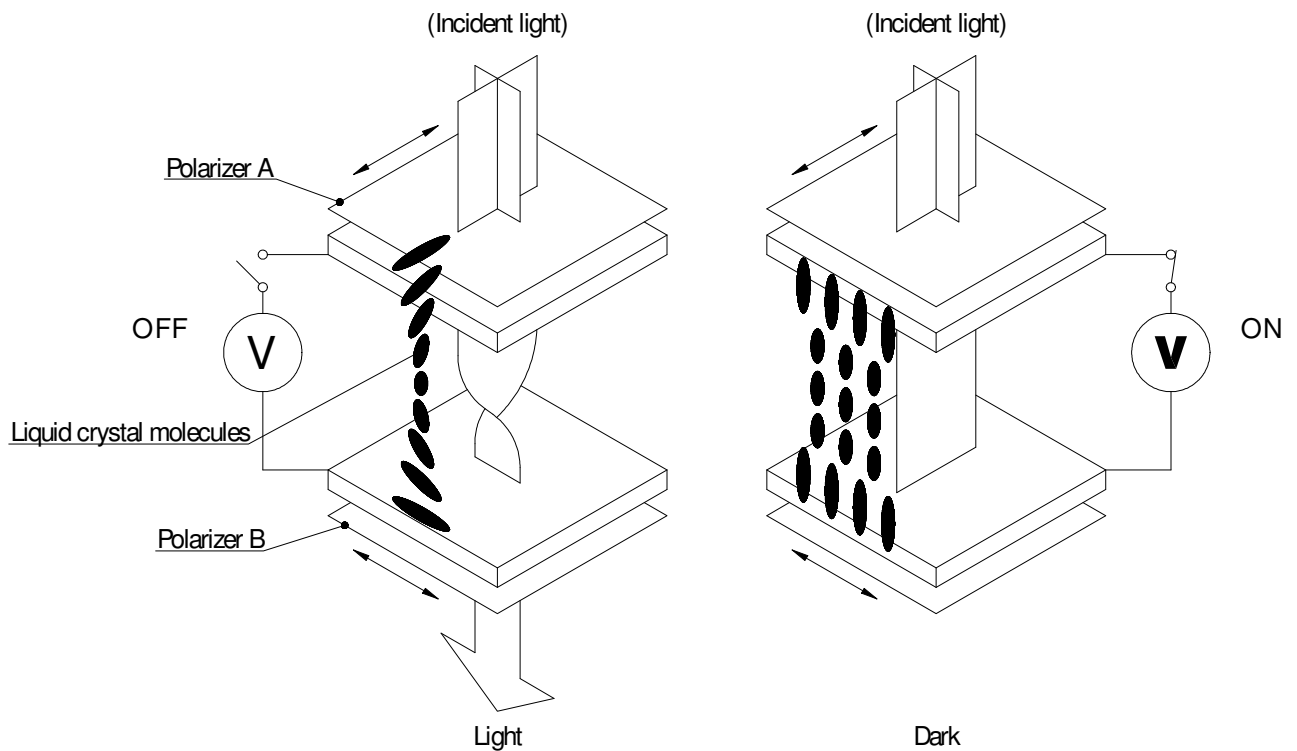


CONCEPT DIAGRAM OF LCD OPERATION



When incident (natural) light reaches Polarizer A, only the light in the direction of the liquid crystal molecules is allowed to pass.

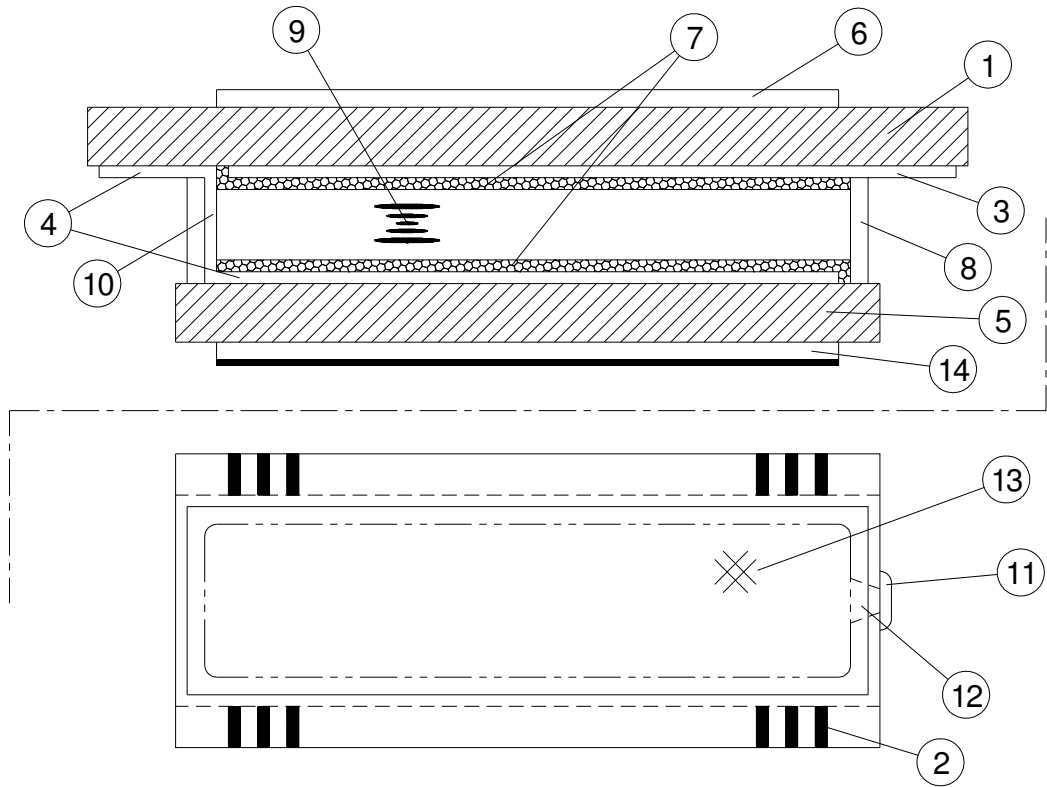
? **POWER OFF (no voltage applied)**

The light passing through Polarizer A is forced to follow the twist (90°) of the liquid crystal molecules. All of the light reaching Polarizer B from Polarizer A is allowed to pass because the Polarizers are perpendicular to each other.

? **POWER ON (voltage applied)**

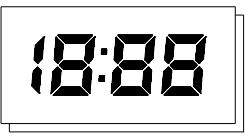
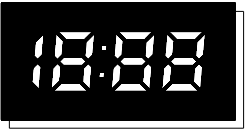
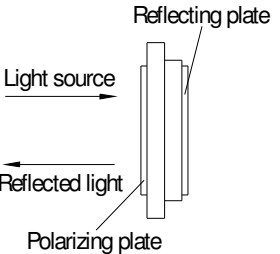
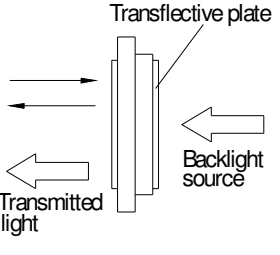
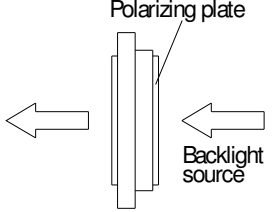
When voltage is applied, the liquid crystal molecules of Polarizer A do not twist the light, and so it passes through as it is to Polarizer B. Because of this, the light reaching Polarizer B is blocked.

LCD CONSTRUCTION AND NOMENCLATURE

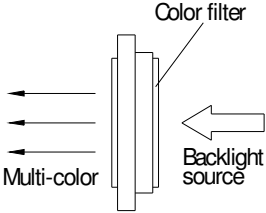
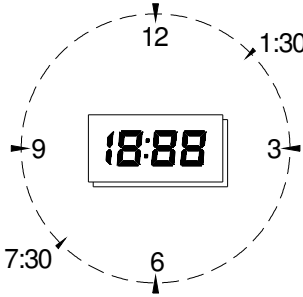
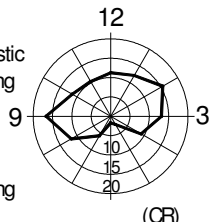


- 1) F substrate (glass)
- 2) Terminal
- 3) Segment electrode
- 4) Common electrode
- 5) B substrate (glass)
- 6) Upper polarizing plate
- 7) Orientation layer
- 8) Sealant
- 9) LC (liquid crystal)
- 10) Conducting material
- 11) Sealant
- 12) Inlet
- 13) Viewing area
- 14) Lower polarizing plate, or lower polarizing plate and reflecting plate

DISPLAY CONDITIONS AND VIEWING ANGLE (I)

| Display Mode | | Applications | Characteristics |
|---|---|---|---|
| A) Display type | Positive display  | General | Basic low-power LCD. Display is illuminated by ambient light, making it difficult to read in dark environments. |
| | Negative display  | Back light display Multi-color display | A backlight makes characters stand out clearer. Multi-color display produced using color filters. |
| B) Polarizing plates, reflecting plates | Reflective type  | General | Generally used in bright environments. |
| | Transflective type (Semi-transparent)  | External light and back light display | Can be used as reflective type when ambient light is bright, and as transmissive type when ambient light is dim. |
| | Transmissive type (transparent)  | Back light display | Used with backlight for dark environments. |
| <p>The thickness of the polarizing plate, transflecting plate, and reflecting plate may be restricted in order to allow optimum LCD characteristics.</p> <p>Standard specification:</p> <ol style="list-style-type: none"> 1) Polarizing plate thickness : 0.15mm 2) Transflecting plate thickness : 0.25mm <p>Reflecting plate thickness : 0.25mm</p> | | | |

DISPLAY CONDITIONS AND VIEWING ANGLE (II)

| | Display Mode | | Applications | Characteristics |
|-------------------------------------|---|---|---|---|
| C) Wide angle viewing field display | TN | (backlight color) / (light color) Gray / Black | Viewing angle and direction somewhat limited. | |
| | HTN | Gray / Black | Up to 1/48 duty drive possible. Wide visual field. | |
| | STN | Green / Blue Gray / Purple Blue / White | Up to 1/200 duty drive possible. High quality image. | |
| | FSTN | White / Black | Up to 1/200 duty drive possible. High quality image. | |
| D) Color display | Color Filter |  | Color display stands out for alarms, etc. | Used in combination with negative display for partial coloring. |
| E) Viewing direction |  | | For displays that require high-contrast at various angles and directions. | <p>Example</p> <p>Contrast characteristic diagram for following conditions: 3V, 1/3D, 1/3B $\Theta = 60^\circ X$ Viewing angle setting 12:00</p>  <p style="text-align: right;">(CF)</p> |

DRIVING SYSTEMS OF LCD

| Driving systems | Characteristics | Example |
|--------------------------------------|---|---------|
| Static drive system | <ul style="list-style-type: none"> - Obtainable high margin of operating voltage allows higher quality display. - Simple drive circuit conditions, low-voltage operations possible. | |
| Dynamic (time-division drive system) | <p>When a large number of elements are driven:</p> <ul style="list-style-type: none"> - Fewer drive circuits. - Fewer connections between circuit and display cells. | |

Dynamic (time-division) drive system

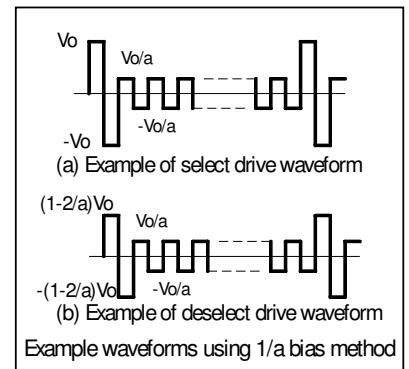
1. Voltage averaging method

This method provides optimum bias $1/a$ for the number of time divisions by weighting the drive voltage for $N-1$ deselects of the scanning side less than the drive voltage of one select of the scanning side.

? The voltage averaging method $1/a$ bias is calculated according to the following formula:

$$a = ?N + 1 \quad \dots\dots\dots N : \text{number of time divisions}$$

The resulting value for "a" is generally truncated to an integer.



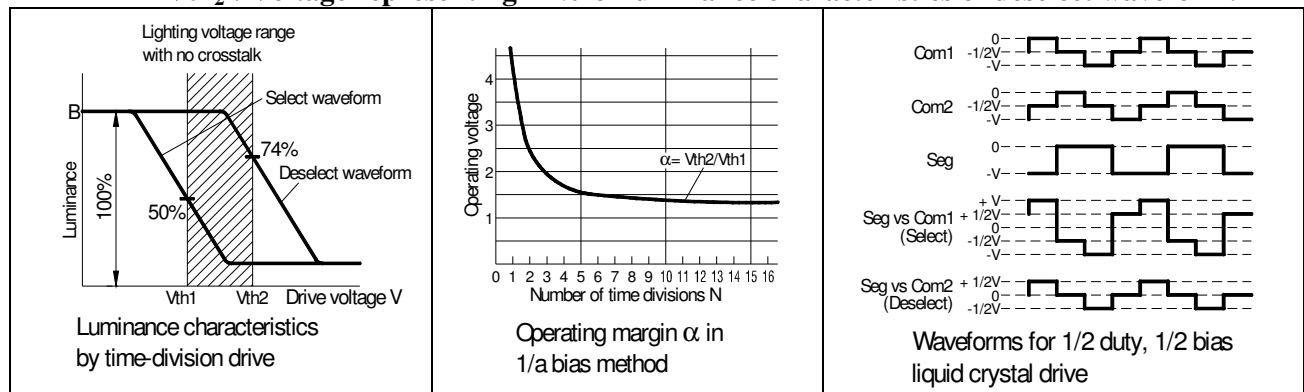
2. Operating voltage range

The lighting condition of the liquid crystal depends on the effective value of the drive voltage. The maximum operating margin α is expressed as follows:

$$\alpha = ?((?N + 1) / (?N - 1)) = (V_{th2}) / (V_{th1})$$

V_{th1} : Voltage representing 50% of luminance characteristics of select waveform.

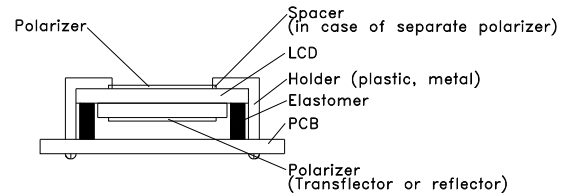
V_{th2} : Voltage representing 74% of luminance characteristics of deselect waveform.



LCD CONNECTION TYPES

ELASTOMER CONNECTOR

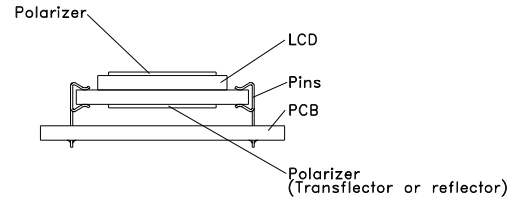
- **Connection method**
Mechanical compression
- **Structure**
Alternate laminations of conductive and insulating rubber
- **Contact pitch**
Min. 0.5mm recommended



- Easily assembled
- Long service life
- Suitable for fine pitch

PIN CONNECTOR

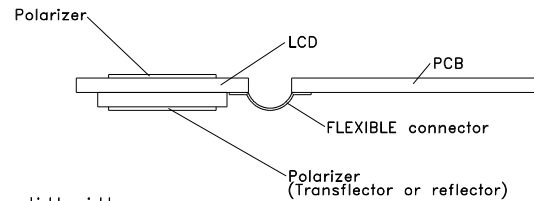
- **Connection method**
Solder
- **Structure**
Plated metal pins
- **Contact pitch**
1.5, 1.8, 2.0, 2.54mm



- SMT mount possible
- Suitable small batch production

FLEX CONNECTOR

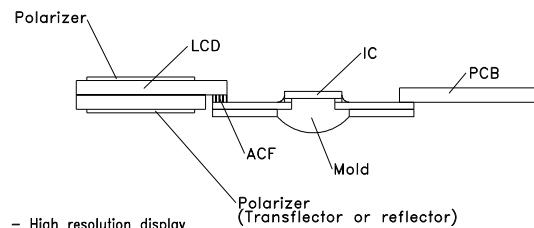
- **Connection method**
Heat seal (heat + pressure), solder or mechanical compression
- **Structure**
Base film with electro-conductive traces
- **Contact pitch**
Heat seal type 0.28mm Min.
Solder type 0.8mm Min.



- Light weight
- Flexible
- Thin structure

TCP STRUCTURE

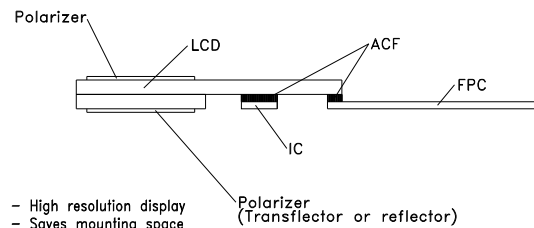
- **Connection method**
Heat and pressure fitting (ACF), soldering



- High resolution display
- Thin structure

COG STRUCTURE

- **Connection method**
Heat and pressure fitting (ACF), heatseal, FPC, rubber, socket or pin



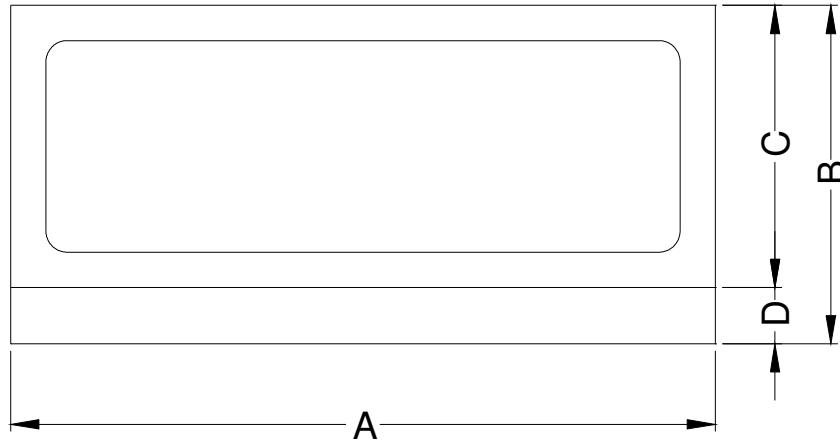
- High resolution display
- Saves mounting space
- Thin structure

LCD BASIC DESIGN RULES

| FEATURE | | MIN | TYP | MAX |
|--------------------------------|---------------------------|-----------------|-------------|--------------|
| Glass thickness | | --- | 1.10 | --- |
| | | --- | 0.70 | --- |
| | | --- | 0.55 | --- |
| Polarizer thickness | Front | --- | 0.20 | --- |
| | Back (RF) | --- | 0.20 | 0.30 |
| Total display thickness | G=1.10 | --- | 2.60 | --- |
| | G=0.70 | --- | 1.80 | --- |
| | G=0.55 | --- | 1.50 | --- |
| Seal width | G=1.10 | 1.80 | 2.00 | 3.00 |
| | G=0.70 | 1.50 | 2.00 | 3.00 |
| | G=0.55 | 1.20 | 2.00 | 3.00 |
| Contact ledge width | For DIL pins type | | | |
| | For DIL pins type | P=2.51 | 2.20 | 2.50 |
| | For DIL pins type | P=1.80 | 2.00 | 2.50 |
| | For elastomer type | | | |
| | For elastomer type | G=1.10 | 2.00 | 2.50 |
| | For elastomer type | G=0.70 | 1.20 | 2.00 |
| | For elastomer type | G=0.55 | 1.00 | 2.00 |
| For heat seal type | | 2.00 | 3.00 | --- |
| Pin length | P=2.54 | 3.20 | 6.35 | 20.00 |
| | P=1.80 | 3.20 | 6.35 | 22.00 |
| Minimum track widths | General design | | | |
| | - Line | L<3mm | 0.05 | |
| | | L>3mm | 0.06 | |
| | - Space | L<3mm | 0.05 | |
| | | L>3mm | 0.06 | |
| | Graphic | | | |
| - Line | | 0.20 | | |
| - Space | | 0.02 | | |

OPTIMUM GLASS SIZES

SINGLE EDGE CONNECT

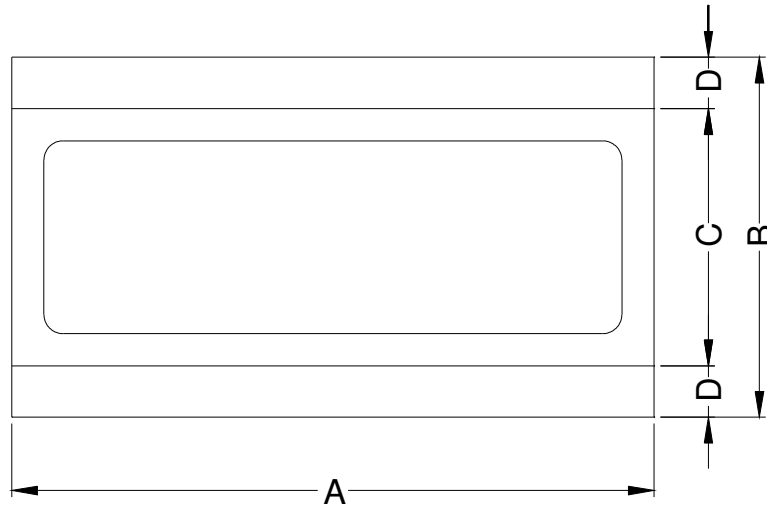


| | | | | | | | | | | |
|----------|-----|-----|----|----|----|----|----|----|----|----|
| A | 170 | 113 | 85 | 68 | 56 | 48 | 42 | 37 | 34 | 30 |
|----------|-----|-----|----|----|----|----|----|----|----|----|

if D = 2.5

| | | | | | | | | | |
|----------|-------|------|------|------|------|------|------|------|------|
| B | 114 | 86 | 69 | 57 | 49 | 43 | 39 | 35 | 32 |
| C | 111.5 | 83.5 | 66.5 | 54.5 | 46.5 | 41.5 | 36.5 | 32.5 | 29.5 |

DOUBLE EDGE CONNECT



| | | | | | | | | | | |
|----------|-----|-----|----|----|----|----|----|----|----|----|
| A | 170 | 113 | 85 | 68 | 56 | 48 | 42 | 37 | 34 | 30 |
|----------|-----|-----|----|----|----|----|----|----|----|----|

if D = 2.5

| | | | | | | | | | | |
|----------|-----|----|----|----|----|----|----|----|----|----|
| B | 115 | 87 | 70 | 59 | 51 | 45 | 40 | 36 | 33 | 28 |
| C | 110 | 82 | 65 | 54 | 46 | 40 | 35 | 31 | 28 | 23 |

TYPICAL CUSTOM LCDS

