EL160.120.39-SPI (3.1”) Operation Manual

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1 EL160.120.39-SPI display

The EL160.120.39-SPI thin film electroluminescent (TFEL) display is a small, high visual performance graphic display that excels in a wide range of ambient lighting environments. The EL160.120.39-SPI utilizes Lumineq® Displays' proprietary Integral Contrast Enhancement (ICEBrite™) technology to achieve unparalleled image quality without the use of filters or temperature compensation.

The display module consists of a TFEL glass panel and control electronics assembled into a space-saving, rugged package for easy mounting and includes an integrated DC/DC converter. The EL160.120.39-SPI is easily interfaced using the Serial Peripheral Interface (SPI) bus. Each of the pixels has an aspect ratio of 1:1 and is individually addressable to clearly display high information-content graphics and text.

1.1 Features and benefits

- Excellent visual performance
  - High brightness and contrast
  - Wide viewing angle > 179°
- Rapid display response < 1 ms
- Space-efficient mechanical package
- Low EMI emissions
- Extremely rugged and durable
- Reliable, long operating life: >50,000 MTBF
- SPI interface

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.

CAUTION: To prevent injury in the event of glass breakage, a protective overlay should be used on the viewer side of the display.

2.1 Mounting

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. Mounting surfaces should be flat to within ±0.6 mm (±.025"). Use all the mounting holes provided. Failure to do so will impair the shock and vibration resistance of the final installation.

The EL160.120.39-SPI is a tab-mounted display. Use appropriate length standoffs to assure that screws through the mounting tabs do not introduce bending stresses into the display. Do not deflect the circuit board out of its normal plane.

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 and source unwanted EMI.

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. Particular care should be taken when cleaning displays with anti-glare or anti-reflective films.

2.4 Avoiding burn-in

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

3 Specifications

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

3.1 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.

Any combination or sequencing in the application or removal of V_L, V_H, or video signals will not result in abnormal display operation or display catastrophic failure.

Table 1. DC input voltage requirements

Description	Symbol	Min	Typ.	Max	Absolute Max	Units
Input voltage (nom=12.0 V)	V_H	8		18	19	V_{DC}
Input voltage (nom=5.0 V)	V_L	4.75		5.25	6.0	V_{DC}
12 V input current (V_H =12.0 V)	I_H max			0.35		A_{DC}
5 V input current (V_L =5.0 V)	I_L max			0.10		A_{DC}
Power consumption 5 V/12 V @ max. frame rate			3.0		3.9	W

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

Table 2. SPI input requirements

Description	Symbol	Min	Max	Units
SPI logic high voltage	VI_H	2	5.5	V
SPI logic low voltage	VI_L	0	0.8	V
SPI logic input current	II_L	-10	+10	µA

3.2 Data and power connector

The EL160.120.39-SPI uses the 20-pin, 2 mm locking connector, Samtec EHT-110-01-S-D. The mating connector is the Samtec TCSD family of cable strips. Compatibility with non-Samtec equivalents should be verified before use.

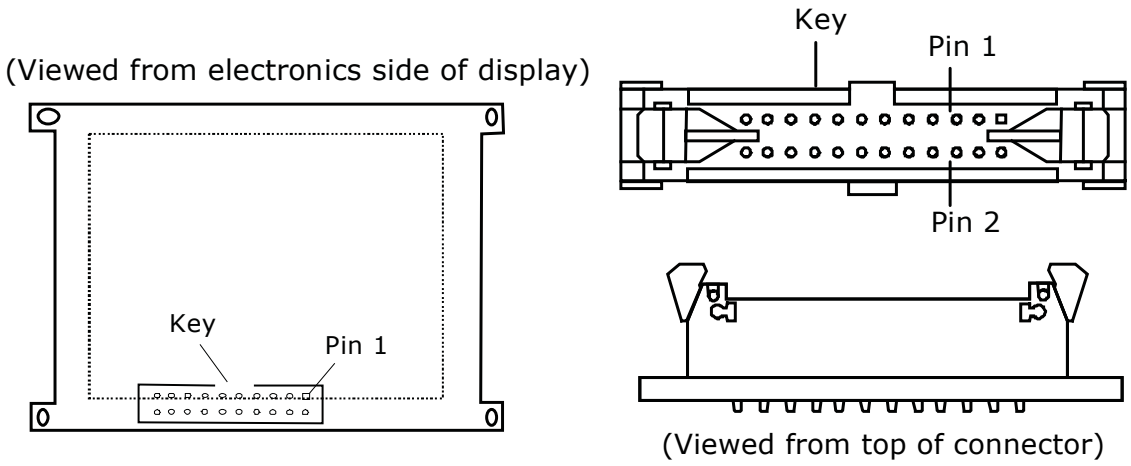


Figure 1. Data/power connector

Table 3. J1 connector pinouts

Pin	Signal	Description	Pin	Signal	Description
1	V_H	+12 V Power	2	V_H	+12 V Power
3	Self-test	Self-test Input [1]	4	LUM	Luminance Control
5	V_L	+5 VDC Power	6	GND	Ground
7	SS	Slave Select	8	GND	Ground
9	Reserved	Do not connect	10	GND	Ground
11	SCLK	Clock from master	12	GND	Ground
13	MOSI	Master Out Slave In	14	GND	Ground
15	Reserved	Do not connect	16	GND	Ground
17	Reserved	Do not connect	18	GND	Ground
19	Reserved	Do not connect	20	GND	Ground

[1] Connect pin 3 to ground for normal display operation.

3.3 Interface information

Beneq EL160.120.39-SPI Small Graphics Display (SGD) incorporates a SPI interface that is similar to many LCD modules. This SPI video interface provides a low-cost, flexible method for controlling display brightness and power consumption. Designers should select the chip set or embedded board that best suits their particular architecture.

3.3.1 Video Input signals

The SPI is driven with the rising edge of SCLK. A falling edge on SS signal indicates the beginning of an access on the SPI, the rising edge of SS signal ends an access on SPI. An access must consist of exactly 8 bits for write operation.

The SPI interface Clock polarity (CPOL) and clock phase (CPHA) are 0.At CPOL=0 the base value of the clock is zero for CPHA=0 and data are captured on the clock's rising edge (low to high transition) and data is propagated on a falling edge (high to low clock transition).

The timing restrictions on SPI are defined in figure 2 and table 4:

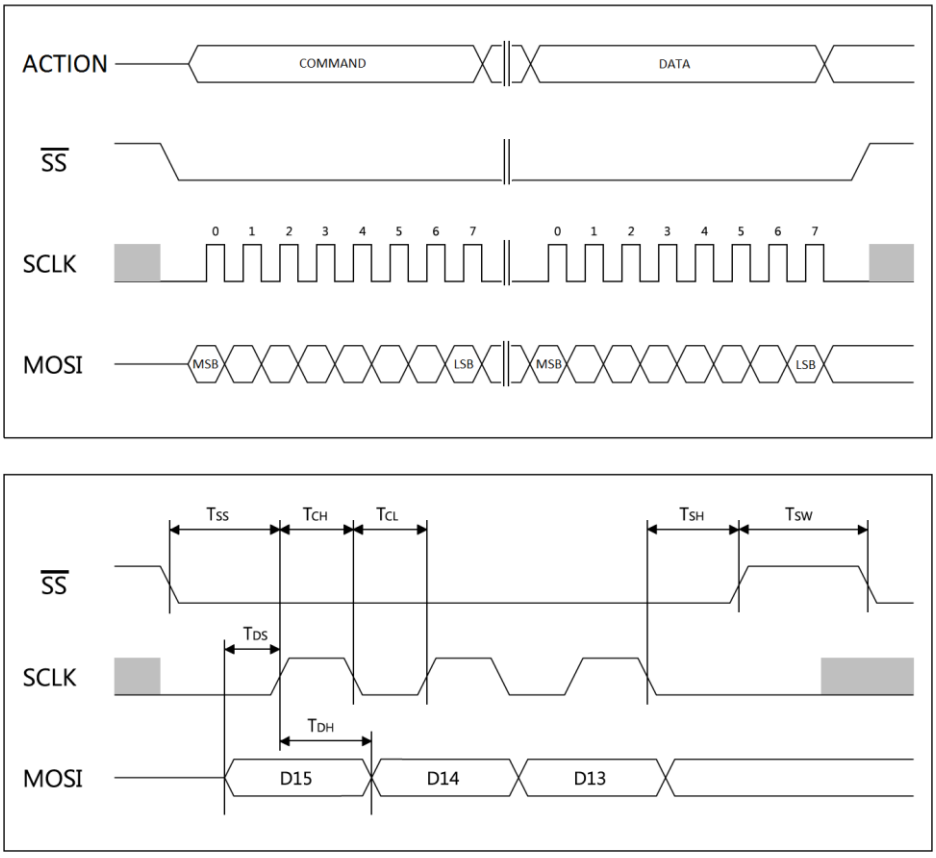


Figure 2. Video input timing diagram

Table 4. Timing restrictions

Description	Symbol	Minimum value (ns)
SCLK high time	T_{CH}	100
SCLK low time	T_{CL}	100
SS -> SCLK setup time	T_{SS}	100
SCLK -> SS hold time	T_{SH}	100
SS disabled between cycles	T_{SW}	100
Data setup time	T_{DS}	100
Data hold time	T_{DH}	100

3.3.2 Initial Power-up

On initial power-up, the display registers are reset to their default values and all pixels are blanked. At this time all registers must be programmed for normal operations.

3.4 SPI protocol

3.4.1 Commands

Command	Hex #	Binary							
Write complete display data	01h	0	0	0	0	0	0	0	1
Write display block (multiple rows)	02h	0	0	0	0	0	0	1	0
Write one row	03h	0	0	0	0	0	0	1	1
Clear screen (full black)	11h	0	0	0	1	0	0	0	1
All pixels ON (full yellow)	12h	0	0	0	1	0	0	1	0
Invert display image	13h	0	0	0	1	0	0	1	1
Write frame frequency, 100 % luminance (1)	81h	1	0	0	0	0	0	0	1
Write frame frequency, 75 % luminance	82h	1	0	0	0	0	0	1	0
Write frame frequency, 50 % luminance	83h	1	0	0	0	0	0	1	1
Write frame frequency, 30 % luminance	84h	1	0	0	0	0	1	0	0

Notes: (1) Default luminance

3.4.2 Write complete display data

Command	Data1 (1)	---	Data N (2)
01_h	8 bits	8 bits	8 bits

Notes: (1) First bits of first row
(2) Last bits of last row. N=(Number of rows/8) * Number of columns
(3) Pixels are going from left to right from top to bottom. A first pixel in a byte is the most significant one. See Figure 3. for reference.

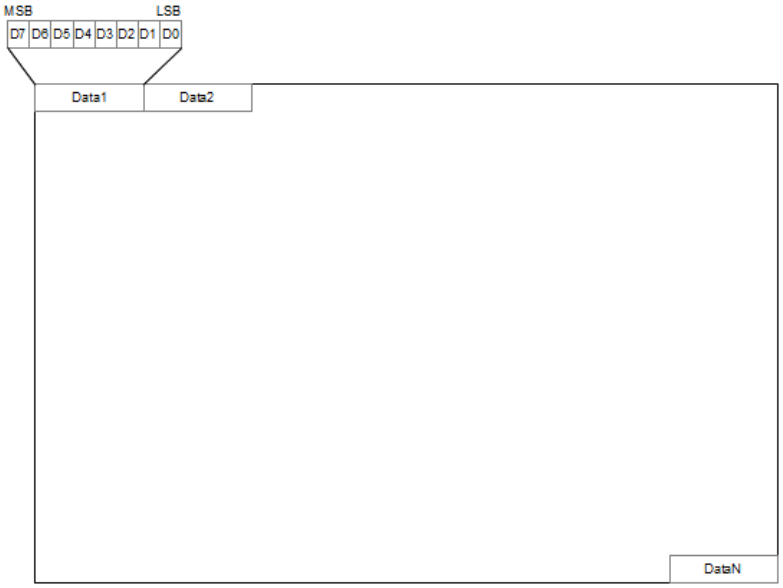


Figure 3. Display pixel locations on image data mapping.

3.4.3 Write display block (multiple rows)

Command	First row number	Last row number	First bits of first row	----	Last bits of last row
02_h	8 bits	8 bits	8 bits	8 bits	8 bits

3.4.4 Write one row

Command	Row number	First bits of row	----	Last bits of row
03_h	8 bits	8 bits	8 bits	8 bits

3.4.5 Clear screen (full black)

Command
11_h

3.4.6 All pixels ON (full yellow)

Command
12_h

3.4.7 Invert display image

Invert command only inverts visible display picture and does not manipulate picture data on display frame memory. Consecutive invert commands toggle displayed image between inverted and non-inverted mode.

Command
13_h

3.4.8 Write frame frequency

Command	Relative Luminance
81h	100 %
82h	75 %
83h	50 %
84h	30 %

3.5 Self-test mode

The display incorporates a self-test mode composed of four patterns displayed for approximately six seconds each, and then repeated. The self-test mode is entered at power when pin 3 is pulled high or left open. For normal operation, the SELFTEST pin must be connected to ground.

3.6 Optical

Table 4. Optical characteristics

Luminance		
L_{on} (areal), min	50 cd/m²	Screen center@ 150 Hz frame rate.
L_{on} (areal), typ	70 cd/m²	Screen center @ 150 Hz frame rate.
L_{off} (areal), max	0.3 cd/m²	5 points: center plus four corners measured 10±2 mm from display edges @ 150 Hz
Non-uniformity		
All pixels fully lit	25%	Maximum difference between two of five points, using the formula: LNU%=[1- (min_lum/max_lum)] x 100
Luminance variation (Temperature)		
Maximum	±20%	Across operating temperature range @ 150 Hz
Luminance variation (Time)		
Maximum	<20%	10,000 hours at 25°C ambient @ 150 Hz
Viewing angle		
Minimum	>179°	
Contrast ratio		
Typical	59:1	@ 500 lux ambient, max frame rate
	32:1	@ 1,000 lux ambient, max frame rate
	4.3:1	@ 10,000 lux ambient, max frame rate

3.6.1 Dimming

There are two standard methods for dimming the EL3160.120.39-SPI display. Analog dimming is available on the EL160.120.39-SPI display by connecting an external 50 kΩ logarithmic potentiometer to the dimming port. Alternatively, an external voltage or current-mode D/A converter may be used to dim the display by sinking a 0-250 μA current at 4-0 voltages respectively from the control pin to ground. Alternatively, the display can be dimmed by changing the display frame rate controller register value. Please, see details 3.4 SPI protocol.

Table 5. Dimming rates

Resistance	**Dimming**
Maximum (no resistor connected)	100% (Default)
Maximum (50 kΩ resistor connected)	95%
Minimum (0 Ωresistor connected)	5% maximum
Values are measured as a percentage of full on luminance	

3.7 Environmental

Table 6. Environmental characteristics

Temperature	
Operating	-50 °C to +70 °C,
Operating survival	-50 °C to +85 °C
Non-operating	-60 °C to +105 °C
Humidity	
Non-condensing, operating	93% RH max @ 40 ºC, per IEC 60068-2-78
Condensing, Non-operating	95% RH max @ 55 °C, per IEC 60068-2-30
Altitude	
Operating	0 to 18,000 m (58k ft) per IEC 60068-2-13
Vibration	
Operating/non-operating	0.02 g^2/Hz, ASD level, 5-500 Hz per, IEC 60068-2-64 test Fh.
Shock	
Operating/non-operating	Ea. 100 g, 6 ms, half sine wave per IEC 60068-2-27, test Ea.
Thermal shock	
Non-operating	Lower -45 ºC, upper +85 ºC. Dwell time 30 min., transition time < 3 min. Number of cycles 5. Per IEC 60068-2-14.

3.8 Reliability

The display demonstrates MTBF greater than 50,000 hours at the maximum frame rate with a 90% confidence level at 25 °C.

3.9 Safety and EMI performance

The display module will not prohibit the end product from obtaining EN61010-1 certification. Creepage distance on the PCB will be according to EN61010 table D.18 pollution degree 2 wherever possible. Clearance will be 0.2 mm.

The display module will not inhibit the end product from obtaining EN55022 B certification.

The display is provided with a current-limiting circuit in the DC/DC converter to ensure safety in the case of a short circuit between a high voltage and +5 VDC circuitry.

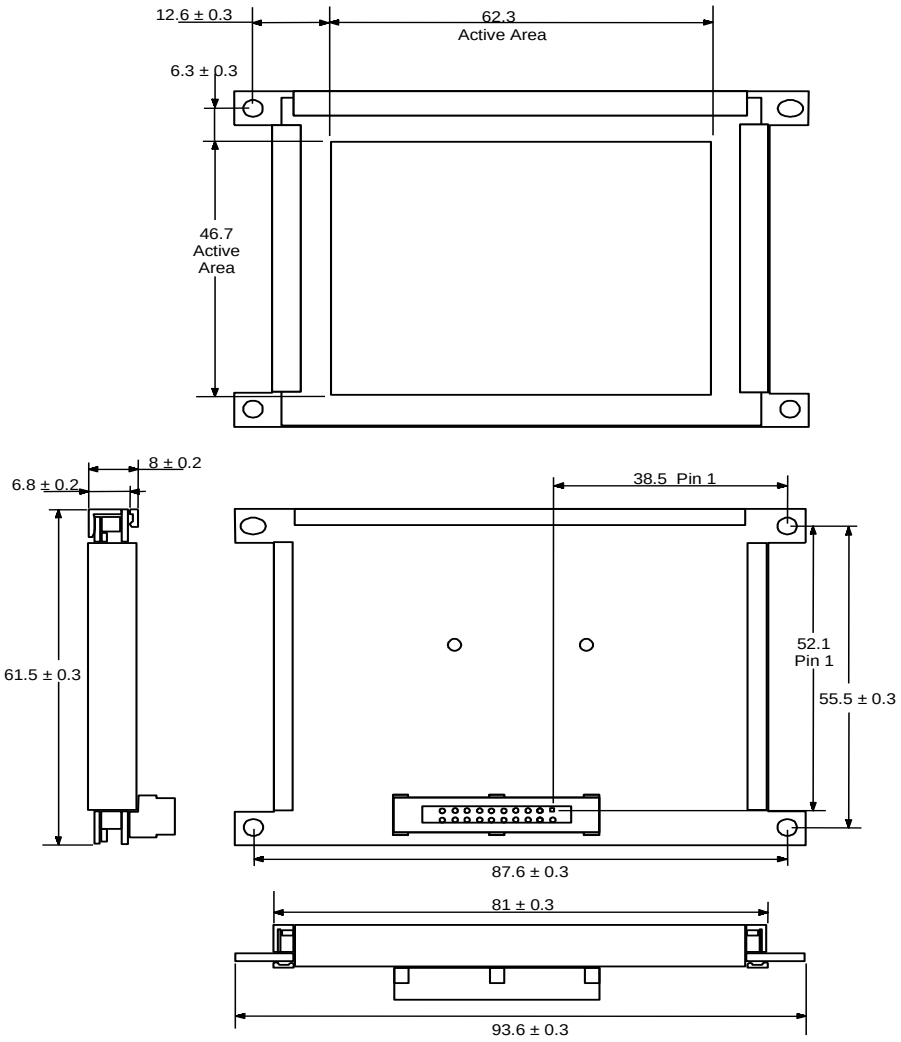
3.10 Mechanical characteristics

Display external dimensions		
millimeters (inches)	width	93.6 (3.68)
	height	61.5 (2.42)
	depth	20.0 (0.78)
Weight (typical)		65 g, typical
Fill factor		59% nominal
Display active area		
millimeters (inches)	width	62.3 (2.45)
	height	46.7 (1.83)
	diagonal	77.86 (3.07)
Pixel size		
millimeters (inches)	width	0.30 (0.012)
	height	0.30 (0.012)
Pixel pitch		
millimeters (inches)	width	0.39 (0.015)
	height	0.39 (0.015)

3.11 Component envelope

The component envelope shown in Figure 4 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.

An air gap is recommended to dissipate heat from display components. Device designers need to consider their specific system requirements to determine the necessary spacing.



Dimensions in are millimeters.

Figure 4. Display dimensions

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	Features
EL160.120.39-SPI	996-0303-02LF	Small graphics display with a wide temperature range, dimming and SPI interface.
EL160.120.39-SPI CC	996-0303-03LF	Small graphics display with a wide temperature range, dimming, conformal coating and SPI Interface.

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 II

Beneq Oy is committed to continuous improvement. As part of this process we are fully in support of EU directive 2011/65/EU, the Restriction of Hazardous Substances, commonly known as RoHS II or RoHS Recast, which, compared to RoHS, keeps the restrictions on the original six hazardous substances, including lead (Pb) in electronic equipment. It also expands these restrictions to previously exempted categories including medical devices and monitoring and control instruments.