
# EL320.256-FD6
# Operation Manual

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## Table of contents:

# 1 Product profile

The EL320.256-FD6 display is low-power, rugged, electroluminescent (TFEL) display. The display has an integral DC/DC converter and compact dimension save space that allows addition of features or reduction in overall size. The display is designed to function in extreme environments, and a crisp display is viewable under most lighting conditions at wide viewing angles. The display ease of installation reduces system integration costs.

The EL320.256-FD6 is 320 columns by 256 row flat panel display with a resolution of 80 dots per inch. The pixel aspect ratio is 1:1. The digital flat panel interface is designed to match the needs of most systems. The display may be driven at frame rates up to 75 Hz.

The EL320.256-FD6 display requires +5 V and +11 V to +30 V ($V_{cc1}$, $V_{cc2}$) power and 4 basic signals to operate:

1. Video Data or pixel information (VID)
2. Video Clock, pixel clock, or dot clock (VCLK)
3. Horizontal Sync (HS)
4. Vertical Sync (VS)

# 2 TFEL technology

The display consists of an electroluminescent glass panel and two mounted circuit boards with control electronics.

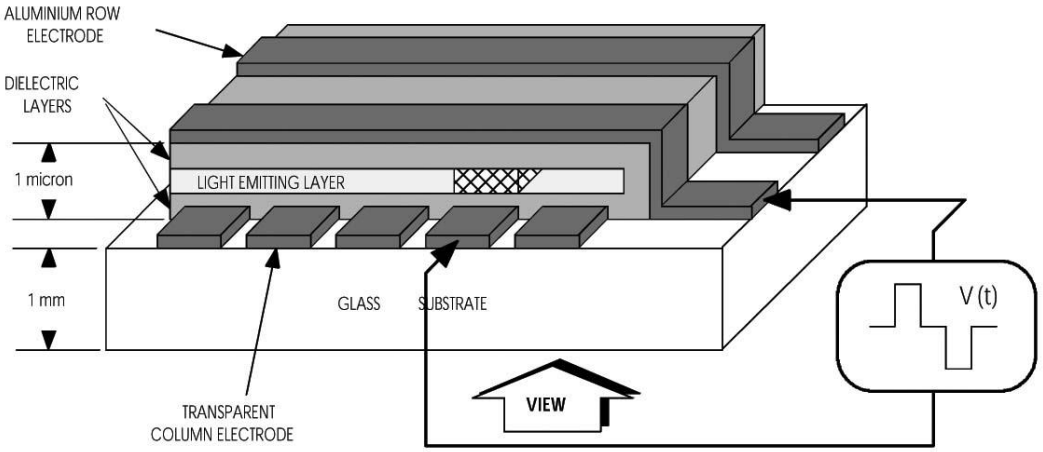


**Figure 1. TFEL technology**

The TFEL glass panel is a solid-state device with a thin film luminescent layer sandwiched between transparent dielectric layers and a matrix of row and column electrodes. The row electrodes, in back, are aluminums; the column electrodes, in front, are transparent. The entire thin film device is deposited on a single glass substrate. The glass panel is mounted to an electronic circuit assembly board (ECA) with an elastic spacer. The ECAs are connected to the TFEL glass panel with soldered lead frames. The result is a flat, compact, reliable, and rugged display device.

The EL320.256–FD6 display includes a dark ICEBrite™ (Integral Contrast Enhancement) background in the display glass. The ICEBrite background significantly improves the luminance contrast of the display in bright ambient. ICEBrite also removes the halo around the lit pixels in dark ambient, making the appearance of each pixel crisp and clear.

In the EL320.256-FD6 display, the 320 column electrodes and 256 row electrodes are arranged in an X-Y formation with the intersecting areas performing as pixels. Voltage is applied to both the correct row electrode and the correct column electrode to cause a lit pixel. Operating voltages required are provided by an integral DC/DC converter.

# 3 Electrical characteristics

## 3.1 Connector layout

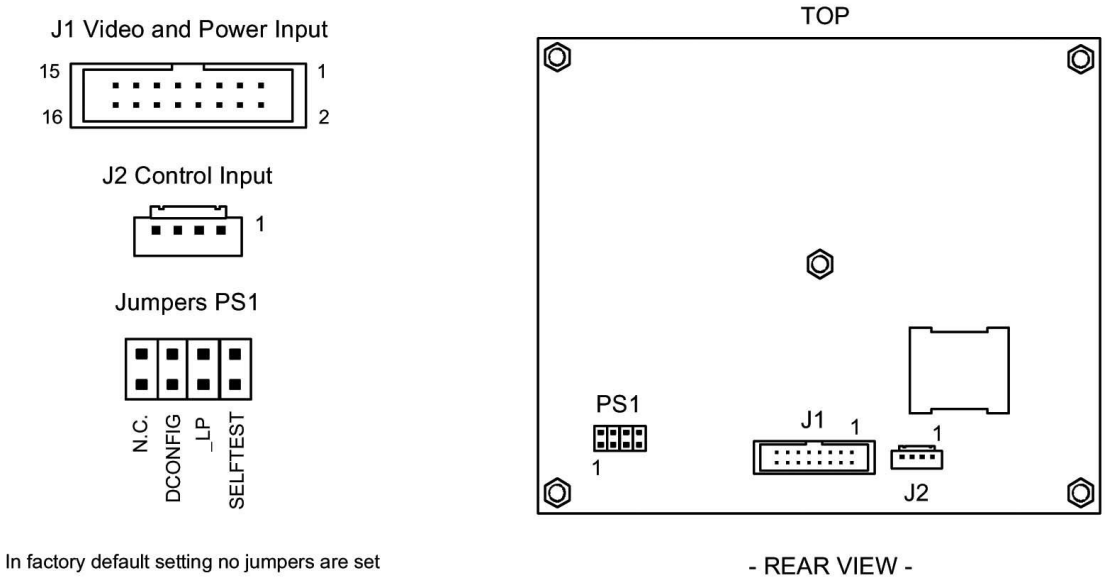


**Figure 2. Input connectors and programmable jumpers**

## 3.2 Input connectors and programmable jumpers

**Table 1. Input connectors and programmable jumpers**

| Pins | Signal | Symbol | Description |
|---|---|---|---|
| **J1(Data/power input connector)** | | | |
| 1, 2 | Voltage | $V_{cc2}$ | Supply voltage (+11 V… 30 V) converted to required internal high voltages. |
| 3, 4 | Voltage | $V_{cc1}$ | Supply voltage (+5 V) for the logic. |
| 5 | Enable | _ENABLE | Display operation is enabled when LOW or left is disconnected. |
| 6, 8, 10 12, 14, 16 | Ground | GND | Signal and power return. |
| 7 | Two-bit data | TVID | Odd column data input for optional two-bit parallel mode. See page 6. |
| 9 | Vertical Sync | VS | The vertical sync signal VS controls the vertical position of the picture. The topmost row displayed is the first HS HIGH time ending after the rising edge of the VS. |
| 11 | Horizontal Sync | HS | The horizontal sync signal HS controls the horizontal position of the picture. The last 320 pixels before the fall of HS are displayed. |
| 13 | Video Clock | VCLK | The VCLK signal shifts data present on the VID and TVID lines into the display system. VCLK is active on the rising edge. |
| 15 | Video Data | VID | Signal that supplies the pixel information to the system. Even pixel data for two-bit parallel mode. See page 6. |
| **J2 (Control input)** | | | |
| 1 | Luminance | LCa | Brightness control inputs a and b. If left disconnected, luminance is at its maximum level. See brightness control on page 7. |
| 2 | Luminance | LCb | |
| 3 | Ground | GND | Signal return. Same as GND in connector J1. |

| Pins | Signal | Symbol | Description |
|---|---|---|---|
| 4 | Low Power | _LOWPOW | If pulled LOW, the display is in Low Power Mode. The display has its normal brightness if HIGH or left disconnected. See page 6. |
| **Pinstrip PS1** | | | |
| 1 | | NC | No connection. |
| 2 | Two-bit parallel | DCONFIG | The video data is input two pixels per video clock using VID and TVID if jumper is set. |
| 3 | Low Power | _LP | Low Power Mode is selected when jumper is set. This function overrules the _LOWPOW control input. |
| 4 | SELFTEST | | When set, video data input in VID and TVID is displayed asynchronously. |

## 3.3 Connectors

**Table 2. Connectors**

| | | |
|---|---|---|
| J1 | 16-pin header | TE connectivity 2-1761603-6 or OUPIIN 3012-16G00SBA/OP6 or eq. |
| | Mating | TE Connectivity 1-1658526-1 or eq. or OUPIIN 1001 series. |
| J2 | 4-pin header | Hirose DF1–4P–2.5 DSA or eq. |
| | Mating | Hirose DF1–4S–2.5 R 24 or eq. |
| | Protector | Hirose DF1–4A 1.33 |

## 3.4 Control basics

The TFEL panel has 320 transparent column electrodes crossing 256 row electrodes in an X-Y fashion. Light is emitted when an AC voltage is applied at a row-column intersection. The display operation is based on the symmetric, line-at-a-time data addressing scheme, which is synchronized by the external VS, HS, and video clock input signals. The signal inputs are HCT-compatible with 100 Ω series resistors.

## 3.5 Power input

The input voltages needed are the +5 V input ($V_{cc1}$) for the logic and the +11 V… +30 V input ($V_{cc2}$) for the DC/DC converter generating all internal high voltages.

# 4 Display features

## 4.1 Low power mode

The power consumption of the display is possible to be reduced typically to 3 W by using the low power mode. This mode is selected either with the _LP jumper (PS1/3) or temporarily with the _LOWPOW control input (J2/4). The _LP jumper overrules the control input.

Low power mode is selected when the _LP jumper is set or the _LOWPOW input is pulled LOW. When _LP is open and _LOWPOW is HIGH of left disconnected, the display has its normal brightness. This function slightly reduces the contrast and average brightness of the display.

## 4.2 Two-bits-parallel

For reduction of data clock frequency, it is possible to input the data of two pixels per pixel clock. This feature is selected with the DCONFIG jumper (PS1/2). If the jumper is set, data for even columns is input in VID and data for odd columns is input in TVID. If the jumper is open, data is input normally to VID only.

## 4.3 Brightness control

The brightness of the display can be adjusted from below 10% up to full brightness by a 50 kΩ external logarithmic potentiometer between the LCa and LCb control inputs (J2/1 and /2). The control function is achieved by sinking a small current from LCa to LCb (when open, the voltages are at 5 V and 0 V respectively).

If the two inputs are left disconnected, the brightness is at its maximum level.

## 4.4 Self-test

The operation of the display can be easily tested using the two self-test features.

When the SELFEST jumper (PS1/4) is set, the video data at VID and TVID are displayed asynchronously without the use of any timing signals.

When only supply voltages without any video data are input, the display starts scanning with all pixels except the leftmost half of the topmost row on.

## 4.5 Input specifications

**Table 3. Input specifications**

| Parameter | Symbol | Min. | Typ. | Max. | Absolute min./max. |
|---|---|---|---|---|---|
| Logic input HIGH | | 2.0 V | — | $V_{cc1}$ | $V_{cc1}$ + 0.5 V abs. max. |
| Logic input LOW | | | — | 0.8 V | –0.5 V abs. min. |
| Supply voltage | $V_{cc1}$ | 4.75 V | 5.0 V | 5.25 V | 6.0 V abs. max. |
| Supply current at 5 V | $I_{cc1}$ | — | 0.1 A | 0.2 A | |
| Supply voltage | $V_{cc2}$ | 10.8 V | — | 30 V | 33 V abs. max. |
| Supply current at 12 V | $I_{cc2}$ | — | 0.3 A | 0.6 A | |
| Supply current at 12 V (Low Power) | $I_{cc2}$ | — | 0.2 A | 0.4 A | |
| Power consumption | | | 4 W | 8.2 W | |
| Power consumption (Low Power) | | | 3 W | 5 W | |

Operating conditions: Ambient temperature 25 °C @ 60 Hz

**NOTE:** Absolute maximum ratings are those values beyond which damage to the device may occur. The minimum and maximum specifications in this Operation Manual should be met, without exception, to ensure the long-term reliability of the display. Beneq does not recommend operation of the display outside these specifications.

## 4.6 Timing characteristics

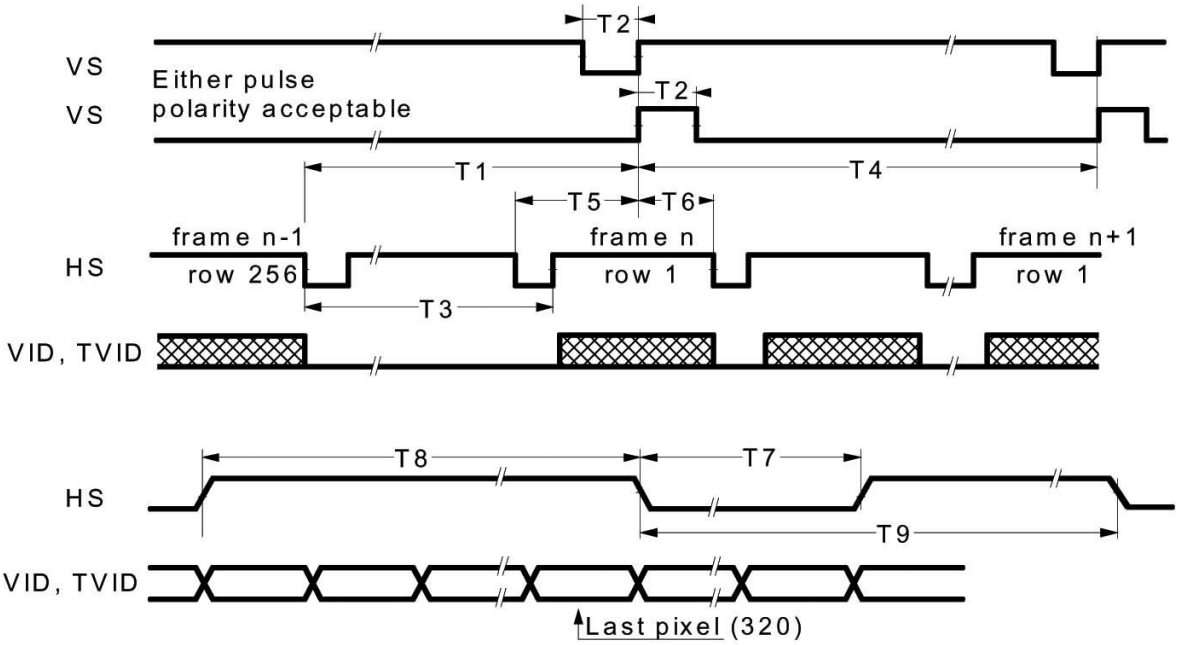


**Figure 3. Timing characteristics**

**Table 4. Timing characteristics**

| Description | Min | Max | Unit | Note |
|---|---|---|---|---|
| T1 Vertical Front Porch | 100 | | µs | 1 |
| T2 VS HIGH/LOW time | 30 | | ns | 2 |
| T3 Vertical Blank | 70 | | µs | |
| T4 Vertical Period | 256 | | tHS | |
| VS frequency | | 75 | Hz | |
| **Description** | **Min** | **Typ** | **Unit** | **Note** |
| T5 HS setup to VS | 1 | | µs | 3 |
| T6 HS hold from VS | 3 | | µs | |
| T7 HS Low Time | 4 | | tVCLK | |
| T8 HS High Time | 320 | 320 | tVCLK | 4 |
| T9 HS period (tHS) | 51 | | µs | |

Notes:

1. This time is needed to display the last row and to initiate the following frame.

2. Only rising edge is used.

3. 2 tVCLK minimum.

4. The number of VCLK pulses during HS high time must be even. Video clock VCLK must be kept running continuously.

## 4.7 Setup and hold timing

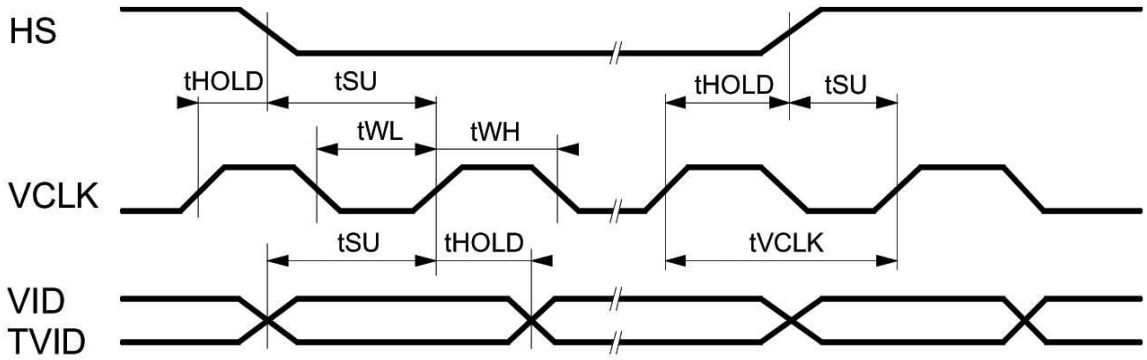


**Figure 4. Setup and hold timing**

**Table 5. Setup and hold timing**

| Symbol | Description | Min | Max |
|---|---|---|---|
| tSU | HS, VID, TVID setup to VCLK | 5 ns | |
| tHOLD | HS, VID, TVID hold from VCLK | 8 ns | |
| tWL | VCLK low width | 16 ns | |
| tWH | VCLK high width | 16 ns | |
| tVCLK | VCLK period | 40 ns | |
| | VCLK frequency | | 25 MHz |

# 5 Operational specifications

## 5.1 Environmental

**Table 6. Environmental characteristics**

| | |
|---|---|
| **Temperature** | |
| Operating | –25 °C…+65 °C |
| Non-operating | –40 °C…+85 °C |
| Operating survival | –40 °C…+70 °C (no permanent damage) |
| **Humidity** | |
| Relative humidity | +40 °C, 93% RH, operating (IEC 60068-2-78) |
| Damp heat | +25 °C…+55 °C, 95% RH, non-operating (IEC 60068-2-30) |
| **Altitude** | |
| | 15,000 m (50,000 ft.) above sea level<br>Standard IEC 60068-2-13 |
| **Vibration** | |
| | 20…500 Hz<br>ASD level 0.05 $g^2$/Hz<br>30 min each axis<br>Standard IEC 60068-2-64, Random Vibration, Test Fdb |
| **Shock** | |
| Magnitude<br>Duration<br>Number of shocks | 100 g<br>4 ms (half sine wave)<br>18 (3 on each of the 6 surfaces) IEC 60068-2-27, test Ea |

## 5.2 Reliability

MTBF > 50,000 h @ 25 °C

## 5.3 Safety

The display will not inhibit the end product from obtaining any of the following certifications: UL544, IEC 601.

## 5.4 Electromagnetic compatibility

The display is capable of operating in an end product that complies with: EN55022 Class B, FCC Part 15J Class B.

## 5.5 Optical

Determined at 60 Hz frame rate at 25 °C ambient.

### 5.5.1 Display color

Wide band amber (ZnS:Mn) Peak wavelength 580 nm typ.

**Table 7. Optical characteristics**

| | | |
|---|---|---|
| **Areal luminance** | | |
| On Luminance (typ) | 25 cd/m$^2$ (7.3 fL) | |
| On Luminance (min.) | 22 cd/m$^2$ (6.4 fL) | |
| Low power (min.) | 18 cd/m$^2$ (5.2 fL) | |
| Measured at the center and the four corners of the screen. | | |
| **Luminance non-uniformity** | | |
| | 20% max. | |
| Low Power | 26% max. | = (1– min. luminance/max luminance) x 100. Maximum difference between any two of five points (center and four corners) |
| **Luminance variation (time)** | | |
| Maximum | 10% | 15,000 h @ 25 °C |
| **Luminance variation (temperature)** | | |
| Maximum | 15% | Over –25 °C …+65 °C range. |
| **Luminance contrast ratio** | | |
| | 12:1 typ.<br>3:1 typ. | @ 500 lx<br>@ 3,000 lx |
| **Viewing angle** | | |
| | 179° | |

| Illuminance | Classification |
|---|---|
| 100 … 1000 lx | Office |
| 1000 … 10000 lx | Bright |
| 10000 … 100000 lx | Sunlight |

# 6 Mechanical characteristics

Table 8 shows the mechanical dimensions of a standard EL320.256-FD6 display unit.

**Table 8. Display external dimensions**

| | | |
|---|---|---|
| **Height** | 110 mm | 4.33 in. |
| **Width** | 130 mm | 5.12 in. |
| **Depth** | 31.0 mm | 1.22 in. |
| **Weight** | 260 g max. | 9.2 oz. |

The EL320.256-FD6 is mechanically compatible with other MD320.256 and EL320.256 displays.

**Table 9. Display viewing area characteristics**

| | | |
|---|---|---|
| **Active area** | | |
| millimeters (inches) | height | 76.7 (3.02) |
| | width | 95.9 (3.77) |
| **Pixel pitch** | | |
| millimeters (inches) | height | 0.30 (0.012) |
| | width | 0.30 (0.012) |
| **Pixel size** | | |
| millimeters (inches) | height | 0.30 (0.012) |
| | width | 0.30 (0.012) |
| **Pixel fill factor** | 49% | |
| **Pixel matrix** | 320 horizontal by 256 vertical | |

**CAUTION:** The ambient temperature of the display should not be allowed to exceed the environmental specifications (see page 9). In most applications, an air gap of a minimum of 5 mm is recommended (see mechanical drawings). Some applications may require, however, a larger air gap or cooling of the display unit in the system. Note that this may slightly increase the total depth of the design.

**CAUTION:** In order to ensure mechanical compatibility with future revisions of the display, it is highly recommended not to intrude in the component envelope by any part of the customer application.

**WARNING:** The product generates potentially dangerous voltages capable of causing personal injury (high voltage pulses up to 195 $V_{ac}$). Do not touch the display electronics during operation!

**ELECTROSTATIC CAUTION:** The Beneq display uses CMOS and power MOS-FET devices. These components are electrostatic-sensitive. Unpack, assemble and examine this assembly in a static-controlled area only. When shipping, use packing materials designed for protection of electrostatic-sensitive components.

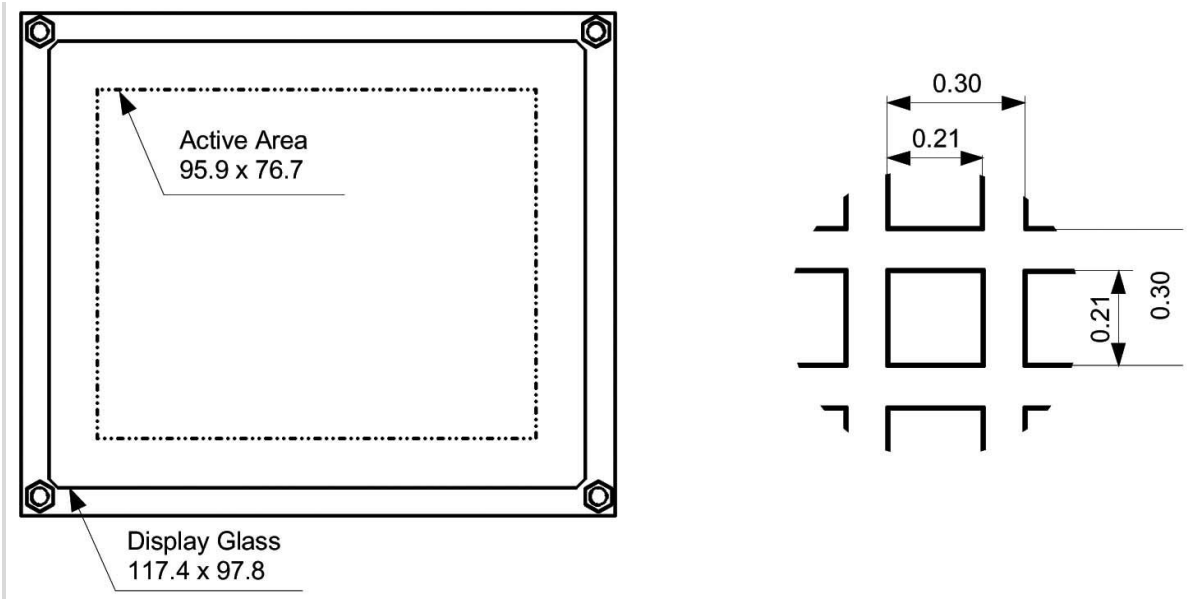


**Figure 5. EL320.256-FD6 display viewing area characteristics.**

# 7 Installation and handling

The product should be mounted using the M3 insert nuts on the ECA. Beside the four corner nuts, it is recommended to use also the center nut in the mounting if the vibration or shock stress is severe.

Before touching the display, necessary precaution must be taken to prevent application of static charges on the display from the operator or tools.

The display is made of glass material and should be handled with proper care. Do not drop the display or allow hard objects to strike its surface.

**NOTE:** For trouble-free data transfer, a maximum cable length of 300 mm (12 in.) from data transmitter to display input connector is recommended. If longer cables up to 2 m (80 in.) length are needed, a serial resistor of approximately 100 Ω could be placed at each of the four signal line outputs of the transmitter in order to lower signal reflections.

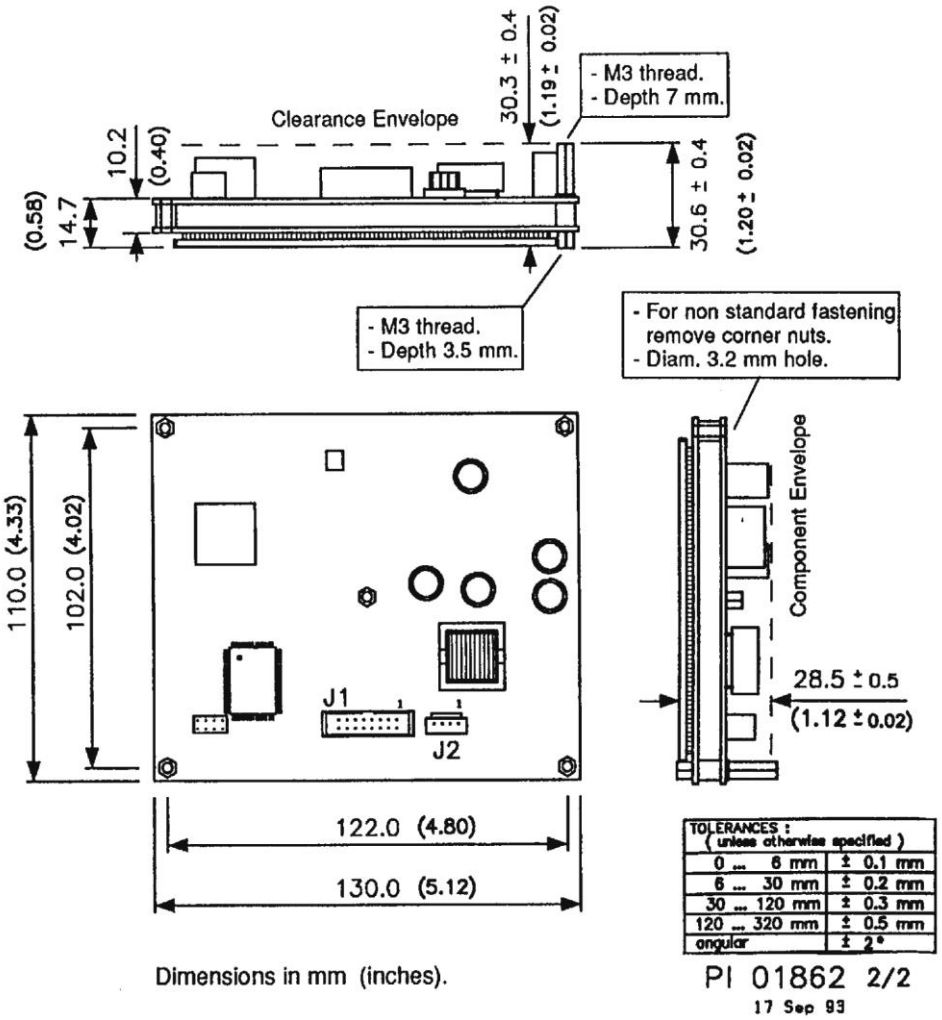


**Figure 6. EL320.256–FD6 display mechanical dimensions**

# 8 Description of warranty

Seller warrants that the Goods will conform to published specifications and be free from defects in material during warranty time from delivery. To the extent that goods incorporate third party-owned software, seller shall pass on seller's licensor's warranty to buyer subject to the terms and conditions of seller's license.

Warranty repairs shall be warranted for the remainder of the original warranty period. Buyer shall report defect claims in writing to seller immediately upon discovery, and in any event, within the warranty period. Buyer must return goods to seller within 30 days of seller's receipt of a warranty claim notice and only after receiving seller's return goods authorization. Seller shall, at its sole option, repair or replace the goods.

If goods were repaired, altered or modified by persons other than seller, this warranty is void. Conditions resulting from normal wear and tear and buyer's failure to properly store, install, operate, handle or maintain the goods are not within this warranty. Repair or replacement of goods is seller's sole obligation and buyer's exclusive remedy for all claims of defects. If that remedy is adjudicated insufficient, Seller shall refund buyer's paid price for the goods and have no other liability to buyer.

All warranty repairs must be performed at seller's authorized service center using parts approved by seller. Buyer shall pay costs of sending goods to seller on a warranty claim and seller shall pay costs of returning goods to buyer. The turnaround time on repairs will usually be 30 working days or less. Seller accepts no added liability for additional days for repair or replacement.

If seller offers technical support relating to the goods, such support shall neither modify the warranty nor create an obligation of seller. Buyer is not relying on seller's skill or judgment to select goods for buyer's purposes. Seller's software, if included with goods, is sold as is, and this warranty is inapplicable to such software.

SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

# 9 Easy to use

There are many options available, which make Beneq flat panel displays easy to use, easy to interface, and easy to package. Call Beneq for complete information.

# 10 Ordering information

| Product | Part number | Description |
|---|---|---|
| EL320.256-FD6 | 996-5087-00LF | ICE display |

Design and specifications are subject to change without notice.

# 11 Support and service

Beneq Oy is a Finnish company based in Espoo, Finland, with a world-wide sales distribution network. Full application engineering support and service are available to make the integration of Lumineq® displays as simple and quick as possible for our customers.

**RMA Procedure:** For a Returned Material Authorization number, please contact Beneq Oy by email (rma.lumineq@beneq.com) with the model number(s), serial number(s) and brief description of the problem. When returning goods for repair, please include a brief description of the problem, and mark the outside of the shipping container with the RMA number.

# 12 RoHS III

Lumineq displays are RoHS3 (Restrictions of Hazardous Substances in Electronic/Electrical Equipment) compliant and meet the requirements defined under European Union Directive (2015/863), that restrict the use of various hazardous substances in electronic equipment.