



EL640.480-AA1

(10.4")

Operation Manual

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1 EL640.480-AA1 Multicolor VGA display

The EL640.480-AA1 display is a VGA compatible high-resolution electroluminescent (TFEL) display. It delivers eight different hues of red, green and yellow with excellent image clarity. The EL640.480-AA1 is designed to function in extreme environments and is totally service free. Its image contrast and colors remain constant over a wide viewing angle and without the need for an additional polarizing filter under most lighting conditions.

The EL640.480-AA1 features a 640 (x 2) column by 480 row matrix with each pixel composed of a red and green subpixel. Each subpixel has three intensity levels. It accommodates a digital flat panel interface.

1.1 Features and benefits

- Very wide operating temperature area
- Instant-On at – 60 °C
- Excellent visual performance
- Wide viewing angle
- Rapid display response < 1 ms
- Frame buffer
- Extremely rugged and durable
- Reliable, long operating life
- Three video interface modes

2 Installation and handling

Do not drop, bend, or flex the display. Do not allow objects to strike the surface of the display.

CAUTION: The 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.

WARNING: The product generates potentially dangerous voltages capable of causing personal injury (high voltage pulses up to 230 V_{AC}). Do not touch the display electronics during operation!

2.1 Mounting TFEL displays

Properly mounted, TFEL displays can withstand high shock loads as well as severe vibration found in demanding applications. However, the glass panel used in a TFEL display will break if subjected to bending stresses, high impact, or excessive loads.

Avoid bending the display. Stresses are often introduced when a display is mounted into a product. Ideally, the mounting tabs of the display should be the only point of contact with the system. Use a spacer or boss for support; failure to do so will bend the display and cause the glass to break. The instrument enclosure or frame should not flex or distort in such a way that the bending loads might be transferred to the display during use. The EL640.480-AA1 mounting tabs are designed for 4 mm screws. Mounting surfaces should be flat to within ± 0.6 mm (± 0.025 "). Use all the mounting holes provided. Failure to do so will impair the shock and vibration resistance of the final installation.

WARNING: These products generate voltages capable of causing personal injury (high voltage up to 230 V_{AC}). Do not touch the display electronics during operation.

2.2 Cable length

A maximum cable length of 600 mm (24 in.) is recommended. Longer cables may cause data transfer problems between the data transmitted and the display input connector. Excessive cable lengths can pick up unwanted EMI. When driving the display from a VGA Feature Connector, proper signal buffering should be ensured.

2.3 Cleaning

As with any glass or coated surface, care should be taken to minimize scratching. Clean the display glass with mild, water-based detergents only. Apply the cleaner sparingly to a soft cloth, and then wipe the display. Disposable cleaning cloths are recommended to minimize the risk of inadvertently scratching the display with particles embedded in a re-used cloth. Care should be taken when cleaning displays with anti-glare and anti-reflective films.

2.4 Avoiding burn-in

As with other light-emitting displays, use a screensaver or image inversion to avoid causing burn-in on the display. Displaying fixed patterns on the screen can cause burn-in where luminance variations can be noticed.

3 Specifications

Performance characteristics are guaranteed when measured at 25 °C with rated input voltage unless otherwise specified.

3.1 Control basics

The TFEL panel is a matrix structure with column and row electrodes arranged in an X-Y formation. Light is emitted when an AC voltage of sufficient amplitude is applied at a row-column intersection. The display operation is based on the symmetric, line-at-a-time data addressing scheme. User signals VCLK, HS or _BLANK, and VS control loading of pixel data into the display's internal frame buffer. Output of the pixel data from the frame buffer as well as the generation of the display scanning signals are controlled by internal logic.

3.2 Power

The supply voltages are shown in Table 1. All internal high voltages are generated from the display supply voltage (V_H). The logic supply voltage (V_L) should be present whenever video input signals or V_H is applied. The minimum and maximum specifications in this 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.

| Parameter | Symbol | Min | Typ. | Max | Absolute Max |
|------------------------------|--------|--------|--------|--------|--------------|
| Logic supply voltage | V_L | 4.75 V | 5 V | 5.25 V | 6.0 V |
| Logic supply current at +5 V | I_L | | 0.25 A | 0.35 A | |
| Display supply voltage | V_H | 10.8 V | 12 V | 13.2 V | 15 V |
| Supply current at +12 V | I_H | | 0.75 A | 2.25 A | |
| Power consumption 5V/12V | | | 10 W | 26 W | |

Table 1. DC input voltage requirements

CAUTION: Absolute maximum ratings are those values beyond which damage to the device may occur.

| Description | Min | Max | Units | Notes |
|------------------------------|-----|-----|-------|---------------|
| Absolute Input Voltage Range | 0 | 5.3 | V | $V_L = 5.0$ V |
| Video logic high voltage | 3.9 | | V | |
| Video logic low voltage | | 0.9 | V | |

Table 2. Video input requirements

3.3 Connectors

| | | |
|----|---------------|-----------------------------|
| J1 | 34-pin header | ODU 511.066.003.034 or eq. |
| | Mating | ODU 517.065.003.034 or eq. |
| | Locking clip | ODU 511.065.734.700 |
| J2 | 4-pin header | Hirose DF1-4P-2.5 DS or eq. |
| | Mating | Hirose DF1-4S-2.5 R 24 |
| | Protector | Hirose DF1-4A 1.33 |
| J3 | 2-pin header | Hirose DF1-2P-2.5 DS or eq. |
| | Mating | Hirose DF1-2S-2.5 R 24 |
| | Protector | Hirose DF1-2A 1.33 |

Table 3. Connector types

User video signals are brought onto the display via connector J1. The +5 Vdc and +12 Vdc power input to the display is via connector J2, and connector J3 is for the display analog dimming.

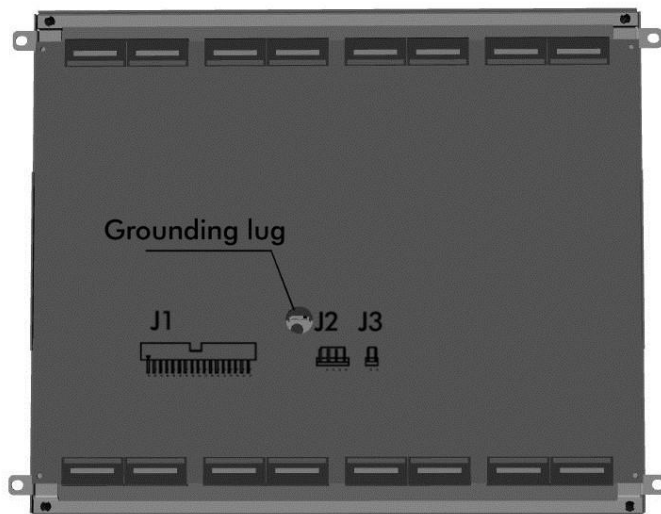


Figure 1. Backside view

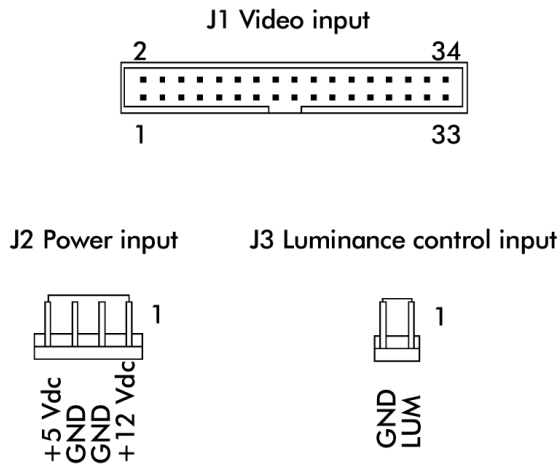


Figure 2. Video, power and luminance control connectors

| Pin | Signal | Symbol | Description |
|-------------------------|------------------|--------|--|
| 1, 3, 5, 15, 17, 19, 21 | Ground | GND | Signal return |
| 2 | Video data (LSB) | D0 | Video Data |
| 4 | Video data | D1 | Video Data |
| 6 | Video data | D2 | Video Data |
| 8 | Video data (MSB) | D3 | Video Data |
| 18 | Video Clock | VCLK | Synchronizing signal for data lines, HS, VS and _BLANK. See setup and hold timings for the various modes on page 15. |
| 20 | Blanking | _BLANK | Frames data in VGA and TFT modes. For Normal mode should be high or left disconnected. |
| 22 | Horizontal Sync | HS | Frames data in Normal mode |
| 24 | Vertical Sync | VS | Controls the vertical position of the picture |
| 28 | Enable | ENABLE | Display operation is enabled when high or left disconnected |
| 29 | Interface mode | VMODE | If high or left disconnected, Normal or VGA mode is selected. If low, TFT LCD mode is selected. |
| 10, 12, 14 | Reserved | | These pins are reserved for future use |
| 16, 33, 34 | Reserved | | These pins are reserved for future use |
| 7, 9, 11, 13 | Not used | N/C | Not connected |
| 23, 25, 26, 27 | Not used | N/C | Not connected |
| 30, 31, 32 | Not used | N/C | Not connected |

| Pin | Signal | Symbol | Description |
|-------------------------------------|-------------------|--------|---|
| J2 (Power input connector) | | | |
| 1 | Voltage | Vcc2 | Supply voltage (+12 V _{DC}) converted to required internal voltages |
| 2 | Ground | GND | Power return |
| 3 | Ground | GND | Power return (same as pin 2) |
| 4 | Voltage | Vcc1 | Supply voltage (+5 V _{DC}) |
| J3 (Luminance control input) | | | |
| 1 | Luminance control | LUM | The inputs for an external 50 kΩ log potentiometer or a 0...5 V DC voltage to adjust the luminance of the display. If left disconnected, the luminance is at the max level. |
| 2 | Ground | GND | Signal return |

Table 4. Connector pinouts

3.3.1 Dimming connector J3

The brightness of the display can be controlled with an external, user supplied 50 kΩ logarithmic potentiometer or a DC-voltage ranging from 0 to 5 V connected to control input J3. Minimum luminance is obtained with a short circuit or 0 V between the pins. Open circuit voltage is +5 V nominal; short circuit current is 0.3 mA max.

3.3.2 Additional Grounding for Low EMI

For best EMI attenuation performance, the metal assembly support should be tied to system ground via the four corner mounting ears or the grounding lug near the data input connector J1. The grounding lug can also be used for grounding the shield of the video signal cable.

3.4 Interface information

The EL640.480-AA1 has an internal frame buffer. The display scan and display brightness is independent of user timing.

3.4.1 Video input signals

Input signals D0...D3 contain the serial video data to be displayed on the screen. Pixel information is supplied from left to right and from top to bottom. For each pixel, D0...D3 select one of the three intensity levels for each of the two subpixels to form the appropriate pixel color. Note that Vcc1 supply voltage should be present whenever data input signals are applied.

3.4.2 Display enable

The display scanning can be shut off for screen saving or minimal power operation by a LOW state on the ENABLE control input. When disabled, the display is totally dark and only the display internal logic remains operating. In normal operation, the ENABLE input should be pulled HIGH or left disconnected.

3.4.3 Display Self-Test

The display self-test mode can be selected with the dip switch S1. The display performs self-test when the self-test mode is selected, and the power is turned on. The display self-test runs in a loop that takes 96 seconds. The self-test contains 16 different test patterns. Each pattern is displayed 6 seconds.

Do not change the dip switch position when power is applied to the display.

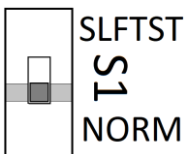


Figure 3. The display Self-Test dip switch S1.

3.4.4 Color mapping

| D3 | D2 | D1 | D0 | VGA Color | AA1 Color |
|----|----|----|----|-------------------|--------------|
| 0 | 0 | 0 | 0 | Black | Black |
| 0 | 0 | 0 | 1 | Blue | Black |
| 0 | 0 | 1 | 0 | Green | Green |
| 0 | 0 | 1 | 1 | Cyan | Green |
| 0 | 1 | 0 | 0 | Red | Red |
| 0 | 1 | 0 | 1 | Magenta | Red |
| 0 | 1 | 1 | 0 | Brown | Yellow |
| 0 | 1 | 1 | 1 | White | Lt. Yellow |
| 1 | 0 | 0 | 0 | Grey | Yellow |
| 1 | 0 | 0 | 1 | Lt. blue | Yellow |
| 1 | 0 | 1 | 0 | Lt. Green | Lt. Green |
| 1 | 0 | 1 | 1 | Lt. Cyan | Green-Yellow |
| 1 | 1 | 0 | 0 | Lt. Red | Lt. Red |
| 1 | 1 | 0 | 1 | Lt. Magenta | Orange |
| 1 | 1 | 1 | 0 | Yellow | Lt. Yellow |
| 1 | 1 | 1 | 1 | White (High Int.) | Lt. Yellow |

Table 5. Color mapping

3.4.5 Display operation modes

The EL640.480-AA1 features three video interface modes. The first is Normal mode which is similar to that used by most other Lumineq display products. The second mode supports 640x400, 720x400 and 640 x 480 subsets of the VGA video interface standard. Mode selection is automatically performed by the display using _BLANK, HS and VS. The third mode is compatible with the interface timings used in most TFT LCD displays.

Normal mode: In this mode only seven input signals are needed: video data (D0...D3), video clock (VCLK), horizontal sync (HS) and vertical sync (VS). _BLANK is not used and should be pulled HIGH or left disconnected.

In Normal mode the first 640 pixels after the rise of HS are displayed. The top most row displayed is the HS high time which is marked by the rise of VS. See details on setup and hold timing on page 15 and Normal Mode timing on page 13.

VGA mode: This input timing mode is compatible with feature connector signals from a VGA video board. The display supports VGA modes 2, 3, 6, E, 2+, 3+, 7+, 11 and 12.

VGA mode operation is similar to Normal mode except that _BLANK is used to frame valid video data. The border timing included in _BLANK is taken into account in the interpretation of this signal. Similarly, the border timing included in VS is taken into account in the placement of the top displayed row. _BLANK must be LOW during the rise of VS for VGA mode to be selected. See details on setup and hold timing on page 15 and VGA Mode timing on page 12.

TFT LCD Mode: This input timing mode is similar to 640x480 pixel VGA mode except that _BLANK signal frames only the active pixels in each row. Selection of TFT mode is done with the VMODE input signal on J1 pin 29. See details on setup and hold timings on page 14.

3.4.6 Supported VGA modes

| VGA Mode | Type | Text format | Char. box | Vsync | Pixels (software) | Double Scan | Border size | |
|----------|----------|-------------|-----------|------------|-------------------|-------------|-------------|---|
| | | | | Freq. (Hz) | | | H | V |
| 2, 3 | text | 80 x 25 | 8 x 8 | 70 | 640 x 200 | Yes | R 8/7 | |
| 2+, 3+ | text | 80 x 25 | 9 x 16 | 70 | 720 x 400 | No | R 9/7 | |
| 6 | graphics | 80 x 25 | 9 x 16 | 70 | 720 x 200 | Yes | R 8/7 | |
| 7+ | text | 80 x 25 | 9 x 16 | 70 | 720 x 400 | No | R 9/7 | |
| E | graphics | 80 x 25 | 8 x 8 | 70 | 640 x 200 | Yes | R 8/7 | |
| 11 | graphics | 80 x 30 | 8 x 16 | 60 | 640 x 480 | No | R 8/T 8 | |
| 12 | graphics | 80 x 30 | 8 x 16 | 60 | 640 x 480 | No | R 8/T 8 | |

Table 6. Supported modes

NOTES:

In modes 2+, 3+, 7+ the box width is narrowed to 8 pixels by omitting every 9th pixel. In modes 2, 3, 6, E rows are automatically double scanned by a VGA controller.

3.4.7 Timing characteristics

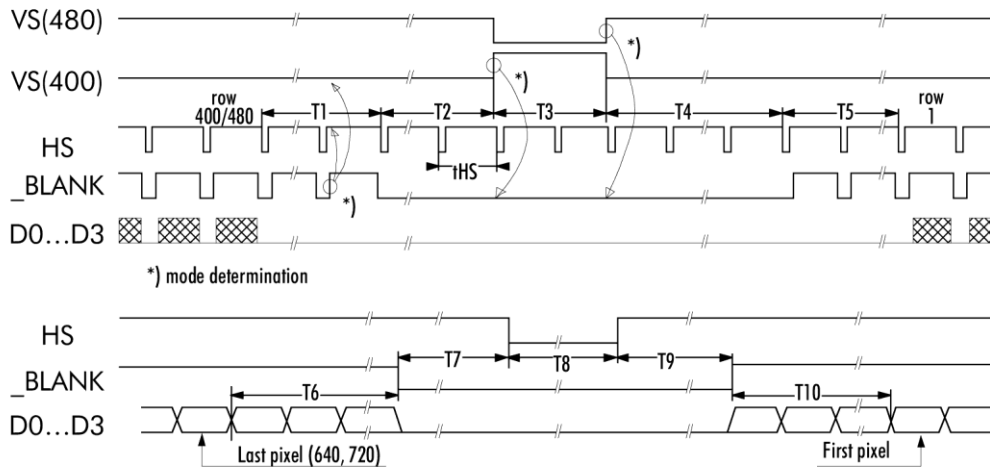


Figure 4. VGA Mode (640 x 400, 720 x 400 and 640 x 480 subsets).

| Description | 640x400 | 720x400 | 640x480 | Unit |
|-------------------------------|---------|---------|---------|-------|
| T1 Vertical Border [1] | 7 | 7 | 8 | tHS |
| T2 Vertical Front Porch [1] | 6 | 6 | 3 | tHS |
| T3 VS Pulse Width [1] | 2 | 2 | 2 | tHS |
| T4 Vertical Back Porch [1] | 27 | 27 | 24 | tHS |
| T5 Vertical Border [2] | 7 | 7 | 8 | tHS |
| VS frequency | 70 | 70 | 60 | Hz |
| T6 Horizontal border [1] | 8 | 9 | 8 | tVCLK |
| T7 Horizontal front porch [1] | 8/11 | 9/13 | 8/11 | tVCLK |
| T8 HS pulse width | ≤103 | >104 | ≤103 | tVCLK |
| T9 Horizontal back porch | 37/40 | 40/45 | 40 | tVCLK |
| T10 Horizontal border [2] | 8 | 9 | 8 | tVCLK |
| VCLK pulses per HS | 800 | 900 | 800 | tVCLK |
| HS pulses per VS | 449 | 449 | 525 | tHS |
| HS period (tHS) | 31.8 | 31.8 | 31.8 | μs |

Table 7. VGA mode

Notes

[1] Ignored by display controller. Values by typical system timing.

[2] These parameters are critical for correct image centering.

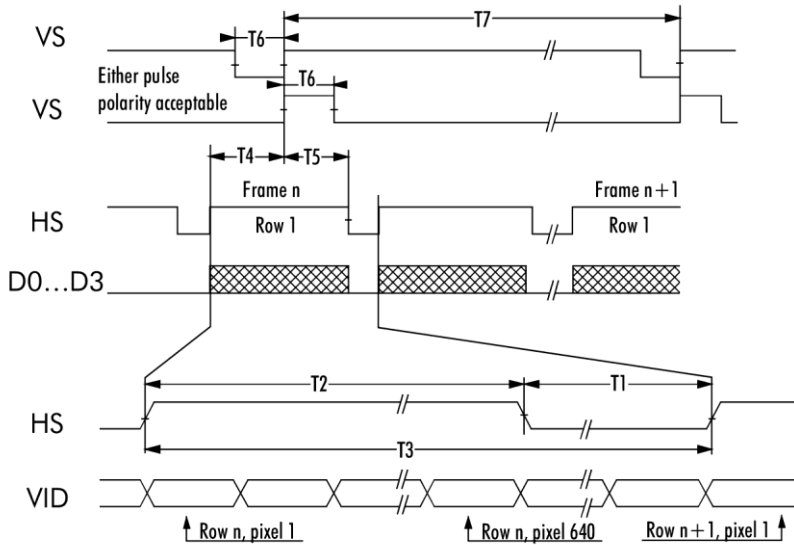


Figure 5. Normal mode

| Description | Min. | Max. | Unit |
|------------------------|------|------|-------|
| T1 HS low time [3] | 4 | | tVCLK |
| T2 HS high time [1, 2] | 640 | | tVCLK |
| T3 HS period [1] (tHS) | 31 | | μs |
| T4 VS hold from HS | 0 | | ns |
| T5 VS setup to HS | 0 | | ns |
| T6 VS high/low width | 1 | | tVCLK |
| T7 VS period (tVS) | 481 | | tHS |
| Frame Rate | | 65 | Hz |

Table 8. Normal mode

Notes

- [1] HS high time must be an even multiple of 2 tVCLK.
- [2] The first 640 pixels after the rise of HS will be displayed.
- [3] VCLK must continue running when HS is low.

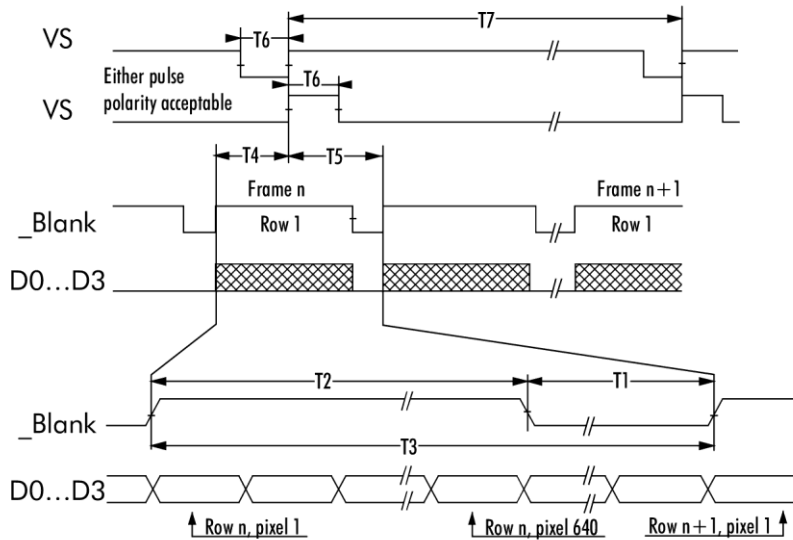


Figure 6. TFT LCD mode timing

| Description | Min. | Max. | Unit |
|------------------------------|------|------|--------|
| T1 Blank low time [3] | 4 | | tVCLK |
| T2 Blank high time [1, 2] | 640 | | tVCLK |
| T3 Blank period [1] (tBlank) | 31 | | μs |
| T4 VS hold from Blank | 0 | | ns |
| T5 VS setup to Blank | 2 | | ns |
| T6 VS high/low width | 1 | | tVCLK |
| T7 VS period (tVS) | 481 | | tBlank |
| Frame Rate | | 80 | Hz |

Table 9. TFT LCD mode timing

Notes

- [1] Blank high time must be an even multiple of 2 tVCLK.
- [2] The first 640 pixels after the rise of HS will be displayed.
- [3] VCLK must continue running when Blank is low.

Caution: The EL640.480-AA1 display includes an internal frame buffer. The display image is not automatically cleared in the absence of input video signals. The ENABLE control input signal can be used to blank the display in the event of system malfunction.

Setup and hold timing

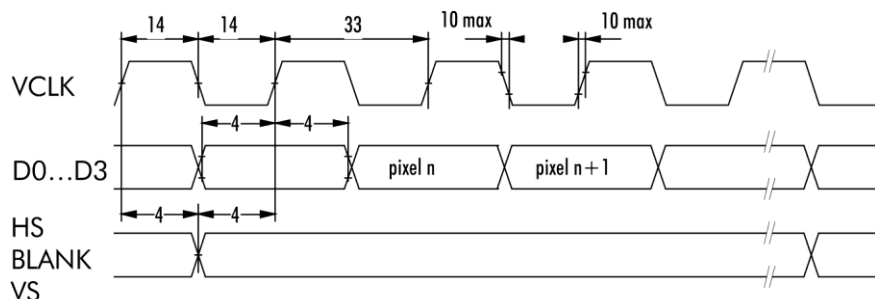


Figure 7. Normal and VGA mode. Minimum values in ns.

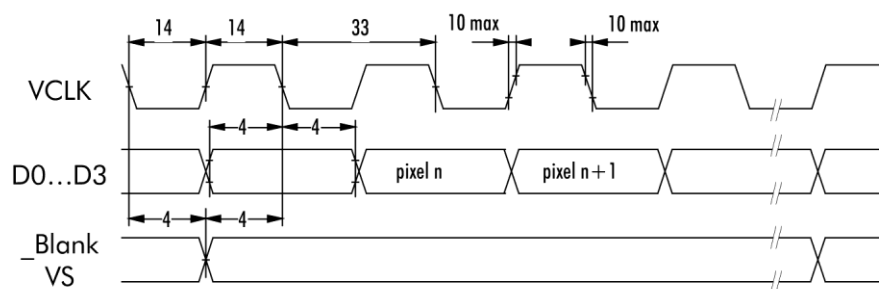


Figure 8. TFT mode. Minimum values in ns.

3.4.8 Operational specifications

Environmental

| | |
|--------------------|--|
| Temperature | |
| Operating | -60...+85 °C |
| Storage | -60...+105 °C |
| Humidity | |
| Relative Humidity | +40 °C, 93 % RH, Operating, IEC 60068-2-78 |
| Damp Heat | +25...+55 °C, 95 % RH, Non-operating, IEC 60068-2-30 <i>Note: Valid only for the Conformal Coated model</i> |
| Altitude | |
| Operating | 18,000 m (58,000 ft.) above sea level, IEC 60068-2-13 |
| Vibration | |
| | 20 to 500 Hz, 0.05 g ² /Hz random IEC 60068-2-64, test Fh. |
| Shock | |
| Magnitude | 100 g-force |
| Duration | 6 ms (half sine wave) |
| Number of shocks | 18 pcs (3 on each of the 6 surfaces) |
| Standard | IEC 60068-2-27, test Ea. |

Table 10. Environmental specifications

Reliability

MTBF > 50,000 h @ 25 °C

Optical

| | | |
|--|---------------------------------------|---|
| Areal luminance | | |
| ON brightness | 18 cd/m ² (5.2 fL) min | |
| | 21 cd/m ² (6.7 fL) typical | |
| Measured at the center of the screen. | | |
| Luminance non-uniformity | | |
| Maximum | 35 % | = (1- min. luminance/max luminance) x 100. Maximum difference between any two of five points (center and four corners) all pixels on. |
| Luminance variation (Time) | | |
| Maximum | 20 % | 10 000 h at 25 °C |
| Luminance variation (Temperature) | | |
| Maximum | 15 % | over -25...+65 °C range |
| Luminance contrast ratio | | |
| Minimum | 10:1 | @ 500 lx |
| Viewing angle | | |
| Minimum | 160° | |

Table 11. Optical specifications

3.5 Mechanical characteristics

| | | |
|---------------|----------|----------|
| Height | 205.3 mm | 8.1 in. |
| Width | 263 mm | 10.4 in. |
| Depth | 21 mm | 0.83 in. |
| Weight | 800 g | 28.2 oz. |

Table 12. Display external dimensions

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

| | |
|--------------------------|---|
| Active Area | |
| millimeters (inches) | height 158.3 (6.232) |
| | width 211.1 (8.311) |
| Pixel Pitch | |
| millimeters (inches) | height 0.33 (0.013) |
| | width 0.33 (0.013) |
| Subpixel Size | |
| millimeters (inches) | |
| Red | height 0.27 (0.011) |
| | width 0.08 (0.003) |
| Green | height 0.27 (0.011) |
| | width 0.15 (0.006) |
| Pixel fill factor | 57 % |
| Pixel Matrix | 640 (x2) horizontal by 480 vertical. Green/Red striped. |

Table 13. Active area

CAUTION: To prevent injury in the event of glass breakage, the use of an impact resistant shield or a protective overlay should be used on the viewer side of the display.

3.6 EMI performance

The display will not inhibit the end product from obtaining EN55022 Class B certification (emissive).

3.7 Component envelope

The component envelope shown in Figure 6 illustrates the distance the components extend behind the display. Tall components do not necessarily fill this area. Beneq reserves the right to relocate components within the constraints of the component envelope without prior customer notification. For this reason, Beneq advises users to design enclosure components to be outside the component envelope.

Device designers will need to consider their specific system requirements to determine the spacing necessary to maintain the specified ambient temperature.

Air flow and surrounding component materials will affect the depth of the air gap.

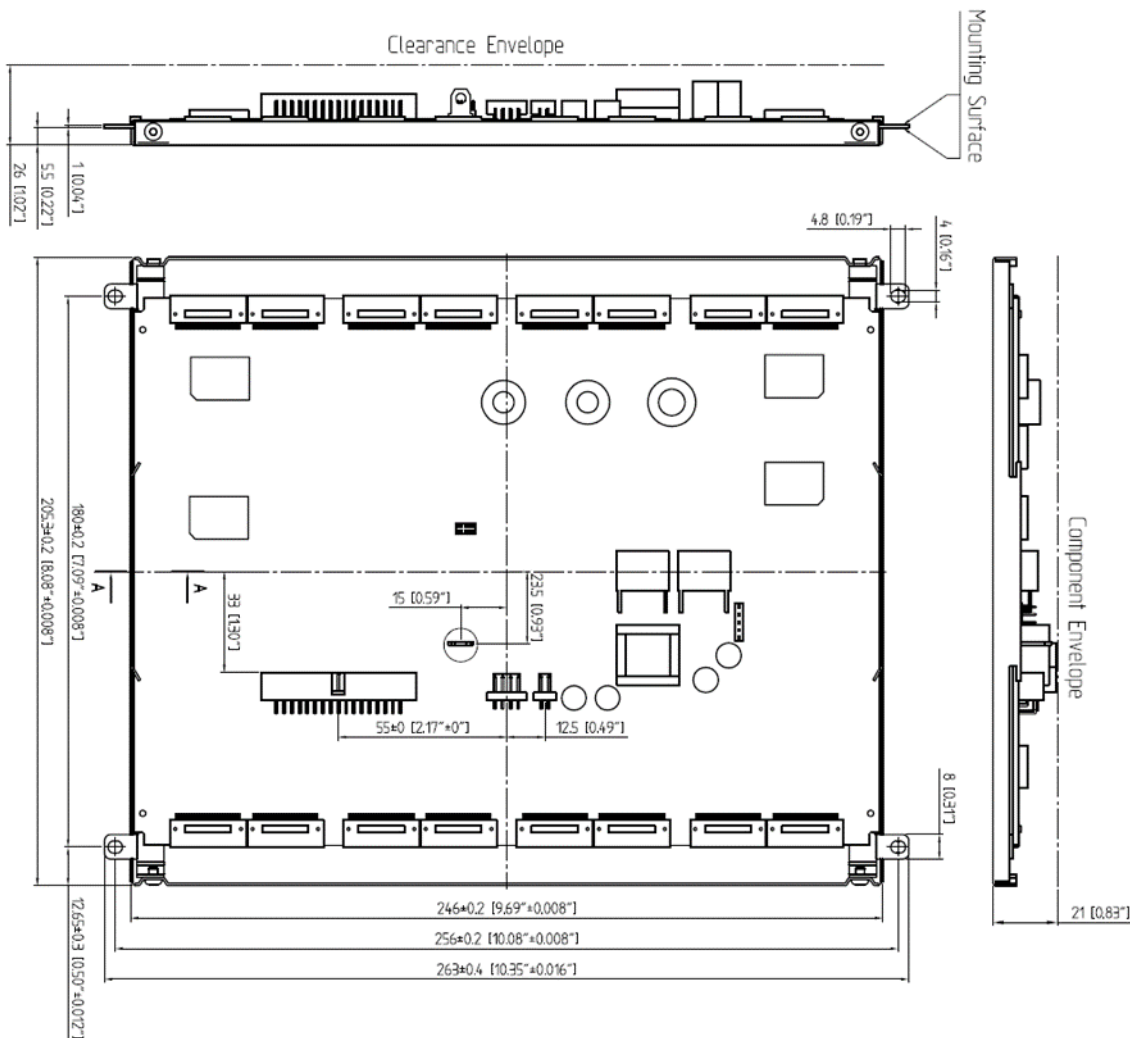


Figure 9. Mechanical dimensions. Dimensions are in millimeters; inches in brackets.

4 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.

5 Ordering information

| Product | Part Number | Description |
|------------------|-------------|--|
| EL640.480-AA1 | EL00004710 | 640x480 multicolor red/green/yellow, 10.4" diagonal, operating temperature from -60 °C to +85 °C |
| EL640.480-AA1 CC | EL00004720 | EL640.480-AA1 display with Conformal Coating |

Design and specifications are subject to change without notice.

Beneq continues to provide optional, and in many cases custom, features to address the specific customer requirements. Consult Beneq Sales for pricing, lead time and minimum quantity requirements.

6 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.

7 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.

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