APPLICATIONS

APPLICATIONS
Product Application

What is the Application of Your Product?

Application	Product Longevity	Long Production Life >5 years	Wide Viewing Angle	High Contrast	Fast Response	Thick Gloves
Medical	•	•	•	•	•	
Military	•	•	•	•	•	•
Marine	•	•	•	•		
Industrial Automation	•	•				•
HVAC	•	•		•		
Alarm Clock				•		
GPS	•	•	•			
Automotive	•	•	•	•	•	
Wearable High End						
Wearable Basic				•		
Desk Monitor					•	
Smart Phone			•		•	
Tablet			•		•	
Point of Sales						
Kiosk	•				•	
ATM	•				•	•
Transportation	•	•	•		•	
Agriculture	•	•	•			•
Security	•				•	•
Spa/Pool Controller	•			•		

Application Table

Latex Gloves	Rugged	Strengthened Glass	Privacy Required	Anti- Reflective	Sunlight Readable	Battery Powered
•				•		
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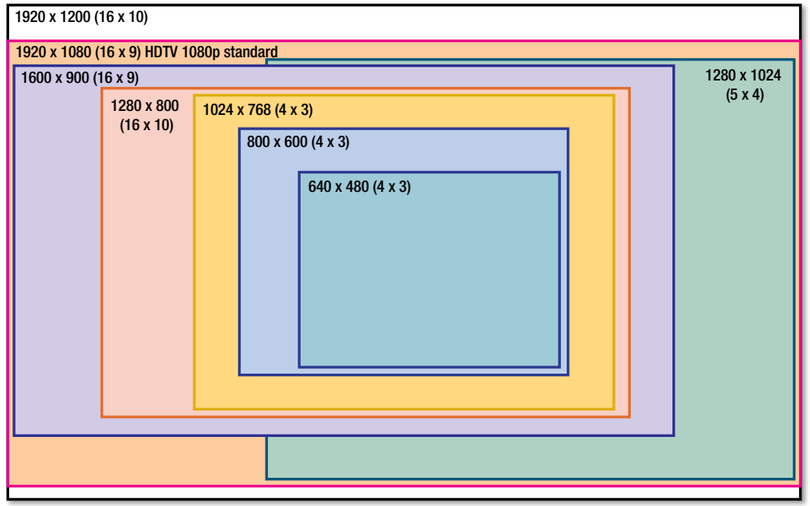
What Size of Display Do You Need?

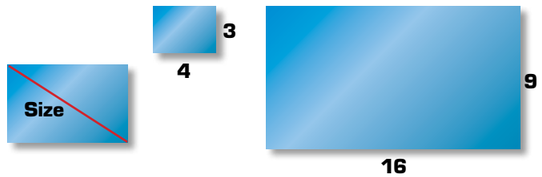
Displays sizes are measured by the diagonal length of the active area, as with televisions. Although this is a great reference, the shape can be variable, for example: 4:3 aspect ratio, 16:9, landscape, portrait, or span (custom cut).

Resolution



Typical Sizes and Shapes

3.5" – 4:3	10.1" – 16:9	15" – 4:3
4.3" - 16:9	10.4" – 4:3	15.6" – 16:9
7" – 16:9	12.1" – 4:3	21.5" – 16:9



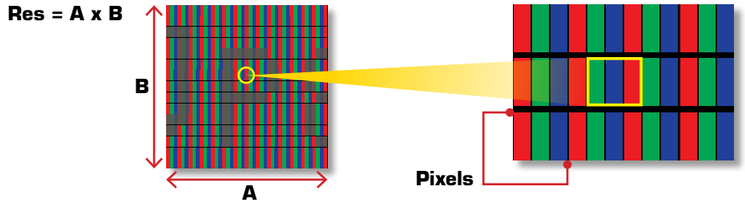
It is also possible to buy parts that are non-standard or customized, for example SpanPixel from Litemax. They have a very wide displays for transport or signage - SSD3840 - 38" resized, 2000 nits, ultra high brightness LED backlight, 1920 x 502 pixels, ultra wide aspect ratio 16:4.2.

Manufacturer	Part Number	Size (In)	Resolution Name	Resolution Pixels
AZ Displays	ATM0177B3A-T	1.8	N/A	128 x 160
Tianma NLT USA	TM035HBHT6	3.5	QVGA	240 x 320
Tianma NLT USA	NL6448BC20-30C	6.5	VGA	640 x 480
Tianma NLT USA	NLB150XG01L-01	15	XGA	1024 x 768
Sharp	LQ156M1LG21	15.6	FHD1080	1920 x 1080
Litemax	DLF1825-ETN	18.5	WXGA	1280 x 800

What is the Preferred Resolution?

The resolution is the number of pixels left to right multiplied by the number of pixels top to bottom. The resolution will define the quality of the final image displayed.

Typical resolutions are: 640 x 480 (VGA), 1920 x 1080 (Full HD), 3840 x 2160 (UHD), 4096 x 2160 (True 4K HD).



In resolution when the first number is larger than the second number, the display has been manufactured for landscape mode (typical or larger size displays above 5"). Some displays have been designed to be switched between landscape or portrait. This is typical on mobile devices. Care has to be taken in the design as not all displays can switch between either landscape or portrait.

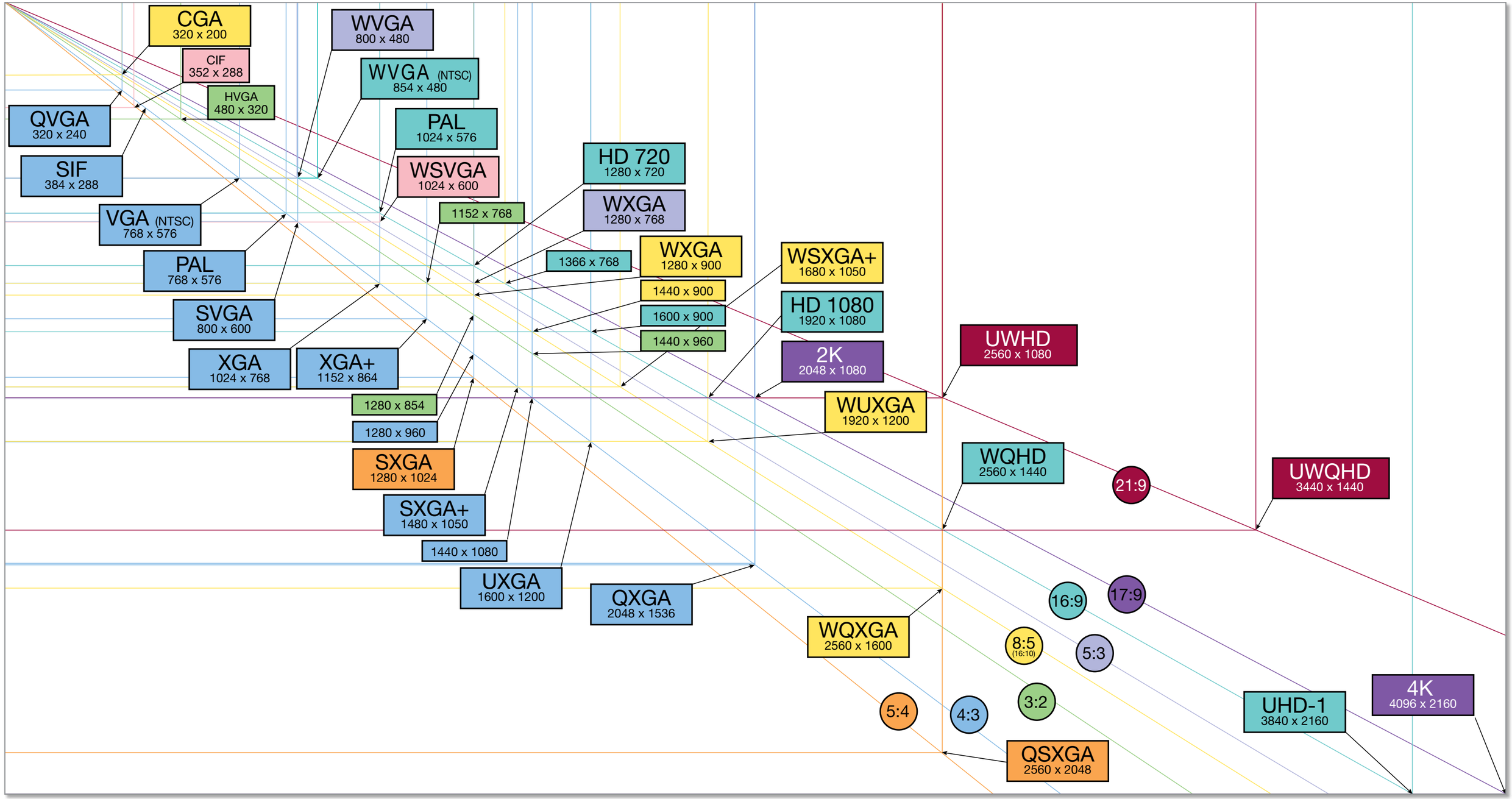
Pixels and Resolution

The display resolution of an LCD is the number of distinct pixels horizontally and vertically that can be displayed. It is usually quoted as width × height, with the units in pixels. For example, the full HD resolution of 1920 x 1080 means 1920 pixels wide and the height is 1080 pixels from top to bottom. Full HD is also a 16 x 9 aspect ratio commonly called wide screen.

Refer to the chart on page 44 for more details on standard resolutions and aspect ratios.

DID YOU KNOW?

In 1987 IBM introduced Video Graphics Array (VGA) for their computer hardware. This standard was cloned by other manufacturers and became a standard resolution of 640 x 480.

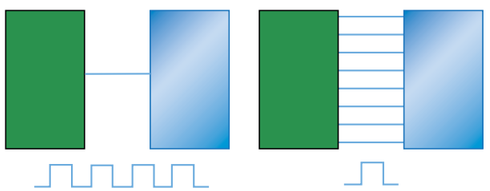

CGA
320 x 200
CIF
352 x 288
HVGA
480 x 320
QVGA
320 x 240
SIF
384 x 288
VGA (NTSC)
768 x 576
PAL
768 x 576
SVGA
800 x 600
XGA
1024 x 768
XGA+
1152 x 864
1280 x 854
1280 x 960
SXGA
1280 x 1024
SXGA+
1480 x 1050
1440 x 1080
UXGA
1600 x 1200
QXGA
2048 x 1536
WVGA
800 x 480
WVGA (NTSC)
854 x 480
PAL
1024 x 576
WSVGA
1024 x 600
1152 x 768
HD 720
1280 x 720
WXGA
1280 x 768
1366 x 768
WXGA
1280 x 900
1440 x 900
1600 x 900
1440 x 960
WSXGA+
1680 x 1050
HD 1080
1920 x 1080
2K
2048 x 1080
WUXGA
1920 x 1200
UWHD
2560 x 1080
WQHD
2560 x 1440
21:9
UWQHD
3440 x 1440
16:9
17:9
8:5
(16:10)
5:3
3:2
5:4
4:3
WQXGA
2560 x 1600
QSXGA
2560 x 2048
UHD-1
3840 x 2160
4K
4096 x 2160

Choosing the Right Interface

Displays have many different interfaces; sometimes a single display may use more than one type. Typically, one interface carries the image information and a second interface is used for configuration.

The interface for the image can be divided in two major categories: serial or parallel. With the serial method, the information is sent as a series of bits or logic levels (0 or 1), where as in parallel the bits are sent simultaneously across multiple wires. Refer to the diagrams below.

The biggest advantage of the serial interface displays is that they use fewer pins with smaller connectors. However, compared to a parallel interface, a serial interface will require a faster speed to transfer the same amount of information over fewer wires. Depending on the panel data rate requirement, there may be many serial channels transmitted in parallel.



Serial Interface
(one bit at a time)

Parallel Interface
(multiple bits at a time)

For color TFT panels, both serial or parallel interfaces can handle a different number of bits, which are typically related to the amount of colors that can be displayed. For monochrome displays, the amount of bits may refer to the resolution of the grayscale or a single color scale.

Parallel interfaces are typically used to transfer image content to a display. Serial interfaces can also be used to either transfer image content and/or to act as a configuration serial bus. For example:

- High speed serial for high resolution panels: LVDS, MIPI
- Low speed configuration bus: I²C, SPI, UART

Parallel Interface (also known as RGB or Parallel CMOS)

Examples of LCD parallel interfaces (but not limited to):

- 24-bits - 8-bits Red, 8-bits Blue, 8-bits Green – up to 16 million colors
- 16-bits - 5-bits Red, 6-bits Green, 6-bits – up to 65,536 colors
- 8-bits - Most common - used on graphic and character controllers
- 4-bits - Used on some monochrome QVGA modules

Parallel CMOS LCDs are typically used for medium resolutions in the 480 x 272 range and may have up to 8-bits per color channel (red, green and blue). Typical color depths are 8-bits per pixel color channel (8 x 3 = 24-bit display) and 5 + 6 + 5-bits for each respective pixel color for a total of 16-bits.

Serial Interface

Main Serial Interface Types:

- RS232/UART Interface
- LVDS
- MIPI
- SPI (Serial Peripheral Interface)
- I²C (Inter-Integrated Circuit)

SPI Interface

SPI, or Serial Peripheral Interface bus, is a synchronous (data is synchronized to the clock) serial data link standard that operates in full duplex mode, which means that devices that can communicate with one another simultaneously. To do this, two data lines are required (MISO/MOSI). With this standard, devices communicate in a master/slave mode, where the master device (host processor) initiates the data, the clock and the slave select. The LCD module is the (or one of the) peripheral slave device(s) attached to the data bus. Multiple peripherals (display modules and other devices) can be addressed on the same serial data bus. However, the LCD module will only listen to the data it sees when the slave select line is active (usually low). If the slave select line is inactive (usually high), the LCD module listens to the data on the bus, but ignores it. The SDO line is not active when this state occurs.

The SPI bus is comprised of four logic signals, two control lines and two data lines and is commonly referred to as 'SPI (4 wire)'.

I²C (Inter-Integrated Circuit)

I²C uses only two bi-directional lines, serial data line (SDA) and serial clock (SCL), which are both typically pulled up with resistors. Typical voltages used are +5V or +3.3V. One of the strengths of the I²C interface is that a microcontroller can control multiple devices with just the two I/O pins (+ground) and software. Because of the I²C design using a single data line, it is therefore only half-duplex. The interface generally transmits 8-bit words, sending the most significant bit first.

RS232/UART Interface

The RS232 or UART serial interface uses 3 (up to 5) lines to control the LCD module. These are transmit, receive, and ground (also RTS and CTS if necessary). This is an asynchronous interface; therefore the pattern on the data line will determine the start and stop ends of a message frame, which frame conveys a single byte of data at a time.

It is used most often as a side configuration serial bus since it is low speed, but also as main data lines for slow displays.

LVDS (Low-Voltage Differential Signaling)

LVDS is typically used on displays from resolutions of 800 x 600 and above. The interface can handle color depths of 8 bits per pixel color channel (24-bit display) or 6-bits per pixel color channel (18-bit display). Some newer LCD panels are increasing their color depths to beyond 8-bits per color channel.

LVDS is the mechanical hardware method of transmitting data across wires and is not an interface protocol. It is generally used for high speed data transfer over longer distances and can be used with a either serial or a parallel protocol.

By transmitting the same voltage level across two wires then subtracting them at the LCD module, the common noise is removed, leaving the desired logic signal. The wires are typically in twisted pairs which reduces the amount of radiated electromagnetic noise. The fact that it is low voltage swing means the power losses are reduced for a given bit rate compared to CMOS or similar higher voltage interfaces.

Using coupled twisted pairs with odd mode differential signaling (180 degree opposed waveforms) will tend to radiate much less than single wire data signals, due to the canceling of the induced magnetic fields.

MIPI (Mobile Industry Processor Interface)

MIPI was created by the MIPI Alliance companies and was designed for mobile devices that were battery powered and where power consumption is a design requirement. The MIPI standard for displays is the display serial interface or DSI (a low-power high speed interface). Following trends in the electronic industry moving from parallel to serial, an OEM can use the standardized interconnect protocol to run seamless integration from either one IC supplier or another as long as they comply with the same MIPI interfaces.

Because it was intended for the mobile handheld markets, it is mostly used in the consumer products. Larger displays are expected to continue to be either parallel CMOS, LVDS or eDP for FHD resolution panels.

Future Display Solutions provides displays with MIPI interfaces or controllers that can convert MIPI signals. MIPI is increasing as video resolutions and power demands for mobile type applications grow.

Indirect Display Interfaces

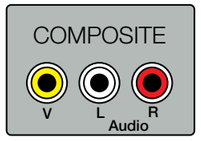
The following interfaces are common connections that are not on the display glass but on the finished product, for example on a monitor or an LCD controller. They do not connect directly to the display module. These types of interfaces require some processing of the video signal to activate the display module. The interfaces are VGA, USB, S-Video, HDMI, DVI and DisplayPort. Interfaces that connect directly to the display are RGB, Parallel CMOS, SPI, I^2C, RS232/UART, LVDS or MIPI. These interfaces are covered in the previous section.

VGA (Video Graphic Array)

VGA is the most common connection for external monitors and the standard for displaying color graphics. Created by IBM in 1987 for their computers, it was originally capable of a resolution of 640 x 480 colored pixels, which was a breakthrough at the time. Although the VGA analog interface has been superseded by 4K UHD resolution (3840 x 2160) monitors and TVs (with HDMI, DVI and DisplayPort interfaces), it is still used in industry applications. VGA can handle resolutions of up to WUXGA (1920 x 1200), although the picture quality can degrade depending on the length or quality of the cable. You also find VGA interfaces on laptops to connect to projectors.

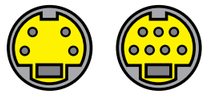
Composite Video

A composite video interface is typically a single yellow RCA connector on most consumer devices. The composite video signal carries all the line, frame synchronization and the video information on a single coax cable. The cable is normally combined with the left and right audio that are carried on separate wires. Details of the composite encoding process vary among the NTSC, PAL and SECAM systems. The resolution is typically 480i or 576i.



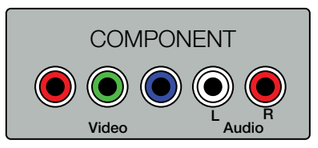
S-Video

Separate video (sometimes referred to as super video) separates the video data as two signals, lumen (luminance or the black and white levels) and chroma (color signals) is typically 480i or 576i. It is a higher quality of video than composite video but lower quality than component video.



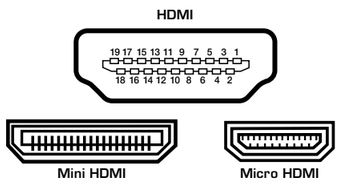
Component Video

Similar to analog composite video except the color is typically split into three RCA connectors, red, green and blue. In the format of YPBPR the green cable carries the Luma (Y) which includes the brightness as well as the synchronization signal. Luma Y = 0.2126 R + 0.7152 G + 0.0722 B. Including a separate wire for the green is not required, as it can be calculated from the red, blue and Luma information.



HDMI: High Definition Multi-media Interface

HDMI carries uncompressed digital data that includes video and audio on a single cable. It is designed as a digital replacement for analog video and audio. In a home theater system, one HDMI cable can replace as many as eleven older cables. It can handle resolutions of full HD and 4K with refresh rates of 120Hz. It also includes Ethernet connectivity, enabling other connected devices to share an Internet connection.



Pin #	Signal	Pin #	Signal
1	TMDS data 2+	11	TMDS clock shield
2	TMDS data 2 shield	12	TMDS clock -
3	TMDS data 2-	13	CEC
4	TMDS data 1+	14	No connected
5	TMDS data1 shield	15	DDC clock
6	TMDS data 1-	16	DDC data
7	TMDS data 0+	17	Ground
8	TMDS data 0 shield	18	+5V power
9	TMDS data 0-	19	Hot plug detect
10	TMDS clock+		

DVI: Digital Video Interface

DVI is a standard developed by the Digital Display Working Group (DDWG), designed to provide very high video quality on digital displays and digital projectors. It can be configured to support multiple modes such as DVI-D (digital only), DVI-A (analog only), or DVI-I (digital and analog).

DVI is backward compatible with VGA and includes some of the contacts within the DVI connector. It is required to handle 640 × 480 at 60Hz, but can handle up to a resolution of 1920 x 1200 at 60Hz with a provision for Dual-link DVI which doubles the number of TMDS pairs, doubling the video bandwidth up to 2560 x 1600 supported at 60Hz.

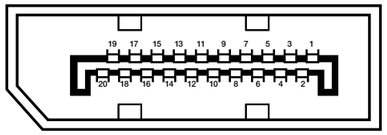
In a single-link DVI connection, the video pixel data is digitally encoded and transported using four TMDS (transition-minimized differential signaling) links: the pixel clock, red, green, and blue video signals = 24 bits per pixel. These TMDS links are highly resistant to electrical noise and distortion, as each link transmits over one twisted pair.

Digital Video Interface

DVI connectors may not always work together.

DisplayPort

The Video Electronics Standards Association (VESA) developed the DisplayPort standard using packetized data transmission. It can carry video, audio, USB and other data. DisplayPort is able to transmit audio and video individually or at the same time.



Although it is designed to replace VGA and DVI, it is backward compatible with the use of adapters.

Embedding the clock signal within the data stream using micro packets, DisplayPort can have higher resolutions with fewer pins. The protocol has additional packets to extend features over time without changing the connector.

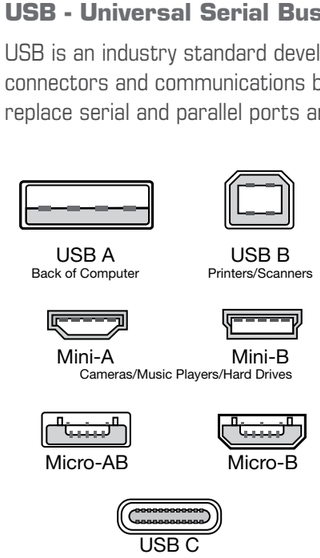
DisplayPort version 1.3 can support a resolution of 4K UHD at a 120Hz refresh rate using 24-bit pixels, and in the future should handle displays that support 8K at 60Hz.

Mini DisplayPort

The Mini DisplayPort was designed to replace the bulky DVI and VGA connections on devices to transport the video signals to a monitor. Mini DisplayPort 1.2 can handle resolutions up to 4096 x 2160 (4K). Mini DisplayPort can drive older display devices with VGA, DVI, or HDMI interfaces with the addition of an adapter.

USB - Universal Serial Bus

USB is an industry standard developed in the mid-1990s defining the protocols for cables, connectors and communications between computers and electronic devices, designed to replace serial and parallel ports and also used as power connector.



USB-A: Originally used to connect a mouse, memory or a touch panel to a computer.

USB-B: Normally used to connect to a printer or similar device.

Mini-B: Smaller in size to the USB, as these connect to touch panels and can supply power to display controllers.

Micro-B: Micro connectors are about half the thickness of the Mini-Bs and are used for smaller portable devices such as smart phones.

Micro-AB: A type of connector that can accept either a Micro-A plug or a Micro-B plug.

USB-C: A reversible 24-pin double-sided connector similar in size to the Micro-B USB connector for USB devices and USB cabling. The Type-C replaces Type-B and Type-A connectors and cables, designed to be future-proof. Type-C is backward compatible and is possible to connect an Type-A or Type-B device to Type-C with a cable or adapter.

Designing to Mitigate Obsolescence

In the previous section, we outlined a myriad of different interfaces a display can use. If your application is likely to outlive the availability of your selected display, it may be prudent to make some design provisions to accommodate the eventual replacement of the initial display by another that may not leverage the same interface protocol. The inclusion of a bridge chip, such as a low cost FPGA (Field Programmable Gate Array) from Lattice, can future proof your application.

Basically, a bridge chip architecture allows users to navigate interface mismatches between processor and displays.

It can also allow users to leverage lower cost display options without incurring a complete board redesign.

In the example design below, the DSI transmit accepts RGB (Red, Green and Blue) pixel bus data from a processor or other display control output device. The output of the design interfaces to a D-PHY (high speed MIPI bus) interface IP core, allowing the FPGA to directly drive a DSI (Display Serial Interface) receiving device, such as a display.

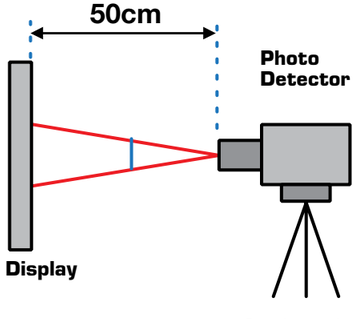
DSI Transmit Example Block Diagram

The parallel RGB to DSI transmit design illustrates how low density FPGAs can be used to connect various processors to DSI displays. The DSI transmit design enables embedded designers to utilize low cost screens with embedded processors.

How Bright do You Need the Display?

The brightness of a display is called luminance and is measured in nits or candelas.

The candela per square meter (cd/m2) is the unit of luminance. Nit (nt) is a name also used for this unit (1 nt = 1 cd/m^2). This measurement is used to specify the brightness of a display device. For example, most LCDs range from 100 to about 1000 cd/m2 (or nits).



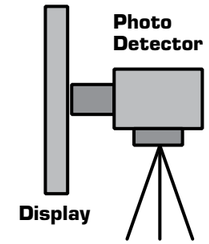
Nits are measured by a photodetector focused at the center area of the LCD panel, with a white screen on in a dark room normally positioned 50cm from the display.

The application of the end product will dictate the luminance you require. If it is for a wearable device to be read only at night, then a lower nit level would be recommended. If the device is a kiosk in a brightly lit shopping mall or an operating room, for example, then a higher nit value would be required to compensate for the ambient surrounding light.

Normal ambient light levels indoors with the lights on, are typically less than 1k nits, and the display should be in the range of from 200 - 300 nits (computer monitor). Outdoors in indirect sunlight, the ambient light is around 3k - 7k nits so the LCD need to be emitting 500 - 800 nits (airport display). In bright direct sunlight the ambient light level can be as high as 10k nits, requiring the display to have 1k nit output (gas station display).

Do You Need a Sunlight Readable Display?

Sunlight readable is typically referred to as 1000 nits and above. The request for sunlight readable has to be questioned. For example, a device that will be placed in an automobile may request sunlight readable but the roof of the vehicle will reduce the direct sunlight hitting the device and a lower brightness may be acceptable, say 600 nits. Care has to be taken as glare and the contrast ratio may also affects the view-ability of the display.



Contrast ratio is the difference between the brightest and the darkest parts of a screen and would be in the 500:1 range or above. The contrast ratio is calculated by using the following formula.

Contrast ratio (CR) = Luminance of white screen/Luminance of black screen

Manufacturer	Part Number	Size (In)	Resolution Pixels	Brightness in NITS	Contrast Ratio (xxx)
AZ Displays	ATM0700D6J-CT	7	800 x 480	830	500
Tianma NLT America	NL6448BC20-30C	6.5	640 x 480	1000	800
Litemax	DLF1085-ENN	10.4	1024 x 768	1000	600
Sharp	LQ150X1LG96	15	1024 x 768	1000	800
Litemax	DLF1825-ETN	18.5	1280 x 800	1000	1000
Tianma NLT America	NL13676BC25-03F	15.6	1366 x 768	1100	900
Sharp	LS044Q7DH01	4.4	320 x 240	Reflective Display	14

Glare

Glare is a result of the light emitted from a display backlight and ambient light reflected back from the LCD glass. Glare should be considered when designing the display to be placed in a brightly lit room or used where sunlight could reflect on it. Both glossy and matte displays are made the same, except the matte display has a light diffusing coating on the front of the display.

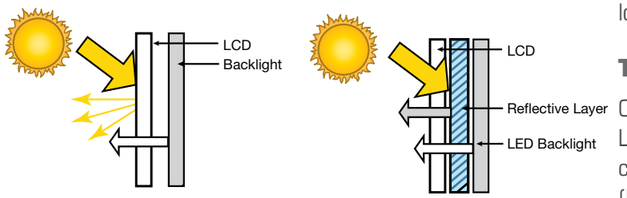
Glossy displays have brighter, clearer colors, better contrast and deeper black levels than matte displays. The issue arises when light shines on the display creating reflections and the display image is difficult to see. Matte displays have an anti-glare coating that reduces the reflections but the LCD colors look more dull. If the display is to be used in a darker room, a glossy display might be better. If a display requires an anti-glare coating refer to page 6.

For a sunlight readable display our recommendation is to choose a display early in your design cycle of at least 900 nits luminance, a minimum contrast ratio of 500:1 with anti-glare film added.

Future Display Solutions can provide off-the-shelf sunlight readable displays or take existing displays and enhance them with brighter backlights, anti-glare or anti-reflecting films to make them better suited to the application.

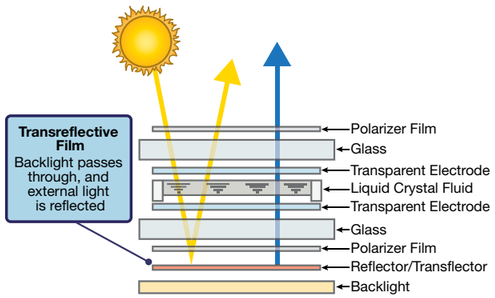
Transflective

Transflective LCDs are displays that reflect back sunlight through the LCD layer as well as the emitted luminance from the backlight. This results in a display that uses lower power and is measured as a lower nits value but is a great display for outdoor use. Building a transflective display is difficult to manufacture but some of our suppliers have mastered it, creating great looking, long lasting displays.



Standard LCDs are difficult or impossible to read in daylight or sunlight

Transflective LCD Technology uses the ambient light to add to the screen brightness



Transreflective = Transflective

Other options for sunlight readable displays are memory LCDs, electrophoretic and OLED displays that have high contrast ratios. They are typically monochrome and smaller (below 6 inches) but they normally have lower power consumption than a comparable LCD. Refer to pages 30-33 for memory LCDs, electrophoretic and OLEDs.

We also recommend that you ask Future Display Solutions for demonstrations to compare displays side by side and then choose the preferred display for your product. Your display specialist can assist you with choosing your sunlight readable display.

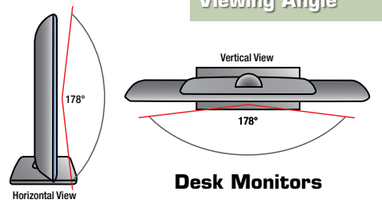
Manufacturer	Part Number	Size (In)	Resolution Pixels	Brightness in NITS	Contrast Ratio(xxx)	Viewing Angle° (up/down; left/right)	Notes
Tianma NLT America	TM035HBHT6	3.5	240 x 320	80	150	95/85	Transflective
Tianma NLT USA	TM035HDHT1	3.5	240 x 320	100	150	95/85	Transflective
Sharp	LS037V7DW03A	3.7	640 x 480	200	200	160/160	AG Portrait mode, w/o TS, 4% Transflective, CGS
Sharp	LS037V7DW05	3.7	480 x 640	240	450	160/160	AG Portrait mode, w/ TS, 4% Transflective, CGS
Sharp	LS037V7DW06	3.7	480 x 640	300	500	160/160	AG Portrait mode, w/o TS, 4% Transflective, CGS
Tianma NLT USA	NL6448BC26-26C	8.4	640 x 480	900	900	160/160	Transflective, T-EVT
Tianma NLT USA	NL8060BC21-11C	8.4	800 x 600	800	800	160/160	Transflective, T-EVT, Color Xcell

What is the Viewing Angle Required?

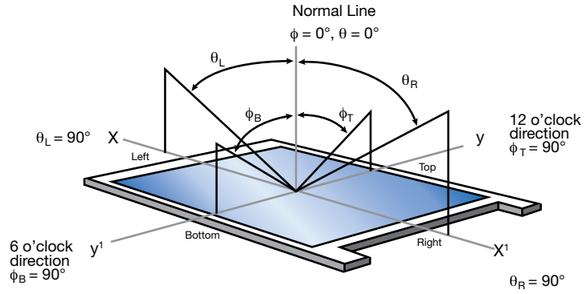
Viewing angle is the angle from the center of the display, either tilting it up or down and panning it left or right. The angles range from 0 to 90 degrees from the center point. Depending on the manufacturing process, the maximum angle you can view the display at is set during production.

An example would be 60° top view looking down, 60° bottom view looking up, 70° looking from the left and 70° looking from the right = 60, 60, 70, 70.

This can also be expressed as Up Down and Left Right = 120/140.



Desk Monitors

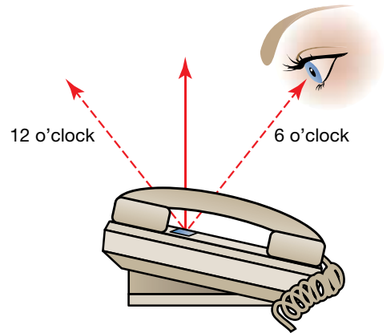


Note (1) Definition of Viewing Angle:
Viewing angle range (10≤ CR)

Note (2) Definition of Contrast Ration (CR):
Ration of gray max (Gmax),
gray min (Gmin) at the center
of the screen

$$CR = \frac{\text{Luminance with all pixels white (Gmax)}}{\text{Luminance with all pixels black (Gmax)}}$$

If the display is for a bedside clock, a wide angle may not be required, where as a clock display in a car should have a wide angle so that all the passengers can view the image.



The angle can be improved by adding special films to the front of the display, but the angle can also deteriorate with additional films or touch panels added to the display. Future Display Solutions uses reputable integrators to add the correct films or touch panels to achieve the best display image.

Displays that have a better viewing angle on the top are commonly referred to as a 12 o'clock display (top view), and displays that have a better viewing angle at the bottom are normally refer to as a 6 o'clock display (bottom view). This is an important design point depending on whether the viewer is looking up at the display or down on the display. For example, a desk phone would be 6 o'clock, as the viewer is looking from the bottom of the display.

Manufacturer	Part Number	Size (In)	Resolution Pixels	Brightness in NITS	Viewing Angle° (up/down; left/right)
Sharp	LQ065Y5DZ01A	6.5	800 x 480	675	170/170
Tianma NLT America	NL10276BC16-06D	8.4	1024 x 768	600	176/176
Innolux	G101ICE-L01	10.1	1280 x 800	500	170/170
Innolux	G104X1-L04	10.4	1024 x 768	500	176/176
Innolux	G121AGE-L03	12.1	800 x 600	450	178/178
Tianma NLT America	NL12876BC26-32D	15.3	1280 x 800	470	176/176

APPLICATIONS
Power Consumption

Is Power Consumption an Issue?

If the product is a portable device that runs on batteries, then the power of the display is a key design component. Generally, the larger the display the higher the power requirements.

Previously, backlights were made with cold cathode fluorescent (CCFL) lights. This required more power to drive. Now the backlight is powered by LEDs and manufacturers are continuously improving the efficiency of the LEDs in their displays.

The power consumption can be reduced by using a smaller display, dimming the backlight brightness, limiting the time the backlight/ display is on (sleep mode), selecting a transflective display, a reflective LCD (memory LCD), an electrophoretic display or an emissive display (for example OLED).

For more in-depth information on backlights go to page 36.

Manufacturer	Part Number	Size (In)	Resolution Pixels	Brightness in NITS	Total Power (Watts)
Sharp	LS013B7DH01	1.26	144 x 168	xx	uW Range
Sharp	LS013B7DH03	1.28	128 x 128	xx	uW Range
AZ Displays	ATM0350D19-T	3.5	320 x 240	500	0.434

APPLICATIONS
Extended Temperature

Do You Require Extended Temperature Range?

The typical temperature range for a display is -20°C to +70°C, and some displays can handle wider operating ranges from -35°C to +85°C. LCDs contain liquid, which can slow down or stop working in extreme heat or cold.

Do not confuse the operating range with the storage range. Storage range is normally wider than the operating range and will not affect the display after it is turned on in a normal ambient temperature.

An example is a device added to an ATV that is stored in a cold shed in the winter, but is actually used in milder conditions -20/70°C. Therefore a standard display temperature range could be sufficient in this design.

For wider temperature ranges, Future Display Solutions can add heaters or fans to the display as required. Ask your display specialist for more information.

Refer to the section on Integration, page 59.

Manufacturer	Part Number	Size (In)	Resolution Pixels	Operating Temperature °C (min/max)
Sharp	LQ065Y5DZ01A	6.5	800 x 480	-40/85
Innolux	G070Y2-L01	7	800 x 480	-30/85
Tianma NLT America	NL6448BC20-30C	6.5	640 x 480	-30/80
Sharp	LQ104S1LG81	10.4	800 x 600	-30/80
Innolux	G121AGE-L03	12.1	800 x 600	-30/80
Sharp	LQ084S3LG03	8.4	800 x 600	-30/75

What is the Desired Response Time?

Motion blur is caused when the liquid crystal is unable to change its state rapidly enough from one frame to the next. For HD video, the standard rate is 60 frames per second or 16.7 milli-seconds. The time it takes to switch states is called the Response Time. It is the time taken for a pixel to go from black to peak intensity white and then back to black again.

This response time is an industry standard but it has to be treated with caution, as switching from complete black to white and back to complete black again is not typical with most video. Normally, video has more subtle changes from grey to grey that is harder to measure.

Some caution is also required, as certain manufacturers only measure the time taken to switch from black to white, and therefore the time documented is only half the typical standard response time.

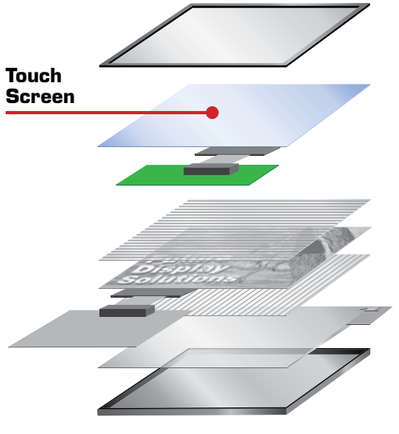
Based on the application, visually examining displays simultaneously side by side early in the design stage is recommended. That way, even subtle differences become obvious. Using the human eye for evaluation rather than instrumentation is preferred, because that is exactly what all the end viewers will be using.

Contact the Future Display Solutions team for demonstrations.

Manufacturer	Part Number	Size (In)	Resolution Pixels	Response Time (Typ) in ms
Innolux	G185BGE-L01	18.5	1366 x 768	5
Litemax	DLF1825-ETN	18.5	1280 x 800	5
Innolux	G156BGE-L01	15.6	1366 x 768	7
Tianma NLT America	NLB150XG01L-01	15	1024 x 768	8

Do You Require a Touch Panel on Your Product?

To communicate with the device that you are designing, you will need an interface. This interface could be in the form of buttons, a keyboard or a mouse, but more commonly a touch panel is the desired input.



The touch panels that cover the majority of applications are resistive (4, 5 or 8-wire) or projective capacitive.

The touch panel may be added to the display during manufacturing or afterward by an integrator. Future Display Solutions will assist you in selecting the best touch solution for your application.

Remember to add a touch panel controller.

For more detailed information, go to page 11 for touch panels and page 20 for touch controllers.

Display Integration

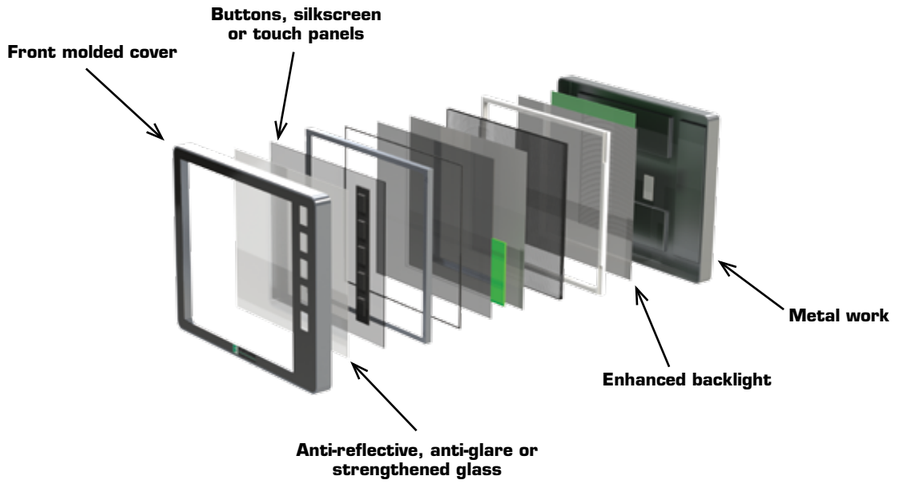
Most projects that Future Display Solutions supports require either integration, customization or enhancement of the display.

Future Display Solutions can integrate your display for the following additions: touch panel, cover glass, strengthened glass, custom interface boards, high brightness, anti-glare film, anti-reflective film and enhancing viewing angles.

We also offer third party value added options, including keypads, enclosures, bezels, assembly and custom cables.

The Future Display Solutions team is available to assist you every step of the way.

Please contact us at 514-694-7710, ext 6363 or LCDTechnicalSupport@FutureElectronics.com



Integrated Solutions

Do You Want to Use an All-In-One Solution?

For minimal engineering, or when timeline is a factor, Future Display Solutions can provide all-in-one solutions from our suppliers, where the integration of the display, touch panel, interfaces and software are already completed. All-in-one solutions have passed lengthy medical certifications, creating a fast time to market, and can normally be purchased in smaller volumes to get the project or prototype off the ground. A typical application is point-of-care equipment for medical staff to assist patients.

Front

Marine Display

Back

Span Displays for Transport or Multimedia

We hope this handbook, in conjunction with the Selector Guide, will assist in the initial design of your product.

Remember that with an extensive product range, expansive knowledge and experience, the **Future Display Solutions** team is available to assist you every step of the way.

Please contact us at **514-694-7710, ext 6363** or **LCDTechnicalSupport@FutureElectronics.com**.

Whatever your product environment, cost, style or practicality, remember that the best design is the one that best meets your requirements.

Associated Parts to Consider