

# EL640.480-AG1 Series

## Operation Manual



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## **1 EL640.480-AG1 series VGA display**

The EL640.480-AG1 series displays are 8.1" diagonal VGA products which offer designers an affordable solution in demanding applications where superior visual performance and environmental ruggedness are critical. Utilizing Lumineq® Displays' proprietary ICEBrite™ (Integral Contrast and Brightness Enhancement) technology, these displays excel in ambient light environments ranging from dark to nearly sunlight-bright. This technology achieves very high contrast and exceptionally clear images using a common 8-bit FPD-type interface compatible with most LCD video controller chips.

The EL640.480-AG1 ET (AG ET) is the extended-temperature version of the EL640.480-AG1 (AG) display. See temperature specifications on page 14 for more information. The EL640.480-AG1 ET LP (AG ET LP) is the low-profile version of the AG1 ET.

Through simple design and advanced manufacturing technologies, Lumineq's new VGA display family brings the visual performance and image quality of TFEL into cost-sensitive applications that have up to now been limited by the performance of LCD displays.

### **1.1 Features and benefits**

- Excellent visual performance
  - High brightness and contrast
  - Wide viewing angle > 179°
- Reliable, long operating life
- Extremely rugged and durable
- Low EMI emissions
- Rapid display response < 1 ms
- Low power design

### **1.2 Options**

A locking connector, which is standard in the AG ET version, is optional with the AG display.



## 2 Installation and handling

The mechanical package consists of the display panel and electronic circuit board adhesively bonded together and mounted in a plastic bezel. The bezel supplies the mounting ears and protects otherwise exposed leads. The display is made of glass material and must be handled with care.

**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.

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

### 2.1 Mounting TFEL displays

The AG1 display series was designed to facilitate the mounting of optical treatments and touch screens on the viewing side of the display. To this end, the glass extends in front of the mounting bezel by approximately 0.5 mm (0.02"). It is imperative that any mounting scheme apply uniform pressure across the glass at all times. Pressure applied only to the corners or edge of the glass is likely to cause breakage.

Mounting should be done using the mounting ears only. Use either metric M3 screws tightened to 350 Ncm maximum, or unified #4 screws tightened to 4.7 in/lb maximum.

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

**CAUTION:** To prevent injury in the event of 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 230 V<sub>AC</sub>). Do not touch the display electronics during operation.

### 2.2 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.

The TAB (tape-automated bonding) leads between the electronics and the display glass are very sensitive to handling. When cleaning the edges of the display glass, special care should be taken not to damage the leads.



## 2.3 Cable length

A maximum cable length of 0.6m (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.

## 2.4 Avoiding burn-in

As with other light-emitting displays, use a screen saver or image inversion technique 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 EL 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. Required operating voltages are provided by an integrated DC/DC converter.

### 3.2 Power

The supply voltages required for the displays are shown in Table 1. All internal high voltages are generated from 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.

**Table 1. DC input voltage requirements**

Parameter	AG1	AG1 ET	Notes
$V_L$	+5 V $\pm$ 5%	+5 V $\pm$ 5%	absolute max 6.0 V
$V_H$	+12 V $\pm$ 10%	+8 to +18 V	
$V_H$ , max	15 V	19 V	
$I_L$ , max	75 mA	0.1 A	@ $V_L$ = +5 V
$I_H$ , max	1.0 A	1.0 A	@ $V_H$ = +12 V
Ptyp, 120 Hz	6.5 W	6.5 W	3840 'E' characters
Pmax, 120 Hz	12.0 W	12.0 W	50/50 2x2 checkerboard

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



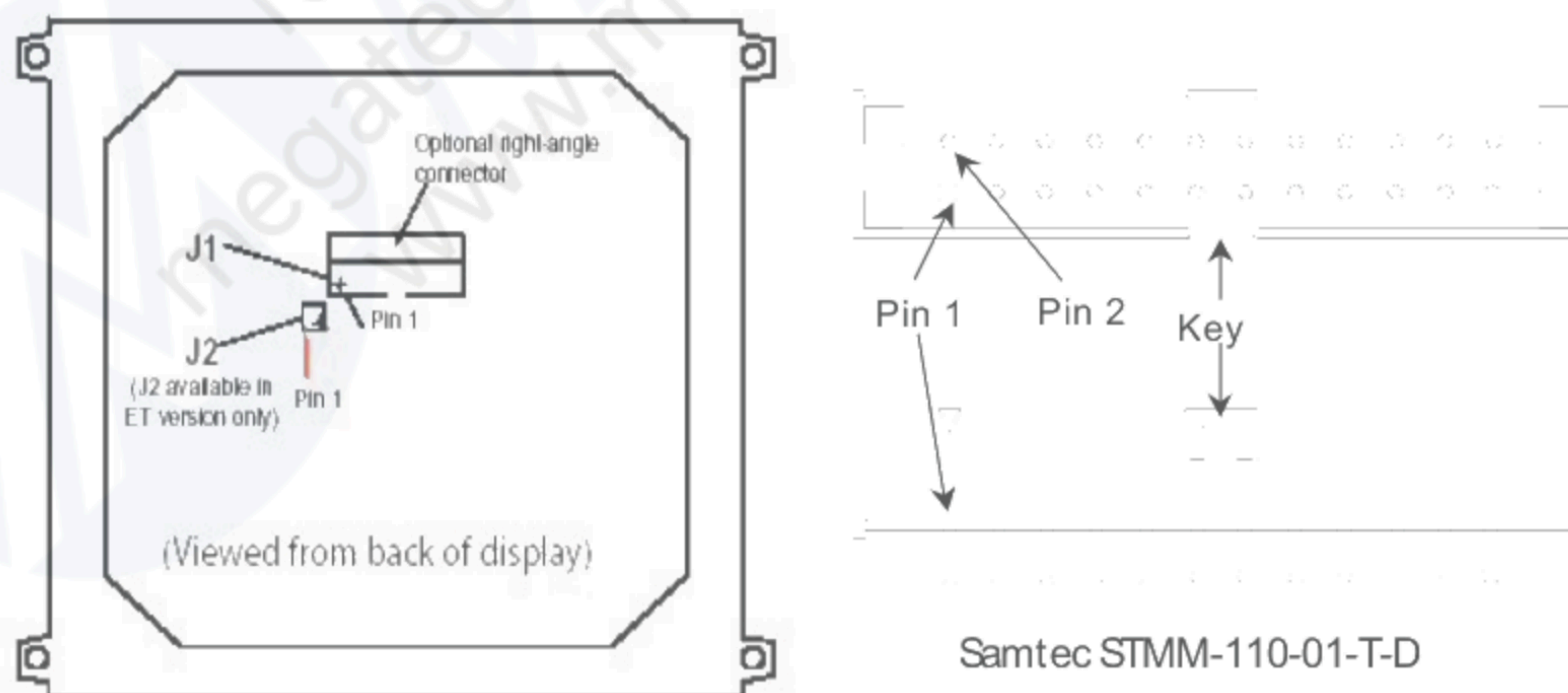
**Table 2. Video input requirements**

	AG1 (CMOS)		AG1 ET (TTL)			
Description	Min	Max	Min	Max	Units	Notes
Video logic high voltage	3.7	5.0	2.0	$V_L + 0.5$	V	
Video logic low voltage	0	0.9	-0.5	0.8	V	Video lines have 100 $\Omega$ series resistors, AG1 ET has internal pull-up in S input.
Video logic input current	–	$\pm 10$	–	$\pm 10$ (-300)	$\mu A$	

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

### 3.3 Data and power connector

The EL640.480-AG1 display uses the Samtec STMM-110-01-T-D and the EL640.480-AG1 ET display uses the Samtec EHT 110 01 S D or equivalent locking connectors. Although these connectors differ slightly, their pinouts are identical and are shown in the table below. The mating connector for both displays is in the Samtec TCSD family of cable strips. The proper connector, user-specified cable length, and connector configuration are supplied as a single unit. A low-profile version display, the EL640.480-AG1 LP, uses the EHT110 01 S D RA right-angle connector. Consult your Samtec representative for the cable/connector options.



**Figure 1. Data/power connector**

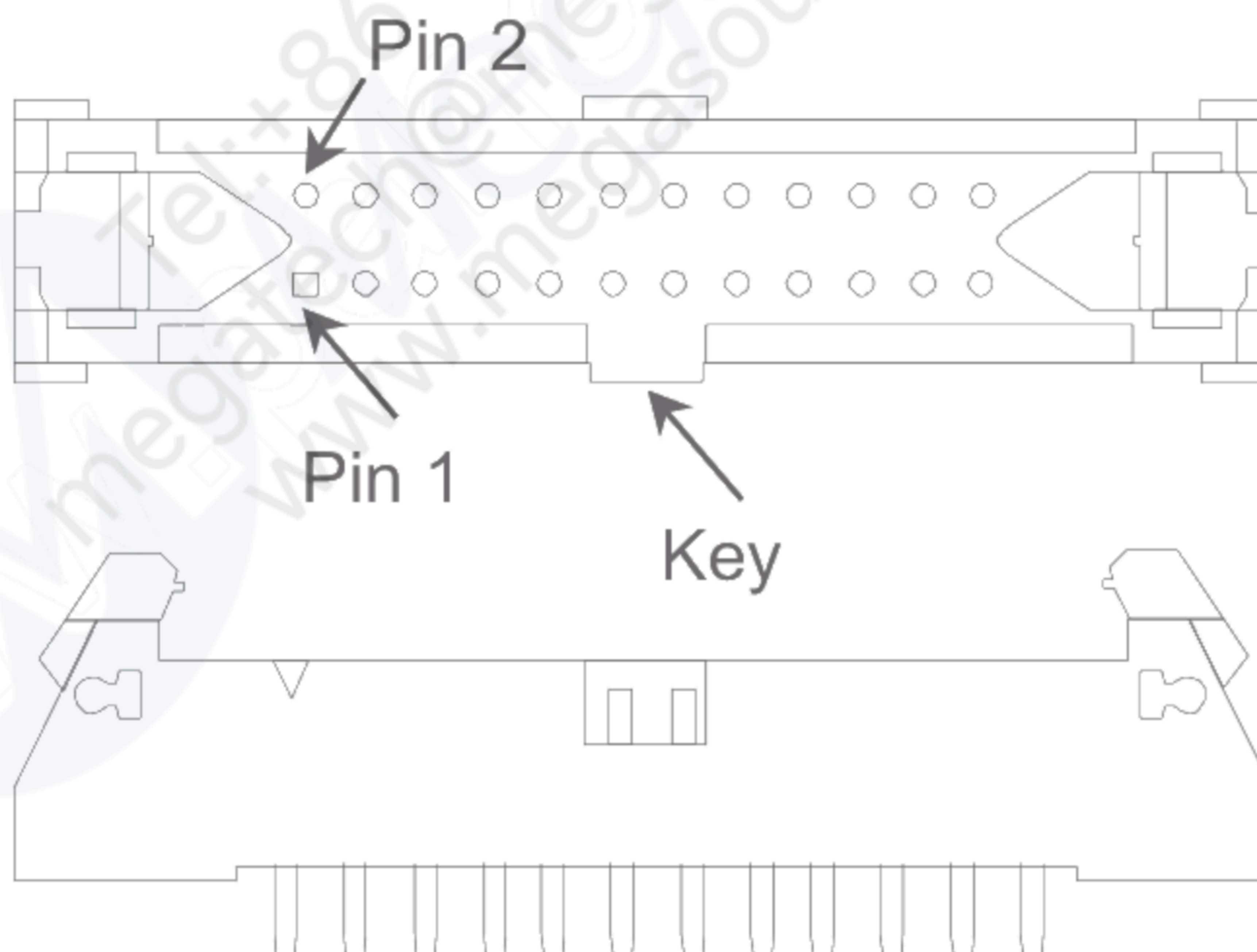


**Table 3. J1 Connector pinouts**

Pin	Signal	Description	Pin	Signal	Description
1	UD1	Video data (upper)	2	UD0	Video data (upper)
3	UD3	Video data (upper)	4	UD2	Video data (upper)
5	LD1	Video data (lower)	6	LD0	Video data (lower)
7	LD3	Video data (lower)	8	LD2	Video data (lower)
9	CP2	Data input clock	10	GND	Ground
11	CP1	Input data latch.	12	GND	Ground
13	S	Scan start-up signal	14	GND	Ground
15	GND	Ground	16	GND	Ground
17	V <sub>L</sub>	+5 V Power	18	V <sub>L</sub>	+5 V Power
19	V <sub>H</sub>	+12 V Power	20	V <sub>H</sub>	+12 V Power

### 3.3.1 Locking power and data connector

The display may be ordered with an optional 20 pin, 2 mm through-hole locking male header, Samtec EHT-110-01-S-D or equivalent. This locking connector is standard on the EL640.480 AG1 ET display. The mating connector is in the Samtec TCSD family of cable strips. Compatibility with non-Samtec equivalents should be verified before use.

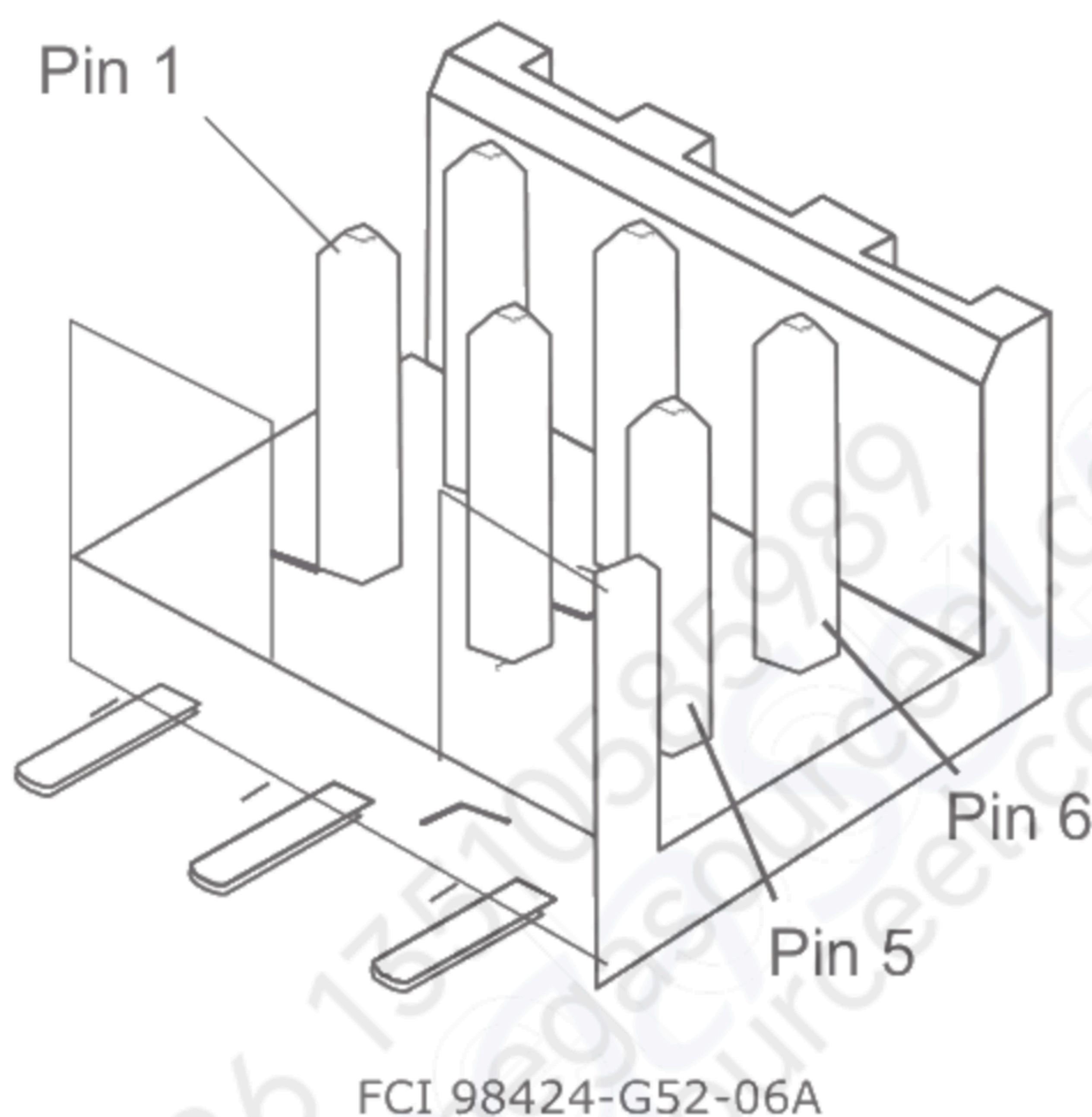


**Samtec EHT-110-01-S-D**



### 3.3.2 Dimming connector J2

The ET version of this display includes a J2 analog dimming circuit which is not available on the standard display. The J2 dimming connector is a 6-pin, straight-locking header made by FCI, part number 98424-G52-06A. The recommended mating connector is an FCI 89947-306 (IDC) or FCI 77138-001 and 90311-006 (crimp-to-wire receptacle plus housing) or equivalent.



**Table 4. J2 connector pinout**

Pin	Signal	Description	Pin	Signal	Description
1	LUM	Input for pot.	2	GND	Signal ground return
3	SLF	Self test mode selection, active low.	4	NC	No connect
5	NC	No connect	6	NC	No connect

## 3.4 Interface information

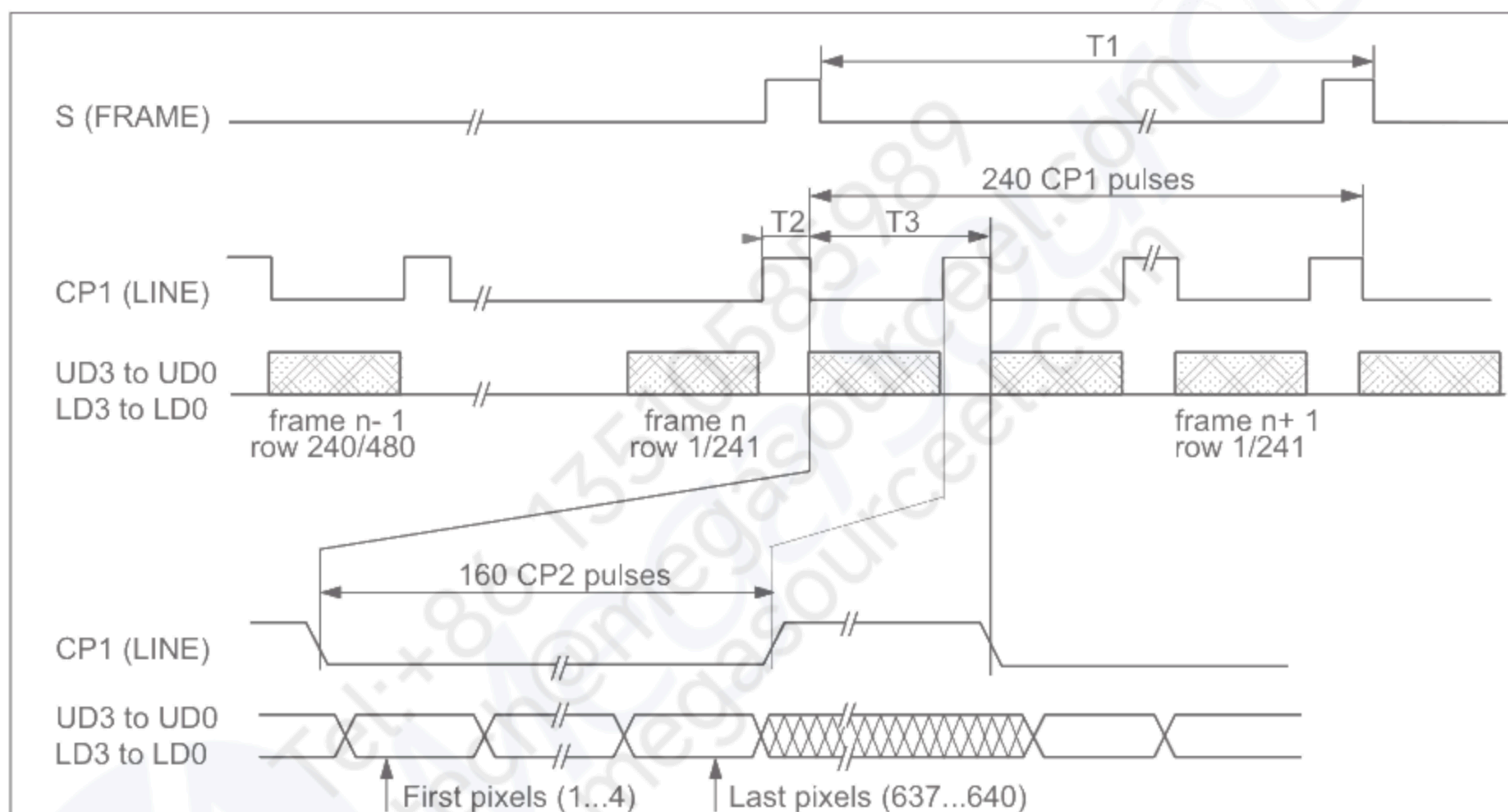
This dual scan LCD-type video interface provides a low cost, flexible method for controlling display brightness and power consumption. Many off-the-shelf chipsets are available for interfacing to flat panel displays. If your application does not require chip-level integration, there are many vendors that can supply board-level solutions for serial control, PC104, ISA, and many other interfaces.



### 3.4.1 Video input signals

The end of the top line of a frame is marked by S, scan start up signal as shown in Figure 2. The end of each row of data is marked by CP1 as shown in Figure 2 and Figure 3.

Input signals UD3—UD0 contain the video data for the upper screen and signals LD3—LD0 contain the data for the lower screen. For example, four pixels (UD3—UD0) are sent to row 1 at the same time as four pixels (LD0—LD3) are sent to row 241. This results in eight pixels sent on each cycle of video clock CP2. Pixel information is supplied from left to right and from top to bottom. Video data for one row is latched on the fall of CP1 (Figure 4).

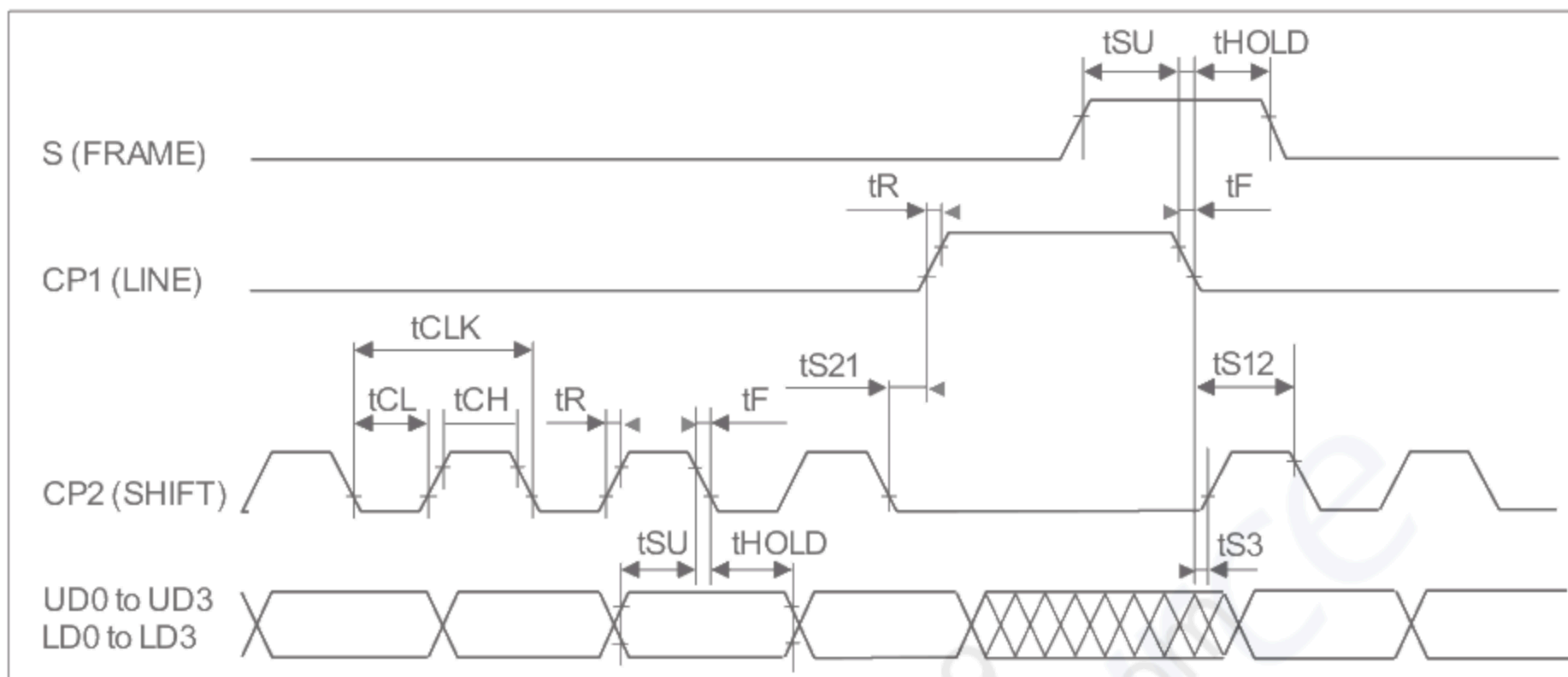


**Figure 2. Video input timing diagram**

**Table 5. Video input timing**

Symbol	Name	AG1		AG1 ET		Units
		Min	Max	Min	Max	
T1	Frame time	8.3	---	8.3	---	ms
	Frame frequency	---	120	---	120	Hz
T2	CP1 High time	60	---	60	---	ns
T3	CP1 Period	34.5	---	31.5	---	µs



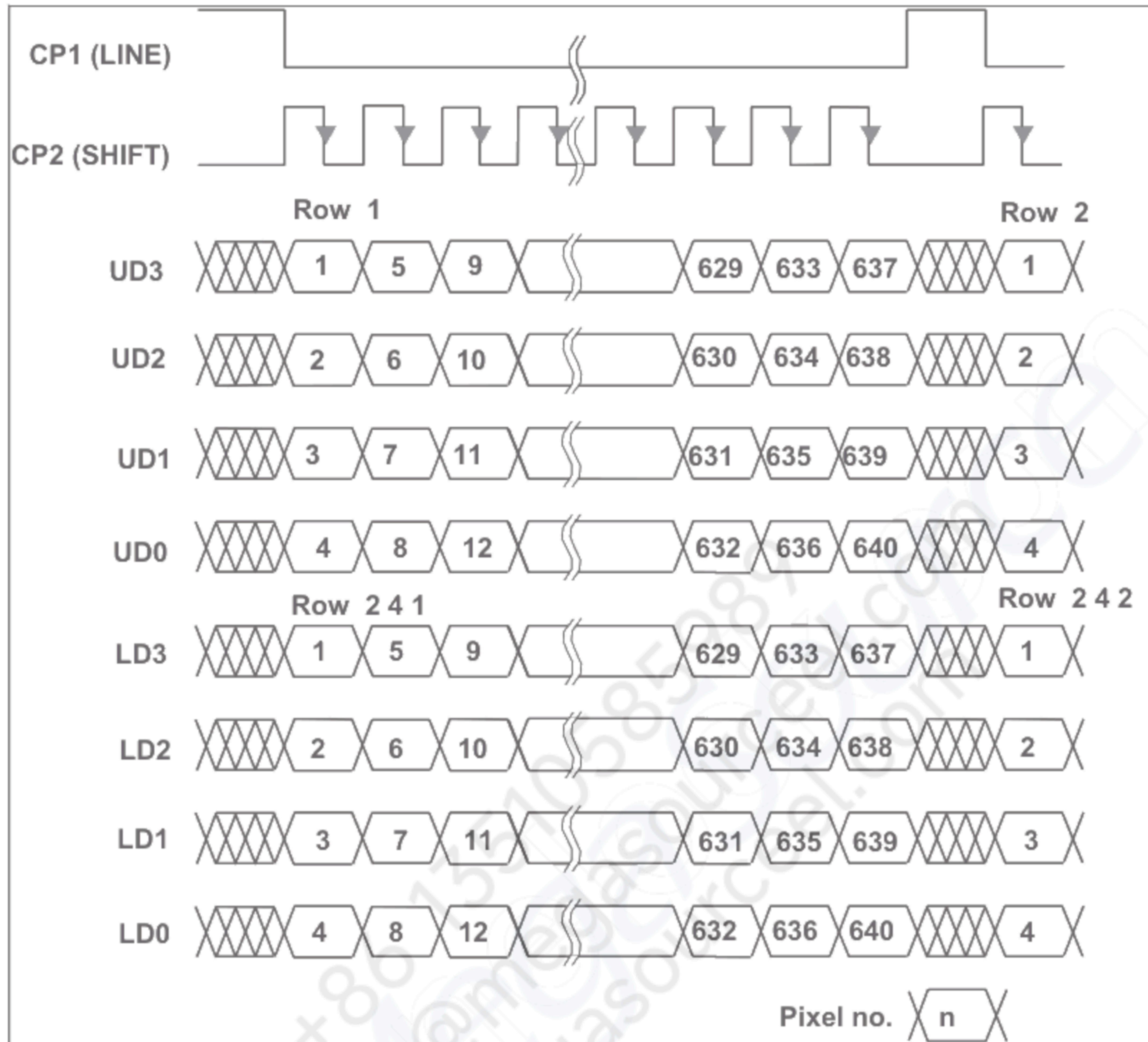


**Figure 3. Setup and hold timing diagram**

**Table 6. Setup and hold timing**

Symbol	Name	Min.	Max	Unit
tS21	CP1 allowance from CP2	0		ns
tS12	CP2 allowance from CP1	200		ns
tS3	CP1 allowance to CP2	50		ns
tSU	Setup time	50		ns
tHOLD	Hold time	40		ns
tR	Rise time		30	ns
tF	Fall time		30	ns
tCLK	CP2 clock cycle	154		ns
tCL	CP2 clock low time	60		ns
tCH	CP2 clock high time	60		ns
If CP1 (HS) low time >160 CP2 pulses, then non-displayed pixels should be at a logic low.				





**Figure 4. Data format**

### 3.5 Self-test mode

The EL640.480-AG1 display incorporates a self-test mode composed of a 1x2 checkerboard pattern that inverts every few seconds. The self-test mode is entered by applying power to the display with the S signal static. The display remains in this mode until two (2) low-to-high transitions of the S signal are detected. The display then enters and remains in normal (user video driven) operation as long as power is applied. To enter self-test mode again, the display must be reset by cycling the V<sub>H</sub> power input.

The EL640.480-AG1 ET display can enter self-test mode using the above method and also by grounding pin 3 of connector J2.



### 3.6 Optical performance

**Table 7. Optical characteristics**

<b>Luminance</b>		
L <sub>on</sub> (areal), min	40.0 cd/m <sup>2</sup>	Screen center, 120 Hz frame rate
L <sub>on</sub> (areal), typ	55 cd/m <sup>2</sup>	Screen center, 120 Hz frame rate
L <sub>off</sub> (areal), max	0.2 cd/m <sup>2</sup>	Center and four corners
<b>Non-uniformity</b>		
All pixels fully lit	35%	Maximum difference two of five points: $LNU\% = [1 - (\min\_lum / \max\_lum)] \times 100\%$
<b>Luminance variation (temperature)</b>		
Maximum	15%	Across operating temperature range
<b>Luminance variation (time)</b>		
Maximum	20%	10,000 hours at 25 °C ambient
<b>Viewing angle</b>		
Minimum	160°	
<b>Contrast ratio</b>		
Typical	33:1	@ 500 lux, 120 Hz
	5:1	@ 5000 lux, 120 Hz
	2.2:1	@ 15000 lux, 120 Hz

### 3.7 Dimming

The EL640.480-AG1 display uses frame rate dimming, which allows the display brightness to be lowered proportionally by reducing the frame rate. This is performed within the application by lowering the frame rate of the video input signals. Because brightness is proportional to the frame rate, the display can be dimmed by adding pauses between every horizontal period. The lowest useable frame rate (brightness) is dependent on the perceived flicker of the displayed image, but will most likely be around 60 Hz.

In addition to frame rate dimming, the EL640.480-AG1 ET display features analog dimming which dims the display to approximately 5% of the full brightness by connecting a 50K ohm logarithmic external potentiometer to the dimming port. Alternatively, an external voltage or current mode D/A converter may be used to facilitate dimming by sinking a maximum of 250 µA (for maximum dimming) from pin 1 to pin 2 of the dimming port.



### 3.8 Generating greyscales

The AG1 has a maximum frame rate frequency of 120 Hz. Using the higher frame rate, combined with flat panel controllers designed for this faster display, it is possible to generate usable greys through frame rate control and dithering. Many video controllers use these methods with proprietary algorithms to generate greyscales.

The fast response time of ICEBrite displays may cause loss of usable greyscales generated by the video controller. Many of the greyscales may flicker or swim. Careful testing is necessary to select appropriate greyscales for an application, especially when the ICEBrite displays are driven at less than their maximum frame rate.

### 3.9 Environmental

**Table 8. Environmental characteristics**

Temperature	AG1	AG1 ET
Operating	-5 to +55 °C	-40 to +85 °C
Operating Survival	-20 to +65 °C	-45 to +105 °C
Non-Operating	-40 to +75 °C	-45 to +110 °C
Humidity		
Non-condensing	93% RH max, @ 40 °C per IEC 68-2-3.	
Altitude	AG1	AG1 ET
Operating	0 to 5 km (16k ft)	18 km (58k ft)
Non-Operating	0 to 18 km (58k ft), per IEC 68-2-13.	
Vibration		
Random	0.05 g <sup>2</sup> /Hz, ASD level, 20-500 Hz, per IEC 68-2-36, test Fdb	
Shock	AG1	AG1 ET
Half sine wave	100 g, 4 ms	100 g, 6 ms
	18 (3 each, 6 surfaces) per IEC 68-2-27, test Ea	



### 3.10 Reliability

Except for performance characteristics with an otherwise specified life expectancy, the MTBF (mean time between failure) at 25 °C ambient is as shown in the table below.

**Table 9. Display life expectancy**

<b>EL640.480-AG1</b>	<b>EL640.480-AG1 ET</b>
30,000 hours	minimum of 50,000 hours

### 3.11 Safety and EMI performance

The display will not inhibit the end product from obtaining these certifications:

Safety      UL1950, IEC950

EMI          FCC Part 15/J, Class B; EN55022 Level B

### 3.12 Mechanical characteristics

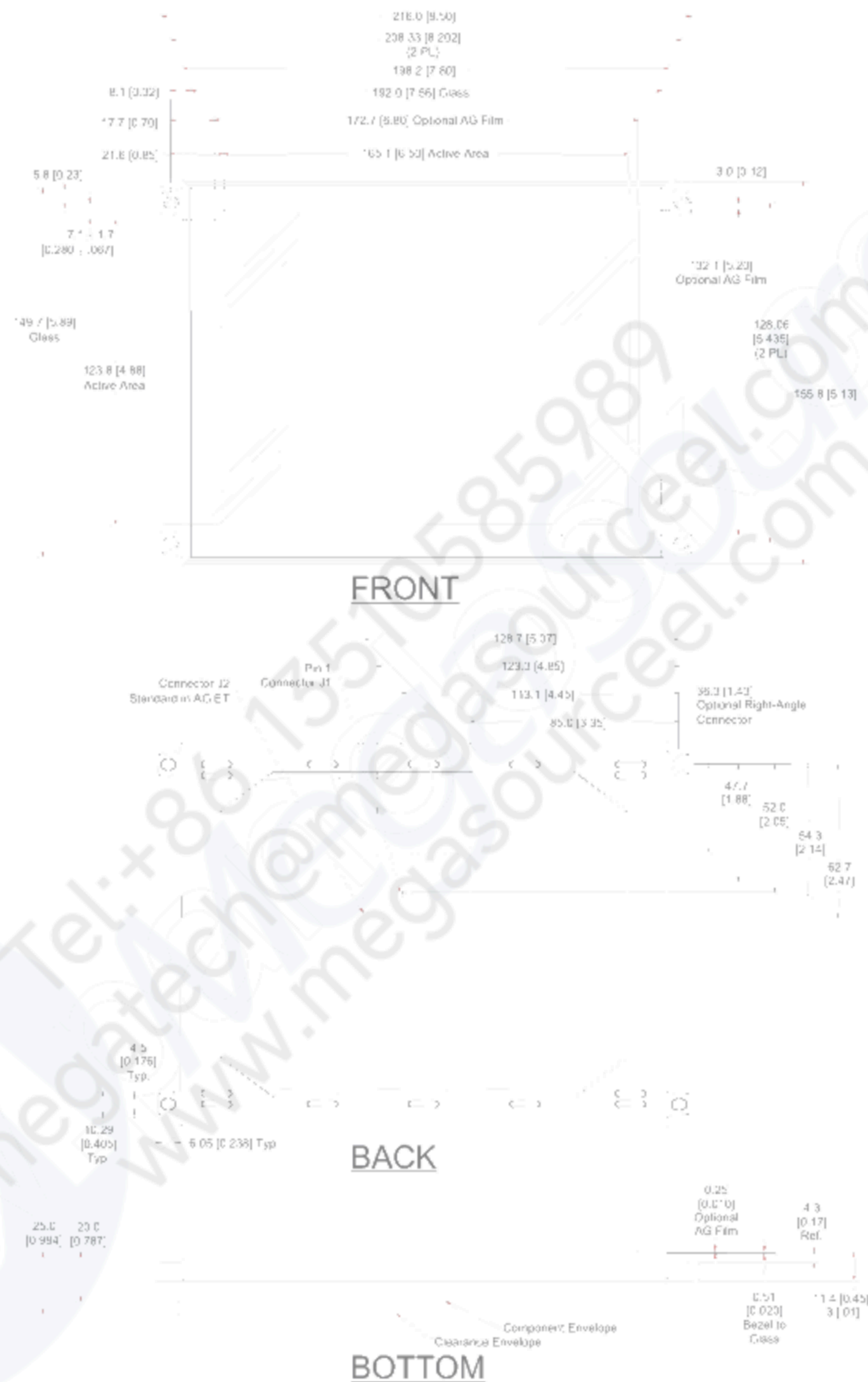
**Table 10. Mechanical characteristics**

<b>Weight</b>		AG1: 450 g, AG1 ET: 340 g
<b>Display size</b>		
millimeters (inches)	Width	218.4 (8.6)
	Height	155.8 (6.1)
	Depth	20.0 (0.8) Low-profile version is 18.0 (0.7)
<b>Active area</b>		
millimeters (inches)	Width	165.1 (6.5)
	Height	123.8 (4.8)
	Diagonal	205.0 (8.1)
<b>Fill factor</b>		58%
<b>Pixel pitch</b>		
millimeters (inches)	Width	.258 (0.010)
	Height	.258 (0.010)
<b>Pixel size</b>		
millimeters (inches)	Width	.197 (0.007)
	Height	.197 (0.007)



### 3.13 Component envelope

Figure 5 illustrates the distance 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.



Dimensions in are millimeters; inches in brackets.

Tolerances, unless otherwise stated,  $\pm 0.2$  mm. Connector is shown from the back side.

**Figure 5. EL640.480 AG1 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	Description
EL640.480-AG1	996-0269-00LF	Standard version
EL640.480-AG1 ET	996-0269-03	EL640.480-AG1 with -40 to +85 °C operating temperature and analog dimming. Non-RoHS

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.

### **Beneq Products Oy**

Olarinluoma 9  
FI-02200 Espoo  
Finland

Tel. +358 9 7599 530  
Fax +358 9 7599 5310  
lumineq@beneq.com

VAT ID FI25115461  
www.beneq.com  
www.lumineq.com



## 6 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.

## 7 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.

Beneq part number with an "LF" suffix designation indicates RoHS compliance, as shown on the part number label affixed to the display and on the box containing the display.

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