



# **EL40S**

## **Operation Manual**

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## 1 EL40S display

The EL40S thin film electroluminescent (TFEL) display is a high-performance alternative to segment displays and an ideal solution in demanding applications where superior visual performance and environmental ruggedness are critical. The EL40S utilizes Lumineq® Displays' proprietary Integral Contrast Enhancement (ICEBrite™) technology to achieve unparalleled image quality without the use of expensive filters. This segment display excels in a wide range of ambient lighting environments while effectively eliminating the blooming common to other high-bright displays.

The display consists of a TFEL glass panel and control electronics assembled into a space-saving, rugged package for easy mounting. The EL40S is easily interfaced using SPI-interface.

### 1.1 Features and benefits

- Excellent visual performance
  - High brightness and contrast
  - Wide viewing angle < 179°
- Very wide operating temperature range
- Rapid display response < 1 ms
- Space-efficient mechanical package
- Low EMI emissions
- Extremely rugged and durable
- Reliable, long operating life
- Serial peripheral interface (SPI)

## 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. Use packing materials designed for electrostatic-sensitive components protection while shipping.

## 2.1 Mounting TFEL displays

A properly mounted TFEL display 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 an assembly. Ideally, the mounting tabs of the display should be the only points of contact with the system. Use spacers or bosses for support; failure to do so will bend the display and may cause the glass to break. The instrument enclosure or frame should not flex or distort so that the bending loads might be transferred to the display during use. The EL40S mounting tabs are designed for 3 mm screws. Mounting surfaces should be flat to within  $\pm 0.6$  mm ( $\pm 0.025$ " ). Use all the mounting holes provided. Failure to do so will impair the shock and vibration resistance of the final installation.

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

**WARNING:** These products generate voltages capable of causing personal injury (high voltage up to 235 V<sub>AC</sub>). Do not touch the display electronics during operation.

## 2.2 Cable length

A maximum cable length of 0.6 m (24 in.) is recommended. Longer cables may cause data transfer issues between the data transmitted and the display input connector. Excessive cable lengths can pick up 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 and anti-reflective films.

### 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 segment structure with 40 segments. Light is emitted when an AC-voltage of sufficient amplitude is applied at the segment-common intersection.

#### 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 display supply voltage ( $V_H$ ) should be present whenever video input signals are 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
Display supply voltage	$V_H$	10.8 V <sub>DC</sub>	12 V <sub>DC</sub>	13.2 V <sub>DC</sub>
Supply current at +12 V	$I_H$	-	0.4 A	0.6 A
Power consumption @ maximum frame rate	P	-	3 W	6 W

**Table 1. DC-voltage requirements for input**

**CAUTION:** Damage to the device may occur beyond absolute maximum ratings values.

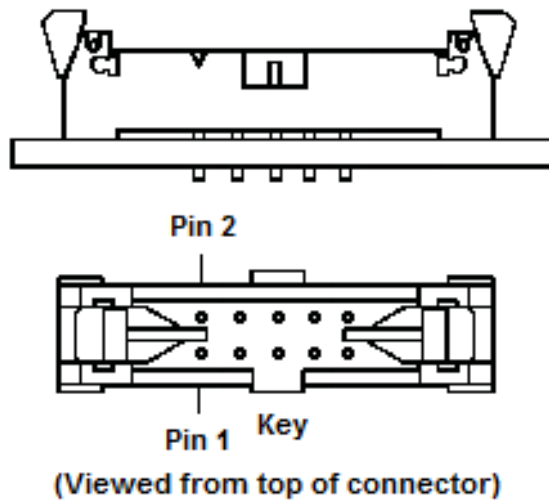
Description	Min	Nominal	Max	Unit
Absolute Input Voltage Range	-0.5	-	4.1	V <sub>DC</sub>
Video logic high voltage	2.0	3.3	3.8	V <sub>DC</sub>
Video logic low voltage	0	0	0.8	V <sub>DC</sub>

**Table 2. Video input requirements**

There is no overcurrent protection on the  $V_H$  input to protect against catastrophic faults. Beneq recommends the use of a series fuse on the 12 volt supply ( $V_H$ ). A general guideline is to rate the fuse at 1.8 to 2 times the display maximum current rating.

### 3.3 Connector

The display uses the Samtec EHT-105-01-1-D-SM-LC or equivalent locking connector. The mating connector is in the Samtec TCSD family of cable strips. The proper connector, user-specified cable length and connector configuration is supplied as a single unit. Consult your Samtec representative for the cable/connector options. Compatibility with non-Samtec equivalents should be verified before use.



**Figure 1. Data/power connector**

Symbol	Pin	Pin	Symbol
+12 VDC	1	2	GND
SCLK	3	4	GND
MOSI	5	6	GND
SS	7	8	GND
ST	9	10	Reserved

**Table 3. Pin assignments**

Signal	Functional Description
+12 VDC	Display power supply
GND	Display ground
SCLK	Clock from Master
MOSI	Master Output Slave Input
SS	Slave Select
ST	Self-Test (Open for normal operation)
Reserved	Reserved for Master Input Slave Output (MOSI), Do not connect

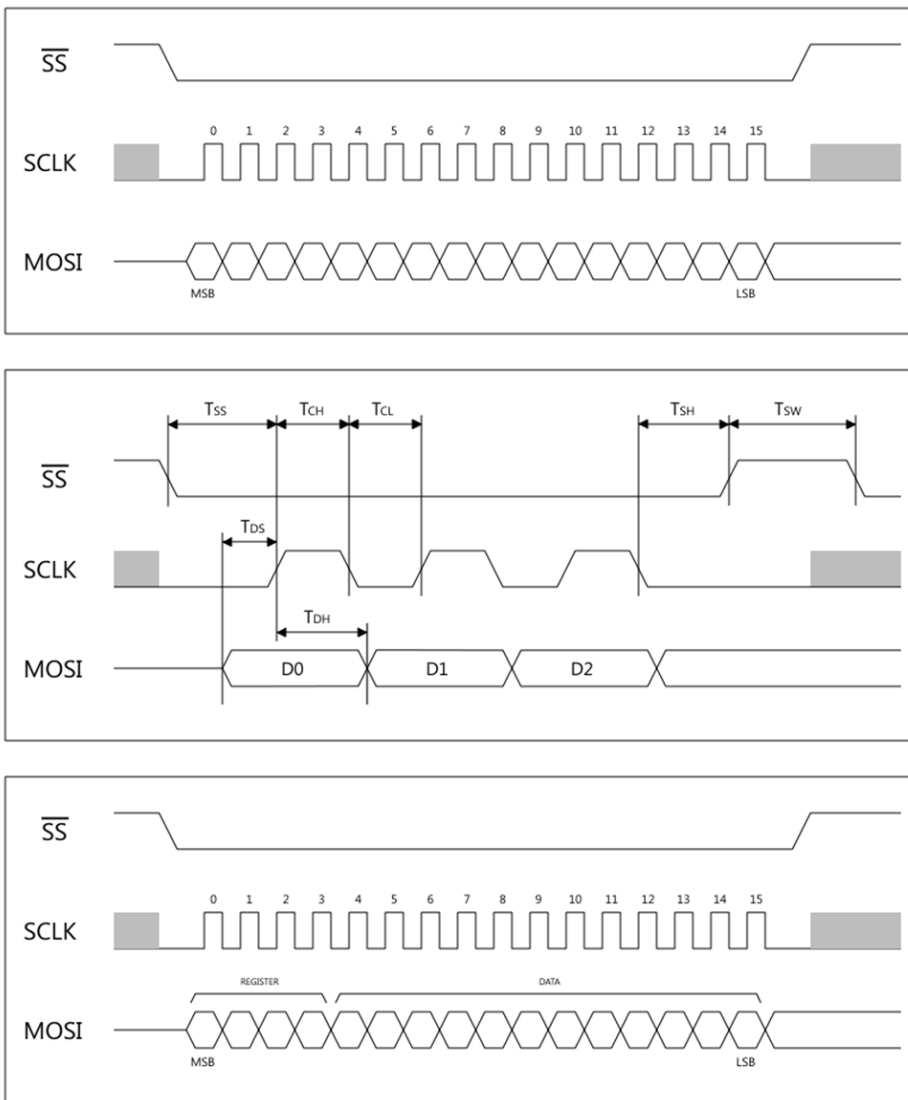
**Table 4. Input descriptions**

### 3.4 Interface information

Beneq EL40S display incorporates a common SPI interface. This interface is supported by a variety of off-the-shelf chip sets and embedded boards. Designers should select the chip set or embedded board that best suits their particular architecture.

#### 3.4.1 Video input signals

The SPI is driven with the rising edge of SCLK. A falling edge on LD signal indicates the beginning of an access on the SPI, the rising edge of LD determines an access on SPI. An access must consist of exactly 16 bits for write operation. The timing restrictions on SPI are defined in figure 2 and table 4:



**Figure 2. Video input timing diagram**

Description	Symbol	Minimum value (ns)
SCLK high time	T <sub>CH</sub>	150
SCLK low time	T <sub>CL</sub>	150
SS -> SCLK setup time	T <sub>SS</sub>	150
SCLK -> SS hold time	T <sub>SH</sub>	150
SS disabled between cycles	T <sub>SW</sub>	150
Data setup time	T <sub>DS</sub>	150
Data hold time	T <sub>DH</sub>	150

**Table 5. SPI video input description**

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).

### 3.5 Initial power-up

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

### 3.6 Self-test mode

The display input connector has a self-test input. When this input is continuously at a low state, the display enters in the self-test mode. At this mode all segments are turned on, and the display brightness is set to full.



### 3.7 Optical

<b>Luminance</b>		
L <sub>on</sub> (areal), min	270 cd/m <sup>2</sup>	Screen center, maximum frame rate
L <sub>on</sub> (areal), typ.	300 cd/m <sup>2</sup>	Screen center, maximum frame rate
<b>Non-uniformity</b>		
All segments fully lit	35%	Maximum difference two of segments, using the formula: $BNU\% = [1 - (\min\_lum / \max\_lum)] \times 100\%$
<b>Luminance variation (temperature)</b>		
Maximum	±25%	Across the operating temperature range
<b>Luminance variation (time)</b>		
Maximum	< 20%	10,000 hours at 25°C ambient
<b>Viewing angle</b>		
Minimum	> 179° in all directions; no contrast or luminance change	
<b>Contrast ratio (typical)</b>		
Typical	180:1	@ 500 lux ambient, maximum frame rate
	32:1	@ 10,000 lux ambient, maximum frame rate
	4:1	@ 50,000 lux ambient, maximum frame rate

**Table 6. Optical characteristics**

### 3.8 Environmental

<b>Temperature</b>	
Operating	-60 °C to +85 °C
Storage	-60 °C to +105 °C
<b>Humidity</b>	
Non-condensing, operating	93% RH max at +40 °C, per IEC 68-2-3
Condensing, non-operating	95% RH max at +55 °C, per IEC 68-2-30
<b>Altitude</b>	
Operating/non-operating	0 to 18 km (58k ft.), per IEC 68-2-13
<b>Vibration</b>	
Random Operating/non-operating	0.20 g <sup>2</sup> /Hz, ASD level, 5-500 Hz per IEC 68-2-64, test Fh.
<b>Shock</b>	
Operating/non-operating	100 g, 4 ms, half sine wave per IEC 68-2-27, test Ea.

**Table 7. Environmental characteristics**

Note: The display electronics has a circuit to protect electronics for overheating. This will turn off the display if too high temperature is present. After activation of the circuitry the display should be placed into conditions it is specified for before continuing the use. Failure to do so may result into display damage.

### **3.9 Reliability**

The display MTBF is to be greater than 100,000 hours with a 60 % confidence level at 25 °C.

### **3.10 Safety and EMI performance**

The display will not inhibit the end product from obtaining these certifications: IEC 950, IEC 601-1-1, UL2601, CSA 22.2 #601-M89, FCC Docket, Part 15, Subpart J, Class B; CISPR22, Class B; and VDE 871/VFG243 Class B.

### **3.11 Optional features**

Conformal coating is available as an option.

### 3.12 Mechanical characteristics

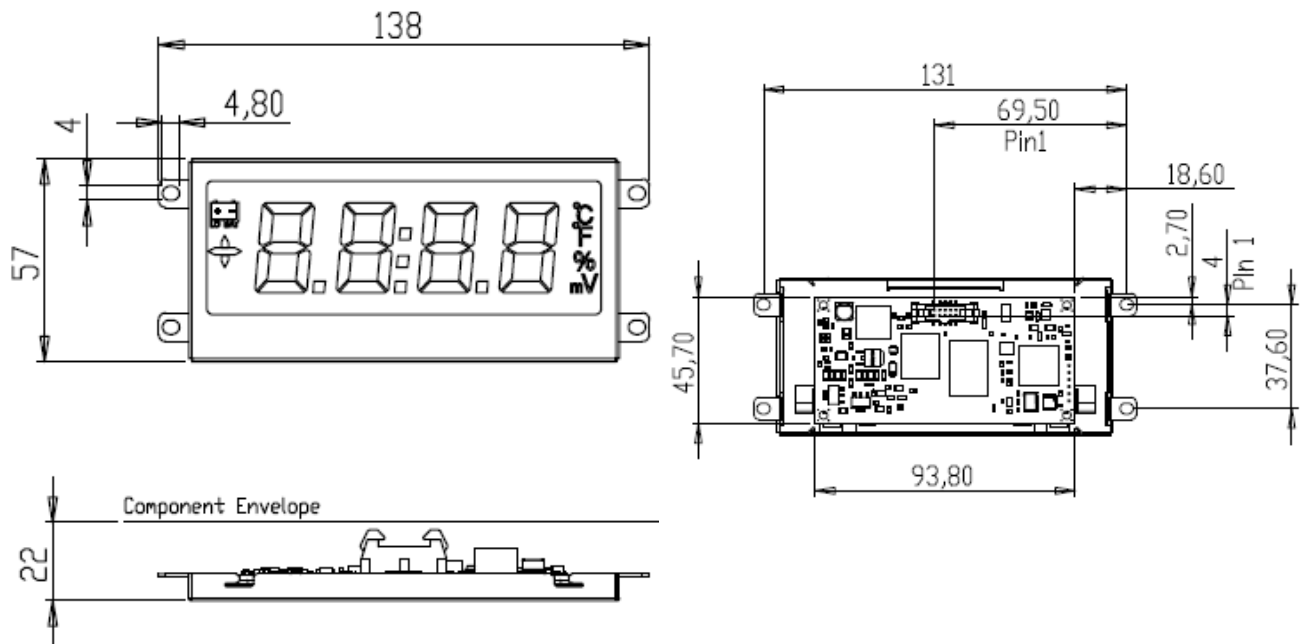
<b>Display external dimensions</b>		
millimeters (inches)	width	138.0 (5.43) with mounting ears
	height	57.0 (2.24)
	depth	22.0 (0.87) with component envelope Approx. 20 (0.79) display only
<b>Weight (typical)</b>		136 g (4.8 oz.)
<b>Display active area</b>		
millimeters (inches)	width	26.0 (1.02)
	height	109.6 (4.31)

**Table 8. Mechanical characteristics**

### 3.13 Component envelope

The component envelope shown in Figure 3 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.



**Figure 3. Display dimensions**

Air flow and surrounding component materials will affect the depth of the air gap. Dimensions are in millimeters; inches in brackets.

Tolerances unless specified

.x  $\pm 0.50$  [0.02]

.xx  $\pm 0.25$  [0.01]

## 4 16 bits SPI Interface Protocol

### 4.1 Serial data format

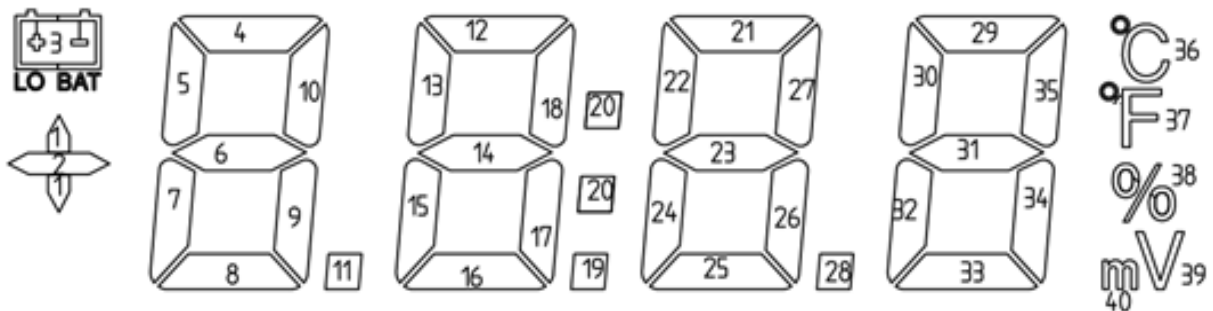
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Register address				Data											

**Table 9. 16-bits serial data format**

### 4.2 Registers

Reg. #	Register	D15	D14	D13	D12	Notes
0	Segment 0	0	0	0	0	Segments 1-12
1	Segment 1	0	0	0	1	Segments 13-24
2	Segment 2	0	0	1	0	Segments 25-36
3	Segment 3	0	0	1	1	Segments 37-40
4	Reserved	0	1	0	0	
5	Reserved	0	1	0	1	
6	Reserved	0	1	1	0	
7	Reserved	0	1	1	1	
8	Reserved	1	0	0	0	
9	Frame freq.	1	0	0	1	
10	Reserved	1	0	1	0	
11	Reserved	1	0	1	1	
12	Reserved	1	1	0	0	
13	Reserved	1	1	0	1	
14	Reserved	1	1	1	0	
15	Reserved	1	1	1	1	

**Table 10. Register address**



**Figure 4. Display segment numbering**

Register	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Segment 0	12	11	10	9	8	7	6	5	4	3	2	1
Segment 1	24	23	22	21	20	19	18	17	16	15	14	13
Segment 2	36	35	34	33	32	31	30	29	28	27	26	25
Segment 3	-	-	-	-	-	-	-	-	40	39	38	37

**Table 11. Display segment addresses**

Segment register value 1 = Segment ON, value = segment OFF.

Frame rate	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Notes
Minimum	0	0	0	0	0	0	0	0	0	0	0	0	70 Hz
Maximum	1	1	1	1	1	1	1	1	1	1	1	1	300 Hz

**Table 12. Frame rate dimming**

## 5 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.**

## 6 Ordering information

Product	Part Number	Description
EL40S	EL00010800	Standard Segment Display, 40 Segments, ICEBrite background, SPI Interface
EL40S CC	EL00010801	EL40S 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.

## 7 Support and service

Beneq Products 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 Products Oy by email ([rma.lumineq@beneq.com](mailto: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.

## 8 RoHS II

Beneq Products 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.

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