Dignity Electronics

DISPLAY INTEGRATION SERVICES

Dignity Product Line Introduction

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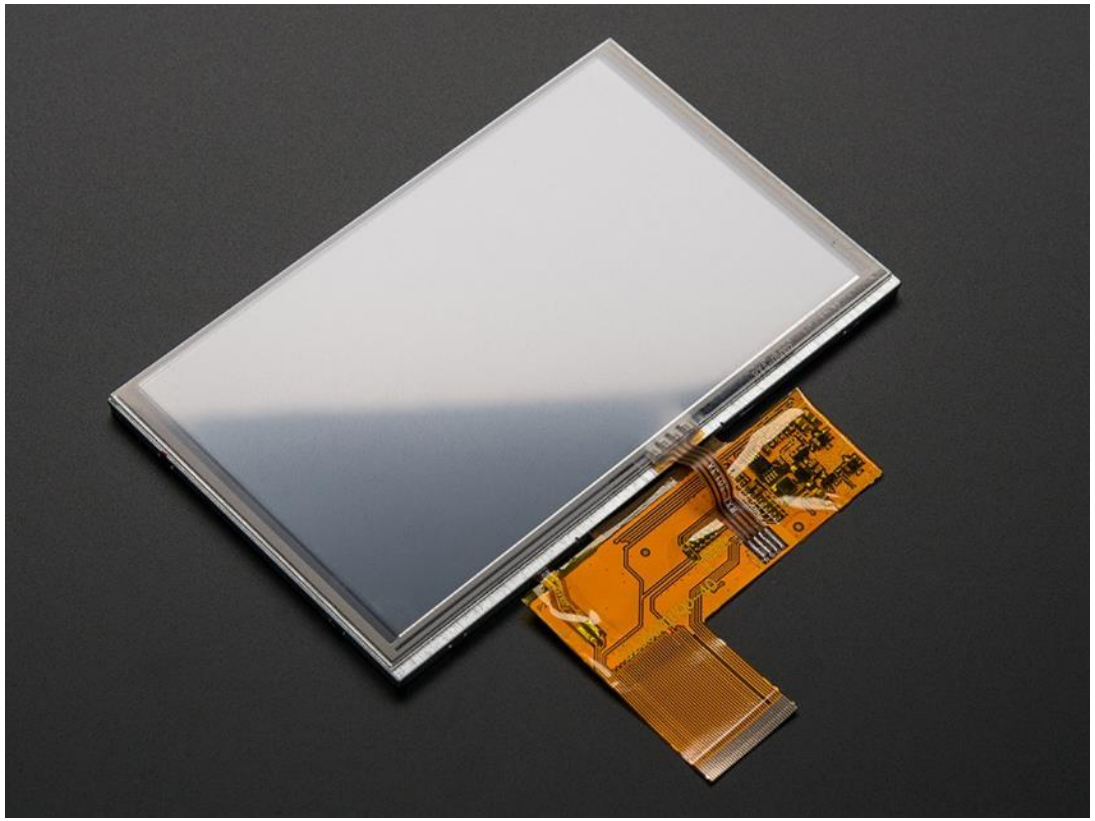
4 **LCM/LCD Touch Modules**

1. Integration Overview

Touch Panel Integration – Overview



Touch Screen & Display Integration

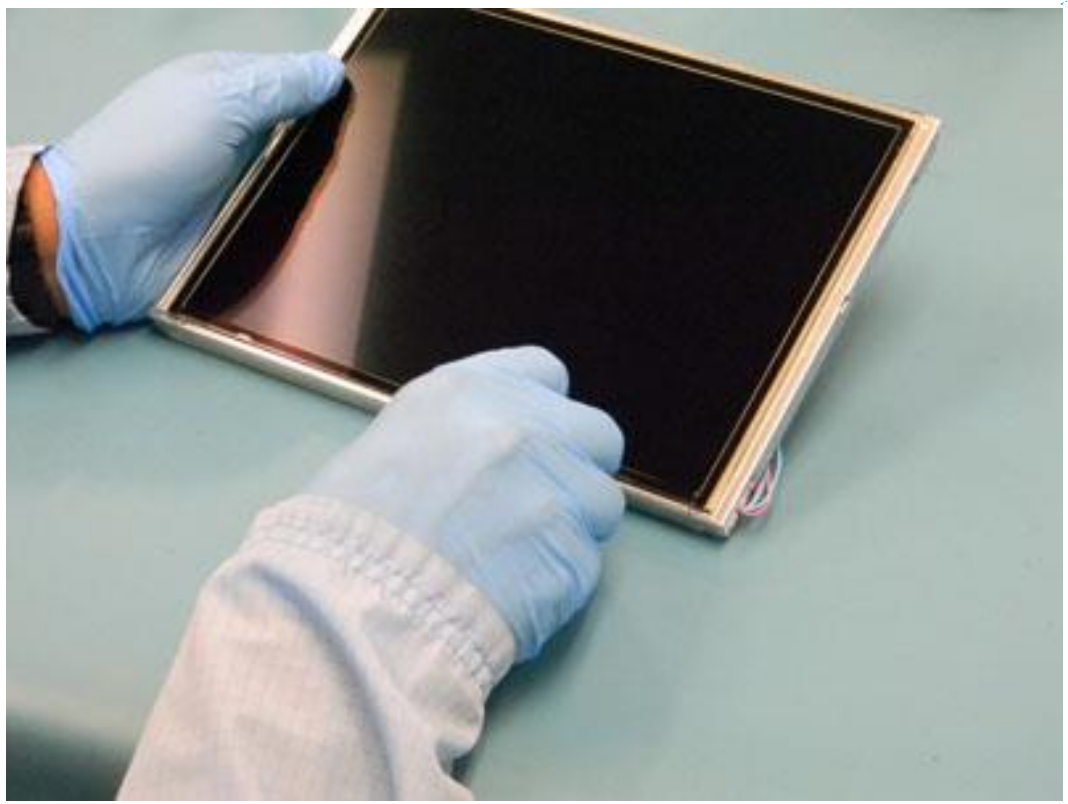
In addition to our touch screen product line, we also offer touch screen integration services to our customers. Touch screen integration bonds the touch panel and sensor to the selected display in order to fix it in place for final integration into a metal or plastic enclosure. There are multiple varieties of bonding available based on cost and performance considerations:

Tape Bonding – using high quality 3M and other double sided adhesives, we attach the display to the touch panel, while leaving an air gap between the two. A low cost, efficient solution that provides some ruggedization and improves product lifespan.

Dry Optical Bonding (OCA) – this process uses sheets of clear, pressure-sensitive sheet adhesive to completely fill the air gap between the display and touch panel and enhance the performance of the assembly. A good mix of improved performance, efficiency and cost competitiveness.

Liquid Optical Bonding (LOCA/OCR) – this uses a liquid clear adhesive cured by UV light to fill the gap between screen and display. LOCA provides the greatest improvement in display performance, though at a significant increase in cost due to the complex, two-step curing process and higher raw material costs.

Touch Panel Integration – Production Overview



Overview

Our production facility has a class 1k+ clean room and workshop with five integration/production cells rated to class 100+ to reduce display contamination, and for maximum flexibility when dealing with various order and product types.

Product Environment

Class 1000 cleanroom and modern processing facility.

Flexible Production Cells

With multiple production cells we can offer lower MOQs & improved process control for better yield.

Flexible Production Methodology

We can provide a variety of options for your integration needs depending on your final product requirements. Our sales and engineering team will find a solution for your problem.

Integration - Capabilities

Integration Capabilities			
Bonding Process	*Tape Bonding / 框贴*	*Optical Bonding / OCA全贴合*	*Liquid Optical Bonding / LOCA全贴合*
Minimum Size	None	4.3"	None
Maximum Size	None	15.6"	None
Minimum Thickness	0	0	0
Maximum Thickness	0	0	0
Material	3M Double-sided Tape	OCA	LOCA / 11.6 - 15.6 UV cured fixed adhesive
Process	Manual	Manual	Semi-Automated
Reworkable	Yes	No	Yes

Touch Panel Integration - Product Applications

Some common product applications for integration

Industrial

Optical bonding improves environmental and impact resistance as well as durability in a touch operating environment.

Marine

Optical bonding will increase resistance to vibration, improve display visibility.

Home Appliances

The improved environmental resistance is crucial in a high humidity operating environment.

POS System

Additional structural stability improves length of service while improved optics eases reading in bright lighting.

POI / Kiosks

Durability is key for publicly located screens in order to improve their resistance to vandalism.

2. Integration Methods

Tape Bonding

Also known as air gap or perimeter bonding, this is the simplest and most economical way of adhering the touch panel to the display. This process takes place in our cleanroom where we use a variety of industrial adhesive tapes and specialized jigs/positioning frames to assist the process.

Material Used

3M-supplied industrial, double-sided adhesives.

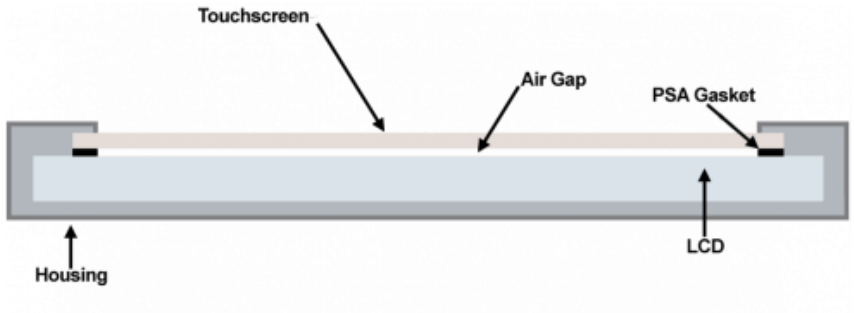
Capacity

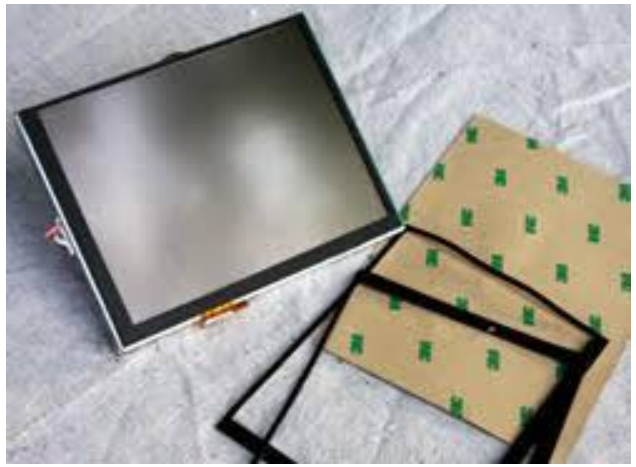
Dependent on screen size and structure.

Primary Applications

Cost-sensitive modules; standard applications or non-demanding environments

Tape Bonding - Overview





- Tape or perimeter bonding is the most widely used method for touch panel attachment due to its high yield rate and low cost, and when applications are not especially demanding it is a very common choice
- An adhesive gasket is applied between the display and touch panel using the area around the perimeter of the module – this results in a “gap” between the touch panel assembly and the display, hence “air-gap bonding”.
- The most commonly used adhesives are 3M-branded industrial double-sided products.
- A variety of gasket materials and thicknesses are used in order to achieve the required assembly height and to protect against contamination, vibration and other damage.

Advantages
Extremely reworkable, with a high process yield and low cost.

Disadvantages
Due to air gap between display and touch assembly, optical and physical properties are noticeably poorer.

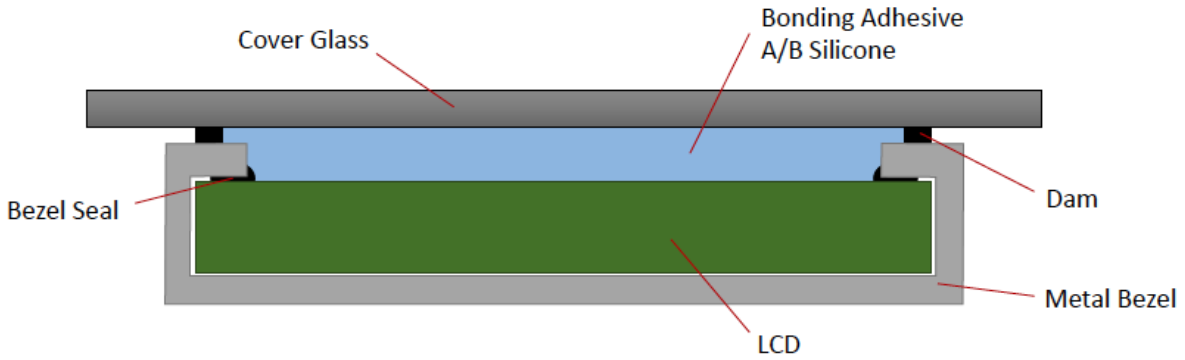
Product Sizes
In practice unlimited, though greater difficult in achieving good results at very large sizes.

Tape Bonding - Processing

1. **Tape Preparation** – The tape is often prepared using a die cut, though it can also come in pre-cut strips or rectangles.
2. **Tape Application** - The application process is completely manual, with the pre-cut gasket (either in one continuous strip or four separate strips) being applied around the perimeter of the display
3. **Alignment** - Once the gasket is applied, an integration fixture is used to properly align the touch screen to the display.
4. **Assembly** – once the alignment has been checked, the touch screen is pressed down in place over the display, which is held in a fixture. This can be a manual or semi-automatic process, and is generally conducted using a production fixture to ensure even adhesion and height.

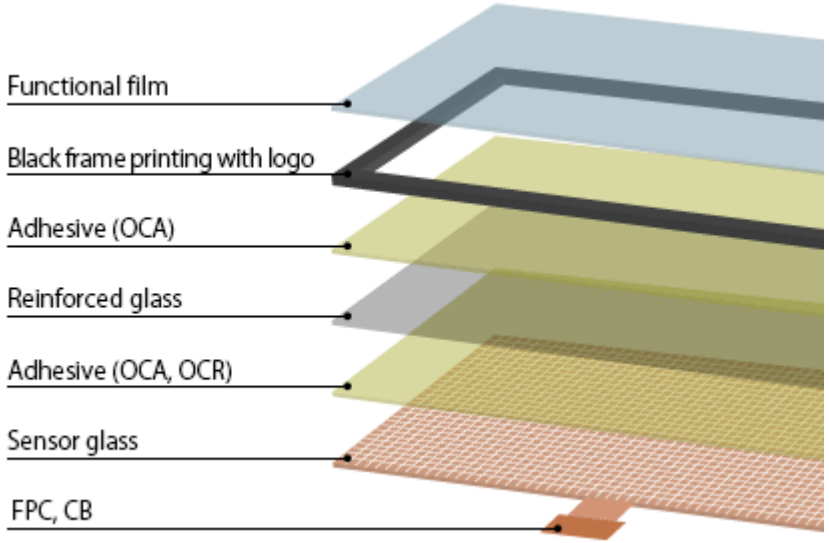
Dry Optical Bonding (OCA)

Dry optical bonding uses sheets of clear sheet adhesive to completely fill the air gap between the display and touch panel and enhance the performance of the assembly. A good mix of improved performance, efficiency and cost competitiveness.



- Materials
  Imported OCA pressure adhesive sheets
- Capacity
  Dependent on screen size and structure.
- Primary Applications
  For applications and industries with moderately demanding environments and/or some cost sensitivity.

Dry Optical Bonding (OCA) – Overview



- Optically clear adhesive (OCA) bonding is a cost-effective and high-performing alternative to liquid optical bonding (LOCA). OCA provides many of LOCA's benefits, including improved optical clarity, ruggedness, environmental stability, etc. but is significantly less expensive.
- OCA is a dry film pressure sensitive adhesive that comes in two primary varieties: acrylic and urethane, and is purchased by in rolls of material that are cut via pre-cut dies on site into the desired dimensions.
- OCA has high clarity, high transparency (more than >99% of light), relatively high adhesion, is waterproof, resistant to environmental factors, high-temp resistant, UV light resistant, provides even spacing, and is resistant to yellowing, weathering and peeling.
- OCA can be used for various applications depending on the thickness of the material, everything from display assembly, lens assembly, resistive and capacitive touch panel assembly, avionic optical components, etc.

Advantages
Excellent optical qualities, simplified production process, single cure process (optional).

Disadvantages
Depending on the material used, not reworkable

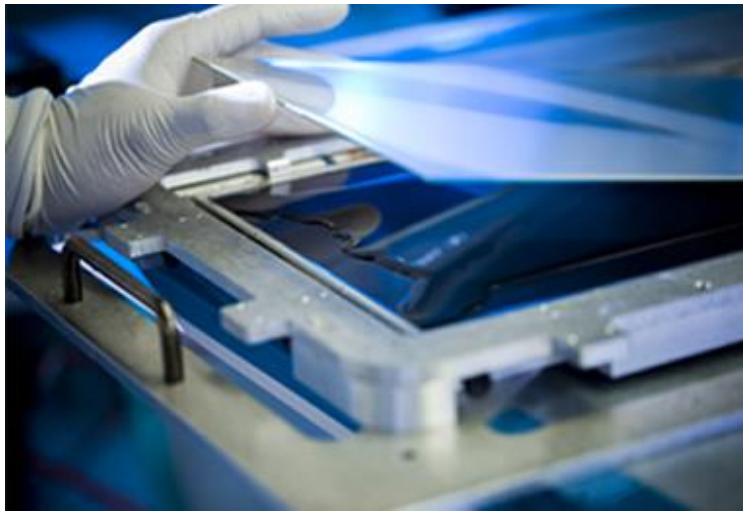
Product Sizes
OCA integration for sizes from 4.3" up to 15.6" available.

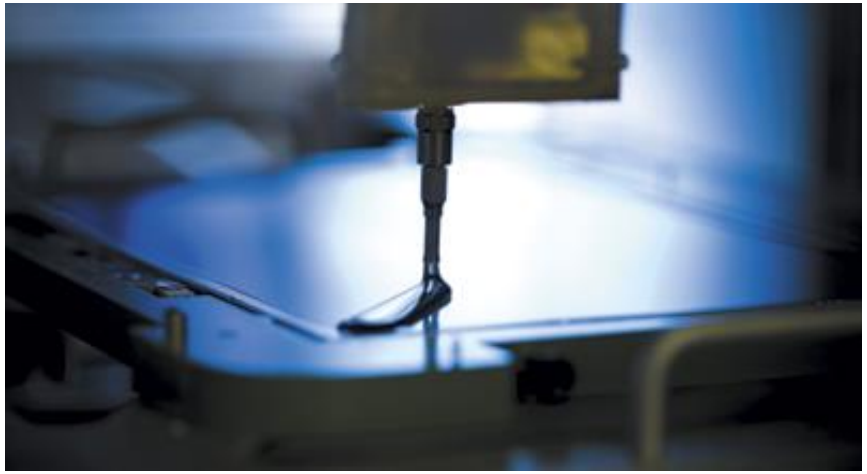
Dry Optical Bonding (OCA) - Processing

1. **LCD Preparation** – LCD and touch assembly must be thoroughly cleaned using conventional cleaning methods with automated or manual systems. The bonding process must be done in a clean room to avoid the particles and contaminations.
2. **OCA Adhesive Preparation** – The optically clear adhesive (OCA) usually consists of a sheet of adhesive with double-sided liners that is cut to the required size by die-cutting or laser cutting.
3. **Bonding TP & LCD** – After material preparation, the OCA is roller laminated to the touch assembly using a semi-automated machine
4. **Alignment –** the LCD is loaded into a fixture/jig to hold it in place while the touch assembly is being aligned for placement
5. **Laminate** – The touch assembly is placed over the LCD and pressed down into place to adhere the two.
6. **Autoclave** – the full assembly is placed into an autoclave to reduce any bubbles formed during the bonding process.

Liquid Optical Bonding (LOCA/OCR)

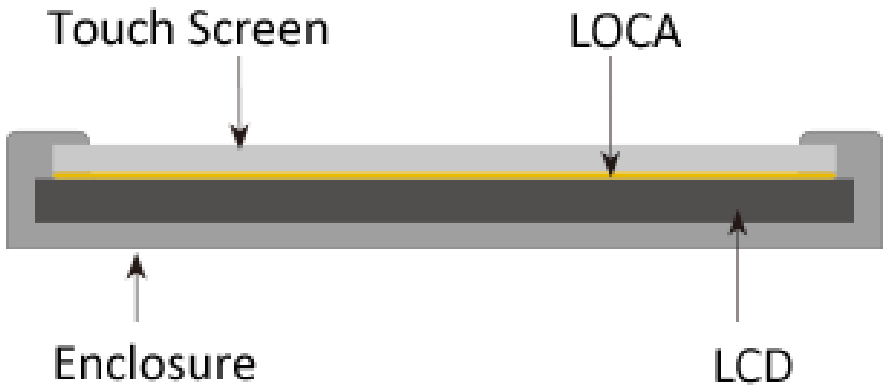
Liquid optical bonding utilizes a single or dual process curable liquid adhesive that is dispensed to fill the space between the LCD and the touch panel. It is the most expensive bonding process and is often used for the most demanding or exacting environments, where performance is at a premium.

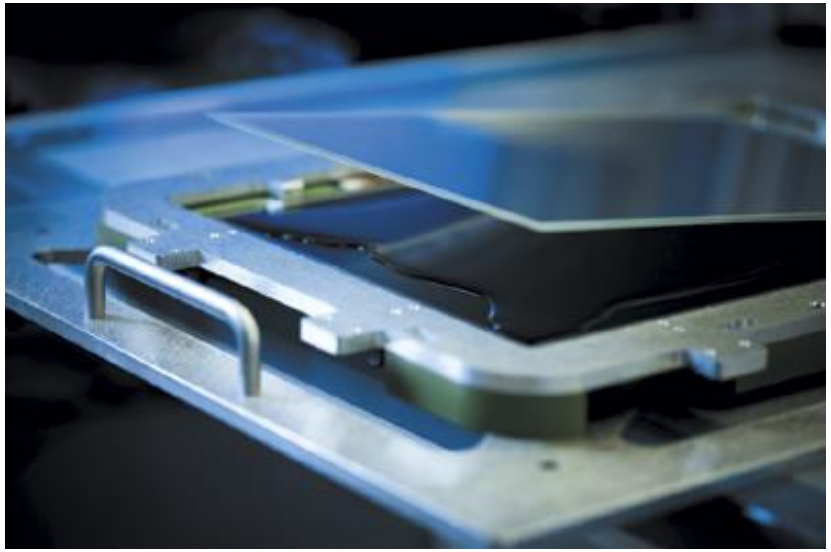




- **Materials**
  Liquid silicone and urethane adhesives available.
- **Capacity**
  Dependent on screen size and structure.
- **Primary Applications**
  Demanding environments that value performance over cost issues – aeronautics, industrial, in-vehicle, etc.

Liquid Optical Bonding (OCR/LOCA) - Overview





- LOCA is a clear liquid adhesive bonding agent (usually made of silicone or less commonly, urethane/epoxy) widely used for smartphones and tablet devices.
- The liquid type bonding adhesive is re-workable and suitable for use on curved or uneven surfaces.
- **Dam** - UV Cured Acrylate material is dispensed around the perimeter to control the gap between the LCD and touch screen and control the perimeter flow of the fill material.
- **Seal** - UV Cured Acrylic material is dispensed around the inside edge of the LCD metal bezel to prevent fill material from leaking into the LCD.
- **LOCA (Liquid Optically Clear Adhesive) Fill** - Clear UV-cured liquid material that fills the space between the touch screen and LCD

Advantages

Liquid nature means it provides excellent coverage; provides superior optical and mechanical performance.

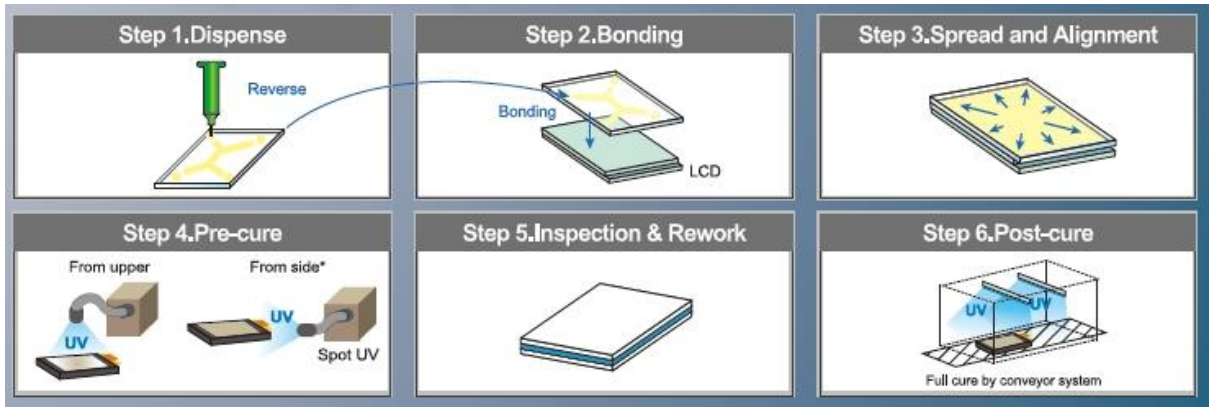
Disadvantages

Process is significantly more complex and expensive than other bonding methods. Cycle times also significantly longer.

Product Sizes

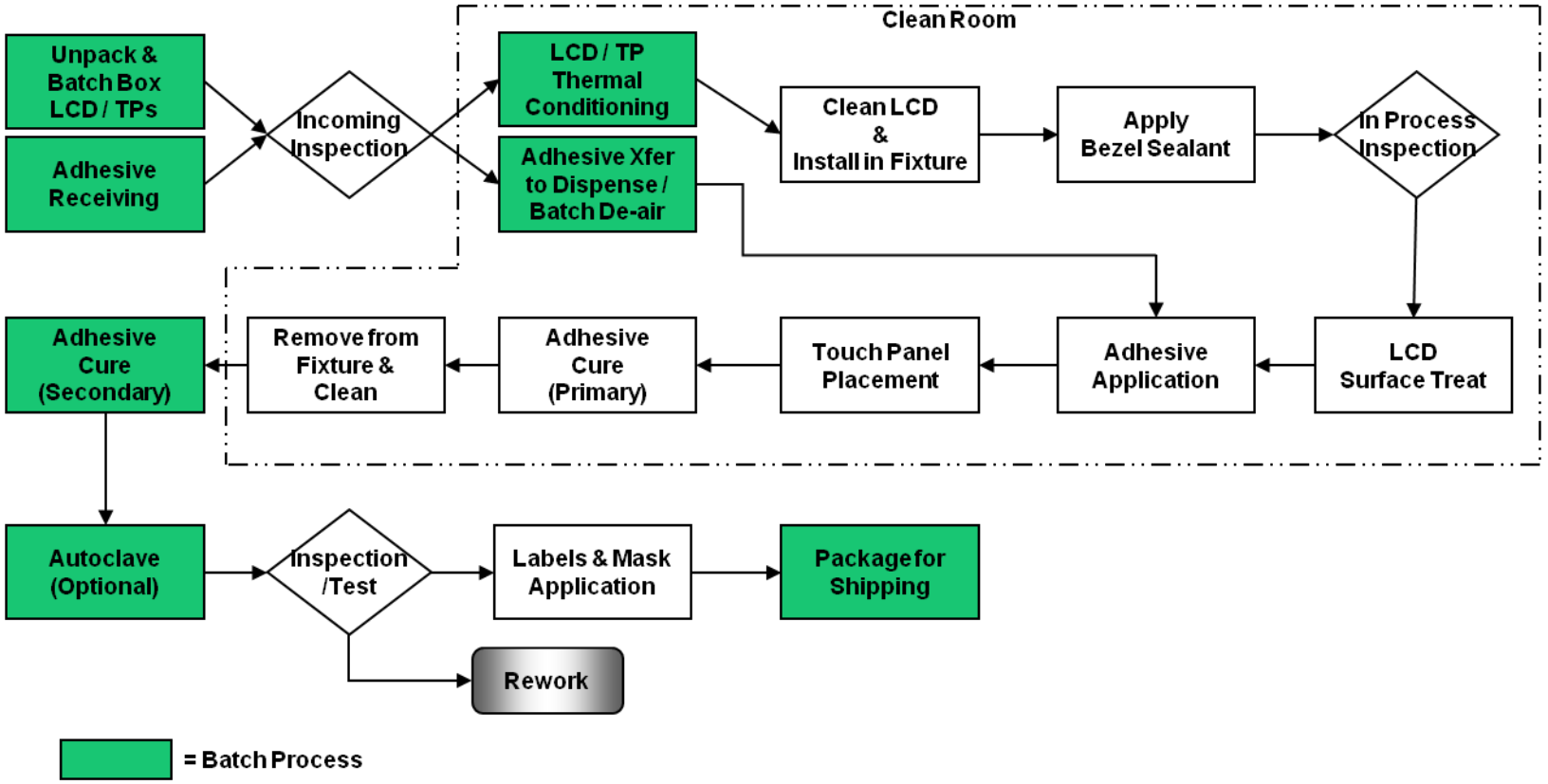
LOCA integration for sizes from 4.3” up to 75” available.

Liquid Optical Bonding (LOCA/OCR) - Processing



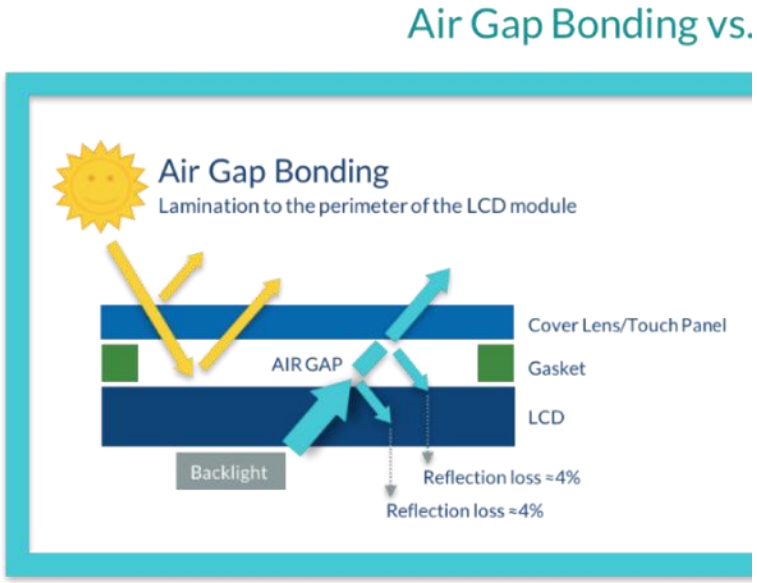
1. **Design Process -** Each project requires a custom design to determine how to apply dams to hold the liquid adhesive in place prior to curing, the precise amount of adhesive required, the dispensing pattern, etc.
2. **LCD Cleaning & Preparation** – the surface of the LCD is cleaned and conditioned (often by applying atmospheric plasma) to prepare for adhesion. This improves bond strength and removes contaminants.
3. **Dispensing LOCA** – LOCA is dispensed on to the surface of the LCD; the amount and dispensing pattern are carefully calculated before production to reduce overflow and make for a consistent bond thickness. A gasket or dam is applied beforehand to stop the LOCA from flowing over the edges.
4. **Bonding TP & LCD** – The two components of the assembly are carefully aligned and then bonded by a slow top-down process. This is key to controlling the consistent spreading of the LOCA over the full display surface and that there or no gaps or voids.
5. **Curing Process** – The bonded assembly will then undergo a the first curing process, after which it will be inspected for defects or alignment issues. If there are any issues, the assembly can be reworked. If the assembly passes, it then proceeds to the final curing process (generally through moderate heating or UV curing).

Liquid Optical Bonding (LOCA/OCR) – Processing (2)



3. Integration Comparison

Optical Bonding vs Air Bonding – Tape Bonding Overview

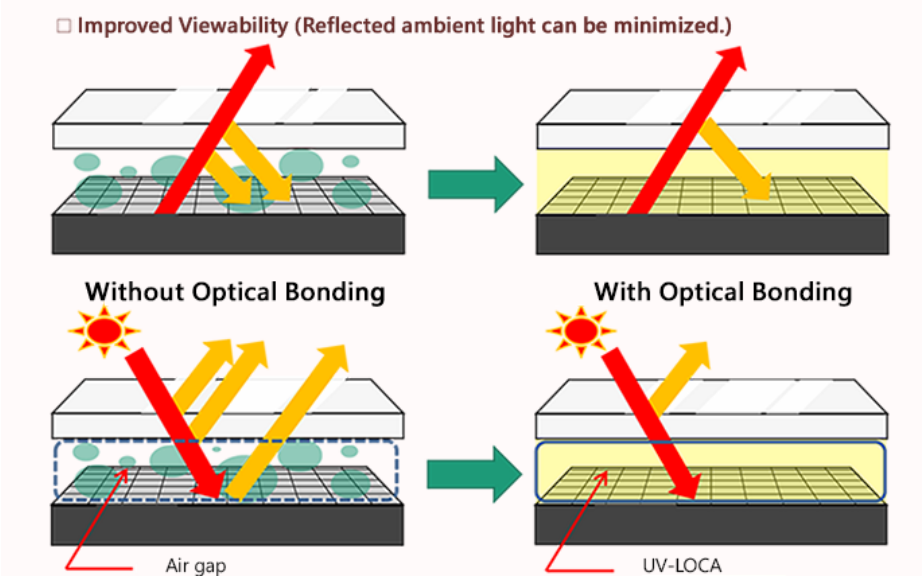


- **Economical** – tape bonding is the most cost effective option for display integration. In situations where there is not the need for exceptional ruggedization or environmental resistance, tape bonding offers some protection from vibration and contaminants at a low cost.
- **Fast** – tape bonding is considerably less complex in terms of engineering and processing, and this is reflected in lead times.
- **100% Reworkable** – With no direct contact to the LCD, tape bonding is the only 100% reworkable option.

Disadvantages:

- **Moisture/condensation**: Condensation can form in the space between touch screen and LCD display, decreasing visibility and creating potential for reduced display life span.
- **Debris**: tape bonding uses gaskets for sealing purposes, however this is not a foolproof solution and debris can enter the assembly, entering the viewing area and reducing visibility.
- **Weakened structural stability**: because there is a gap between the screen and display, the overall structure is weaker and less resistant to impacts, particularly the further you get away from the edges of the display towards the center.
- **Poorer Optical Qualities**: the air gap creates a loss of some optical clarity, display brightness and results in more screen reflection.

Optical Bonding vs Air Bonding – Optical Advantages



Better Optical Performance

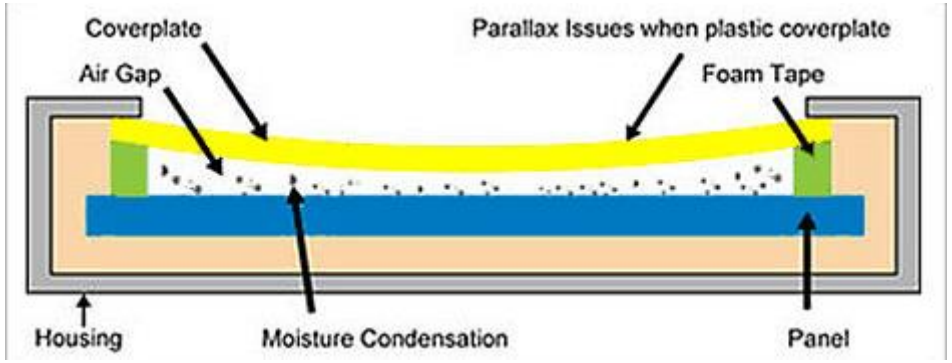
Reduced Reflections – Reflections can not only drastically reduce readability in environments with high ambient lighting, they can also cause safety hazards in certain industrial or in-vehicle uses. While external reflections can be minimized with anti-glare and anti-reflective optical filters, optical bonding can eliminate internal reflections caused by the air gap between the display and touch screen assembly.

Parallax – Parallax is a difference in the apparent position of an object viewed along two different lines of sight. Displays with an air gap have a noticeable amount of parallax that increases with variations of mounting tape thickness or cover lens specifications (particularly plastic lenses which are less rigid). Optical bonding creates a single refraction value for the assembly, which reduces parallax.

Improved Brightness – the air gap can also create a loss of display brightness as part of the light emitted by the LCD is lost. Optical bonding will reduce light loss and increase brightness.

Reduced Display Power Consumption – due to improved brightness and readability, the display's power output can be reduced while maintaining an optimal viewing experience.

Optical Bonding vs Air Bonding - Ruggedization & Environmental



Improved Ruggedization

Impact Resistance – Various industry tests have shown that impact resistance on many LCD modules can be increased by as much as 800% through the use of optical bonding. An air-gap unit's cover lens / touch screen can flex under pressure due to the lacks of support behind it. An optical bond will improve rigidity of the stack and reduce risk of failure.

Vibration Resistance – Display modules can face high levels of vibration in various industries (equipment, industrial, in-vehicle) and even during the course of transportation overseas. This vibration has the potential to damage or reduce the operational lifespan of the LCD and its components. Optical bonding will lock the various components of the display stack in place and reduce the negative effects of vibration.

Better Environmental Performance

Dust, Debris and Contaminants – While air bonded assemblies are sealed with tape and gaskets, they are still vulnerable to dirt, debris, dust and other contaminants. When combined with a more demanding application or environment (agricultural or heavy equipment, industrial facilities), this compound the issue. Not only can this impact the display's viewing area or optical qualities, it can also contribute to failure in the adhesive tapes used for bonding the assembly. Optical bonding removes these risks and helps to extend the life of your display.

Resistance to Fogging & Condensation – another environmental issue faced by air-bonded displays is the build-up of humidity and moisture in the space between the touch panel and the display. Temperature deviations or differences in air pressure can create condensation, which will affect display visibility.

Optical Bonding Comparison – OCA

Advantages to LOCA/OCR

Process Advantages

- The process is much faster with fewer steps and less equipment. Dry bonding can be completed in less than 30 minutes, whereas with “wet” bonding needs to cure after the bonding process, so typically 3 days. LOCA has much longer cycle times.
- OCA is easier to handle than liquid optical adhesive because it is in sheet form – no need for expensive, custom dispensing, no mixing, de-airing or pouring, no need for rework due to air bubbles, moiré, etc.
- while LOCA bonding can achieve a bond line between .015” - .030,” OCA bonding can achieve a .005” - .008” bond line.
- This bonding capability is well suited for thin components including cover glass, touchscreens, and frameless LCDs. This also makes it an excellent choice for smaller LCD modules, particularly those ≤11”
- Using a sheet adhesive also allows the OCA bonding to provide a tighter tolerance and as a result, a consistent and flat bond line.
- No need to account for shrinkage, bond-line control, or varying cure rates that can influence bond-line and internal stress.
- The overall process is much cleaner. The display is laminated without residuals to clean up after bonding and the tooling remains ready for re-use. Reduces labor costs.
- No wastage of optical adhesive due to spreading, leakage, and overflow – material utilization can be ≥80-90%.
- The process is “green”. Cleaning solvents are not required.

Disadvantages to LOCA/OCR

- Reworkability is very limited for most varieties of OCA; this means lower yield rates and higher scraps for LCDs
- For uneven or irregular shapes it can be difficult to avoid small gaps in the adhesive
- No well suited for large applications – labor and prep become more expensive and the process more difficult to control the larger the assembly size becomes.
- OCA’s surface is slightly viscous, which means that it can attract dust and other contaminants during adhesion. The viscosity can also result in bubbles, which is why it requires use of an autoclave process
- Adhesion strength is less than that of LOCA; tends to require more surface preparation. Long term bond strength is weaker than LOCA
- OCA is difficult to apply manually to GF/GFF products – this often results in bubbles.
- OCA does not improve impact resistance, drop resistance and other physical aspects as much as LOCA.

Optical Bonding Comparison – LOCA/OCR

Advantages to OCA

Process Advantages

- Is contaminant-free, resulting in improved bubble resistance in laminations exposed to high temperature and humidity
- Is completely size-independent, while OCA tape must be pre die-cut
- Ideal for filling gaps because it is a liquid
- Is suitable for application on uneven surfaces
- Requires less surface preparation
- Can be more easily used in large panels
- Can be applied by highly automated processes
- Can be repaired and adjusted once cured

Physical Characteristics

- Superior optical properties (transmittance of ≥99%)
- Higher durability
- Has higher adhesion and longer life span than OCA
- High stability under extreme temperatures
- UV light resistant & resistant to yellowing

Disadvantages to OCA

Process Disadvantages

- Complex multi-step production process – liquid adhesive application, pre-curing, curing, etc. Multiple production stations and in-process transfers.
- UV curing only tends to fail to adhere areas where the FPC or silk screening might block the light. Two-stage curing required.
- Can be difficult to control an even thickness level of adhesive during the production process.
- Extreme care must be taken while transferring the assembly during the curing process to avoid misalignment
- Bubbles can occur at multiple stages during the production process and can be difficult to avoid.
- LOCA overflow can be very difficult to control, even with careful calculation beforehand and is difficult to clean up in case of occurrence. This is especially true for large panel applications (≥15.6”), which results in increased material wastage, cost and lower efficiency.

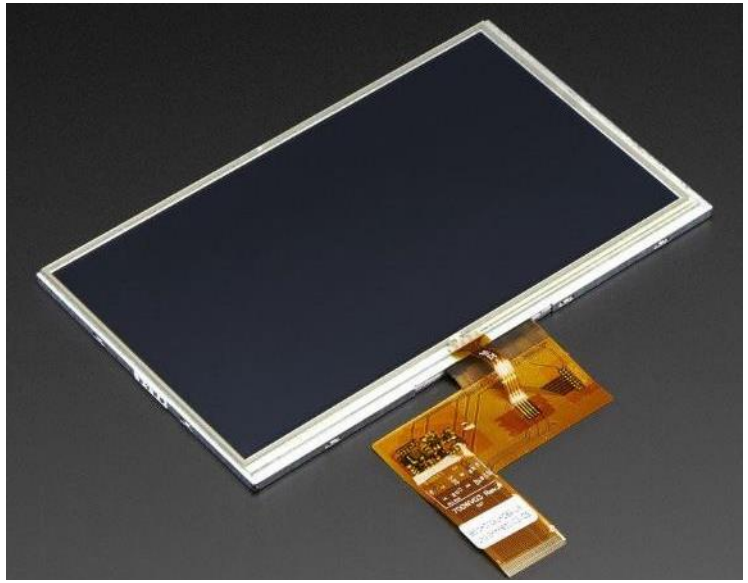
Integration Comparison - Overview

Category	Module Aspect	Tape Bonding	OCA Bonding	LOCA Bonding
General	*Cost*	Low	Medium	High
Ruggedization	*Vibration Resistance*	Low	Medium	High
	Sealed against dirt, dust & debris	Low	High	High
	Impact Resistance	Low	Medium	High
	Bond Strength	Low	Medium	High
Optical Qualities	*Transmission*	≥80%	≥94%	≥99%
	Display brightness	Low	High	High
	Light Reflected	13.5%	≤0.5%	≤0.5%
Processing	*Consistency / Ease of Control*	Medium	High	Medium
	Production Rate	High	Medium	Low
	Reworkability	Very High	Low	High
	Cleaning / Preparation Required	Low	Medium	High
	Yield Rate	≥99%	≥90%	≥95%
	Screen Size	Unlimited	≤15.6”	Unlimited

4. Touch LCM / LCD Modules

LCD Touch Modules & LCD Sourcing

We also offer LCD sourcing, integration and complete LCM touch modules to our customers. Thanks to our extensive supply chain in the Pearl River Delta, we can fulfill a wide range of project requirements and provide a solution at the right price and quality.



- Certifications

  TFT and LCD with a range of product certifications from UL to CE available.

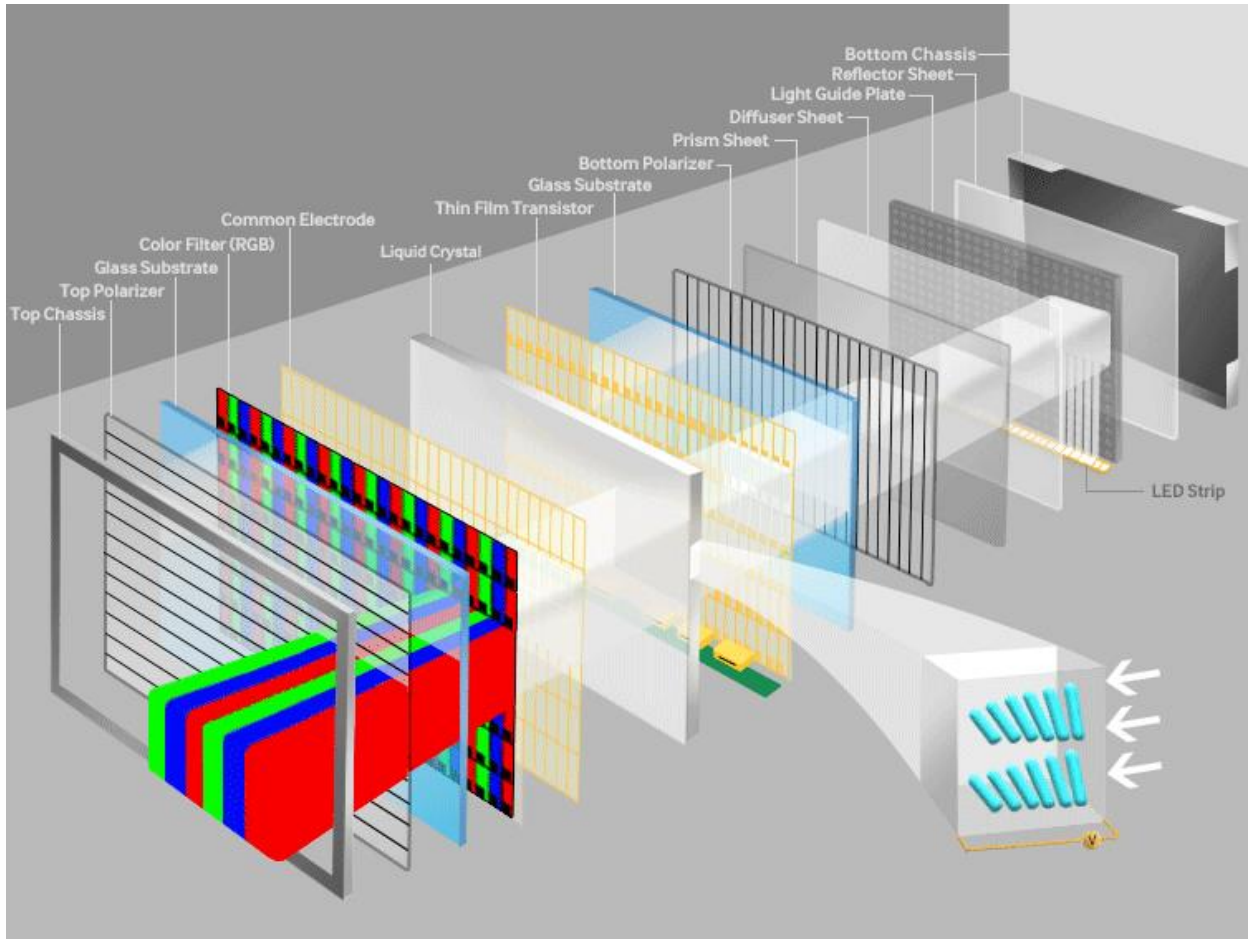
- Capacity

  Our range of LCD partners can supply virtually any capacity required.

- Primary Applications

  Touch screen monitors, POS systems, home appliance interface modules, etc.

LCD Touch Modules & LCD Sourcing – Overview



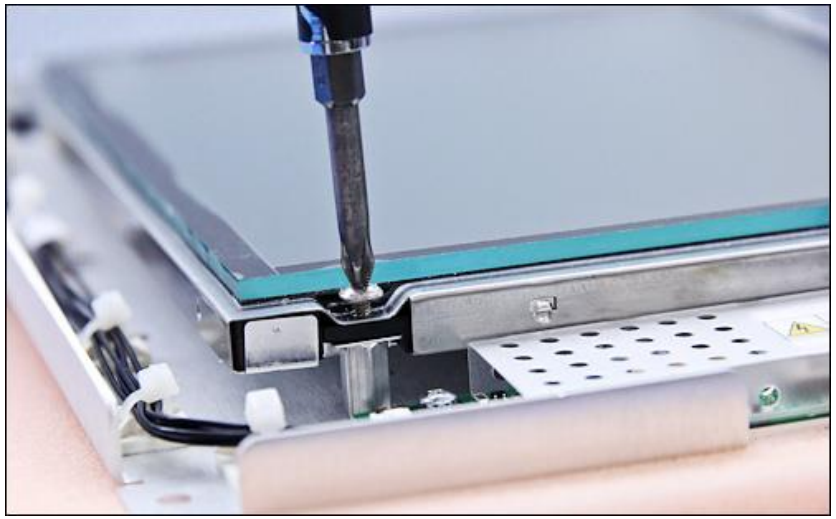
- In addition to our touch panels and our range of standard touch display modules, we also offer display sourcing and integration as an extension of our services.
- Customers are increasingly requesting that display integration occur in China prior to shipment; not only are there are range of world-class display producers in Guangdong that offer good quality product at very competitive pricing, integration in-house allows Dignity to better ensure the module's quality and performance and reduces the risk of issues with off-site integration or damage due to transportation, environment, etc.
- We offer the following services to our customers:
  - Display sourcing
  - Display purchasing / quality assurance
  - Custom display development
  - Display peripherals sourcing, purchasing and development
  - Control board and driver development

LCD Touch Modules & LCD Sourcing – Display Selection

- Our company's supply chain in the Pearl River Delta includes some of the world's leading LCD manufacturers. We can source a wide range of LCD sizes and specifications quickly and easily at a cost-competitive level.
- Display selection depends on a number of key factors, and our experienced project engineers can help you find a display that meet's your projects technical and budgetary needs. Some of the factors to consider:
  - Display size, viewing area and active area
  - Display brightness
  - Power consumption
  - Display lifespan (hours)
  - Operating environment (temperature range)
  - Interface type

5. Integration Related Information

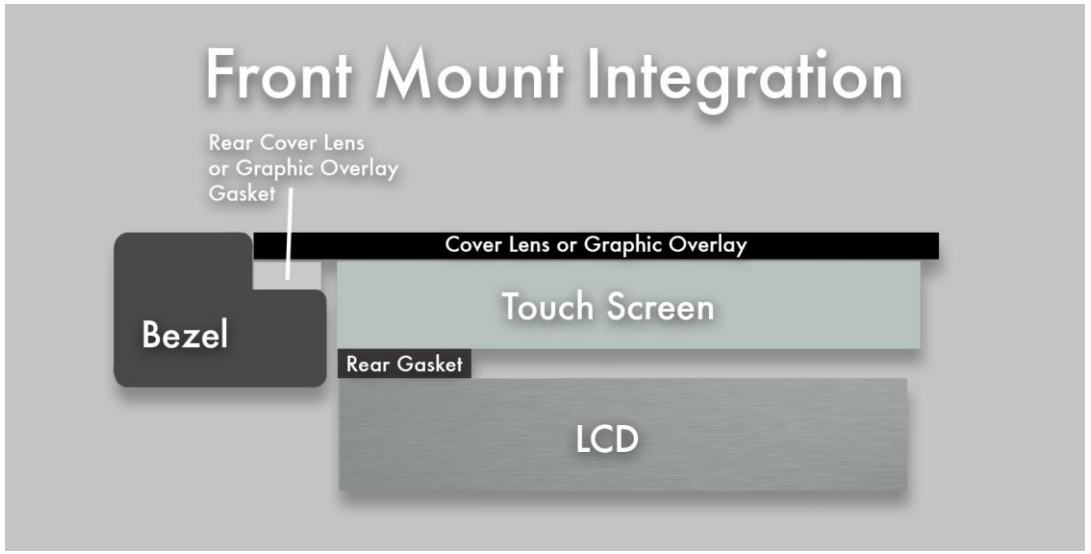
Touch Panel Integration – Project Quotations



Some factors to consider when preparing a quotation for the bonding process:

- **LCD dimensions and structure** - this will need to be considered by the engineering team and will affect the bonding process, yield, labor requirements, etc.
- **Enclosure dimension and structure** – this will need to be considered by the engineering team and will affect the bonding process, yield, labor requirements, tape bonding materials & gasket selection, etc.
- **Connection method** (USB, etc.)
- **Yield rate** – this needs to be carefully calculated and discussed with the client beforehand, especially is Dignity is supplying the LCD.
  - A 95% yield rate in the LOCA bonding process means that up to 5% of LCDs will have to be scrapped – this will generate significant cost.
  - OCA bonding is not reworkable, so yield is even more crucial.
  - LOCA is 98%+ reworkable, but the LOCA adhesive is itself quite expensive and is easily wasted during the bonding process.
- **Display requirements**
  - Environmental factors
  - Quality specifications for fit & tolerance

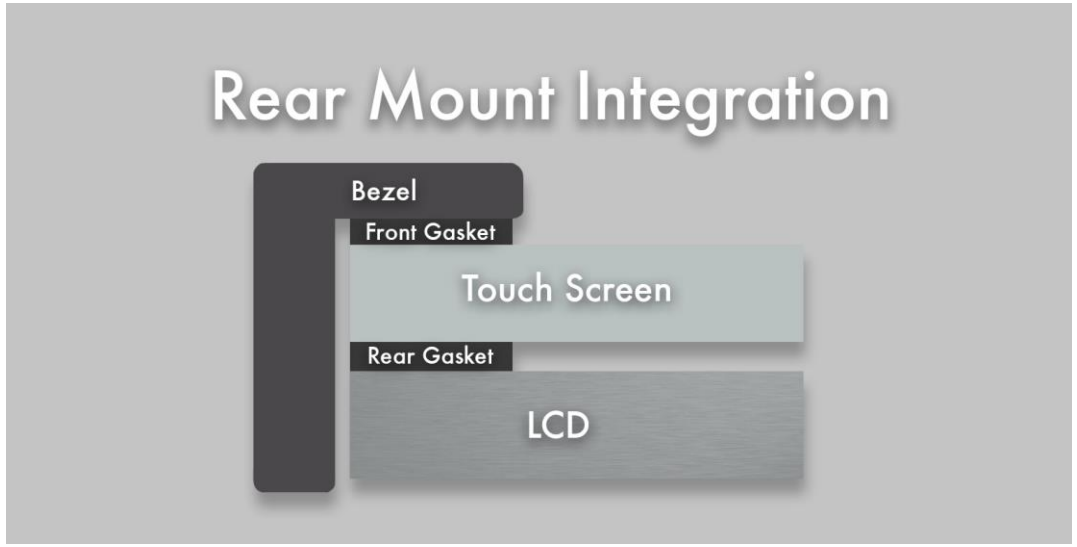
Display & Housing Integration – Front Mounting



Front mount integration is recommended if the user requires a uniformly smooth surface on the front of the product.

- Front mounting requires that the bezel be specifically designed for the application and it is important that the touch screen and LCD are supported from the back side to withstand the pressure from the user touching the screen.
- It is crucial to understand the tolerances for this project and how close to “truly flat” the surface needs to be. This can be difficult to control and is generally a more demanding and expensive mounting method.

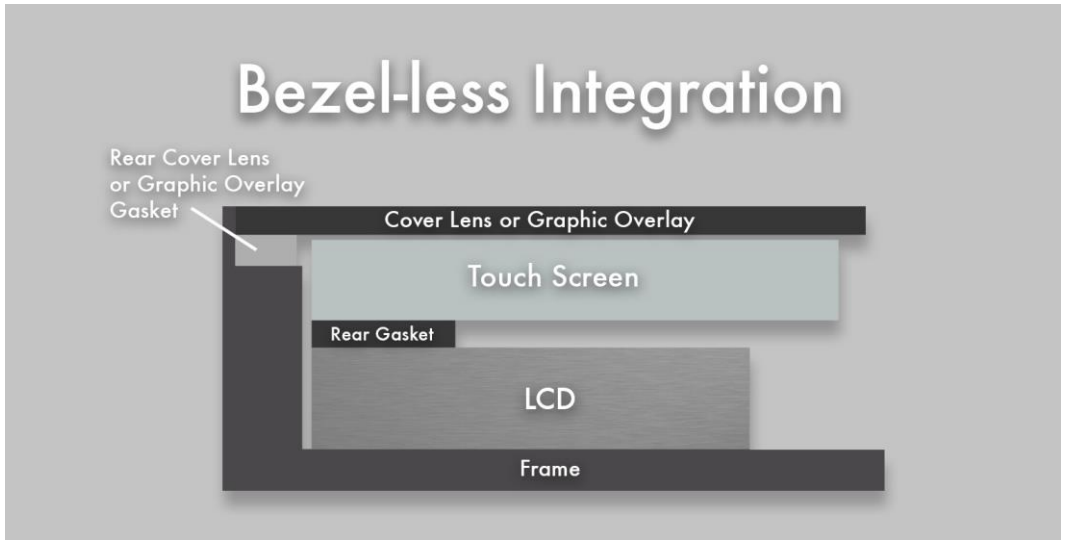
Display & Housing Integration – Rear Mounting



Rear mount integration is similar to how most resistive technologies are integrated today.

- They require a bezel that wraps around the front of the touch screen for the purpose of support, sealing, and hiding the buss bars around the screen.
- The touch screen is mounted directly to the frame of the LCD. As can be seen from the diagrams opposite the touch panel is fixed to the metal bezel of the LCD.
- The maximum tape area possible is recommended between LCD and touch panel, however a minimum of 3mm is needed on any one side.

Display & Housing Integration – Bezel-less Integration



Bezel-less integration is similar to how many smart phones are integrated on the market today. Bezel-less integration is also often used for certain POS and touch monitor AIO products.

- A lens made of glass is bonded to the front surface of the touch screen for extra durability and aesthetics.
- A frame around the edge of the lens is required for mechanical support.