



**EL640.400-CB1/CB3 and –CD4
640 x 400 Pixel Display**

USER'S MANUAL

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Revision Control

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Product Profile

The EL640.400–CB1/3 and –CD4 displays are VGA compatible high-resolution electroluminescent (EL) flat panel displays. They replace the bulky CRT in control and instrument product designs. They feature an intergrated DC/DC converter, and their compact dimensions save space that can allow addition of features or reduction in overall size. The three displays are mechanically identical.

The displays are timing compatible with Planar EL640.400–C3/CD3 displays and signal compatible with VGA Feature Connector supporting the 350 and 400 line VGA modes. They may be driven at frame rates up to 72Hz.

The displays require +5Vdc and +12 or +24Vdc power input and four basic input signals to operate:

1. Video Data or pixel information
2. Video Clock, pixel clock, or dot clock
3. Horizontal Sync or Blanking
4. Vertical Sync

EL Technology

Planar EL displays consist of an electroluminescent glass panel and a mounted circuit board with control electronics.

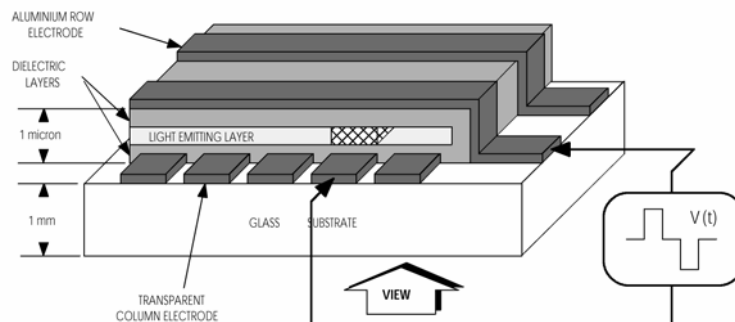


Figure 1. EL Technology.

The EL 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 aluminum; 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 ECA is connected to the EL glass panel with flexible interconnects. The result is a flat, compact, reliable and rugged display device.

The EL640.400-CD4 display includes a dark ICE (Integrated Contrast Enhancement) background in the display glass. ICE background significantly improves the luminance contrast of the display in bright ambients. ICE also removes the halo around the lit pixels in dark ambient making the appearance of each pixel crisp and clear.

In Planar EL640.400-C displays, the 640 column electrodes and 400 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.

Electrical Characteristics

Connector Layout

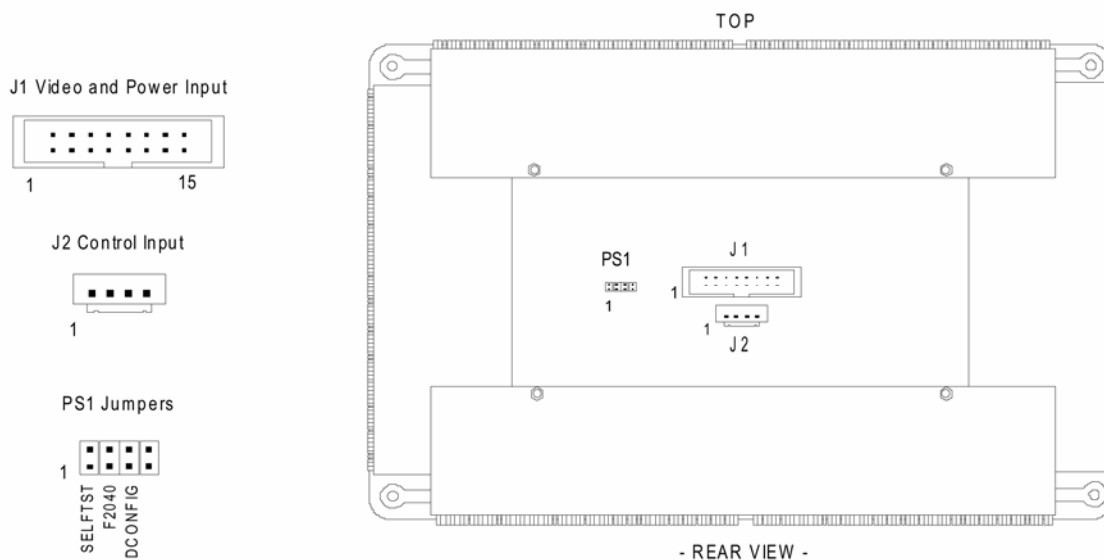


Fig 2. Input Connectors and their location.

Input to the Display

Table 1. Input to the Display.

Pin No.	Signal	Symbol	Description
J1(Data and power input connector)			
1, 2	Voltage	Vcc2	Supply voltage (+12 V/+24 V dependent on version, see Ordering Information in page 23) converted to required internal high voltages.
3, 4	Voltage	Vcc1	Supply voltage (+5 V) for the logic.
5	Blanking	_BLANK	Used in VGA modes. In NORMAL mode should be pulled HIGH or left disconnected.
6, 8, 10 12, 14, 16	Ground	GND	Signal return.
7	Two-bit data	TVID	Second data input for two bit parallel mode. The TVID input is for odd columns and the VID for even columns.
9	Vertical Sync	VS	The vertical sync signal VS controls the vertical position of the picture.
11	Horizontal Sync	HS	The horizontal sync signal HS controls the internal row counter and in the NORMAL mode the horizontal position of the picture.
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.
J2 (Optional control input connector)			
1	Luminance Pot.1	LUMPOT1	The inputs for an external logarithmic 50k Ω potentiometer to adjust the luminance of the display. Can be left disconnected. The luminance is then at the maximum level.
2	Luminance Pot.2	LUMPOT2	
3	Enable	ENABLE	Display operation is enabled if HIGH or left disconnected.
4	Ground	GND	Same as pins 6...16 in J1 (not necessary to be connected)

Control basics

The EL panel has 640 transparent column electrodes crossing 400 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 VCLK input signals. The internal control signals and the high voltage pulses for the column and row drivers are generated internally by the control electronics. All control signal inputs are HCT compatible.

Power Input

The required supply voltages for the display are +5 Vdc (Vcc1) for the logic and either +12 Vdc (-CB1 and -CD4) or +24 Vdc (-CB3) (Vcc2) for the integrated DC/DC converter. The high voltages needed for driving the display are generated by the DC/DC converter from the Vcc2 input voltage.

Signal Inputs

For easy interfacing with VGA display controllers the data and control input signals are VGA Feature Connector compatible. The display automatically determines the mode of operation.

The control input J2 includes contacts for optional luminance control and ENABLE signal to totally shut off the display when not in use (screen saver function).

Connectors

Table 2. Connectors.

J1	16-pin header Mating	ODU 511.066.003.016 or eq. ODU 517.065.003.016 or eq.
J2	4-pin header Mating	Hirose DF1-4P-2.5DSA or eq. Hirose DF1-4S-2.5 R 28 or eq.

Luminance Control

The displays feature luminance control capability for users to set the brightness of the display to meet the ambient lightning. The control function is achieved by drawing a 0...1 mA current from LUMPOT1 to ground (LUMPOT2). The luminance is at maximum level when the inputs are open. The voltage level of LUMPOT1 (J2/1) is appr. 5.1 Vdc when disconnected.

Self Test

The operation of the display can be easily checked using the SELFTST function. Self test is performed when SELFTST jumper (PS1/1) is set or no data input is present. During self test all pixels are lit except the left-most half of the topmost row of the display.

Jumper Description

Table 3. PS1.

Position Name	Function
1 SELFTST	Self test function is selected, if the SELFTTEST jumper is ON. In self test, the input video data at VID and TVID inputs are displayed asynchronously without any other input signals.
2 F2040	200 lines mode. All data is repeated in two consecutive rows. Normally should not be installed
3 DCONFIG	The Two-bits-parallel mode is selected if this jumper is set (see page 10.)
4	Reserved.

When shipped from the factory, no jumpers are set.

Input Specifications

Table 4. Input Specifications.

Parameter	Symbol	Min.	Typ.	Max.	Absolute max. rating
Logic input HIGH		2 V			Vcc1 + 0.5 V
Logic input LOW				0.8 V	-0.5 V
Logic supply voltage	Vcc1	4.75	5.0 V	5.25	6 V
Logic supply current at 5 V	Icc1	V	—	V	
Display Supply voltage (CB1, CD4)	Vcc2	—	12 V	0.2 A	15 V
(CB3)	Vcc2	10.8	24 V	14.4	30 V
Supply current at +12 V (CB1, CD4)	Icc2	V	0.8 A	V	
Supply current at +24 V (CB3)	Icc2	21.6	0.5 A	26.4	
Power consumption 5 V & 12 V		V	11 W	V	
Power consumption 5 V & 24 V		—	13 W	1.5 A	
		—		0.8 A	
		—		19 W	
		—		20 W	

Operating conditions: Frame rate 70 Hz. ambient temperature 25°C.

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

Display Features

Display Operation Modes

The displays have two input timing modes. VGA Mode supports standard 200, 350 and 400 row VGA modes and Normal Mode is similar to Normal Mode in most Planar displays. The operation mode is determined from combination of the polarities of the VS and HS pulses and the `_BLANK` signal at the rising edge of the VS pulse and the polarities of VS and HS pulses at the rising edge of the `_BLANK` pulse.

In VGA modes, the number of columns is determined by the number of VCLK pulses during a HS pulse. A tolerance of ± 1 pulse is accepted.

VGA Modes: The display data and control input is compatible with feature connector signals from VGA board. The display supports VGA modes 0, 1, 2, 3, 0*, 1*, 2*, 3*, 0+, 1+, 2+, 3+, 4, 5, 6, 7, 7+, D, E, F, 10 and 13. It notifies the polarity of the HS and VS at the rising edge of BLANK and determines the number of rows in the mode. **Note that in VGA modes 0, 1, 0*, 1*, 0+, 1+, 4, 5, D and 13, where the software uses 320 or 360 columns, the size of borders varies from one VGA- controller to another. Therefore the image may not be centered properly using those modes.**

The image is centred automatically, and in text modes with 720 pixels horizontally, every ninth pixel is omitted for compatibility. The non-displayed pixel is in the space region of the character matrix, and therefore no information is lost. The borders are normally eliminated because of the centering. The upper and lower borders are however displayed in the modes using 350 rows due to extra rows not needed for the picture.

The 480 row VGA modes are not supported. Even if the display does not scan in these modes (11, 12), it continues to operate with no failures when a supported mode is detected.

Normal Mode: This mode is pin and timing compatible with MD640.400 Series displays and the Normal mode of EL640.400–C3/CD3 series displays. In this mode only four input signals are needed: video data (VID), video clock (VCLK), horizontal synchronizing (HS) and vertical synchronizing (VS). `_BLANK` is not in use and should be pulled high or left disconnected.

In Normal mode the last 640 pixels before the fall of the HS are displayed. The topmost row displayed is the first HS HIGH time ending after HS Hold from VS time (T4 in Normal Mode) from the rising edge of VS. If HS is running continuously, the rising edge of the VS can be simultaneous to the previous falling or rising edge of the HS. See details on setup and hold timing as well as Normal Mode timing on page 14.

Supported VGA Modes

Table 5. Supported VGA Modes.

VGA Mode	Type	Text format	Char. box	Vsync Freq. (Hz)	Pixels (software)	Double Scan	Border size	
							H	V
0, 1	text	40 x 25	8 x 8	70	320 x 200	Yes	0	7
2, 3	text	80 x 25	8 x 8	70	640 x 200	Yes	8	7
0*, 1*	text	40 x 25	8 x 14	70	320 x 350	No	0	6
2*, 3*	text	80 x 25	8 x 14	70	640 x 350	No	8	6
0+, 1+	text	40 x 25	9 x 16	70	360 x 400	No	0	7
2+, 3+	text	80 x 25	9 x 16	70	720 x 400	No	9	7
4, 5	graph	40 x 25	8 x 8	70	320 x 200	Yes	0	7
6	graph	80 x 25	8 x 8	70	640 x 200	Yes	8	7
7	text	80 x 25	9 x 14	70	720 x 350	No	9	6
7+	text	80 x 25	9 x 16	70	720 x 400	No	9	7
D	graph	40 x 25	8 x 8	70	320 x 200	Yes	0	7
E	graph	80 x 25	8 x 8	70	640 x 200	Yes	8	7
F	graph	80 x 25	8 x 14	70	640 x 350	No	8	6
10	graph	80 x 25	8 x 14	70	640 x 350	No	8	6
13	graph	40 x 25	8 x 8	70	320 x 200	Yes	0	7
Normal mode	graphics			72 max	640 x 400			

NOTES:

In VGA modes 0+, 1+, 2+, 3+, 7 and 7+ the character box width is narrowed to 8 pixels by omitting the data of every 9th pixel. In VGA modes 0, 1, 0*, 0+, 1+, 4, 5, D and 13, where the software uses 320 or 360 columns, the size of borders may vary from one VGA-controller card to another. The potentially needed picture adjustments may be done by programming the registers of the VGA controller chip.

Double Scan is a VGA card feature.

VGA modes 11 and 12 with 480 rows are not supported.

Display Enable

The display can be totally shut off for screen save or power reduction by a LOW state in the ENABLE control input. When disabled, the display is totally dark and only the DC/DC converter remains functional consuming only appr. 2 W. In normal operation, the ENABLE input should be pulled HIGH or left disconnected (internal pull-up).

200 Rows Mode

200 Input data rows may be displayed using 400 rows by automatically doubling every data row to two consecutive display rows. This function is

selected by installing jumper PS1/2 (F2040). The _BLANK input must also be in LOW state. For more information of this mode contact Planar.

Two Bit Parallel Data

To reduce the input data frequency in NORMAL mode the Video data can be input two bits per clock cycle. The two data inputs are organized so that the data for the odd columns, numbered from left to the right at the viewers side, is input at the TVID (J1/ pin 7) and the data for the even columns at VID (J1/ pin 15). The two bit parallel mode is selected by installing jumper 3 of the pin strip PS1.

Brightness Control

The brightness of the display can be adjusted (appr. between 10 and 100%) by an external 50 logarithmic potentiometer between the LUMPOT1 and LUMPOT 2 inputs (J2/pins 1 and 2). The control function is done by feeding a small DC current signal via the external potentiometer from LUMPOT1 (+5V reference voltage) to LUMPOT2. If the two inputs are left disconnected, the brightness is at its maximum level.

Self Test

The operation of the display can be easily checked without any external signals by the self test function.

Insert Jumper 1 in pinstrip PS2.

Connect power to the display.

All pixels of the display will be lit with the exception of the first half of the topmost row.

Installation and Handling

Mounting

Mounting of the display should be done using the M3 insert nuts on the four corners of the plastic assembly support or the four holes in the FRA frames.

Note that because all four mounting points are internally connected to signal ground care should be taken to avoid grounding loops.

Handling

Before handling 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.

The flexible interconnects between the display glass and the ECA carry high voltages and are very sensitive to touch. Handling and mounting of the display should be done from the four corners of the assembly support only.

Cable Length

For trouble-free data transfer from data transmitter to display input connector, a maximum cable length of 600 mm (24 in.) is recommended. In case of VGA Feature Connector use, proper signal buffering should be ensured. In order to lower signal reflections, the connecting cable should be terminated with appr. 100 series resistor at each of the five signal line outputs of the signal source.

Avoiding Burn-in

As with any other light emitting display, luminance variations may be noticed if fixed patterns are displayed on the screen for extended periods. It is prudent to use a screen saver or image inversion to avoid burn-in.

Electrostatic Caution: This Planar 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 195 Vac). Do not touch the display electronics during operation!

Timing Characteristics

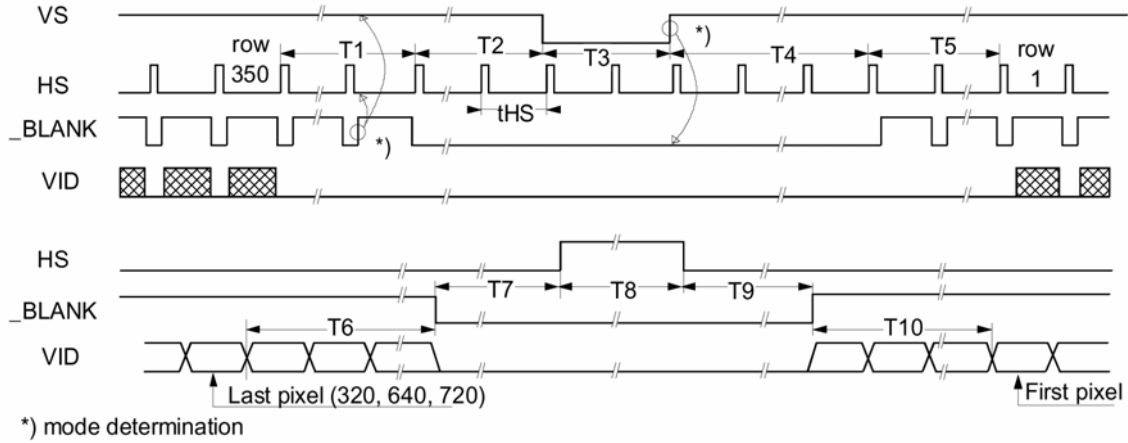


Fig 3. 350 Row VGA Modes (see page 9).

Table 6. 350 Row VGA Modes.

Description				Unit
T1 Vertical Border	6			tHS
T2 Vertical Front Porch	31			tHS
T3 VS Pulse Width	2			tHS
T4 Vertical Back Porch	54			tHS
T5 Vertical Border	6			tHS
HS pulses / VS	449			
VS frequency	70			Hz
Description	320	640	720	Unit
T6 Horizontal Border	0	8	9	tVCLK
T7 Horizontal Front Porch	8	8	9	tVCLK
T8 HS Pulse Width	48	96	108	tVCLK
T9 Horizontal Back Porch	24	40	45	tVCLK
T10 Horizontal Border	0	8	9	tVCLK
VCLK pulses / HS	400	800	900	
HS period	31.8	31.8	31.8	μ s

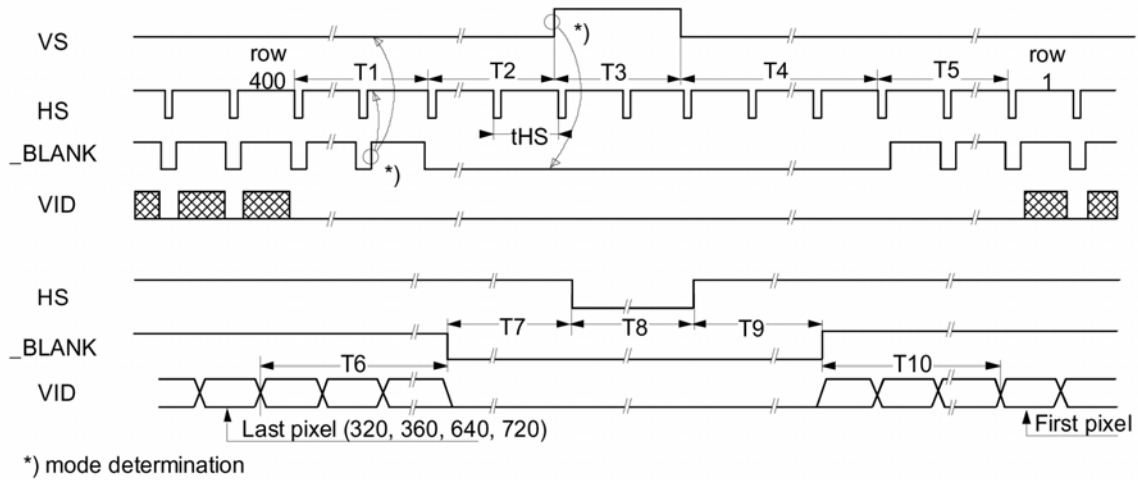


Figure 4. 400 Row VGA Modes (see page 9).

Table 7. 400 Row VGA Modes

Description					Unit
T1 Vertical Border	7				tHS
T2 Vertical Front Porch	5				tHS
T3 VS Pulse Width	2				tHS
T4 Vertical Back Porch	28				tHS
T5 Vertical Border	7				tHS
HS pulses / VS	449				
VS frequency	70				Hz
Description	320	360	640	720	Unit
T6 Horizontal Border	0	0	8	9	tVCLK
T7 Horizontal Front Porch	8	9	8	9	tVCLK
T8 HS Pulse Width	48	54	96	108	tVCLK
T9 Horizontal Back Porch	24	27	40	45	tVCLK
T10 Horizontal Border	0	0	8	9	tVCLK
VCLK pulses / HS	400	450	800	900	
HS period	31.8	31.8	31.8	31.8	μs

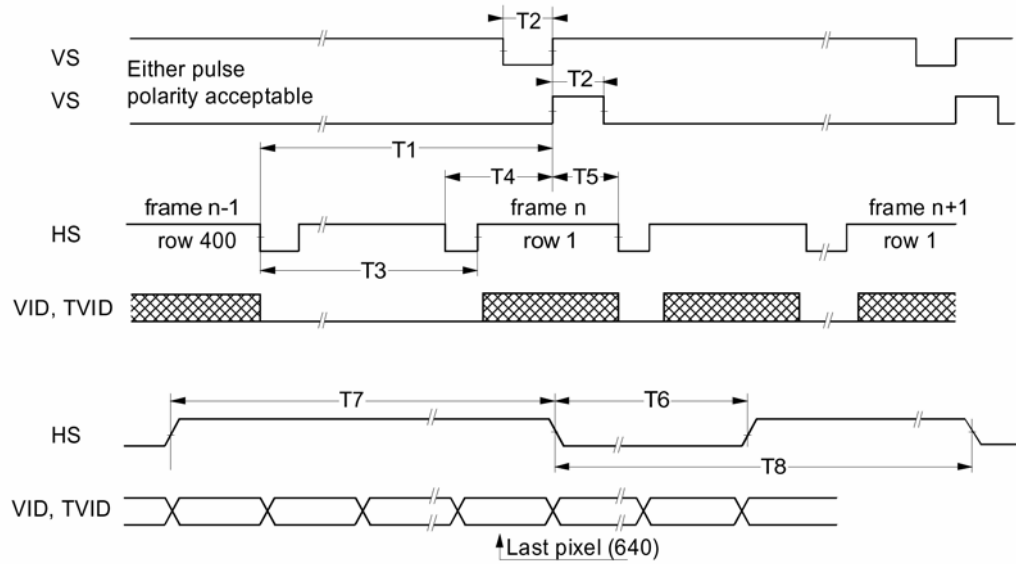


Fig 5. 640 columns x 400 Rows Normal Mode.

Table 8. 640 columns x 400 Rows Normal Mode.

Description	Min	typ	Max	Unit
T1 Vertical Front Porch ¹⁾	60			μ s
T2 VS HIGH/LOW time ²⁾	1			tVCLK
T3 Vertical Blank	40			μ s
VS frequency		70	72	Hz
VS period	400			tHS
Description	Min	Typ	Unit	
T4 HS setup to VS	9		tVCLK	
T5 HS hold from VS	2		μ s	
T6 HS Low Time ⁵⁾	4		tVCLK	
T7 HS High Time ⁶⁾	640	640	tVCLK	
T8 HS period (tHS)	31		μ s	

1) This is the time needed to display the last row and to change the frame.

2) Only rising edge is used.

5) Video Clock VCLK should be kept running continuously.

6) The number of VCLK pulses during HS high time should be even.

Setup and Hold Timing

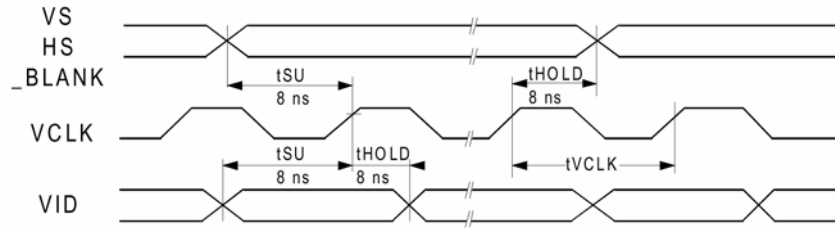


Fig 6. Setup and Hold Timing.

Table 9. Setup and Hold Timing.

Mode	t_{VCLK} ns	f_{VCLK} MHz
2+, 3+, 7, 7+	35.31	28.322
2, 3, 2*, 3*, 6, E, F, 10	39.71	25.175
0+, 1+	70.62	14.161
0, 1, 0*, 1*, 4, 5, D, 13	79.43	12.588
NORMAL	Min 33	Max 30

Operational Specifications

Environmental

Table 10. Environmental Characteristics.

Temperature	
Operating	0...+55°C
Non-operating	-40...+85°C
Operating Survival	-20...+65°C (no permanent damage)
Test duration 24 h at -20°C (without condensation)	
Humidity	
Relative Humidity	+40°C, 93% RH, Operating (IEC 68-2-3)
Damp Heat	+25...+55°C, 95% RH, Non operative (IEC 68-2-30)
Altitude	
Operative	15,000 m (50,000 ft.) above sea level
Vibration	
	20...500 Hz
	ASD level 0.05 G ² /Hz
	Random vibration wide band
	IEC 68-2-36, Test Fdb
Shock	
Magnitude	100 G
Duration	4 ms (half sine wave)
Number of shocks	18 (3 on each of the 6 surfaces)
	IEC 68-2-27, test Ea

Reliability

MTBF > 50000 h @ 25°C

Safety

The display will not inhibit the end product from obtaining any of the following specification: UL1950, UL544, CSA154, IEC 950

EMC

The display will not inhibit the end product from obtaining any of the following specifications: EN55022 Class B, FCC Part 15J Class B

Optical

Determined at 70 Hz frame rate at 25°C

Display colour

Wide band amber (Zn:Mn)

Table 11. Optical Characteristics.

Areal Luminance		
On Luminance (typ)	CB1/CB3	53 cd/m ² (16 fL)
	CD4	22 cd/m ² (6.4 fL)
On Luminance (min.)	CB1/CB3	45 cd/m ² (13 fL)
	CD4	17 cd/m ² (5.0 fL)
Measured at the center and the four corners of the screen.		
Non-uniformity		
	35%	= (1- min. luminance/max luminance) x 100. Maximum difference between any two of five points (center and four corners)
Luminance Variation (Time)		
Maximum	20%	10,000 h
Luminance Variation (Temperature)		
Typical	10%	over 0...+55°C range.
Maximum	15%	
Luminance Contrast Ratio		
Minimum	CD4	7:1 @500 lx 3:1 @ 1800 lx
Viewing Angle		
Minimum	160°	

Illuminance	Classification
1 ... 10 lx	dark
10 ... 100 lx	dim
100 ... 1,000 lx	office
1,000 ... 10,000 lx	bright
10,000 ... 100,000 lx	sunlight

Filter

The luminance contrast of the ICE display CD4 is sufficient for operation without contrast enhancement filter. For best overall performance of the monochrome CB1 and CB3 displays in high or low ambient light levels, a neutral gray circular polarizing filter with anti-reflective coating or etch is recommended. This filter will make the background of the display darker and will improve the luminance contrast ratio. The anti-reflective coating on the filter should face the user.

Mechanical Characteristics

Display External Dimensions

Fig. 7 shows the mechanical dimensions of a standard EL640.400–CB1 /CB3 or –CD4 display unit. The display can also be delivered with aluminium mounting frames (see Fig. 9). See Ordering Information on page 23.

Table 12. Display External Dimensions.

Height	147 mm	5.79 in.
Width	225 mm	8.86 in.
Depth	23 mm	0.91 in.
Weight	400 g	14 oz.

Display Viewing Area Characteristics

Table 13. Display Viewing Area Characteristics.

Active Area millimeters (inches)	height	121.8 (4.80)
	width	195.0 (7.68)
Pixel Pitch millimeters (inches)	height	0.305 (0.012)
	width	0.305 (0.012)
Pixel Size millimeters (inches)	height	0.178 (0.007)
	width	0.212 (0.008)
Pixel fill factor	41%	
Pixel Matrix	640 horizontal by 400 vertical	

CAUTION: The ambient temperature of the display should not be allowed to exceed the environmental specifications (see Table 10). In most applications, an air gap of appr. 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.

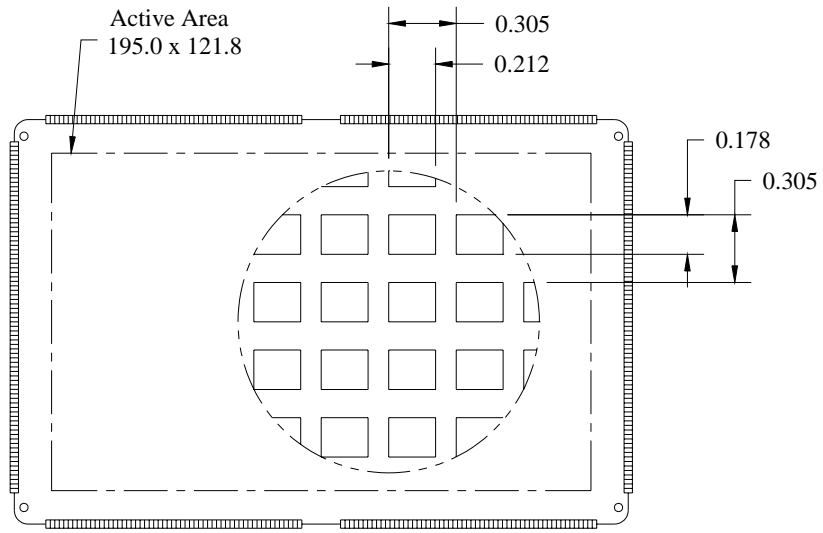


Fig 7. Viewing Area Characteristics.

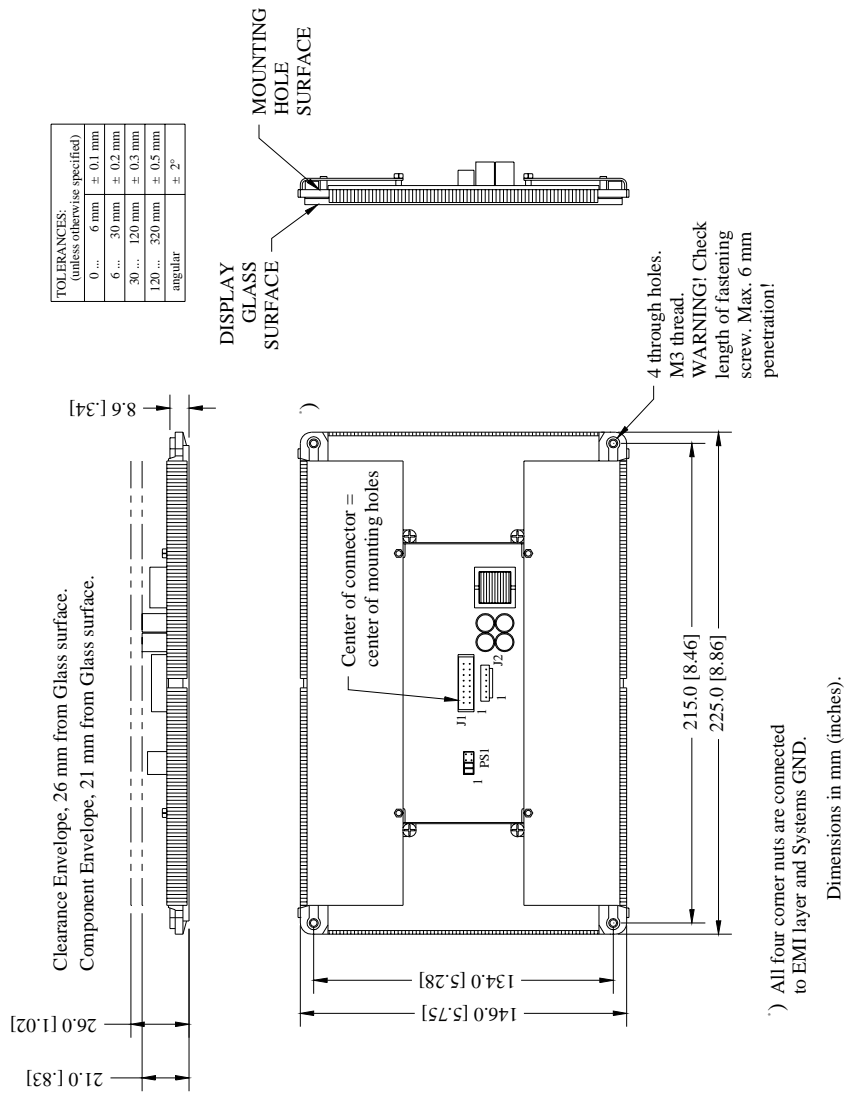
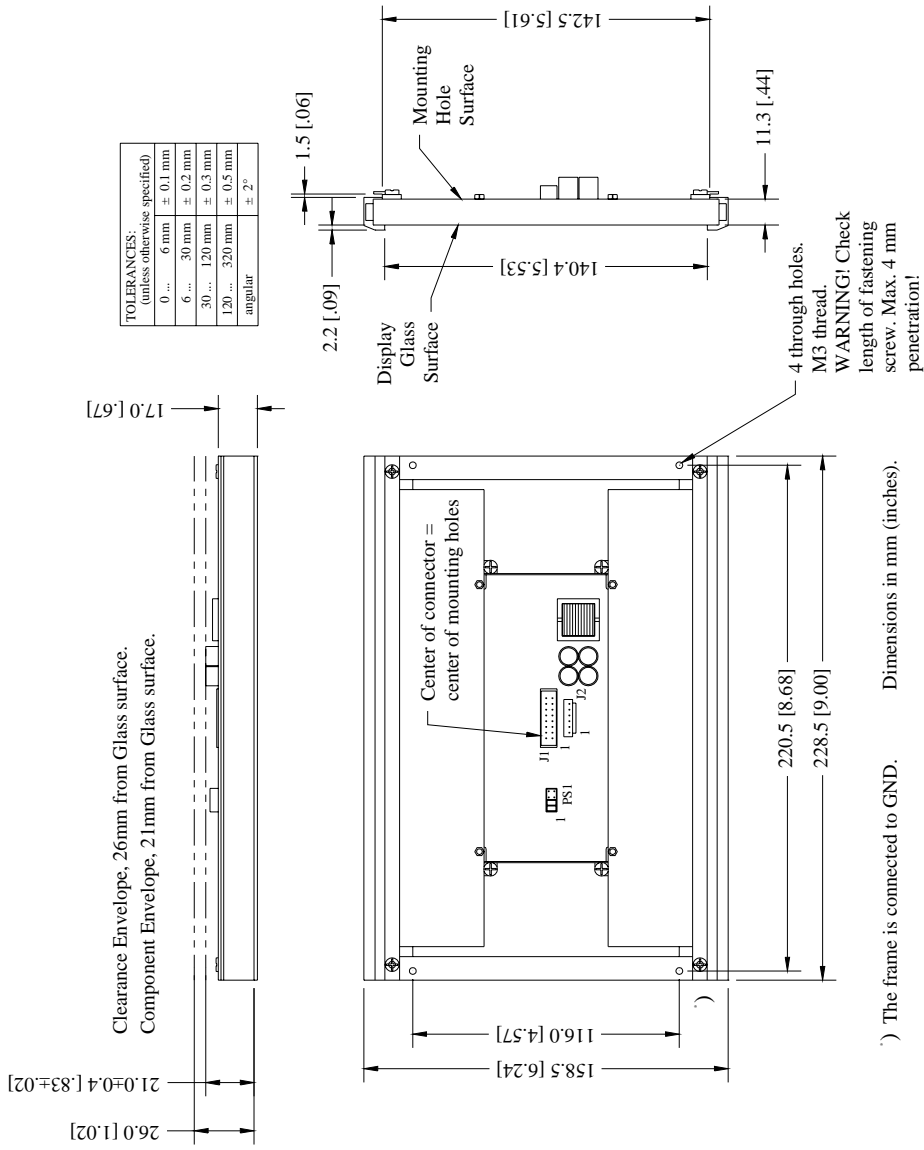


Fig 8. EL640.400-CB1/CB3 and -CD4 Back and Side Views.



EL640.400-CB1/CB3 and -CD4 FRA Back and Side Views.

**Fig
9.**

Description of Warranty

Seller warrants that the Goods will conform to published specifications and be free from defects in material for 12 months 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.

Easy to Use

There are many options available which make Planar flat panel displays easy to use, easy to interface, and easy to package. Examples of options which are typically available include filters, touch panels and interface cards. Call Planar for complete information and availability.

Support and Service

Planar is a US company based in Beaverton, Oregon and Espoo, Finland with a worldwide sales distribution network. Full application engineering support and service are available to make the integration of Planar displays as simple and quick as possible for our customers.

RMA Procedure: For a Returned Material Authorization number, please contact Planar Systems, Inc., with the model number(s) and original purchase order number(s). 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.

Ordering Information

Product	Part Number	Description
EL640.400-CB1 FRA	996-5073-00	EL640.400 non-ICE, Op. temp 0 - +55° C with aluminium mounting frame
EL640.400-CB3	996-5079-00	EL640.400-CB series display with a VH of 24V nominal input and frame.
EL640.400-CB3 FRA	996-5078-00	EL640.400-CB series display with a VH of 24V nominal input and frame.
EL640.400-CD4 FRA	996-5085-00 / E0064450301	EL640.400 ICE, otherwise same as EL640.400 CB1-FRA

Planar Systems, Inc.

Customer Service

24x7 Online Technical Support: <http://www.planar.com/support>

Americas Support

1195 NW Compton Drive

Beaverton, OR 97006-1992

Tel: 1-866-PLANAR1 (866) 752-6271

Hours: M-F, 5am - 5pm Pacific Time

Europe and Asia-Pacific Support

Olarinluoma 9 P.O. Box 46

FIN-02201 Espoo, Finland

Tel: +358-9-420-01

Hours: M-F, 7:00am - 4pm CET

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