

Switchable™

LCD PRIVACY GLASS

# Technical Operations Manual

Revision 16  
Published January 2025



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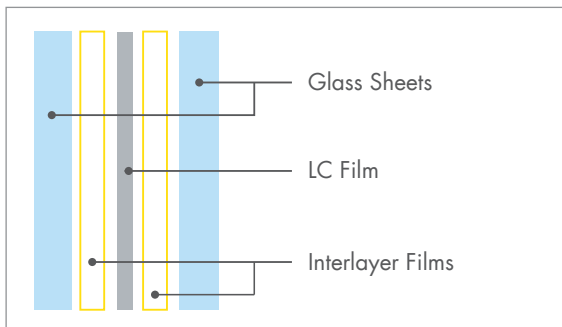
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# Technology

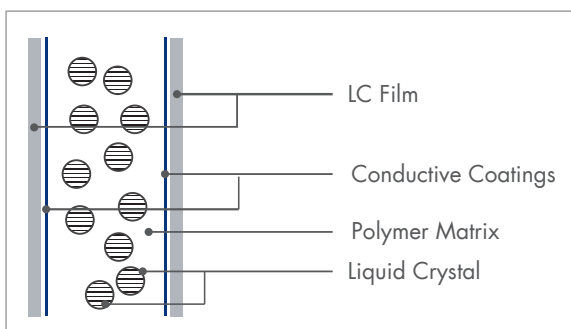
## Principle:

LCD Privacy Film is made of two layers of transparent conductive film sandwiched with PDLC material. The film is then laminated between two pieces of glass. When electricity is applied to the film the liquid crystals line up and ESG Switchable™ becomes transparent. When the power is turned off, the liquid crystals return to their normal scattering positions and turn the glass from transparent to opaque.

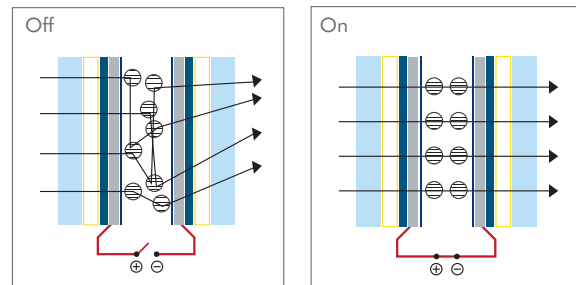
The Liquid Crystal Privacy film is encapsulated between layers of glass in a protective laminate construction. ESG Switchable™ incorporates 5mm low iron tempered glass as standard, offering considerably higher light transmission when transparent. However as ESG manufacture the product in the UK customers can select from a wide range of glass types and colours to suit their project requirements. The outside leafs are made up of glass (normally 5 or 6mm toughened glass) each side, then a PVB interlayer is inserted on each side to trap and hold the Liquid Crystal Privacy film.



The Liquid Crystal Privacy film is made up from electrically conductive coatings, a polymer matrix and liquid crystals. This film is connected to the power supply via bus bars, electrical wiring and a transformer.



## PDLC Light Scattering Mechanism



## Manufacturing

ESG Switchable™ is manufactured in the UK by our experienced team and all stages of its production process are monitored and controlled. ESG employ a variety of laminating methods which enables us to produce a wide range of specialist glass products incorporating ESG Switchable™.

This method allows us:

- to control our production process very precisely
- to use different interlayers optimal for specific applications (PVB and Vanceva)
- to produce all types of glass: shapes, curved, notches, cut outs, holes
- to manufacture special products:

ESG Secure™

ESG Acoustic glass

We use only the best materials in our production process from major global producers, whose materials are manufactured to internationally recognised quality standards.

## Overview

Where discretion is vital, ESG Switchable™ gives you the choice of privacy or the public gaze at the flick of a switch. Normally a diffused white which acts as a screen, this LCD glass can be made transparent simply by passing an electric current through it. With the power off, liquid crystal molecules in the Privacy film are randomly oriented so that incidental light is scattered, making the glass opaque; but when electricity is applied, the liquid crystal molecules line up and, as light passes through it, the Privacy film becomes optically clear.

ESG Switchable™ is available in custom sizes and shapes, making it an ideal choice for architects and designers when creating working, home, retail and leisure spaces.

In its white state, LCD glass even becomes the perfect backdrop on which to project presentations, without the need for a separate screen.

## Principles of Privacy Glass Technology

### Development of LCD Film

Obtained license from Kent State University in 1988

Developed reliable formulations and process

Designed its own equipment for production

Commercialised PDLC film in 1990

Commercialised PDLC glass in 1994

Low Haze version in 2004

### Product Type

ESG Switchable™ LCD privacy glass

## Features & Benefits

### Unique Features

- The largest size film on the market - up to 1,800mm x 3,500 mm
- Can be combined with certified ESG security glass products, acoustic and decorative interlayers
- Available in curved panels, bespoke shapes and with holes, notches and cut outs for bespoke applications
- No distraction of shutters. Not susceptible to mechanical failure as seen with electrical shutters, curtains or blinds
- Blocks 99% of UV rays
- Low working voltage
- Life – average of 25 years with due care

### Benefits to our Customers:

- Manufactured in UK
- Product and technical advice from our specialist 'tech team'
- Solutions for a wide variety of applications
- Complex supply and fix electrical systems service
- UK wide delivery service on ESG's own fleet of specialist glass carrying vehicles
- Crating and shipping export service

# Applications

- **Commercial**

Meeting rooms, conference rooms, office partition screens, executive offices, doors, sliding doors, roof lights, tradeshow exhibits and command centres

- **Dealerships**

Showrooms, meeting rooms, sliding doors and customer areas

- **Hotels and Restaurants**

Hotel room privacy screen, bathroom / bedroom privacy screen, external windows, doors, conference centre windows and roof-lights, bar and restaurant screens, toilet cubicles, balustrades and balconies

- **Projection**

Internal or external high resolution rear projection screens

- **Residential**

Bathroom / Shower enclosure, projection screens, doors, sliding doors, roof lights, ultra-modern residential and commercial blind applications

- **Security**

Security windows, bullet resistant glass, bank cashier window and automated teller security windows, vision panels, entrance foyer and cell doors and windows

- **Entertainment and Showrooms**

Rear projection screens, feature screens, special effects panels and vanity screens

- **Healthcare**

Hospital (nursery, emergency, ICU, operation room), fire resistant doors and viewing panels

- **Retail**

Advertising screens, changing rooms and projection

- **Executive Cars**

Privacy screens and security solution

## Technical Data (ESG Switchable™ LCD Privacy Glass)

<b>Glass Colour:</b>	A range of colours including extra clear ( low iron ), tinted and coloured e.g. bronze
<b>Decorative Glass:</b>	Full digital print, screen printed, sand blasted and patterned
<b>Glass Type:</b>	Low iron, annealed, heat strengthened, tempered (All laminated)
<b>Thickness:</b>	Various from 10 mm to multi layer laminates
<b>Size:</b>	1,800mm x 3,500mm <i>ESG Switchable™ has the largest panel size on the market</i>
<b>Shape:</b>	A range of shapes, including glass with holes, notches and cut outs
<b>Environmental:</b>	<ul style="list-style-type: none"> <li>– Storage -20°C to 70°C (-4°F to 158°F)</li> <li>– Operation -10°C to 70°C (14°F to 158°F)</li> </ul>
<b>Electrical:</b>	<ul style="list-style-type: none"> <li>– Driving voltage: 65 volts A.C. Nominal</li> <li>– Current: 155 mA per square metre</li> </ul>
<b>Switching Time:</b>	Approx. 100 milliseconds at room temperature
<b>Warranty:</b>	5 years - Glass and LCD Film 5 years - Electrical

### Example ESG Switchable™ Glass Sound Control Data

Thickness	Standard Construction	ESG Switchable™ Std dB Rating (Rw)	ESG Switchable™ Acoustic dB Rating (Rw)
10 mm	4 mm Low Iron tempered glass x 1.52 PVB + 0.4 mm LCD x 4 mm Low Iron tempered glass	35	37
12 mm	5 mm Low Iron tempered glass x 1.52 PVB + 0.4 mm LCD x 5 mm Low Iron tempered glass	36	38
14 mm	6 mm Low Iron tempered glass x 1.52 PVB + 0.4 mm LCD x 6 mm Low Iron tempered glass	36	39

### ESG Switchable™ - Examples of Optical Performance\*

Thickness	Standard Construction	Visible Light Transmission % (LT) - ON*	Visible Light Transmission % VS Clear Laminated	Visible Light Transmission % (LT) - OFF*
10 mm	4 mm Low Iron tempered glass x 1.52 PVB + 0.4 mm LCD x 4 mm Low Iron tempered glass	80 **	-12 **	41
12 mm	5 mm Low Iron tempered glass x 1.52 PVB + 0.4 mm LCD x 5 mm Low Iron tempered glass	79 **	-11 **	40
14 mm	6 mm Low Iron tempered glass x 1.52 PVB + 0.4 mm LCD x 6 mm Low Iron tempered glass	78 **	-10 **	38

\* According to manufacturer's test data

\*\* +/- 3%

## Shapes

Rectangles



Squares



Triangles



Circles



Rounded Corners



Trapezoids



Parallelograms



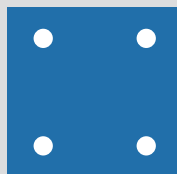
Domed Tops



Notches



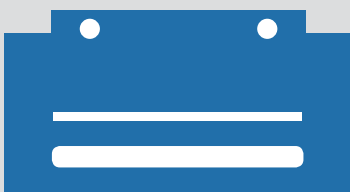
Holes



Cut Outs



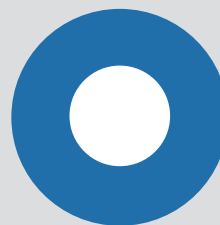
Special shapes



Special shapes



Special shapes



Special shapes

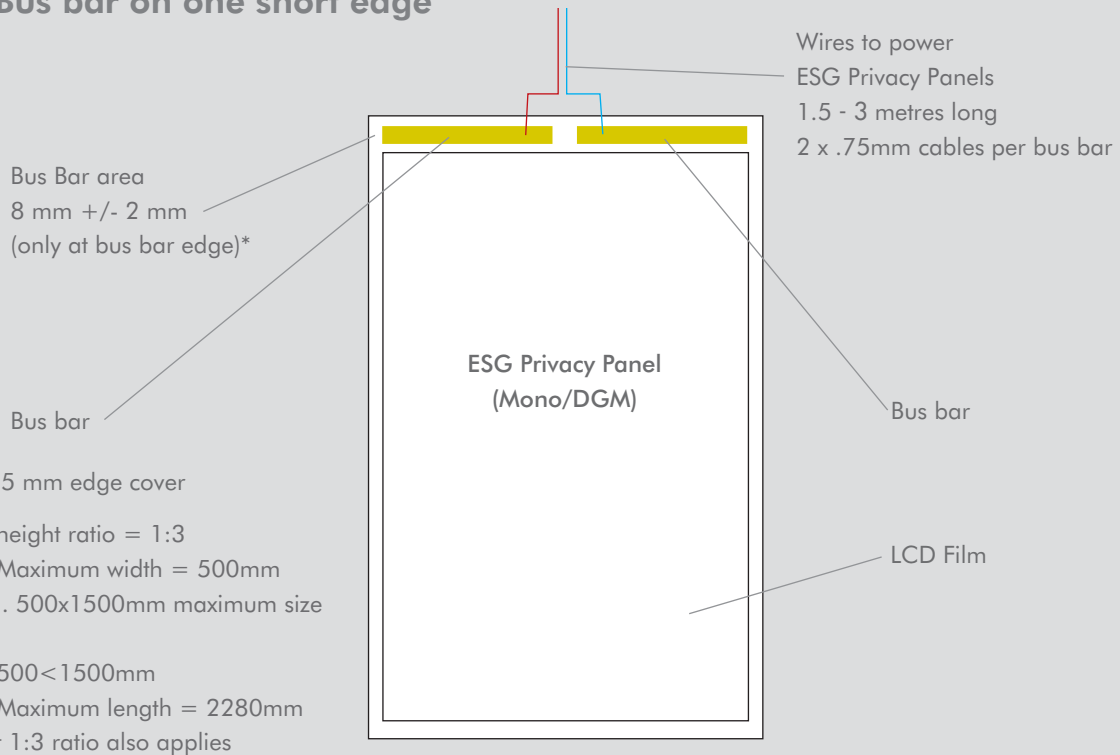


and many more.

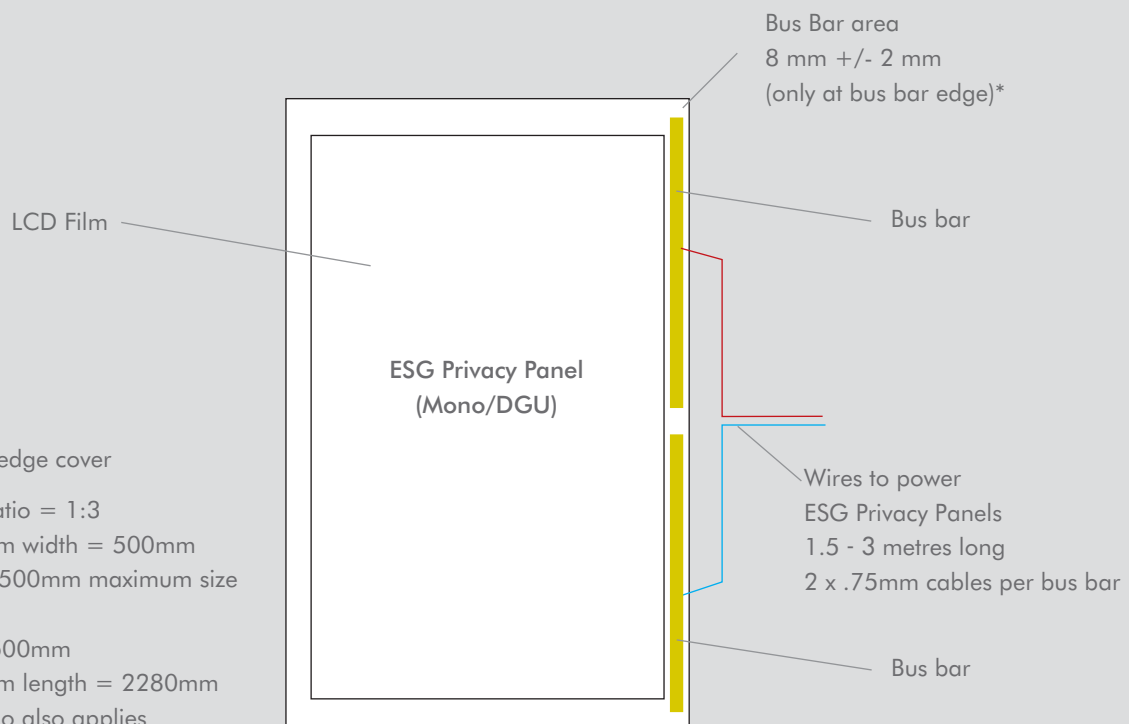
Transparent areas, small bubbles or visual distortions may be present around notches, holes or cutouts. Customers must allow for coverage of 10mm around notches, holes or cutouts.

## Bus bars - Single Laminated or Double Glazed Units

**Fig 1. Bus bar on one short edge**



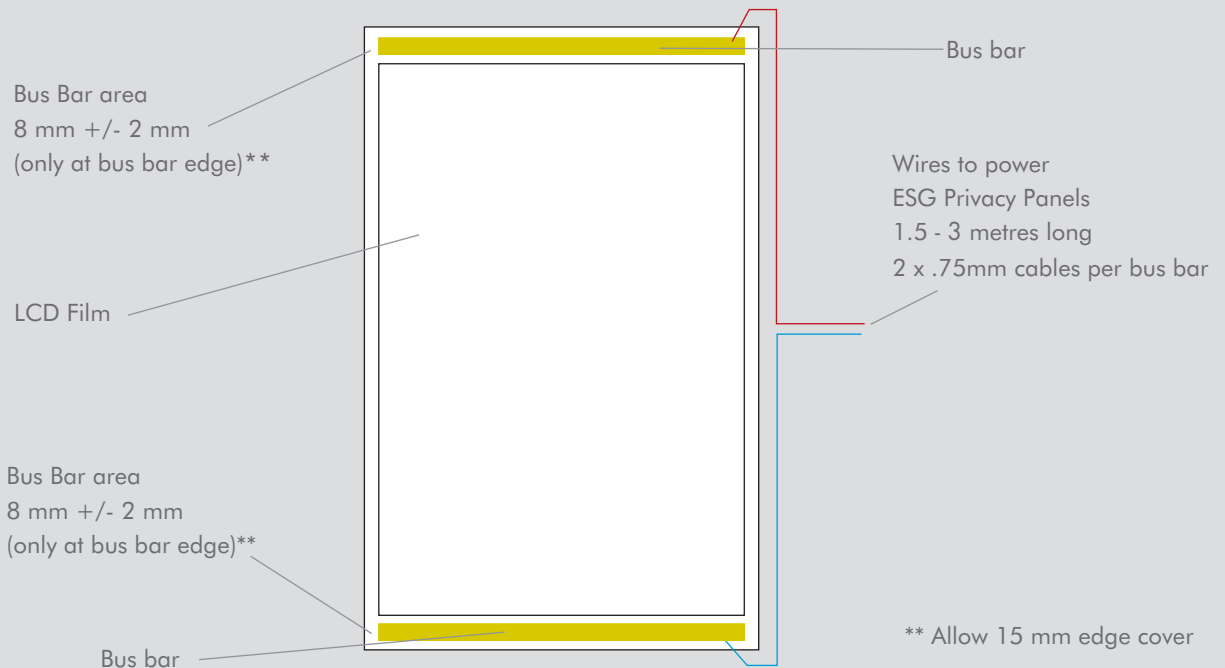
**Fig 2. Bus bar on one long edge**



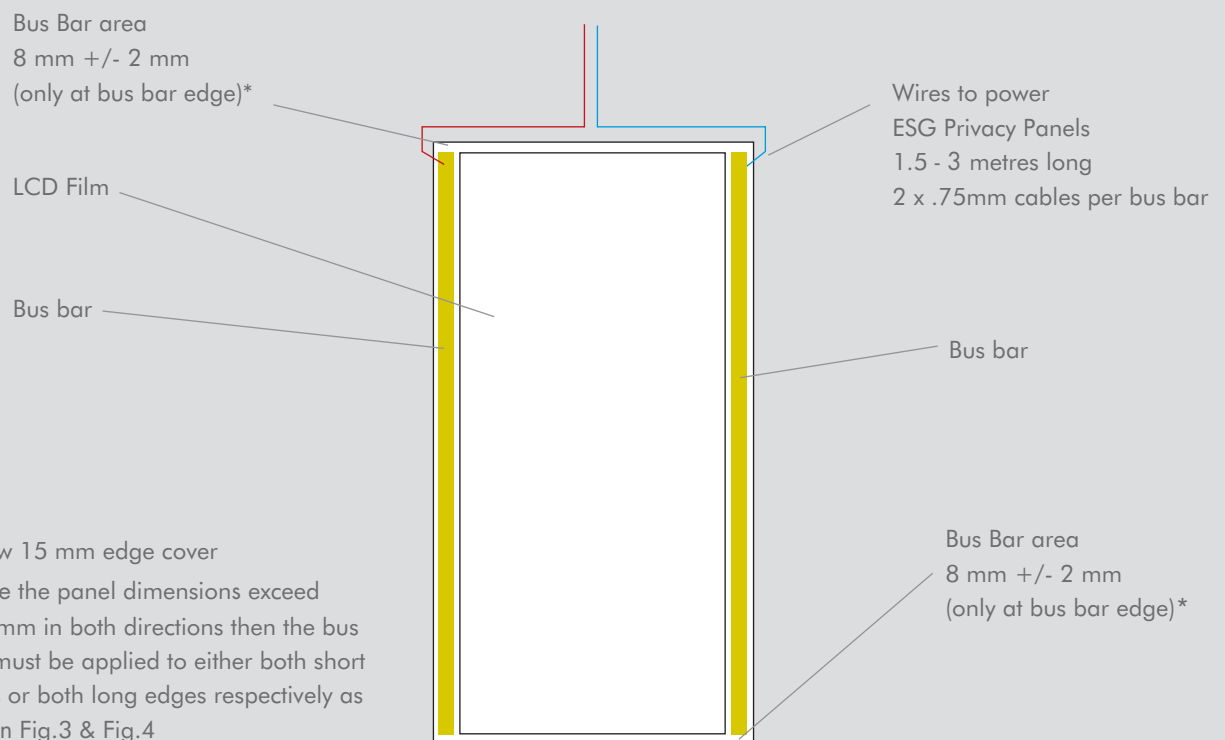
NB: A transparent / non switchable area of 5mm around the perimeter of ESG panels may be observed. This is a natural phenomenon and not a fault with the product



**Fig 3. Bus bars on two short edges\***



**Fig 4. Bus bars on two long edges**



\* Allow 15 mm edge cover  
Where the panel dimensions exceed 1500mm in both directions then the bus bars must be applied to either both short edges or both long edges respectively as seen in Fig.3 & Fig.4

NB: A transparent / non switchable area of 5mm around the perimeter of ESG panels may be observed. This is a natural phenomenon and not a fault with the product

## Considerations Before You Order

- Transparent areas, small bubbles or visual distortions may be present around notches holes or cut outs, therefore customers must allow for coverage of 10mm around all notches, holes and cut outs.
- A transparent / non switchable area of up to 5mm all round the perimeter of the glass may be observed. This is a natural phenomenon and not a fault with the product.
- Once glazed, ESG Switchable™ panels must be switched off (in opaque state) for a minimum of 4 hours a day to help optimise LCD film performance.
- Please note there is always an element of haze in all LCD switchable privacy glass products even when in its transparent state. Please ensure that this level of haze is acceptable to you before ordering as this will not be considered or constitute a reason for rejection or refund once the goods have been manufactured
- All panels are supplied with up to 3m of 2 x 0.75mm low voltage cable attached to each busbar as standard. For longer runs 1.5 or 2.5mm may be used to extend from the 1.5mm, but this must be specified when you order and may affect your price.

### ESG Switchable™ and Clamp Fittings

Please be aware you must notify ESG when placing your order if you intend to use any type of 'clamp fitting'.

If 'clamp fittings' are being used then ESG will introduce a transparent / non switching clamping patch section to ensure no damage occurs to the LCD film during installation. It is imperative that any clamp fittings are not tightened beyond the manufacturers recommended torque rating.

ESG Group are not responsible for damage to the LCD film through over tightening or failure to inform ESG as to the use of clamp fittings

Please see Fig 1. showing the dimensions of these patches. A clear border around the fitting perimeter may be visible depending on the size of your fitting and cover plates.

It is recommended to use a screen print detail to hide this clear boarder.

Please note: This also applies to top and bottom rail fittings that clamp the glass

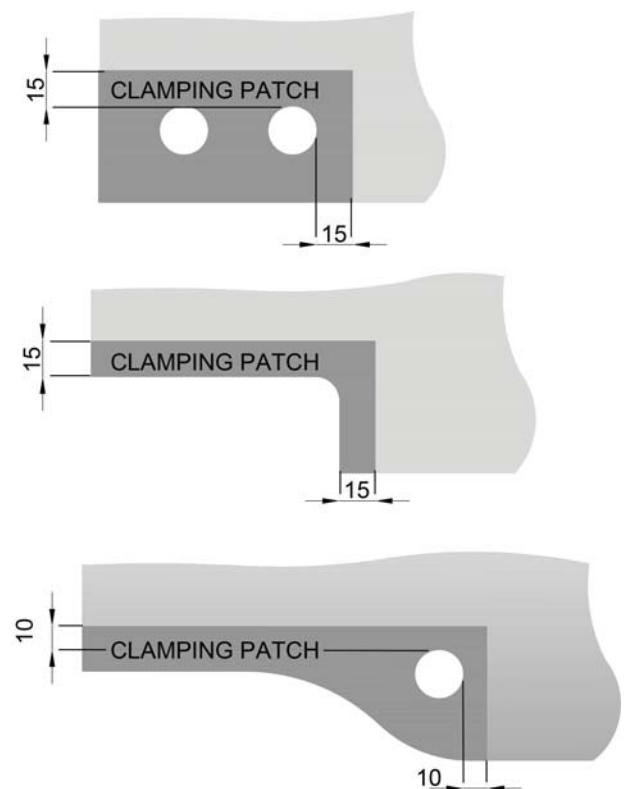


Fig 1.

## Safety Precautions

- Thoroughly read the following safety precautions before using the equipment
- Observe these precautions carefully to ensure safety
- After reading this manual, pass it on to the end user to retain for future reference
- Keep this manual for future reference and refer to it as necessary. This manual should also be made available to those who repair or relocate any element of the ESG Switchable™ electrical installation. Make sure that the manual is passed on to any future users.
- For information not contained in this booklet please refer to ESG Switchable™ on our website - [www.esg.glass](http://www.esg.glass)

## General Precautions

To ensure safety and proper operation of ESG Switchable™ and to avoid invalidating any warranty, the panels must be installed by a qualified electrician. ESG Switchable™ should be delivered, handled, installed, protected, cleaned and used in compliance with all local legislation, regulations and codes of practice and in accordance with the requirements detailed in the ESG Switchable™ Technical Binder.

ESG Switchable™ panels must be operated using the ESG LCD-HD2 or 4K control box in order to avoid damage to the LCD film and invalidating any or all warranties

## Operation

ESG Switchable™ is electrically switched from opaque to optically clear by applying 65V AC to the glass via the ESG control box. Switching may be via a hard wired switch, wireless switch and/or remote control, movement sensor, timer, door lock or via another type of electrical control system e.g. BMS. ESG Switchable™ panels use approximately 5w/m<sup>2</sup> in the 'on' transparent state.

**In their transparent state ESG Switchable™ panels allow approximately 79% light transmission which means that the panels can be seen through but as with all LCD switchable smart type privacy glass there will always be some degree of haze and this is not a reason for rejection or refund.**

**In order to maximise the performance of ESG Switchable™ panels, it is recommended that they be switched off (left in opaque state ) for four hours a day**

***ESG Controllers contain a battery back up that holds software configuration if mains power is lost for a short time. A prolonged period ( 7 days + ) without mains power may cause these batteries to fail. In this event a site visit will be required to reconfigure the software and a charge will be applicable for this visit.***

## Electrical

As with any electrical device, ESG Switchable™ must be included in the electrical layout for each project e.g. position of spurs, switching layout, containment, and connection boxes etc. The installation must meet all local rules and regulations. In addition, any metal frames which could come into contact with the wiring of the panel must be earthed. ESG is not responsible for supplying electrical layout drawings except when they are providing the electrical installation service. Typical wiring diagrams for ESG Switchable™ products are shown in the relevant data sheets.

## Switches and Controllers

When ESG supply switches, remote controls and/or system control equipment for ESG Switchable™ installations, staff will demonstrate operation of the switches and controllers to their customer and provide copies of the technical data sheets for the various electrical components in this manual. ESG's team, will if required, demonstrate the operation of all such equipment to their client or end user.

## Electrical Installation by ESG Contractors (UK)

All electrical installations by ESG contractors will only include wiring and commissioning of all low voltage wiring relating to the ESG Switchable glass panels and controllers. All necessary 240V wiring ( including switches and power points ) are not part of the ESG installation package. ESG require a 240V 13A plug socket or fuse spur for the power supply to each controller in the installation. If a fuse spur is being used, wiring of the supplied controller power cable into the spur is the responsibility of the onsite electrical contractors.

All power source must be within 0.5m of the installation position of the controller

## Electrical Installation by ESG's Customer

ESG require all electrical installations of ESG Switchable™ to be completed by a licensed electrician and in compliance with all local rules and regulations.

Before installation the electrician must inspect bus bars, electrode leads and cables to ensure they are properly insulated. No exposed bus bars, electrodes or cables should be allowed to come into contact with metal frames as this may damage the ESG Switchable™ panels and controller. Any metal framework into which panels will be installed must be earthed.

Before turning on the power supply the electrician must test the resistance reading between the frame and the electrode to ensure the reading is infinite/open circuit i.e. there is no connection between the frame and the panels. If the reading is not infinite then the electrician will need to check all bus bars, electrodes and cables until the short circuit is found and insulated accordingly.

## Glazing - General Notes

### Surface Conditions

- A.** Inspect the areas and conditions under which work will be performed. Correct any circumstances detrimental to the proper completion of the work. You must not proceed with glazing until unsatisfactory circumstances are corrected.
- B.** Ensure all glazing channels, rebates and stops are free from obstructions and substances which may hamper quality of glazing
1. Remove protective coating which might fall in adhesive or interfere with bond of sealants.
  2. Ensure the final wiping of surfaces complies with manufacturers' instructions immediately prior to application of primer and glazing compounds or tapes.

USE ONLY NEUTRAL CURE SILICONES. DO NOT USE ACETIC SILICONES.

**RECOMMENDED:**  
**DOW CORNING**  
399, 795, 799, 982, 991, 1199

### Installation

- A.** Inspect each piece of glass immediately prior to starting installation
1. Do not install items which are improperly sized, have damaged edges, or are scratched, abraded, or deficient in any other manner.
  2. Do not remove labels which are provided by the glass supplier until directed by the Architect.
  3. Adhere to all ESG installation instructions and installation drawings.
- B.** Locate sill setting blocks of standard width and thickness at quarter points of all glass lights unless otherwise recommended by manufacturer or supplier.
1. Use blocks of proper durometer, size and thickness to support the glass in accordance with the manufacturers' recommendations.
  2. Glass lap and edge clearances must be provided according to pertinent codes and standards of manufacturers

- C.** Set the glass in a method which produces the greatest possible degree of uniformity appearance.
1. Indicate clearly when installing glass in dynamic frames such as operable windows or sliding doors.
  2. Glazing to the exterior and wet interior conditions must be wet-sealed and resistant to moisture with provisions to allow for weeping of condensation that may infiltrate the system.
  3. Pressure glazing systems without positive positioning stops must not be used with this glass.
  4. Glazier to place electrical connections to allow access by an electrician.
  5. Electrical connections must exit at the head position of any framing system using ESG Switchable™ panels in wet environment applications.
- D.** Cut and seal the joints of glazing gaskets in accordance with the manufacturers' recommendations, provide watertight and airtight seals at corners and other locations where joints are needed.

### Protection

Reapply protective film after glazing to avoid surface damage prior to commissioning.

### Cleaning

Cleaning can be carried out much in the same way as normal glass by using a slightly damp cloth or professional glass cleaning product. Abrasive products should never be used, particularly when the surface to be cleaned has a reflective coating. ESG advise the use of a professional window cleaning service. Avoid excess moisture / chemical cleaning agents coming into contact with ESG Switchable™ panel edges.

## Setting/Glazing

ESG Switchable™ panels may be orientated in any direction. The Flat Glass Marketing Association (FGMA) Glazing Guidelines are to be followed except as noted.

### Glazing Methods

#### Interior Applications - Laminated ESG Switchable™ panels

Dry Glazing: This is the preferred interior glazing method.

Wet Glazing: If a non-acetic sealant is used, it must be compatible with the panel polyvinyl butyral (PVB) interlayer.

Never use putty or glazing compound to glaze an ESG Switchable™ panel.

#### Exterior Applications - Insulated Glass Units made with ESG Switchable™

Wet Glazing: Pre-shimmed glazing tape and non-acetic sealants are required to create a seal impervious to moisture for all applications.

**Panel Position: When used in external DGU, ESG Switchable panel MUST BE positioned as the internal panel.**

**Electrical Connections: These must exit at the head of any ESG Switchable panels in wet environment applications.**

#### Structural Silicone Glazing

Insulated glass units manufactured with ESG Switchable™ panels should not be structurally silicone glazed.

### Frame Design

- Standard frame edge clearance and face clearances may be used, EXCEPT edge bite must be 11mm minimum and framing must have a hole of 6mm diameter. To maintain a proper seal against the infiltration of water and air, adequate bite is required.
- Inadequate clearance for the edges can cause damage due to glass-to-frame contact.
- The industry standard for framing deflection must be adhered to. The deflection must not exceed either the length of the span divided by 175, or 18 mm, whichever is less. All expansion joints and anchors must be designed so that the glass framing does not incur a load due to structural movement.

### Setting Blocks

- Glass larger than 0.5 square metres should be placed on two EPDM or neoprene setting blocks.
- These blocks should have a durometer hardness of  $85 \pm 5$ .
- They should be centred at the bottom quarter points (i.e. equal distance).
- The blocks should be 1.5 mm narrower than the channel width.
- Lock-strip gasket systems also require setting blocks. Recommendations can be obtained from the gasket manufacturers.

### Glass Protection

- Once the glass is installed, the architect, general contractor, or owner should be provided with instructions for glass protection and cleaning.
- Weathering steel or alkaline materials may cause surface damage due to staining.
- Abrasive cleaners should never be used, particularly when the surface to be cleaned has a reflective coating.
- Windblown objects, welding sparks, or other material applied to the glass surface during construction may cause irreversible damage.

## Glass Protection & Relocation

Important notes for those wishing to relocate ESG Switchable™ panels:-

- Do not expose to the elements whilst moving the glass
- Do not remove edge protection tape
- Do not rest panels on their corners or modify or damage the edges
- Use only neutral cure silicones. Do not use acetic silicones

Recommended Types

Dow Corning 399, 795, 799, 982, 991, 1199

- Avoid damage to the electrical cables
- Panels must be installed by a qualified electrician

## Shipping & Receiving

### Shipping

ESG Switchable™ is delivered by ESG's own experienced logistics team throughout the UK.

Full crating and shipping service for exporting the goods worldwide is available.

All panels must be checked for damage when the panels are delivered and the delivery note marked accordingly as any claims for damage after the delivery driver has left will not be accepted. This includes delivery of both loose panels and those delivered on stillages. If the person receiving the panels marks the delivery note 'unchecked' or any variation on this term then they will still be deemed to have accepted the panels as undamaged and the panels will be chargeable. ESG will not be held responsible for damage if the person receiving the panels fails to inspect them.

### Storage

- Glass edges frequently sustain damage due to careless handling between manufacture and installation.
- Handle with care!
- If the glass is to be stored on site or in warehouse conditions, proper blocking and protection should be maintained at all times.
- As with other flat glass products, ESG Switchable™ must be stored where the relative humidity is less than 80% to prevent the glass from staining.
- The glass temperature should be held nearly constant to prevent moisture condensation on the panels. Storage temperature range is -20-70 °C.
- Panels should be tilted at 5° - 7° from vertical at all times using broad, sturdy uprights to support the weight of the glass.

### "Unexpected" Breakage

"Unexplained" glass breakage may occur after all precautions have been taken. Such breakage is beyond the control of the manufacturer and therefore not warrantable. This includes but is not limited to the following items:

- thermal stress
- damage during sand blasting (if not performed by ESG)
- glazing system pressures
- damage during glazing
- handling and storage problems
- excessive wind loads
- objects and debris striking the glass
- damage by persons/objects at the construction site



## Maintenance & Cleaning

ESG Switchable™ panels do not require any special maintenance procedures. Once installed the glass should be cleaned regularly with warm water and a mild liquid detergent, using a soft clean cloth, then rinsed with clean water and dried with a soft dry clean cloth. Avoid excess moisture and/or chemical cleaning agents coming into contact with the edges of ESG Switchable™ panels.

The use of abrasive cleaners and/or cleaning implements may damage or scratch the panels' exterior surface and should therefore be avoided.

On an annual basis the client should check that all wiring is in good condition and that the controller and switch are in good visible order. Framing materials should also be free from damage and the area around the frame should be checked for signs of excessive temperature or humidity. If these signs appear unusual then the client should contact their supplier in order for the installation to be checked.

## Warranty

ESG warrants that ESG Switchable™ panels should be free from defects for a period of five years from the date of invoice unless otherwise specified. Defects include loss of switching where the electrical system and supply are working correctly and/or de-lamination of the panel.

In order for any warranty claims to be considered, all ESG Switchable™ panels must be controlled with an ESG supplied controller. Controlling / operating ESG Switchable™ products with any other product will instantly render all warranties null and void.

ESG warrants that all ESG Switchable™ controllers are supplied with a 5 year warranty

In the event of a breach of warranty for the reasons as above ESG will repair or replace the defective product. ESG will not accept any costs incurred by others which are associated with gaining access, removal, replacement, installation of panels or consequential loss claims of any kind.

The customer must advise ESG immediately that they are aware a panel is defective and if installed they must leave the panel in situ. ESG will decide whether to inspect the installation on site or may ask to have defective product returned for repair or replacement.

Haze – ESG Switchable™ panels are not as optically clear as standard float glass. Some degree of haze will always appear due to the nature of the product make-up. As with all LCD switchable smart type privacy glass there will always be some degree of haze and this is not a reason for rejection or a refund.

ESG is not responsible for products which are damaged due to external events such as, but not limited to, natural disasters, incorrect silicone use, improper use or maintenance or use of unauthorised parts.

To ensure safety and proper operation of ESG Switchable™ and to avoid invalidating any warranty, the panels must be installed by a qualified electrician. ESG Switchable™ should be delivered, handled, installed, protected, cleaned and used in compliance with all local legislation, regulations and codes of practice and in accordance with the requirements detailed in the ESG Switchable™ Technical Binder.

Due to the physical and chemical properties of PDLC film being unique in each manufactured batch, if a replacement ESG Switchable™ panel is supplied it may not be possible to match operating performance of the other original ESG Switchable™ panels in the same system.

This primarily refers to the switching time of the PDLC film. In a multi panel system, a new replacement panel MAY have a slightly different switching time. Should this occur the difference in switching time will only be milli seconds but our engineers will do everything to reduce the difference. If they cannot resolve this difference in switching time, it is NOT considered to be the fault of ESG and as such NOT a reason for replacement of any other panels than those originally warranted.

Please note that all warranties are valid only from date of original invoice.

## Our Quality Standards - Your Assurance

We are committed to giving customer satisfaction through service provision of the highest standard. This applies to all areas of our business and is central to our mission.

Our products are tested in house and by Europe's leading Independent, third-party certifiers and testers such as BRE, TNO, Technalia, Efectis, Wiltshire Ballistics and the British Standards Institute which distinguish our products and services from our competitors, and gives you, our customers, confidence about their performance.

### ESG BALLISTIC

BS EN 1063:2000 Security Glazing – Testing and classification of resistance against bullet attack

### QMS

BS EN ISO 9001 : 2008 – FM 511206

Audit Body – BSI (British Standards Institute)

Originally Registered – 8th January 2007

### TOUGHENED GLASS

BSI Kite Mark Licence – KM 511207

Class 1 Toughened Glass - BS EN 12150 : 2000

(Glass in building. Thermally toughened soda lime silicate safety glass)

Impact Tested – BS EN 12600 : 2002

(Glass in building. Pendulum test. Impact test method and classification for flat glass)

### HEAT STRENGTHENED GLASS

BSI Kite Mark Licence – KM 511207

Heat Strengthened Glass - BS EN 1863 : 2000

(Glass in building. Heat strengthened soda lime silicate glass).

Bending Strength Tested – BS EN 1288-3 : 2000

(Glass in building. Determination of the bending strength of glass – Part 3 – Test with specimens supported at two points – Four pointbending).

### HEAT SOAKED GLASS

BSI Kite Mark Licence – KM 511207

Heatsoaked Glass – BS EN 14179 : 2005

(Glass in building. Heat-soaked thermally toughened soda lime silicate safety glass)

### LAMINATED GLASS

BSI Kite Mark Licence – KM 511207

Laminated / Toughened Laminated Glass – BS EN 14449 : 2005 (Glass in building. Laminated glass and laminated safety glass)

Tested in accordance to – BS EN 12543-4 : 1998

(Glass in building. Laminated glass and laminated safety glass. Test methods for durability)

### SECURITY GLASS

BS EN 356 : 2000

(Glass in Building – Security glazing. Testing and classification of resistance against manual attack).

LPS 1270 Issue 1

(Requirements and testing procedures for the LPCB approval and listing of intruder resistant security glazing units).

## PHYSICAL TOLERANCES FOR LAMINATED GLASS

All tolerances comply with the minimum requirements pertained within BS EN 12543 : 2011. Though ESG Ltd aims to surpass Industry Standards it reserves the right to defer from these improved tolerances and instead refer and supply in line with relevant industry standards. This applies to both new and existing contracts.

<b>PHYSICAL TOLERANCES – LAMINATED GLASS SUPPLIED BY ESG LTD</b>			
<b>Thickness</b>	<b>No. Plies</b>	<b>Tolerance (mm)</b>	
	3 Ply	±0.5	
	5 ply	±0.8	
	7 Ply	±1.0	
	9 Ply	±1.4	
	11 Ply	±1.7	
	13 Ply	±2.0	
	15 Ply	±2.3	
	>15 Ply	±2.5	
<b>Length &amp; Width</b>	<b>Nominal Dimension</b>	<b>Laminated Glass Thick.</b>	
	L or H	≤30mm	>30mm
	≤2000	±2.0	±2.0
	≤3000	±2.5	±3.0
	>3000	±3.0	±4.0
<b>Max Displacement for Cut and Stock Sizes</b>	<b>Nominal Dimension</b>		<b>Max Permissible Displacement</b>
	L or H		Mm
	L,H ≤1000		2.0
	L <1000, H ≤2000		3.0
	L <2000, H ≤4000		4.0
	L, H >4000		6.0
<b>Holes &amp; Notch Alignment</b>	All Products & Thicknesses		±2mm
<b>Bow</b>	L & W <1000		2mm
	L & W 1000 ≥2000		4mm
	L & W 2000 ≥3000		6mm
	L & W >3000		9mm
	Polycarbonate Laminates		5mm/Linear Metre
<b>Quality Marking</b>	All laminate products are to be stamped with a quality mark where information displayed on them will be in accordance with relevant standards, third party certifications and manufacturing licences.		
<b>Edges</b>	All standard laminates to be edge trimmed to ensure uniform finish. Steps on laminates can be polished out but the interlayer must not be touched. Thermally treated glasses shall not be cut, sawn, drilled or edge worked after laminating. Cut edges must be ground off or edge worked so to minimise the risk of cuts when handling. Possible edge working techniques include arrissing, ground edged, smooth ground edged, polished edged, bevel edged, sawn edged, and water jet cut edged, and bevel edged with angle no greater than 60°±3°.		
<b>LCD</b>	<b>General Appearance</b>	Haze is acceptable when viewing LCD switchable glass other than perpendicular, with levels of haze increasing as the viewing angle becomes more acute.	
	<b>Borders</b>	Optical distortions, creases and any other defect, including those to the film are permitted along all edges up to 5mm inwards.	
	<b>Holes/Notches/Cut-Outs</b>	Visual distortions are permitted up to 10mm from edges of holes, notches and cut-outs.	
<b>Coloured Surfaces &amp; Interlayers</b>	<b>Colour Variances</b>	Visual colour differences are permitted between samples and finished product where lighting, background conditions and panel size can create subtle changes.	

# VISUAL APPEARANCE TOLERANCES FOR LAMINATED GLASS

All tolerances comply with the minimum requirements pertained within BS EN 12543 : 2011.

<b>PRINCIPLE</b>						
<p>The laminated glass is put in a vertical position, in front of and parallel to a matt grey screen, and is lit by diffuse daylight or equivalent. The laminated glass is visually inspected perpendicularly at a distance of 2m from the glass, (except for ESG Switchable LCD Privacy Glass which is 1m), with the matt screen on the other side of the glass. Any visible defects that are disturbing shall be marked. Vents are not permitted, nor are creases and streaks allowed in the visual area (Exceptions to this rule exist for ESG Switchable LCD Privacy Glass as detailed below).</p> <p>Where no defects are visible from the specified distance the panel is deemed acceptable. If defects are observed from within the specified distance, the extent of such defects are to be within the tolerances detailed below and if not, then the panel may be rejected.</p>						
<b>PERMISSIBLE SPOT DEFECTS IN THE VISION AREA</b>						
<p>Spot defects include opaque spots, bubbles and foreign bodies. Defects less than 0.5mm are permitted. Defects greater than 3mm are not permitted.</p> <p>*For laminates consisting of two panes the maximum size of defect is 2mm.</p> <p>For ESG Switchable LCD Glass products, bubbles of any size are not permitted and any defect both spot or linear type which can be observed from a distance of 1 metre away should be rejected.</p>						
Size of Defect		0.5	0.5-1mm	1.0≤3.0mm		
Size of Laminate		Any Size	Any Size	≤1m <sup>2</sup>	1≤2m <sup>2</sup>	>2m <sup>2</sup>
No. or Density of Permissible Defects	2 Panes	Max. 4 defects. Must be further than 200mm apart from each other.	Max. 2 defects. Must be further than 100mm apart from each other.	0	*1	*1
	3 Panes			1	2	2
	4 Panes			2	3	3
	5 Panes			2	3	4
<b>PERMISSIBLE LINEAR DEFECTS IN LAMINATES</b>						
<p>Linear defects include foreign bodies, hairs, scratches or grazes.</p> <p>Linear defects are permitted so long as they cannot be observed from a distance of 2 metres.</p>						

## Appearance of Haze

Haze is an occurrence in ALL PDLC products. Outlined below are a list of factors that may emphasise the appearance of haze in certain situations.

Visible haze is NOT a reason for rejection of the product and as such ESG will not accept any rejection claims. It is the responsibility of our customer to ensure the end user of the product is made aware of this before any orders are placed. Samples are available, however please bear in mind they may not accurately represent performance in all situations.

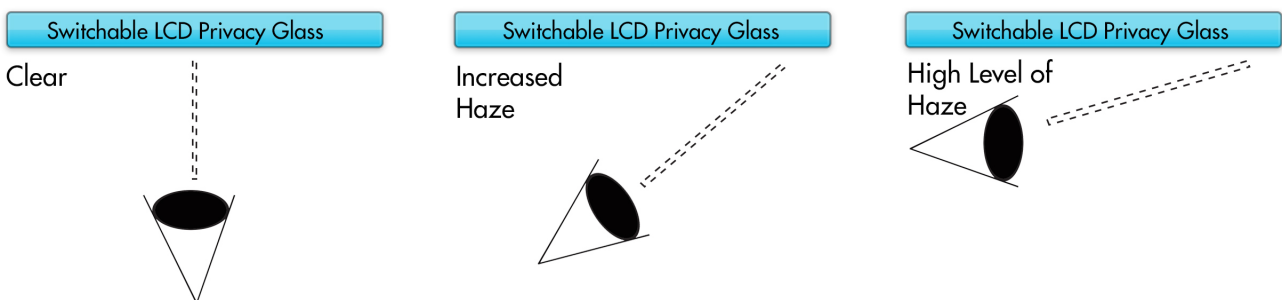
ESG Group use the highest quality film available on the market, meaning ESG Switchable has the lowest levels of haze possible. Due to the variable factors that effect the appearance of haze, it is not possible to compare haze levels between 2 installations.

### Lighting.

Different lighting conditions can alter the amount of visible haze within the glass. Brighter light on the opposite side of the glass from which it is being viewed can cause a light imbalance which emphasises the haze. This includes direct sunlight if the LCD panel is being used on an external window.

### Viewing Angle.

Industry guidelines state the clarity of the switchable LCD glass will be at its clearest when viewed at 90°. This is how clarity levels must be judged, NOT from any other angle. Viewing angles towards the glass do change the amount of visible haze, the greater the angle, the higher the expected levels of visible haze.



### Position and Size.

Both of these have a bearing on the visible haze. A panel of 1m x 1m installed at eye line may appear to be clearer than a group of panels in a line and floor to ceiling height ( e.g. 6m x 3m high ). This is due to the differences in the angles that the glass is being viewed.

Due to the LCD film within the glass make up, Switchable LCD glass will never be as clear as standard glass. Please take this into account if the two types of glass are being installed next to each other.

### Post Installation Accessibility.

Please remember switchable glass is an electrical item and as such it can fail, although this is a rare occurrence. Where ever possible please install the glass with this mind, so that if the glass needs to be replaced it can be easily removed and reinstalled. ESG provide a 5 year warranty on the glass replacement only - our warranty does not cover any associated costs in the removal and replacement of the glass such as labour and repair of surrounding fixtures and fittings which may need to be removed in order to access the glass.