LC SmartGlass™
Electronically Switchable Glass Data Sheet

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We hope that you find this document useful and welcome any feedback.

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About SmartGlass International

SmartGlass International (SGI) is the dedicated manufacturer of Electronically Switchable Glass. Also known as privacy glass, switchable glass, intelligent glass and electric glass, these technologically advanced glass products are fast breaking from being niche to becoming mainstream for use particularly in the commercial, retail, security, transport, healthcare and hospitality sectors. Our main products are LC SmartGlass™ offering Privacy on demand and SPD SmartGlass™ offering Solar-Control.

APPLICATIONS AND FEATURES

- **Hospitality** – Hotel room privacy screen, bathroom / bedroom privacy screen, external windows, doors, conference centre windows & roof-lights, bar & restaurant screens, toilet cubicles, balustrades and balconies.
- **Commercial** – Office & boardroom partition screens, doors, sliding/folding doors, windows, roof-lights.
- **Healthcare** – Fire rated hospital doors, moveable privacy screens, and X-Ray protection screens.
- **Security** – Cell doors and windows, vision panels, entrance foyer, teller & cash counting screens.
- **Industrial** – Machinery screening, roof-lights, doors, components.
- **Rail** – Driver privacy & security screens.
- **Retail & Showroom** – Projection windows, vanity screens, feature screens.
- **Projection** – Internal or External high resolution rear projection screens.
- **High end Domestic** – Screens, windows, doors, roof-lights, sliding/folding doors.

ADVANTAGES & BENEFITS

- Instant and precise privacy control
- Efficient use of space in the built environment
- Blocks 99.5+% of damaging UV rays
- Eco friendly
- Exceptional optical qualities that reduce glare and eye strain
- High durability, solid-state technology with no moving parts to wear out or break
- Large sizes of many shapes can be produced
- Stable colour characteristics for the life of the unit
- Aesthetically pleasing, hygienic & low maintenance
- Reduce uncomfortable “Gold fish bowl” feeling when working in high-density office buildings
- Reduced fading of carpets, furniture and protects valuable artwork
- High UV stability
- Low working voltage
- High contrast for use as rear projection screen
- Long life - tested to in excess of 1,000,000 cycles
**LC SmartGlass** is operated by applying 110V AC to the glass from a power transformer supplied. When a current is applied to the glass it immediately turns from opaque to clear allowing vision through. When the current is removed the glass returns to the frosted “private” state.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Test Item</th>
<th>Test Conditions</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Switching</td>
<td>On(1sec) Off(1sec), 110Vac 60 Hz 1 Million Times</td>
<td>Passed</td>
</tr>
<tr>
<td>2</td>
<td>High Temperature (Boil test)</td>
<td>70°C / 2 Hours</td>
<td>Passed</td>
</tr>
<tr>
<td>3</td>
<td>High Temp. / Humidity</td>
<td>50°C / 95%RH, 14 Days</td>
<td>Passed</td>
</tr>
<tr>
<td>4</td>
<td>Low Temperature</td>
<td>-20°C / 21Days</td>
<td>Passed</td>
</tr>
<tr>
<td>5</td>
<td>Heat Cycle</td>
<td>-20°C to 70°C (1Hrs/Cycle), 5,000Cycles</td>
<td>Passed</td>
</tr>
<tr>
<td>6</td>
<td>Weathering</td>
<td>Standard (For Laminated Glass)</td>
<td>Passed</td>
</tr>
<tr>
<td>7</td>
<td>Heat Resistance</td>
<td>Standard (For Laminated Glass)</td>
<td>Passed</td>
</tr>
<tr>
<td>8</td>
<td>IP Test</td>
<td>IPX7 Water submersion certification tests</td>
<td>Passed</td>
</tr>
</tbody>
</table>

Product samples used 11.2mm LC SmartGlass - Mfg 16/09/08 Batch 2242A
Check on Chemical resistance acc. DIN EN ISO Task 12543-4

**TECHNICAL DATA (For non-standard configurations please contact us to discuss)**

- **GLASS COLOR**: Clear, bronze, grey, green, blue tint.
- **GLASS TYPE (All laminated)**: Low Iron, tempered, curved, bullet resistant, tinted, mirrored.
- **THICKNESS**: Interior 9.2 mm, 11.2 mm, 13.2 mm or 25.2 mm
- **SIZE**: Up to 1,156 mm x 3,200 mm
- **RATIO**: Maximum Ratio Width: Height approx 4:1
- **SHAPE**: Many shapes and curved including drilled holes
- **ENVIRONMENTAL**: Storage / Operation -20°C to 70°C (-4°F to 158°F)
- **SIZE TOLERANCE**: ± 3 mm on OA size and ± 0.5 mm on thickness
- **ELECTRICAL**: Driving voltage 65-130 volts A.C.
  - Current less than 200 mA/m²
  - Power approx. 5 watt/m²
- **SWITCHING TIME**: Approx. 1/100 second at room temperature
- **OPTICAL**: Transmission approx. 75%
  - View angle approx. 120°
  - Scattering effectiveness approx. 100 mm
- **LIFE**: Greater than 10 years
- **WARRANTY**: 5 years
LC SmartGlass™ Panel Sound Control Data*

<table>
<thead>
<tr>
<th>Overall Thickness</th>
<th>Construction</th>
<th>DB Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.2 mm</td>
<td>4 mm / 1.2 / 4 mm</td>
<td>35</td>
</tr>
<tr>
<td>11.2 mm</td>
<td>5 mm / 1.2 / 5 mm</td>
<td>37</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>6 mm / 1.2 / 6 mm</td>
<td>39</td>
</tr>
<tr>
<td>25.2 mm</td>
<td>12 mm / 1.2 / 12 mm</td>
<td>44</td>
</tr>
</tbody>
</table>

*Results vary according to glass specification and framing system employed. The above figures are recommended for guide purposes only.

LC SmartGlass™ Optical performance*

<table>
<thead>
<tr>
<th></th>
<th>11.2 mm Clear LC SmartGlass Power ON</th>
<th>11.2 mm Clear LC SmartGlass Power OFF</th>
<th>6 mm Clear Float Glass</th>
<th>6 mm Frosted Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible Light Transmission</td>
<td>75</td>
<td>67</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Clarity</td>
<td>78</td>
<td>4</td>
<td>83</td>
<td>14</td>
</tr>
</tbody>
</table>

*Values are nominal (+/- 5%) and are dependent on glass configuration used

OVERVIEW

LC SmartGlass™ offers instant privacy at the flick of a switch. All LC SmartGlass panels are bespoke manufactured using a lamination process which encapsulates a PDLC film between 2 or more glass sheets. Using a minute electrical current, users can immediately switch the LC SmartGlass from clear to private (opaque) and vice versa. LC SmartGlass is easily installed and can be utilised in many applications. Various configurations can be supplied including colour tinted, fire rated, double glazed, curved and shaped.

PRINCIPLE

When the electrical supply is switched on, the liquid crystal molecules align and incident light passes through and the LC SmartGlass panel instantly clears.

When the power is switched off the liquid crystal molecules are randomly oriented scattering light and the LC SmartGlass becomes opaque (private).
MATERIALS:  LC SmartGlass™ is real life field tested to last for at least 12 years.

LC SmartGlass™ can be manufactured into various shapes including holes in the film. (Contact us for detailed explanation) All panels are bespoke manufactured and cannot be cut after manufacture.

LC SmartGlass is manufactured using a lamination process employing heat, vacuum and pressure and cooling to produce a multilayer glass sandwich. After cleaning and wiring each panel is tested by switching approximately 57,000 times in rapid on/off sequence before being labelled and packed for shipment.

SMARTGLASS PANEL

Liquid crystals - the same technology is used in digital watches, TV’s and computer screens. Liquid crystals are sandwiched between two layers of transparent conductive film to make LC Smart Film. The film is then laminated between two or more pieces of glass. When electricity is applied to the film the liquid crystals line up and the window is clear (slight haze). When the power is turned off, the liquid crystals return to their normal positions and turn the glass from clear to frosted opaque. 2 wires exit the top of each unit where they are connected to a copper bus bar. Note: Framing needs to hide 15 mm where the copper bus bar is visible.

The Liquid Crystal Privacy film is sandwiched between the glass in a similar way to how Laminated glass is constructed. The outer layers are made up of glass (normally 4 mm or 6 mm thick) each side, then an interlayer (EVA/PU) 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 has electrical wiring to be connected to a transformer to supply power for the “On” (clear state) mode.
SPECIFICATION OF LC SMARTGLASS™

Specifications of SmartGlass International
LC SmartGlass and SPD SmartGlass

Wires to power SmartGlass
(2m Long as Standard)

Busbar

Non Active Area
12mm +/- 2mm
of Busbar edge

Transparent Area
(No LC/SPD Film)
3mm +/- 2mm
Potential bubbles to
be accepted in the
transparent area

Bending
3mm per Metre

13mm DGU Spacer +/- 2mm
from edge of Glass

Note:
In certain circumstances Busbars may be applied
to both the top and bottom of the panels.

TYPICAL SMARTGLASS INSTALLATION DRAWING

SmartGlass Door System

USE ONLY NEUTRAL CURE SILICONES AS SPECIFIED BY SMARTGLASS INTERNATIONAL. DO NOT USE ACETIC SILICONES.

A standard neutral cure structural silicone sealant may be used to close the joint. A minimum of a 4 mm separation between panels is recommended. Alternatively a plastic "H" section can be used instead of silicone to dry join panels.
OPERABLE DOORS AND WINDOWS

Swing door & windows can be glazed with SmartGlass.

Cable connectors will be used to protect wires travelling between the door and frame where the wiring is then connected to the transformer/power conditioner. Contact switches can also be used.

MBW1 72*15MM 2 PIN MAKE /BREAK SPRUNG CONTACT
FDL1 300*10MM FLEXIBLE LOOP
CDL1 291*26MM CONCEALED DOOR LOOP

ELECTRICAL INSTALLATION SUPPLIES NEEDED:

Installation of SmartGlass panels require the following items:

1. A 15 AMP (minimum) ground fault interrupter circuit breaker with 230VAC 50/60Hz electricity (Fused Spur).

2. A wall mounted switch, 230VAC 50/60 Hz (installer/owner supplied). This switch is required to allow the LC SmartGlass™ panels to be turned ON/OFF. Alternatively a radio remote control switch can be specified.

3. SmartGlass power transformer. LC SmartGlass™ panels may be connected in parallel up to 4 square meters total area per single power conditioner/transformer. Bespoke electronic controllers can be used including “smart” systems such as Creston and ABX controllers.

Note: A larger Power Conditioner / Transformer can be provided to power a larger area of Smartglass.

SPECIAL ELECTRICAL CONDITIONS:

1. For all fixed panel installations, a separate SmartGlass International Power Supplier will be provided for each 4 m² or fraction thereof. Power source of 230VAC, 50/60 Hz electricity must be supplied from a fused spur. The power supplier should be connected to an accessible standard double junction box connected to ground continuity.

2. For all swing panel installations, the power supplier should be located near the hinge side of door / window jamb and all installation is to conform to manufacturer’s instructions.

TRANSFORMER DETAIL

Short circuit proof encapsulated auto wound transformers for step up or step down of mains voltage at 50/60Hz. Transformers tested to EN 61558, VDE 0570.

The transformer should be located by the electrical contractor in an easily accessible area in order to replace fuse in the event of damage.
WIRING

1. SmartGlass International requires all electrical installations be completed by a licensed electrician, and in compliance with all local legal requirements.
2. Before installation, inspect bus bars, electrode leads and wires to assure insulation. No exposed bus bars, electrode leads, or wires should contact any metal frames that will damage transformer and LC SmartGlass™.
3. Multiple LC SmartGlass™ panels should be connected parallel with the transformer. Ensure that the transformer "in" connects to 230V AC, and "out" connects to LC SmartGlass™. The output voltage is 110 V AC.
4. Before turning on the power, test resistance reading between the metal frame and electrode and make sure that the resistance reading is infinite. Otherwise, check short location and insulate electrodes from metal frames.
5. LC SmartGlass™ uses approximately 3.5 watts per square meter in the "on" (clear) state. No electricity is consumed in the "off" (opaque) state. LC SmartGlass™ can be controlled with either a single or multiple switches or by radio remote controller.

NOTE: It is vital for correct operation that the switch/remote receiver is positioned on the mains voltage before the transformer/power conditioner. Failure to correctly install the switching mechanism may cause irreparable damage to the LC SmartGlass.

MAINTENANCE

Maintenance is generally as simple as keeping the SmartGlass clean. Regular cleaning with neutral materials is recommended for optimum performance. In external windows soapy warm water performs best. Soft coated glass should be cleaned very carefully following the manufacturers own instructions. Use professional glass cleaner or any reputable cleaner.

Annual checks: The client should check that all wiring is in good condition, framing materials are free of any damage and that the transformer and switch are in good visible order. The areas adjoining the SmartGlass including walls, ceilings and floors should be checked for structural integrity, excess humidity and temperature. Should any of these items appear unusual the client should immediately notify the original supplier / installer / contractor or SmartGlass International.

HAZE

It should be noted that LC SmartGlass is not optically as clear as normal float glass. A haze in the form of clouding in the glass is considered normal and is unavoidable due to the nature of the product makeup. It should also be noted that ambient lighting conditions will have an effect on haze levels; direct lighting onto LC SmartGlass should be avoided. Every precaution has been taken to ensure minimum haze. Tinted glass can be used to reduce the visible haze such as blue, green or grey tints. It is essential that the end client understands that a degree of haze will be present depending on configuration and will not be considered as a reason for exchange or refund.

WARRANTIES

The Installer shall warrant for five years the satisfactory performance of the window installation which includes window, glass glazing, anchorage, and electrical work as detailed by the specifications and approved drawings.

SmartGlass International Ltd. warrants that the physically tangible hardware products delivered should be free from defects in materials and workmanship, assuming normal use, for a period of five years from the date of invoice unless otherwise specified. SmartGlass International Ltd’ sole obligation and clients sole remedy in the event of breach of warranty is to repair or replace the defective products. Distributor/customer should promptly notify SmartGlass International Ltd. of any defect in products delivered there under, and upon obtaining a return authorisation, ship the defective goods to SmartGlass International Ltd for analysis. SmartGlass International Ltd. will bear the expenses to repair or replace the products to the original scope of supply. SmartGlass International Ltd. is not responsible for products damaged by external events such as, but not limited to catastrophe, improper use, or maintenance or use of unauthorised parts.

For more detailed information, please consult our SmartGlass handbook which can be downloaded in various languages at http://www.smartglassinternational.com/about/download-centre/