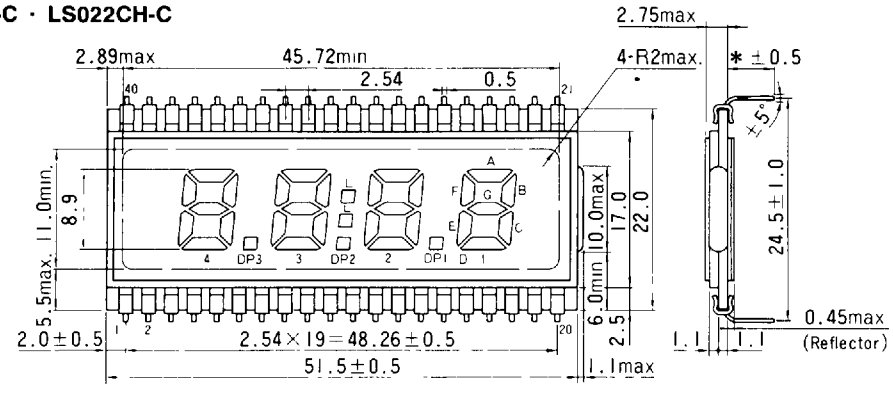
Note :

-C : Without Pins C-E : Transflective
C-C : Standard Part CH-E : WTR + Transflective
CH-C : WTR Version

HITACHI/(OPTOELECTRONICS) 61E D 4496205 0012774 474 HIT4
HITACHI

DIMENSIONS

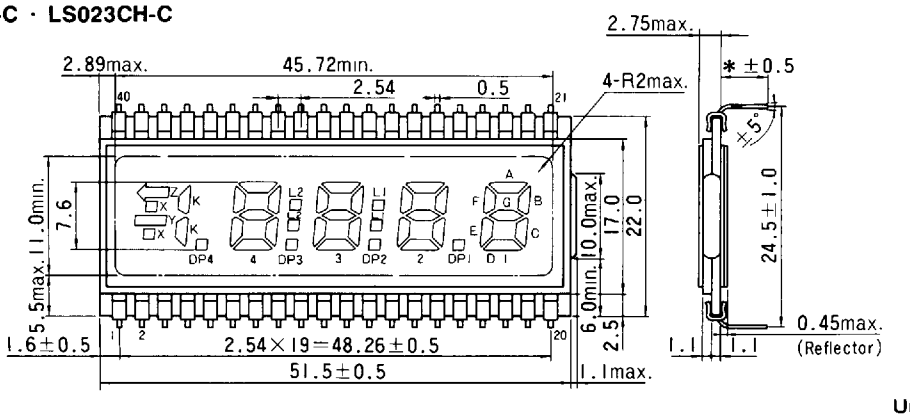
LS022C-C · LS022CH-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	NC	22	F1
3	NC	23	G1
4	NC	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	NC
19	C1	39	NC
20	B1	40	NC

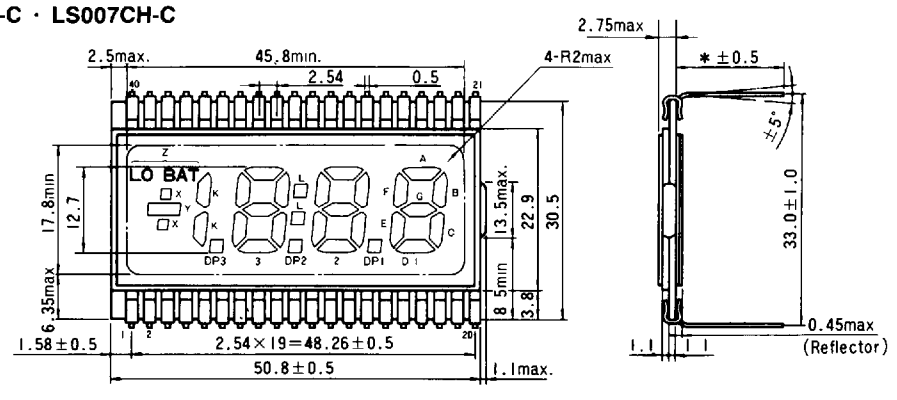
LS023C-C · LS023CH-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	DP4	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L1
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	L2
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	Z
19	C1	39	X
20	B1	40	NC

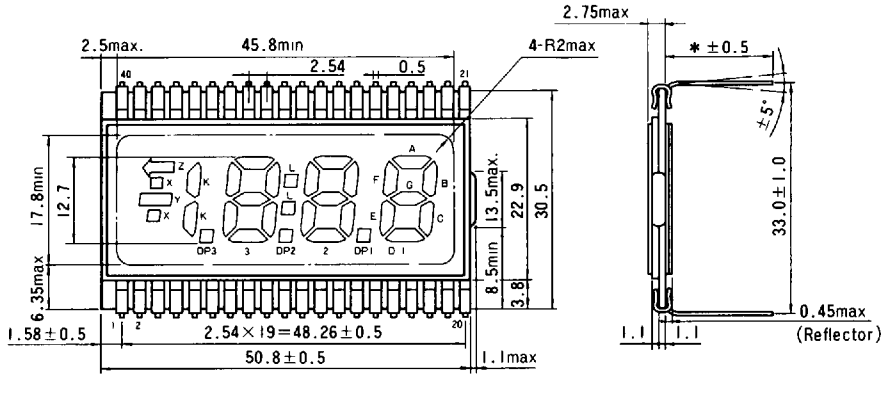
LS007C-C · LS007CH-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	NC	24	B2
5	NC	25	A2
6	NC	26	F2
7	NC	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	20	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	NC
15	C2	35	NC
16	DP1	36	NC
17	E1	37	NC
18	D1	38	Z
19	C1	39	X
20	B1	40	BP(COM)

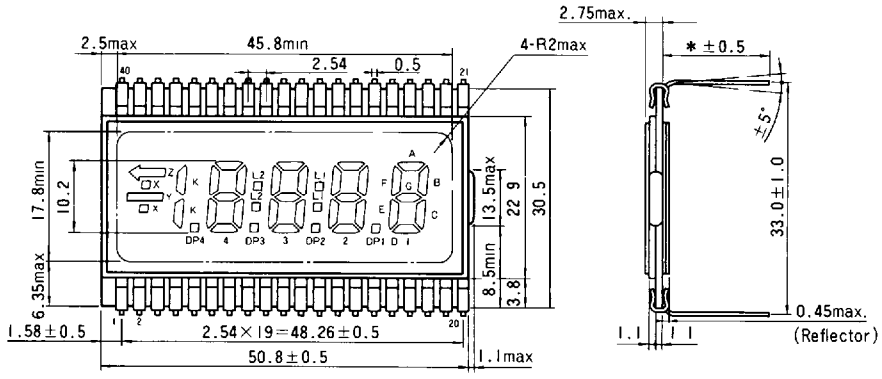
H1331C-C · H1331CH-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	NC	24	B2
5	NC	25	A2
6	NC	26	F2
7	NC	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	NC
15	C2	35	NC
16	DP1	36	NC
17	E1	37	NC
18	D1	38	Z
19	C1	39	Y
20	B1	40	BP(COM)

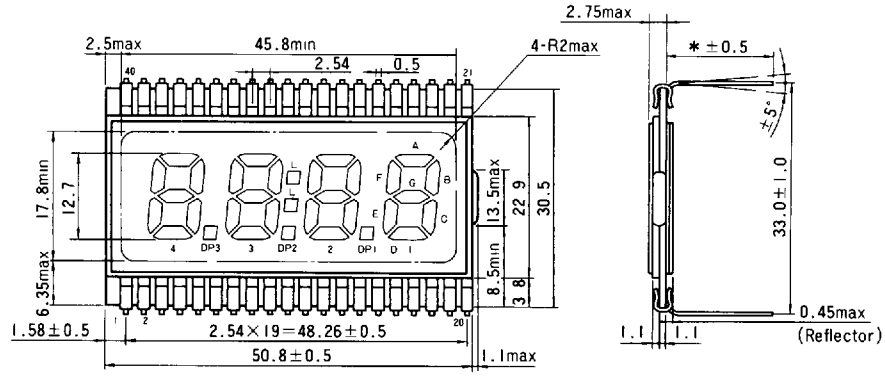
HI332C-C · HI332CH-C



Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	DP4	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L1
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	L2
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	Z
19	C1	39	X
20	B1	40	BP(COM)

Unit: mm

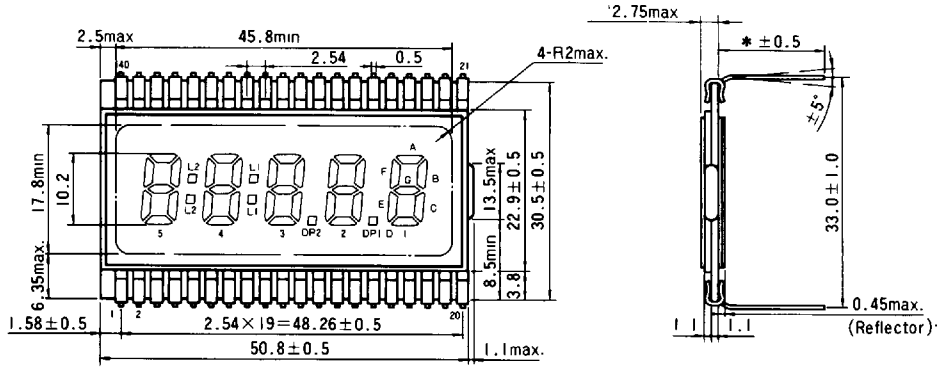
HI333C-C · HI333CH-C



Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	NC	22	F1
3	NC	23	G1
4	NC	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	NC
19	C1	39	NC
20	B1	40	BP(COM)

Unit: mm

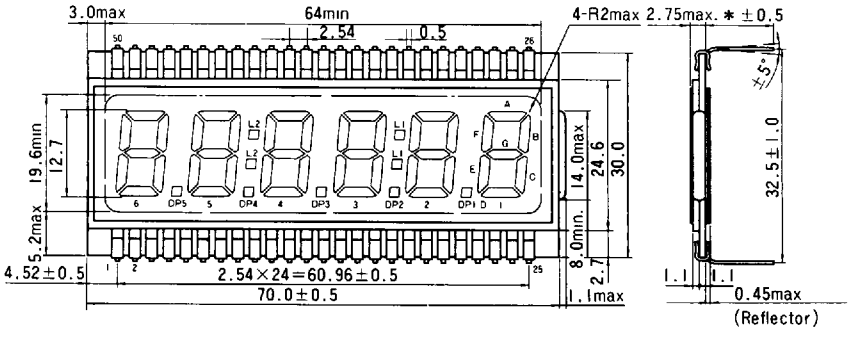
LS024C-C · LS024CH-C



Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	G5	22	F1
3	E5	23	G1
4	D5	24	B2
5	C5	25	A2
6	E4	26	F2
7	D4	27	G2
8	C4	28	B3
9	E3	29	A3
10	D3	30	F3
11	C3	31	G3
12	DP1	32	L1
13	E2	33	B4
14	D2	34	A4
15	C2	35	F4
16	DP1	36	G4
17	E1	37	L2
18	D1	38	B5
19	C1	39	A5
20	B1	40	F5

Unit: mm

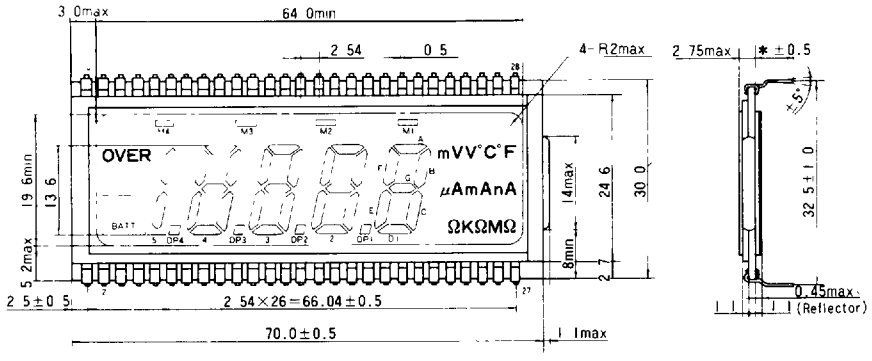
HI335C-C



Pin No	Segment	Pin No.	Segment	Pin No.	Segment
1	BP(COM)	21	DP1	41	G4
2	E6	22	E1	42	L2
3	D6	23	D1	43	B5
4	C6	24	C1	44	A5
5	DP5	25	B1	45	F5
6	E5	26	A1	46	G5
7	D5	27	F1	47	B6
8	C5	28	G1	48	A6
9	DP4	29	B2	49	F6
10	E4	30	A2	50	G6
11	D4	31	F2		
12	C4	32	G2		
13	DP3	33	L1		
14	E3	34	B3		
15	D3	35	A3		
16	C3	36	F3		
17	DP2	37	G3		
18	E2	38	B4		
19	D2	39	A4		
20	C2	40	F4		

Unit: mm

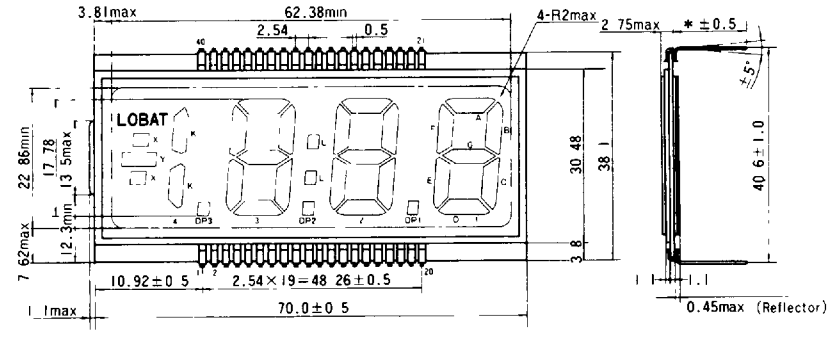
LS060C-C



Unit: mm

Pin No	Segment	Pin No	Segment	Pin No	Segment
1	BP(COM)	21	KΩ	41	E2
2	Z	22	MΩ	42	B3
3	BATT	23	n	43	A3
4	BC5	24	A	44	M3
5	DP4	25	°C	45	F3
6	D4	26	°F	46	G3
7	C4	27	BP	47	E3
8	DP3	28	V	48	B4
9	D3	29	mV	49	A4
10	C3	39	B1	50	M4
11	DP2	31	A1	51	F4
12	D2	32	M1	52	G4
13	C2	33	F1	53	E4
14	—	34	G1	54	OVER
15	DP1	35	E1		
16	D1	36	B2		
17	C1	37	A2		
18	μA	38	M2		
19	mA	39	F2		
20	Ω	40	G2		

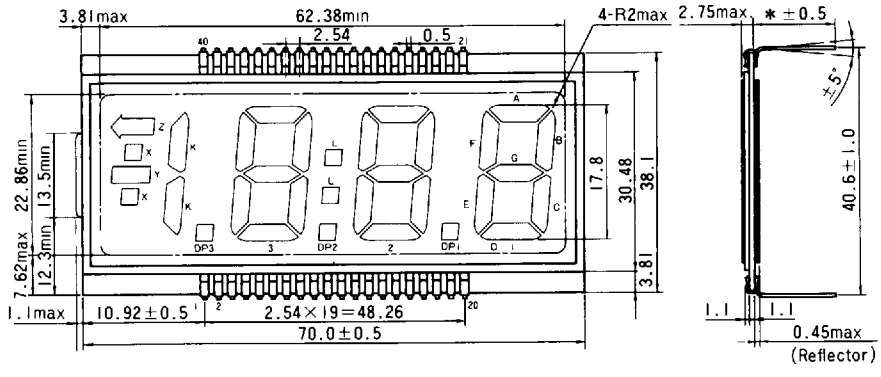
LS066CH-C



Unit: mm

Pin No	Segment	Pin No.	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	NC	24	B2
5	NC	25	A2
6	NC	26	F2
7	NC	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	NC
15	C2	35	NC
16	DP1	36	NC
17	E1	37	NC
18	D1	38	LOBAT
19	C1	39	X
20	B1	40	BP(COM)

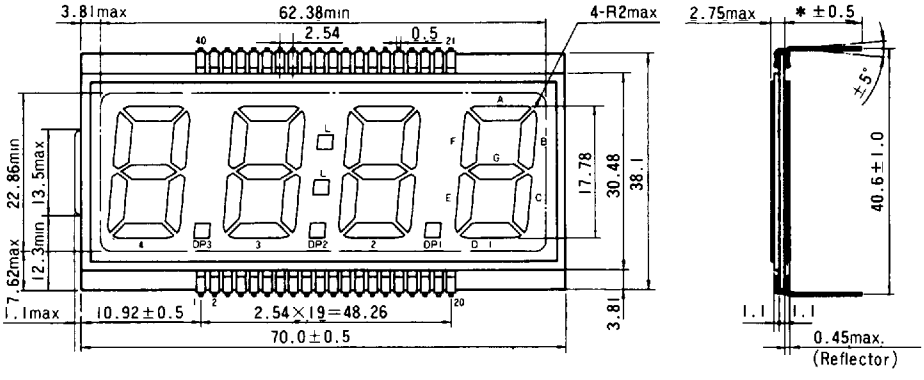
HI336C-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	NC	24	B2
5	NC	25	A2
6	NC	26	F2
7	NC	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	NC
15	C2	35	NC
16	DP1	36	NC
17	E1	37	NC
18	D1	38	Z
19	C1	39	X
20	B1	40	BP(COM)

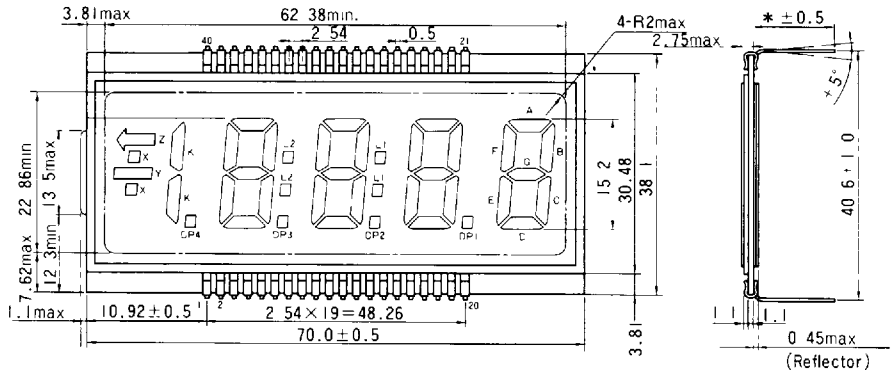
HI337C-C



Unit: mm

Pin No	Segment	Pin No.	Segment
1	BP(COM)	21	A1
2	NC	22	F1
3	NC	23	G1
4	NC	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	NC
19	C1	39	NC
20	B1	40	BP(COM)

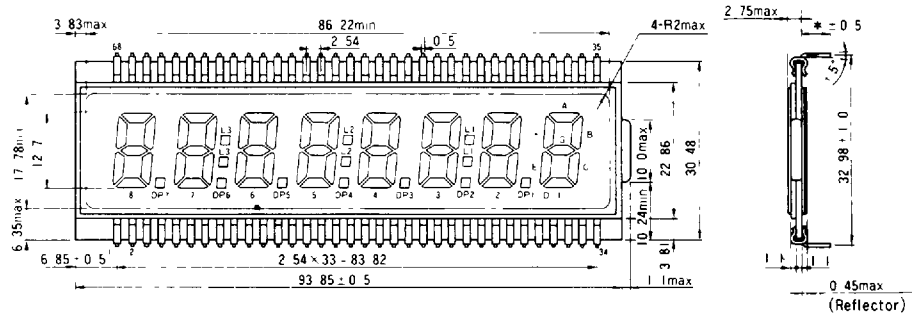
LS025C-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	DP4	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L1
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	L2
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	Z
19	C1	39	X
20	B1	40	NC

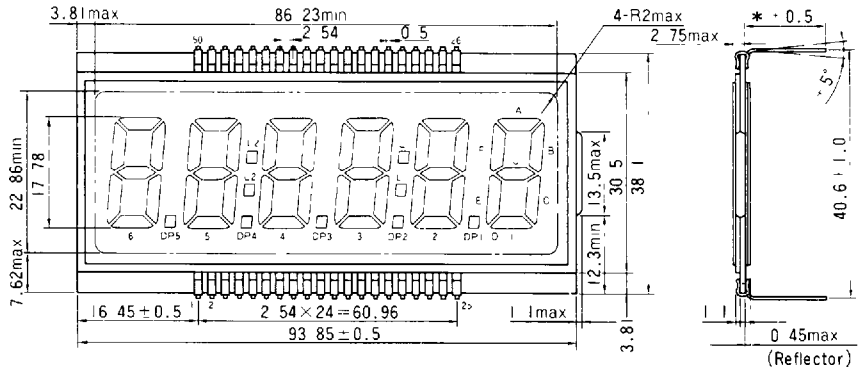
LS026C-C · LS026CH-C



Unit: mm

Pin No	Segment	Pin No	Segment	Pin No	Segment	Pin No	Segment
1	BP(COM)	21	C4	41	G2	61	B7
2	E8	22	DP3	42	L1	62	A7
3	D8	23	E3	43	B3	63	F7
4	C8	24	D3	44	A3	64	G7
5	DP7	25	C3	45	F3	65	B8
6	E7	26	DP2	46	G3	66	A8
7	D7	27	E2	47	B4	67	F8
8	C7	28	D2	48	A4	68	G8
9	DP6	29	C2	49	F4		
10	BP	30	DP1	50	G4		
11	E6	31	E1	51	L2		
12	D6	32	D1	52	B5		
13	C6	33	C1	53	A5		
14	DP5	34	B1	54	F5		
15	E5	35	A1	55	G5		
16	D5	36	F1	56	B6		
17	C5	37	G1	57	A6		
18	DP4	38	B2	58	F6		
19	E4	39	A2	59	G6		
20	D4	40	F2	60	L3		

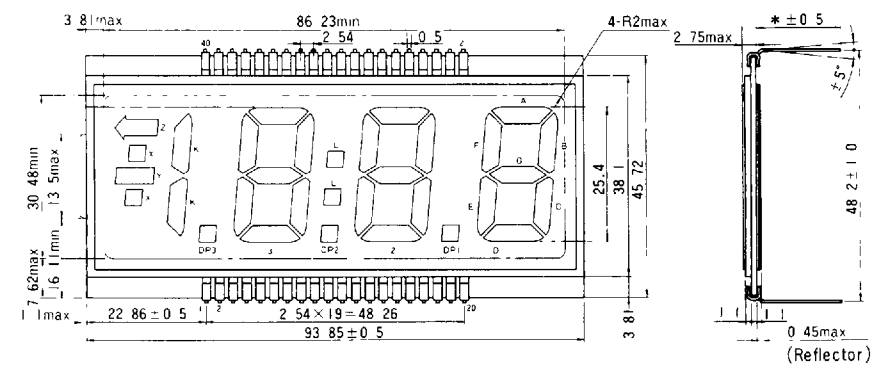
LS027C-C



Unit: mm

Pin No	Segment	Pin No	Segment	Pin No.	Segment
1	BP(COM)	21	DP1	41	G4
2	E6	22	E1	42	L2
3	D6	23	D1	43	B5
4	C6	24	C1	44	A5
5	DP5	25	B1	45	F5
6	E5	26	A1	46	G5
7	D5	27	F1	47	B6
8	C5	28	G1	48	A6
9	DP4	29	B2	49	F6
10	E4	30	A2	50	G6
11	D4	31	F2		
12	C4	32	G2		
13	DP3	33	L1		
14	E3	34	B3		
15	D3	35	A3		
16	C3	36	F3		
17	DP2	37	G3		
18	E2	38	B4		
19	D2	39	A4		
20	C2	40	F4		

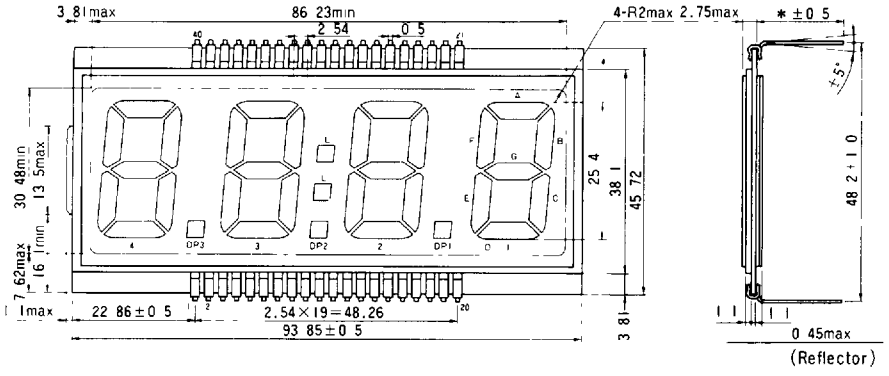
HI338C-C · HI338CH-C



Unit: mm

Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	NC	24	B2
5	NC	25	A2
6	NC	26	F2
7	NC	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	NC
15	C2	35	NC
16	DP1	36	NC
17	E1	37	NC
18	D1	38	Z
19	C1	39	X
20	B1	40	BP(COM)

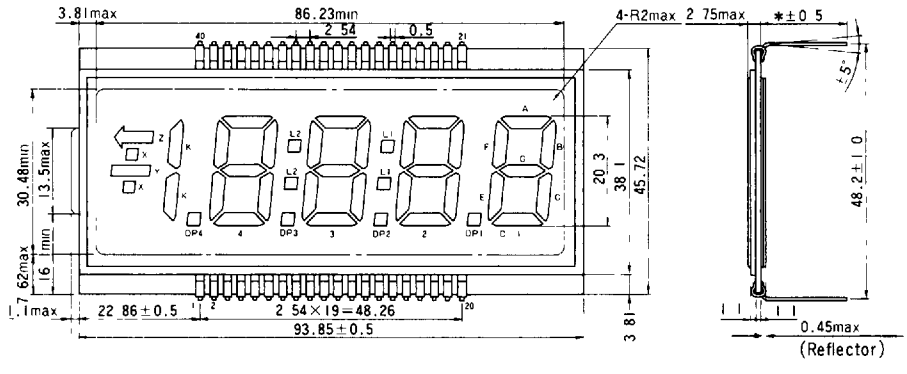
LS028C-C



Pin No	Segment	Pin No	Segment
1	BP(COM)	21	A1
2	NC	22	F1
3	NC	23	G1
4	NC	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	NC
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	NC
19	C1	39	NC
20	B1	40	NC

Unit: mm

HI339C-C



Pin No	Segment	Pin No.	Segment
1	BP(COM)	21	A1
2	Y	22	F1
3	K	23	G1
4	DP4	24	B2
5	E4	25	A2
6	D4	26	F2
7	C4	27	G2
8	DP3	28	L1
9	E3	29	B3
10	D3	30	A3
11	C3	31	F3
12	DP2	32	G3
13	E2	33	L2
14	D2	34	B4
15	C2	35	A4
16	DP1	36	F4
17	E1	37	G4
18	D1	38	Z
19	C1	39	X
20	B1	40	BP(COM)

Unit: mm

CUSTOM LCD FROM HITACHI

Liquid Crystal Displays

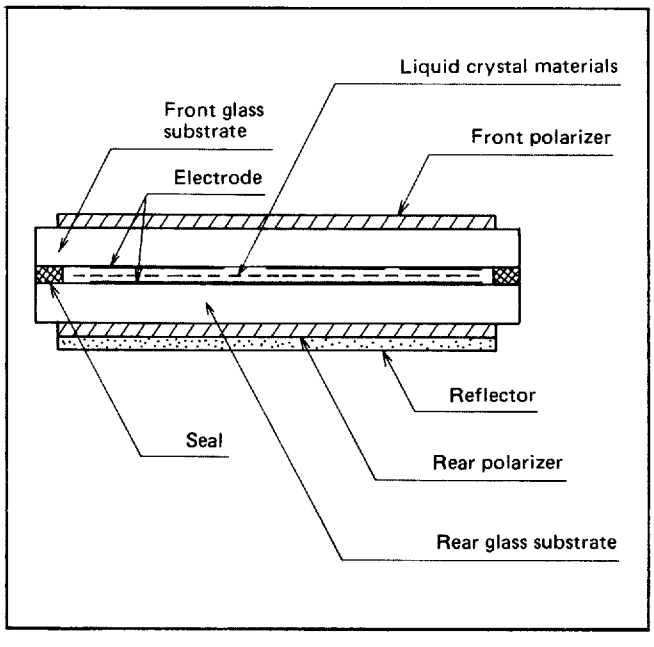
What is liquid crystal?

A liquid crystal is an intermediate phase between the liquid and solid states. Outwardly, it appears to be a liquid, but electrically and optically, it shows the properties of a crystal. Liquid crystals are used in liquid crystal displays.

Types of Liquid Crystal Displays

Type	Description	
Twisted-nematic (TN)	An electric field moves the molecules of the liquid crystal from a twisted alignment to vertical alignment. The display employs polarizer. This type is the most widely used at present. (Detailed below)	Polarizer, Voltage OFF, Transparent (white); Voltage ON, Opaque (black)
Guest-host	An electric field moves the molecules of a liquid crystal containing dye molecules. This type has better viewing angle properties than the TN type, and a bright color display is possible.	Voltage OFF, Dye, Colored light; Voltage ON, Transparent

Basic structure of a Liquid Crystal Display (TN type)

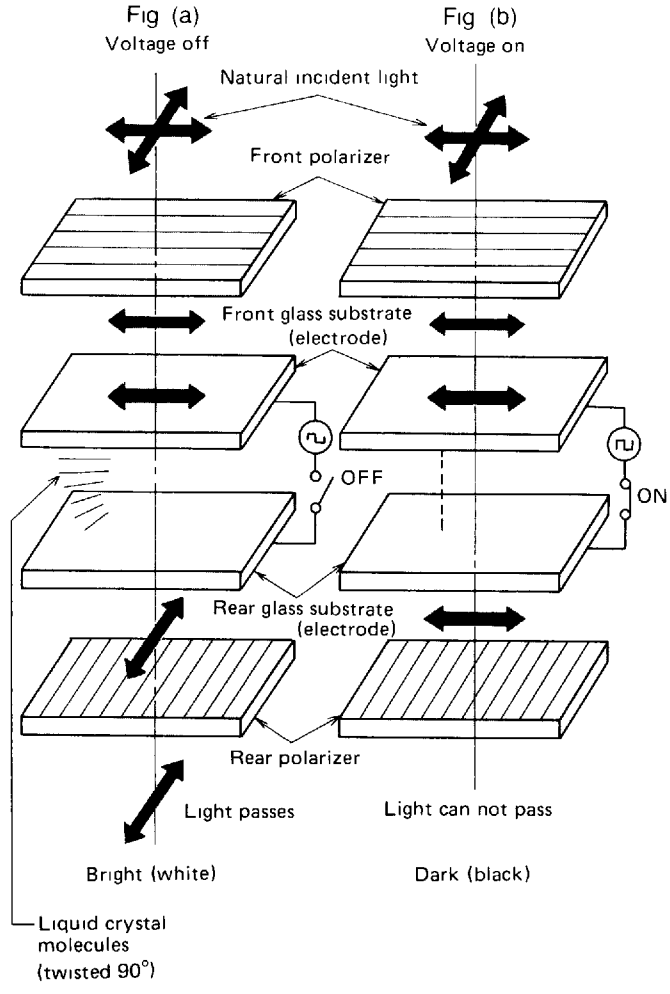


Driving principle (TN type)

A liquid crystal display could be described as an electronic shutter that is transparent when no voltage is applied but becomes opaque when the voltage is turned on (or vice versa). This effect is used to display numerals, characters, and other patterns. The principle of operation of a liquid crystal display is shown in Diagram below.

(1) The liquid crystal display is sandwiched between two polarizers, whose axes of polarization usually are crossed by 90°.
(2) When there is no voltage, the molecules of the liquid crystal are aligned with a 90° twist, and rotate the plane of polarization of the light by 90°, as in Fig. (a), so that the light passes through both polarizers.
(3) When a voltage is applied, the molecules of the liquid crystal align perpendicular to the substrate, so that the light is cut off by the second polarizer, as in Fig. (b).

Principle of operation



Features of Liquid Crystal Displays

Compared with other display devices, liquid crystal displays have the following features.

(1) Low power consumption (1 to 10μW/cm²).
(2) Low-voltage operation (1.5 to 8 V).
(3) Good visibility in bright surroundings (the brighter the better, since the liquid crystal display is a passive display device).
(4) Easy on the eye.
(5) Flexibility of display patterns.

Comparison of displays

Display device	Operating voltage (V)	Power consumption
Fluorescent tube	9 ~ 50	10 ~ 50mW/character
Electroluminescent display	100 ~ 240	500mW/cm2 or less
Plasma display	30 ~ 250	30 ~ 100mW/character
LED	1.5 ~ 5	10 ~ 50mW/character
Liquid crystal (TN type)	1.5 ~ 8	0.5 ~ 2.0μW/character

Custom Liquid Crystal Displays

A custom l.c.d. should be considered as an option only when no standard display or display module exactly matches requirements. For details of the wide range of Hitachi standard products, see:

"Liquid crystal displays for industrial equipment"
"Dot matrix liquid crystal display modules."

A custom l.c.d. offers total flexibility in glass size and pattern format in addition to a number of special and important features.

Some of the options available in a custom designed l.c.d. are:

– positive or negative mode
– reflective, transmissive or transflective
– colour
– fixed legend printing
– connection method
– multiplexing
– viewing direction

They are examined in more detail below:

- **Positive or negative mode** – i.e. black on clear or clear on black respectively. A positive mode display is most effective with front lighting with a negative mode preferred for backlight applications.
- **Reflective, transmissive or transflective** types:
  Reflective – for front lighting only
  Transmissive – for back lighting only
  Transflective – for dual lighting applications
  i.e. front lighting in daylight, back lighting at night.
- **Coloured displays** Displays can be supplied with the segments coloured as opposed to the normal black on clear combination. In addition, certain areas of the display may be coloured or a number of coloured sections obtained on a single display.

  Guest-host displays can also be offered but note that negative contrast only is possible and this technology is limited to simple displays.
- **Fixed legends** and symbols which are permanent and non-switchable may be obtained by screen printing onto the display surface. This option can be offered in single or multi-colours.
- **Connectors** – Displays may be supplied with or without pin connectors suitable either for direct soldering onto a p.c.b. or for elastomeric type connectors.

Pin type	Pitch (mm)	Length (mm)
1	2.54	≤ 9.5
2	2.54	9.5 ≤ 19.5
3	2.54	19.5 ≤ 29.5
4	1.80	≤ 9.5

For details regarding suppliers of elastomers, please contact Hitachi.

- **Multiplexed displays** – LCD multiplexing is a method of sharing edge connections on the display in order to reduce the number of driver LSI's and display to pcb complexity. Multiplexing therefore reduces both cost and size.

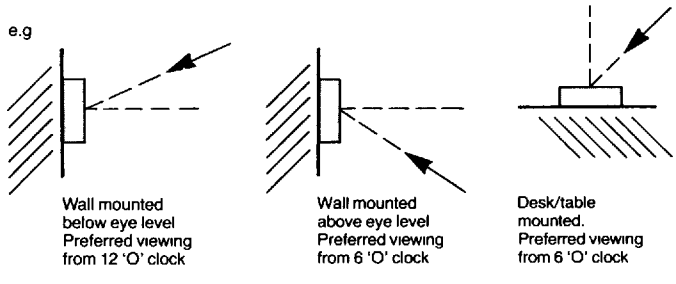
  However, there is a trade-off between multiplexing level (known as duty ratio) and display quality – for example at static drive a contrast ratio in excess of 20:1 may be achieved but at 1/64 duty ratio the contrast may be reduced to 3:1.

In order to keep the contrast and viewing angle of a multiplexed display constant over a wide operating temperature range it may be necessary to 'temperature compensate' the display. This is done by reducing the supply voltage to the l.c.d. driver as the temperature increases and vice-versa (10-20mV/°C is normally sufficient, but please contact Hitachi for accurate figures). The following table may be used as a guide as to whether temperature compensation is necessary:

Duty ratio / OP Temp °C	0–50	–10–60	–20–70
STATIC	NO	NO	NO
1/2	NO	NO	NO
1/3	NO	NO	YES
1/4	NO	YES	YES
1/8	YES	YES	YES

NO – Temperature compensation not essential
YES – Temperature compensation recommended

- **Pre-set viewing direction** All l.c.d.'s have a preferred viewing direction which is fixed at the time of manufacture. The preferred viewing direction can be selected at the time of design and is dependent on the application of the final instrument.



Display Reliability

High temperature and humidity test

Figure 6.1 shows the results of reliability tests under high temperature and humidity. There were no failures after 100 hours at 70°C and 95% RH, and 10% failures after 250 hours. There were two failures modes: Character blurring caused by segment widening, and loss of seal. At 40°C and 95% RH there were no failures after 100 hours and only 1% failures after 3,000 hours. The inferred relation between temperature and lifetime is shown in Fig. 6.2. According to Fig. 6.2 at a normal temperature of 25°C and relative humidity of 95%, a lifetime of more than 90,000 hours (10 years) can be expected.

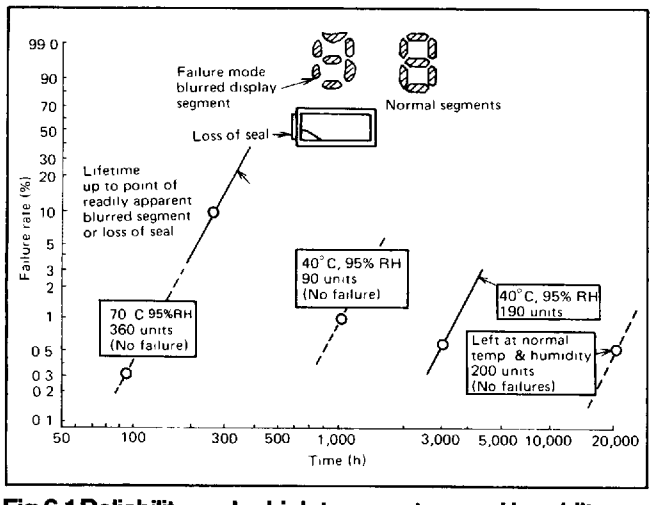


Fig 6.1 Reliability under high temperature and humidity

Operating lifetime

As shown in Fig 6.3, in a voltage-accelerated lifetime test (voltage = 100 VAC), the cumulative failure rate after 600 hours was 10%, but at voltages of 12 VAC and 5 VAC (60°C), there were still no failures after 7,000 hours. The inferred relation between applied voltage and lifetime is shown in Fig 6.4. For a typical practical voltage of 3.1 V, the lifetime is estimated to be in excess of 90,000 hours (10 years). A DC voltage lifetime test showed no failures after 3,000 hours (at 5 VDC). This test establishes the strong insulation qualities of Hitachi liquid crystal displays.

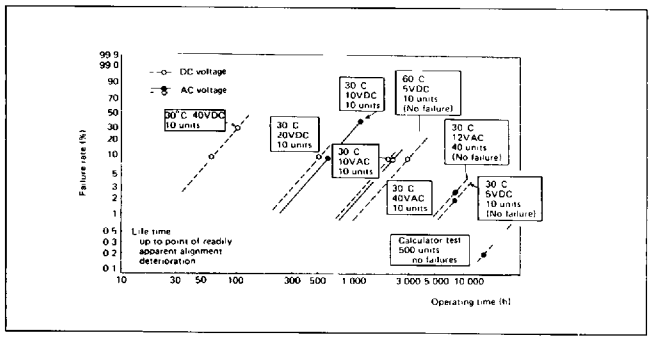


Fig 6.3 Results of voltage-accelerated lifetime tests of Hitachi liquid crystal displays

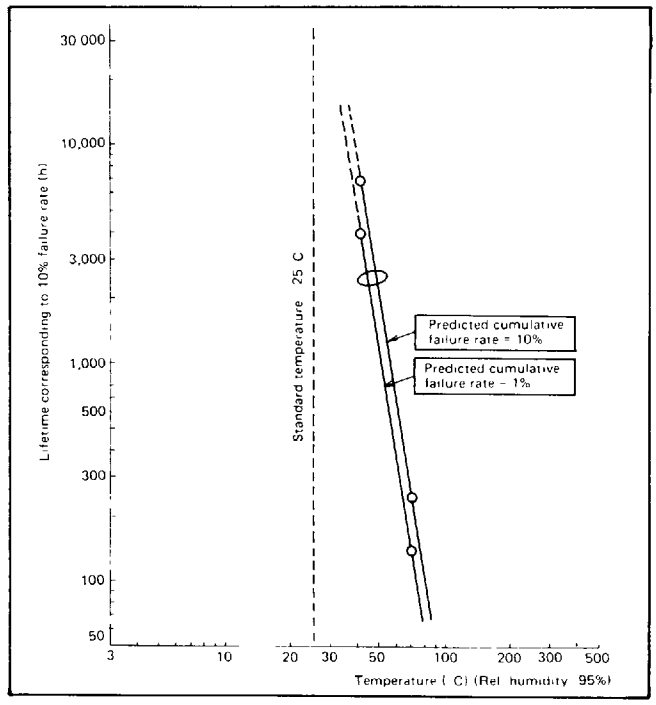


Fig 6.2 Dependence of lifetime on temperature under high humidity conditions

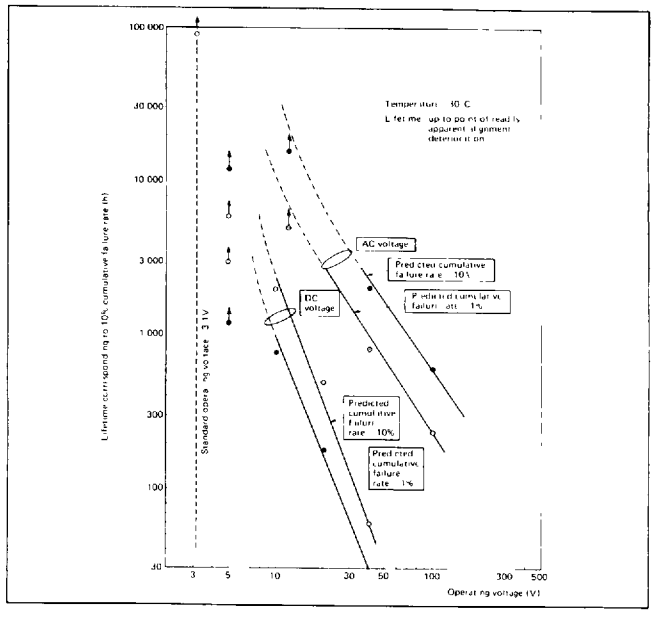


Fig 6.4 Dependence of liquid crystal display lifetime on AC and DC voltage

The First Step

For a technical evaluation and an initial costing on your proposed display simply fill in the form at the end of this brochure with a rough sketch and return to your usual Hitachi sales engineer or distributor.

LCD Drivers From Hitachi

Type Column Driver

Type Number	HD44100H	HD66100F	HD61100A	HD61200	HD61104	HD61104A	HD66204	HD66214*	HD66106F	HD66107T
Power supply for internal circuits (V)	5	5	5	5	5	5	5V	2 7 to 5.5V	5	5
Power supply for LCD Drive Circuit (V)	11	6	17	17	26	28	28V	28V	37	37
Power Dissipation (mW)	5	5	5	5	10	10	15	-	15	25
Operating Temperature (°C)	-20 to +75 •1	-20 to +75 •1	-20 to +75 •1	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75
Memory										
ROM (Bit)	-	-	-	-	-	-	-	-	-	-
RAM (Bit)	-	-	-	-	-	-	-	-	-	-
LCD Driver										
Common	20	-	-	-	-	-	-	-	80	160
Column	40 (20)	80	80	80	80	80	80	80	80	160
Instruction Set	-	-	-	-	-	-	-	-	-	-
Operation Frequency (MHz)	0.4	1	2.5	2.5	3.5	3.5	8	4	6	8
Duty	Static-1/32	Static-1/16	Static-1/100	1/32-1/28	1/64-1/200	1/64-1/240	1/64-1/240	1/64-1/240	1/100-1/480	1/100-1/480
Package	FP-60	FP-100	FP-100	FP-100	FP-100	FP-100 TFP-100	FP-100	TCP	FP-100	192pin TCP

Type Column Driver (TFT) Common Driver

Type Number	HD663300T	HD66310T	HD44103CH	HD44105H	HD61103A	HD611203	HD61105	HD61105A	HD66205
Power supply for internal circuits (V)	5	5	5	5	5	5	5	5	5
Power supply for LCD Drive Circuit (V)	15	23	11	11	17	17	26	28	28
Power Dissipation (mW)	160	100	4.4	4.4	5	5	5	5	5
Operating Temperature (°C)	-20 to +75	-20 to +75 •2 (-20 to +65)	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75
Memory									
ROM (Bit)	-	-	-	-	-	-	-	-	-
RAM (Bit)	-	-	-	-	-	-	-	-	-
LCD Driver									
Common	120	160	20	32	64	64	80	80	80
Column	-	-	-	-	-	-	-	-	-
Instruction Set	-	-	-	-	-	-	-	-	-
Operation Frequency (MHz)	4.8	12/15	1	1	2.5	2.5	0.1	0 1	0.1
Duty	-	-	1/8, 1/12, 1/16, 1/24, 1/32.	1/8, 1/12, 1/32, 1/48.	Static-1/10, 1/64.	1/32-1/128	1/64-1/200	1/64-1/240	1/64-1/240
Package	156pin TCP	236pin TCP	FP-60	FP-60	FP-100	FP-100	FP-100	FP-100 TFP-100	FP-100 TQFP-100

•1. - 40 to + 85°C (Special request). Please contact Hitachi agents.

•2. - 20 to + 75°C in 12 MHz Version, -20 to + 65°C in 15 MHz Version.

* Under development

Type	Column Driver (RAM)			Segment Display				
Type Number	**HD44102CH**	**HD61102**	**HD61202**	**HD66108T**	**HD61602**	**HD61603**	**HD61604**	**HD61605**
Power supply for internal circuits (V)	5	5	5	5	3 to 5	3 to 5	3 to 5	3 to 5
Power supply for LCD Drive Circuit (V)	11	15.5	17	15	5	5	5	5
Power Dissipation (mW)	5	5	5	5	0.5	0.5	0.5	0.5
Operating Temperature (°C)	-20 to +75	-20 to +75	-20 to +75	-20 to +75	-20 to +75 •1	-20 to +75 •1	-20 to +75 •1	-20 to +75 •1
Memory								
ROM (Bit)	-	-	-	-	-	-	-	-
RAM (Bit)	200 x 8	512 x 8	512 x 8	165 x 65	204	64	204	64
LCD Driver								
Common	-	-	-	0 ~ 65	4	1	4	1
Column	50	64	64	100 ~ 165	51	64	51	64
Instruction Set	6	7	7	7	4	4	4	4
Operation Frequency (MHz)	0.28	0.4	0.4	4	0.52	0.52	0.52	0.52
Duty	1/8, 1/12, 1/16, 1/24, 1/32	Static-1/64	1/48, 1/64, 1/96, 1/128	1/32, 1/34, 1/36, 1/48, 1/50, 1/64, 1/66.	Static, 1/2, 1/3, 1/4	Static	Static, 1/2 1/3, 1/4	Static
Package	FP-80	FP-100	FP-100	208pin TCP	FP-80, FP-80A, TFP-80*2	FP-80	FP-80	FP-80

Type	Character Display		Graphic Display					
Type Number	**HD44780 (LCD-II)**	**HD66780 (LCD-IIA)**	**HD66702***	**HD61830**	**HD61830B**	**HD63645F HD64645F HD64646FS LCTC**	**HD66840F HD66841F LVIC**	**HD66850 CLINE**
Power supply for internal circuits (V)	5	5	5/3	5	5	5	5	5
Power supply for LCD Drive Circuit (V)	11	5	6	-	-	-	-	-
Power Dissipation (mW)	2	2	-	30	50	50	250	500
Operating Temperature (°C)	-20 to +75 •1	-20 to +75	-20 to +75	-20 to +75	-20 to +75 •1	-20 to +75	-20 to +75	-20 to +75
Memory								
ROM (Bit)	7200	12000	7200	7360	7360	-	-	-
RAM (Bit)	80 x 8, 64 x 8	80 x 8, 64 x 8	80 x 8, 64 x 8	-	-	-	-	-
LCD Driver								
Common	16	16	16	-	-	-	-	-
Column	40	40	100	-	-	-	-	-
Instruction Set	11	11	11	12	12	15	16/24	63
Operation Frequency (MHz)	0.25	0.25	-	1.1	2 4	10	30	32
Duty	1/8, 1/11, 1/16.	1/8, 1/11, 1/16.	1/8, 1/11, 1/16.	Static 1/128	Static 1/128	Static 1/512	Static 1/1024	1/480
Package	FP-80, FP-80A, TFP-80 *2	FP-80A FP-80B	144pin Bare chip	FP-60	FP-60	FP-80, FP-80B	FP-100A	FP-136

•1. -40 to +85°C (Special request). Please contact Hitachi agents.

*2. Under development

LCD Drivers From Hitachi Cont'd...

4-bit Microprocessor

	Family Name			LCDII[*4]		LCDIV[*5/*6]	
				HD44790	HD44795	HD613900	LOW VOLTAGE T.B.A.
LSI Characteristics	Process			CMOS	CMOS	CMOS	CMOS
	Supply Voltage		(V)	5	2.7 ~ 5.5[*3]	5[*3]	2.5 ~ 5.5[*3]
	Supply Current (typ)		(mA)	1.0	0.12	1.0	T.B.A.
	Max. I/O Terminal Voltage		(V)	10^{*2}	10^{*3}	10^{*2}	10^{*2}
	Output Characteristics		V/mA	2.4V/-1mA 0.8V/1.6mA	V_{cc}-0.4/-0.08 0.4/0.4	2.4V/-1mA 0.8V/1.6mA	V_{cc}-0.4/-0.08 0.4/0.4
	Operating Temperature Range		(°C)	-20 ~ +75	-20 ~ +75	-20 ~ +75	-20 ~ +75
	Package			FP-80	FP-80	FP-80	FP-80
Functions	Memory	ROM	(bits)	2,048 x 10 128 x 10[*1]	2,048 x 10 128 x 10[*1]	4,096 x 10	4,096 x 10
		RAM	(bits)	160 x 4	160 x 4	256 x 4	256 x 4
	Registers			6	6	6	6
	Stack Registers			4	4	4	4
	I/O Ports	4-Bit Data Input		32 4 x 1	32 4 x 1	32 4 x 1	32 4 x 1
		Discrete Input		—	—	—	—
		4-Bit Data Output		4 x 1	4 x 1	4 x 1	4 x 1
		Discrete Output		—	—	—	—
		4-Bit Data Input/Output		4 x 2	4 x 2	4 x 2	4 x 2
		Discrete Input-Output		1 x 16	1 x 16	1 x 6	1 x 6
	Interrupts	Timer/Counter		2	2	2	2
		Timer/Counter		Yes	Yes	Yes	Yes
	Instructions	Number of Instructions		71	71	71	71
		Cycle Time	(μs)	10	20	5	20
	Clock Pulse Generator					EXTERNAL	
	Power on Reset						
	Battery Back-up			Halt	Halt	Halt	Halt
	Evaluation Chip			HD44797E	HD44797E	HD44797E	HD44797E

8-bit Microprocessor

	Type No		HD63L05F1	
LSI Characteristics	Clock Frequency (MHz)		0.1	
	Supply Voltage (V)		3.0	
	Operating Temperature**(°C)		-20 ~ +75	
	Package		DP-64S, FP-80	
Functions	Memory	ROM (k byte)	4	
		RAM (byte)	96	
	I/O Port	I/O Port	20	20
		Input Port		—
		Output Port		(19)
	Interrupt	External	1	
		Soft	1	
		Timer	1	
		Serial	—	
	Timer		8 bit x 1 (with 7-bit prescaler)	
	SCI		—	
	External Memory Expansion		—	
	Other Features		• 8 bit A/D converter • LCD driver (6 x 7 segment) • Low power consumption modes (Standby and halt)	
	EPROM on the Package Type		—	
	Evaluation Chip		HD63L05E0/E1/E2	

* Under development

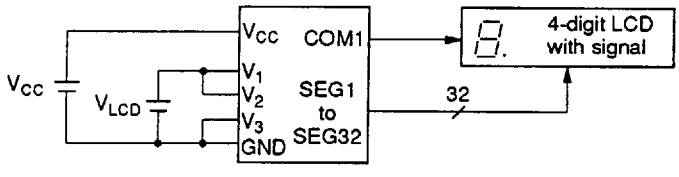
4-bit microcontrollers incorporating LCD drive

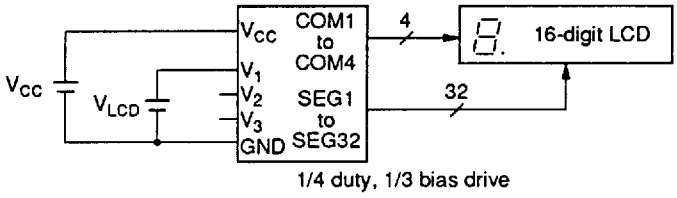
	HD404614 / 8	HD404814 / 8 *	HD404328 / 9	HD404629
	32 segments x 4 commons	32 segments x 4 commons	24 segments x 4 commons	52 segments x 4 commons
Static Drive	4 digits	4 digits	3 digits	6 digits
1/4 Duty 1/3 Bias	16 digits	16 digits	12 digits	26 digits

* : Low voltage versions available

8-bit microcontrollers incorporating LCD drive

	H8 / 3834
	40 segments x 4 commons
Static Drive	5 digits
1/4 Duty 1/3 Bias	20 digits





1/4 duty, 1/3 bias drive

Examples of LCD connections