

Optical Bonding Design Checklist for Heavy-Duty HMIs

Critical design decisions, validations, and risks for robust HMI systems

1 Environmental Profile

Key question:

What real-world stresses is the HMI exposed to?

Design decision / measure:

Define temperature range, humidity, UV exposure, vibration, shock, and chemical exposure early on

Verification / Acceptance Criteria:

Specifications including environmental profile, e.g., -40 °C to +85 °C, 85/85, UV test, Shock/Vibration



Risk if neglected:

Undersizing, subsequent field failures, inappropriate material selection

2 Optical stack

Key question:

Is readability guaranteed in sunlight and in the presence of reflections?

Design decision / measure:

Optical bonding, AR/AG coating, appropriate display brightness, and specify glass/touch assembly

Verification / Acceptance Criteria:

Test contrast, transmittance, haze, reflection, and readability under high ambient brightness



Risk if neglected:

Poor readability, operating errors, safety risk

3 Adhesive System

Key question:

Is the adhesive stable over the long term with respect to temperature, UV, and humidity?

Design decision / measure:

Select silicone- or acrylate-based adhesive based on application profile; for heavy-duty applications, preferentially qualify silicone-based OCR

Verification / Acceptance Criteria:

UV aging, thermal cycling, 85/85, haze/yellowness, adhesion testing



Risk if neglected:

Yellowing, delamination, blistering, optical degradation

4 Cover Glass & Touch

Key question:

Does the front panel withstand mechanical and chemical stresses?

Design decision / measure:

Define chemically toughened glass, appropriate glass thickness, surface coating, and touch technology

Verification / Acceptance Criteria:

Shock, drop, abrasion, chemical, and touch functionality tests



Risk if neglected:

Glass breakage, touchscreen failure, scratches, incorrect operation

5 Edge Sealing

Key question:

Is the bonded assembly permanently protected against moisture?

Design decision / measure:

Define the geometry, material, and application process of the edge seal

Verification / Acceptance Criteria:

85/85, CTHB, visual inspection, leak or delamination test



Risk if neglected:

Moisture ingress, hydrolysis, delamination, fogging

6 Thermal Design

Key question:

Are CTE mismatch and heat generation controlled?

Design decision / measure:

Consider an elastic adhesive layer, a symmetrical stack, and heat dissipation via the frame/housing

Verification / Acceptance Criteria:

Thermal cycling, high-temperature storage, warpage measurement, functional testing



Risk if neglected:

Stress, cracks, Newton's rings, warping, premature failure

7 Mechanical Design

Key question:

Is the HMI protected against vibration, shock, and assembly forces?

Design decision / measure:

Design the housing, mounting, seals, mounting points, and decoupling

Verification / Acceptance Criteria:

Vibration and shock tests in accordance with MIL/IEC standards, drop test, functional test



Risk if neglected:

Glass breakage, microcracks, solder joint or bond failures

8 Process Capability

Key question:

Can the bonding process be carried out reproducibly and without defects?

Design decision / measure:

Define cleanroom class, cleaning, plasma activation, lamination/dispensing parameters, and AOI

Verification / Acceptance Criteria:

Process FMEA, Cp/Cpk, 100% inspection, particle/bubble inspection



Risk if neglected:

Particles, bubbles, silvering, fluctuating adhesion

9 Validation

Key question:

Are the critical failure modes systematically mitigated?

Design decision / measure:

FMEA, test plan, prototype testing, define acceptance criteria and design iterations

Verification / Acceptance Criteria:

No visible delamination; haze/yellowing within specified limits; touch/display functional



Risk if neglected:

Undetected weaknesses, late design changes, high qualification costs

10 Series & Field Feedback

Key question:

Will quality remain stable during series production and in the field?

Design decision / measure:

Establish HASS/burn-in, traceability, field monitoring, and a lessons-learned process

Verification / Acceptance Criteria:

Production approval, complaint analysis, continuous updating of the FMEA



Risk if neglected:

Early failures, high warranty costs, lack of feedback into the design



More information:
[via-optronics.com](https://www.via-optronics.com)