

FOS-ECS-PA™ OPTICAL-SHUTTER

PRODUCT DESCRIPTION

FOS-ECS-PA™ (Fast Optical Shutter, Electrically Commanded Surface, Planar Alignment) operating in the *normally-white* mode (LIGHT state with no applied voltage). *Normally-black* mode of operation (DARK state with no applied voltage) available upon request.

FOS-ECS-PA provides ultra-fast switching speeds (switching frequency > 50Hz) together with high contrast and low dark-state transmittance. Maximum light-state transmittance approx 35%.

Standard dimensions ONE-INCH-SQUARE with thickness 2.20mm (Part-number **FOS-25x30-ECS-PA**). Custom sizes from minimum 5 x 5mm up to maximum 14 x 16 inches available upon request.

OPERATION

FOS-ECS-PA possesses two states; (a) transparent state (LIGHT or homogeneous state), and (b) DARK state (homeotropic texture).

Transparent state is obtained with no voltage applied (voltage-OFF) and DARK state is obtained with voltage being applied to the cell (voltage-ON).

Voltage required to obtain DARK (ON) state $5.0 < V < 20$ volt (typical) square-wave voltage with frequency $10 < f < 1000$ Hz (typical). No long term DC component in driving voltage recommended.

OPTICAL PERFORMANCE

$T > 35\%$ (typical)* at wavelength 550nm (non-polarised incident light) in transparent (OFF) state.

$T < 0.5\%$ (typical) at a wavelength of 550nm when in the DARK (ON) state.

* Transmittance measured with incident light being initially **unpolarised**. For Incident light that is initially **polarised** in the same orientation as the entrance polariser of the FOS-ECS-PA, $T > 85\%$.

SWITCHING SPEED

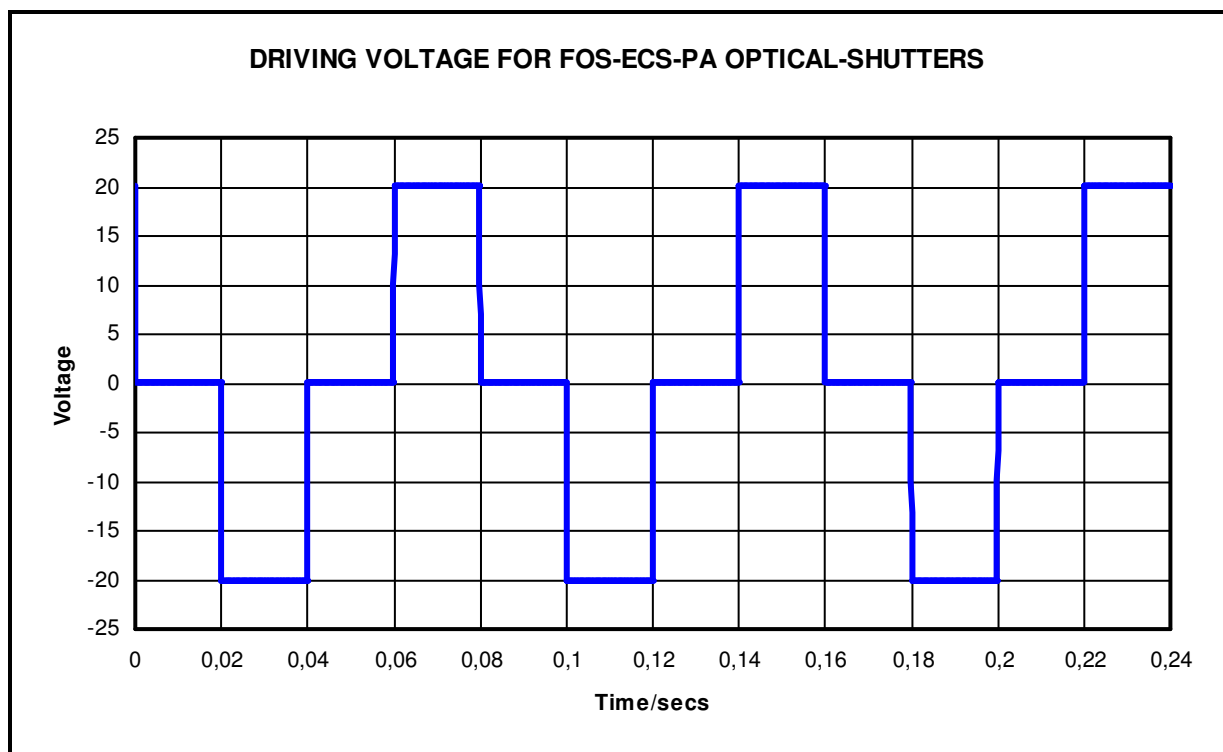
ACTIVATION switching speed from LIGHT (OFF) to DARK (ON) state < 0.05ms (< 50 microseconds) (typical) at room temperature with applied voltage of ± 20 volt (defined as being time for T to switch from 90% to 10% levels of dynamic range). ACTIVATION switching speed is a function of applied voltage.

RELAXATION switching speed from DARK (ON) to LIGHT (OFF) state < 3.5ms (typical) at room temperature (defined as being time for T to switch from 10% to 90% levels of dynamic range). RELAXATION switching speed is independent of the operating voltage.

Both switching speeds (ACTIVATION & RELAXATION) are a functions of temperature and elevated temperatures enhance switching response times.

TECHNICAL CHARACTERISTICS & OPERATION EXAMPLES

Electro-optical switching characteristics of FOS-ECS-PA measured at temperature 25°C and with a wavelength of 550nm. Operating voltage ± 20 volt square-wave at frequency 12.5Hz possessing a 20ms zero-voltage period between polarity-reversals. Driving voltage schematically shown in following figure:



Typical response of FOS-ECS-PA shown below. Measured values as follows:
(FOS-ECS-PA optically switching at 25Hz.)

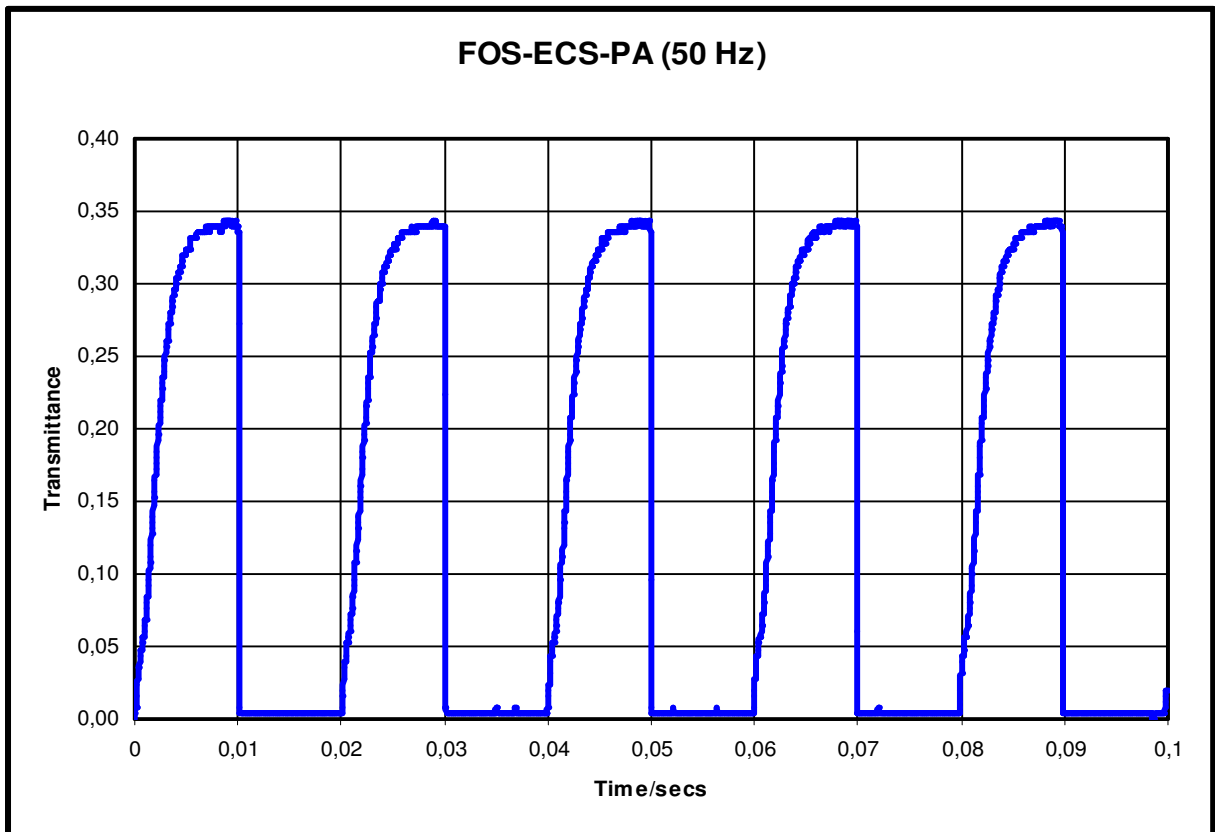
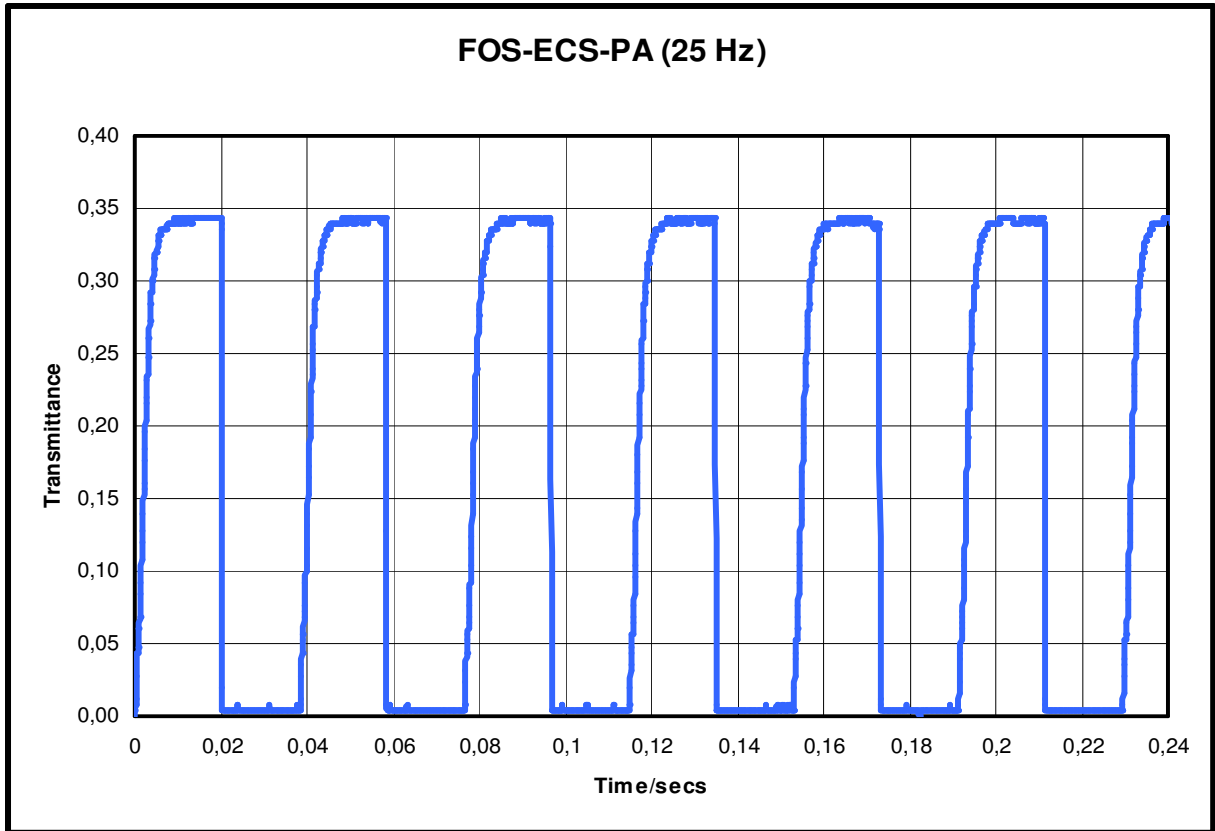
T_{maximum} : 34.2 %¹
 T_{minimum} : 0.5 %

ACTIVATION : 0.063 ms²
 RELAXATION : 4.02 ms³

¹ Maximum transmittance for incident unpolarised light.

² Switching speed from LIGHT to DARK state defined as time for T to switch from 90% to 10% of dynamic range.

³ Switching speed from DARK to LIGHT state defined as time for T to switch from 10% to 90% of dynamic range.



In the second example above, FOS-ECS-PA is driven with ± 20 volt square-wave at a frequency of 25Hz possessing a 10ms zero-voltage period between polarity-reversals.

The ambient temperature is 25°C and transmittance is measured at a wavelength of 550nm. Here, the FOS-ECS-PA is switching at 50Hz.

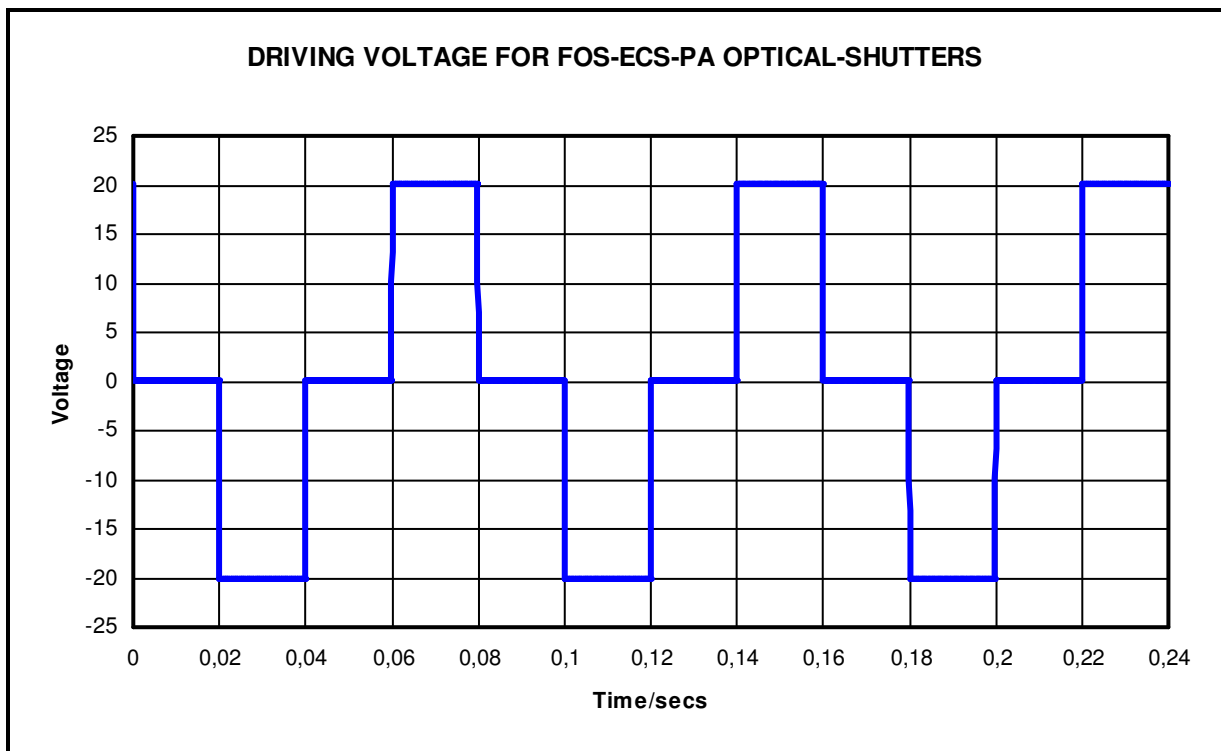
DRIVING VOLTAGES FOR FOS-ECS-PA™

With voltage applied to FOS-ECS-PA, shutter is in the DARK state (ON); with no voltage applied, the LIGHT state (OFF) is obtained (normally-white mode of operation).

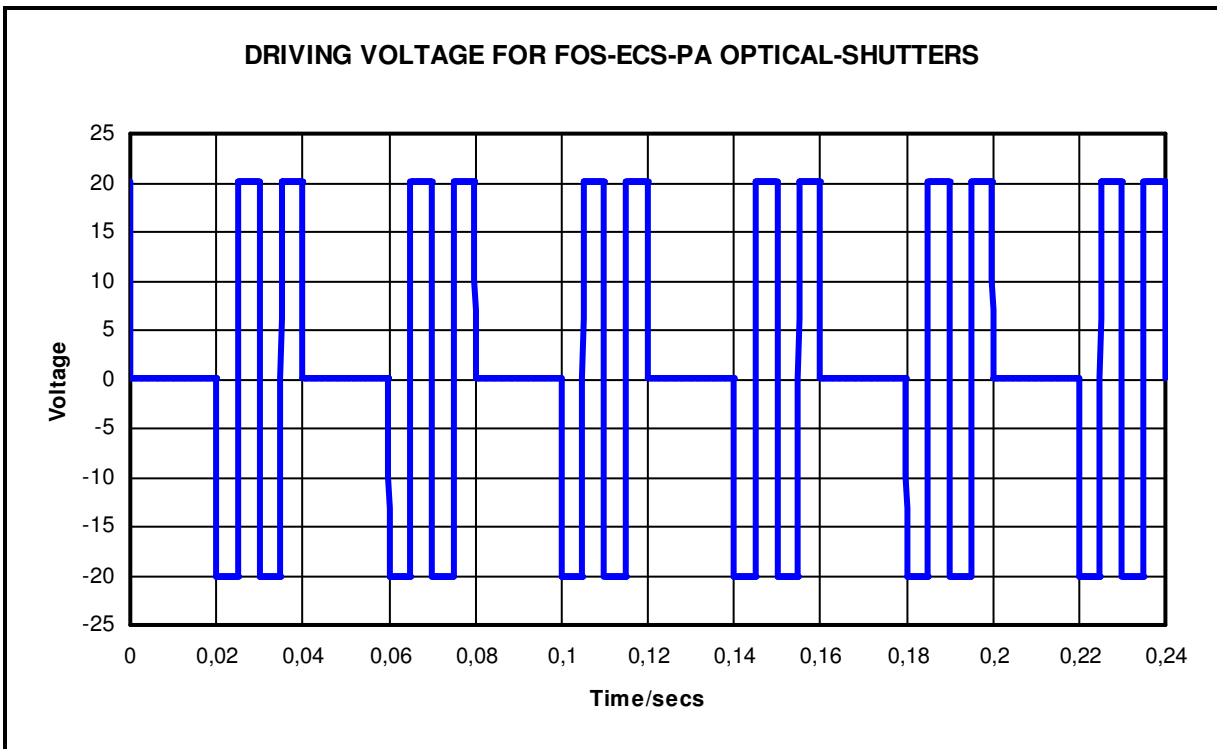
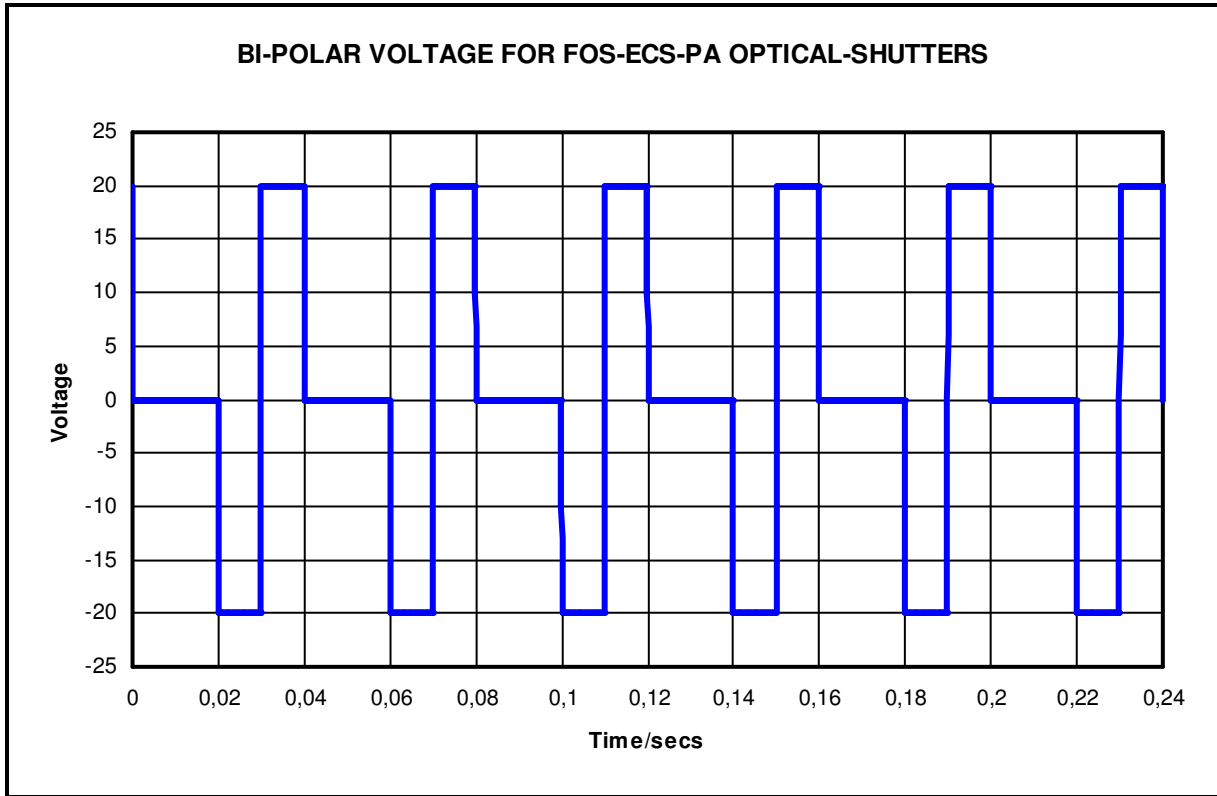
FOS-ECS-PA is controlled by the RMS voltage; in order to prevent impurity ion migration from occurring within the liquid crystal material, it is recommended to ensure that there is no long-term DC component of the applied voltage.

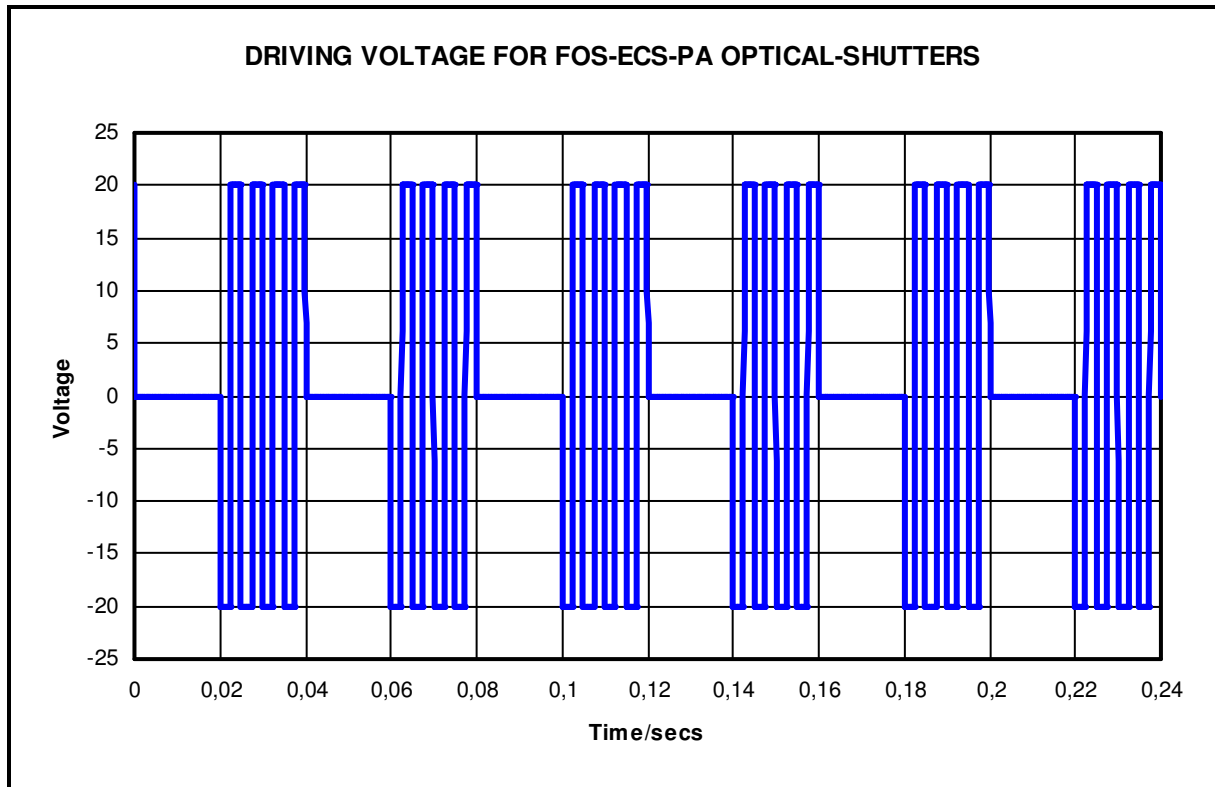
This can best be achieved via use of square-wave driving voltages. In the following example, the FOS-ECS-PA is in the LIGHT state during the **zero-voltage** period (20ms) between polarity reversals of the square-wave voltage. Voltage applied to the shutter in order to achieve the DARK state ± 20 volt and in this example the voltage frequency is 12.5Hz (80ms period).

FOS-ECS-PA is in LIGHT state two (2) times each period (80ms); shutter therefore optically switches at frequency of 25Hz.



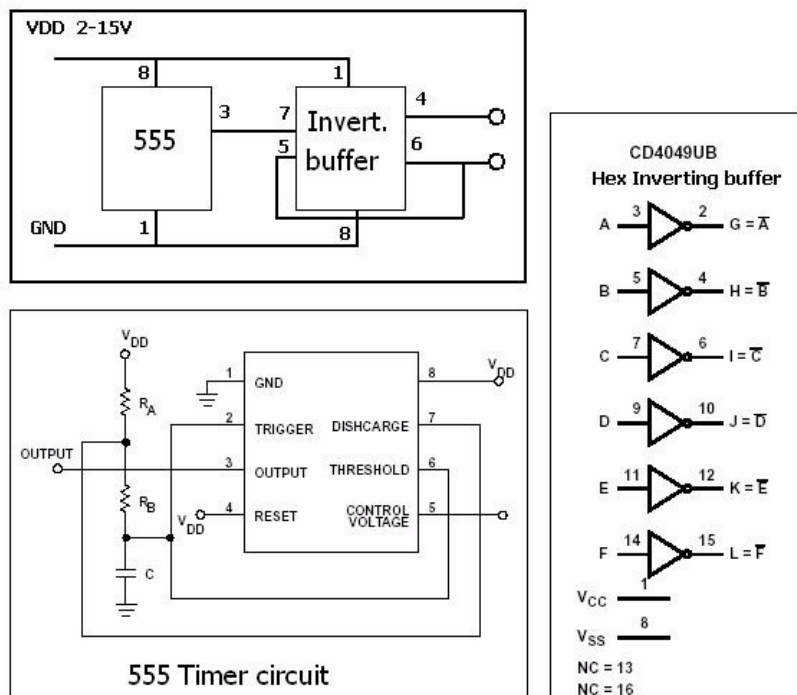
FOS-ECS-PA reacts to the RMS voltage, therefore switching response with above driving scheme is identical to that when using any of the following voltage driving schemes. Here, the FOS-ECS-PA will be in the LIGHT state during the period of **zero-voltage** and will be in the DARK state when the applied RMS voltage is 20 volt.





In terms of power consumption, it is advantageous to minimise the voltage frequency of the voltage-ON pulse, i.e reduce the total number of charge/discharge cycles when FOS-ECS-PA is in the DARK (ON) state. However, it is important to ensure that there is no long term DC component of applied voltage for life-time stability of this product.

Example of driving-electronics in order to generate required voltage-pulses shown schematically below:



TECHNICAL SPECIFICATIONS
SPECIFICATION AND PERFORMANCE SHEET

Product	FOS-ECS-PA™
Description	normally white mode

GENERAL SPECIFICATION

Dimensions	1 x 1" (standard). Custom sizes up to max 14 * 16 inches available
Total thickness	2.20mm (standard). Custom sizes down to 0.80mm available
Technology	ECSIBEO PA HiPAL™ technology

ABSOLUTE MAXIMUM RATINGS

Parameter	Min	Max	Unit	Remark
Driving voltage (AC)	0	50	V	-
Driving frequency	0	1000	Hz	-
Operating temperature	-30	+60	°C	-

ELECTRICAL SPECIFICATIONS

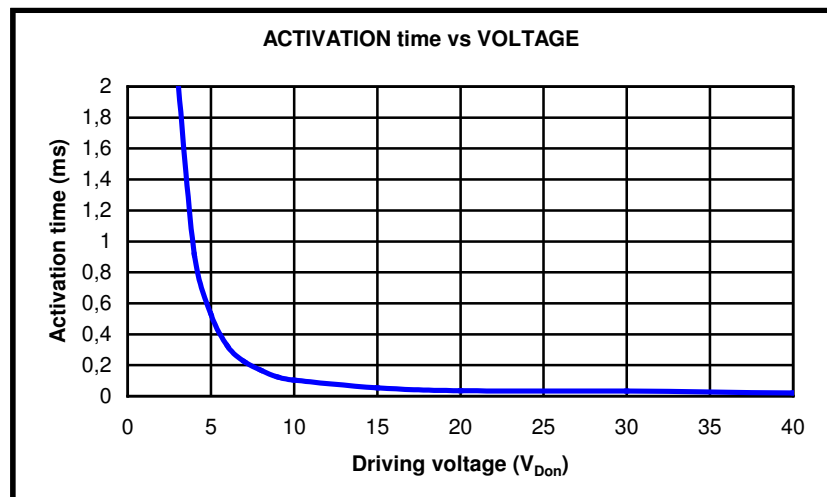
Parameter	Remark	Min	Typ	Max	Unit	
Driving voltage (AC)	V_{Don}	0	-	50	V	
Driving frequency (rec)	f_D	Square-wave	30	50	100	Hz

OPTICAL SPECIFICATIONS

 General test conditions: $T=23^{\circ}C$, Viewing angle: normal incidence

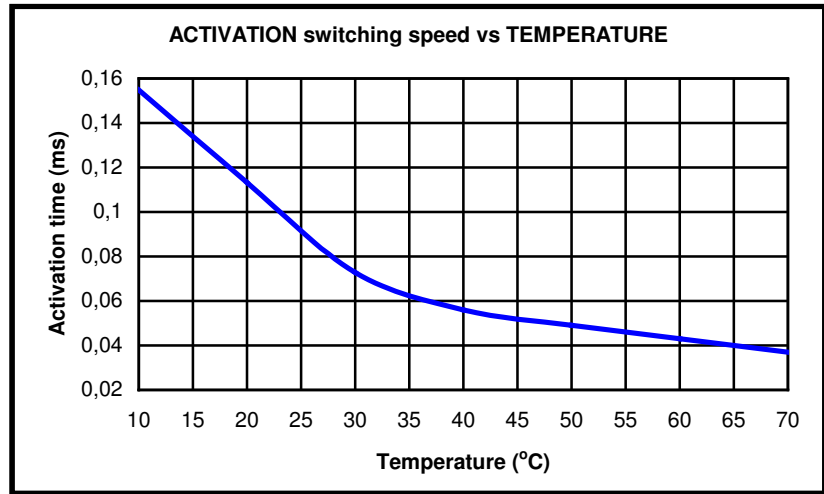
Parameter	Test conditions	Min	Typ	Max	Unit
Transmission (550nm)	$V_{Don}=10V$ $V_{Doff}=0V$	0.2	-	35	%
Contrast ratio	CR $V_{Don}=10V$ $V_{Doff}=0V$	-	1:75	-	-
Threshold voltage	V_{th}	-	1.6	-	V
Saturation voltage	V_s	-	3.5	-	V
RELAXATION time	t_{relax} $T = 25^{\circ}C$	-	3.5	-	ms
ACTIVATION time	T_{activ} $V_D=10V$	-	0.15	-	ms

ACTIVATION time versus voltage ($T=25^{\circ}C$)

 Driving voltage (V_{Don})
 ACTIVATION time (ms)


ACTIVATION time vs temperature ($V_{Don}= 10V$)

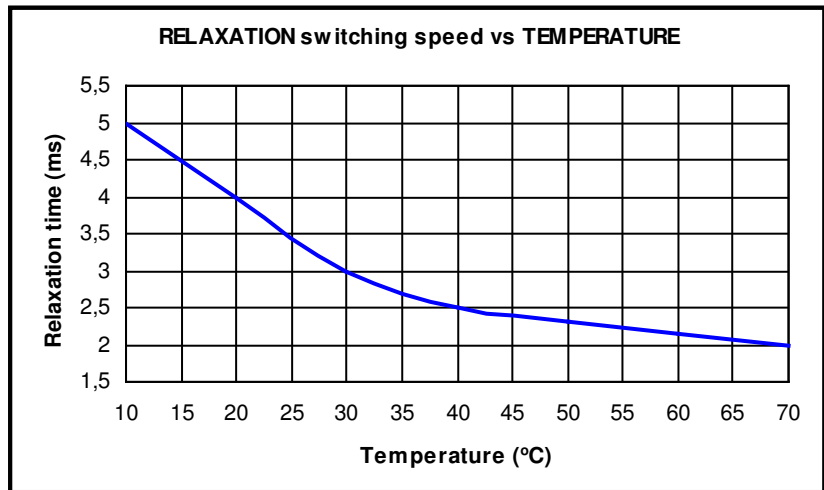
Temperature ($^{\circ}C$)
ACTIVATION time (ms)



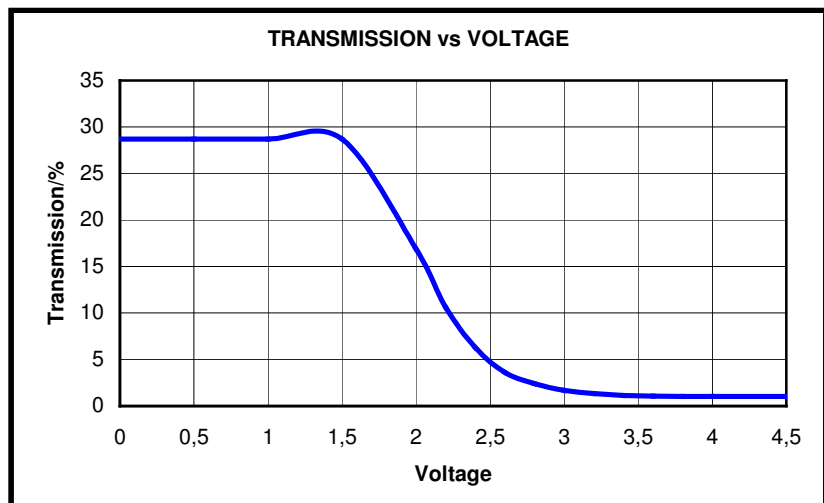
RELAXATION time vs temperature

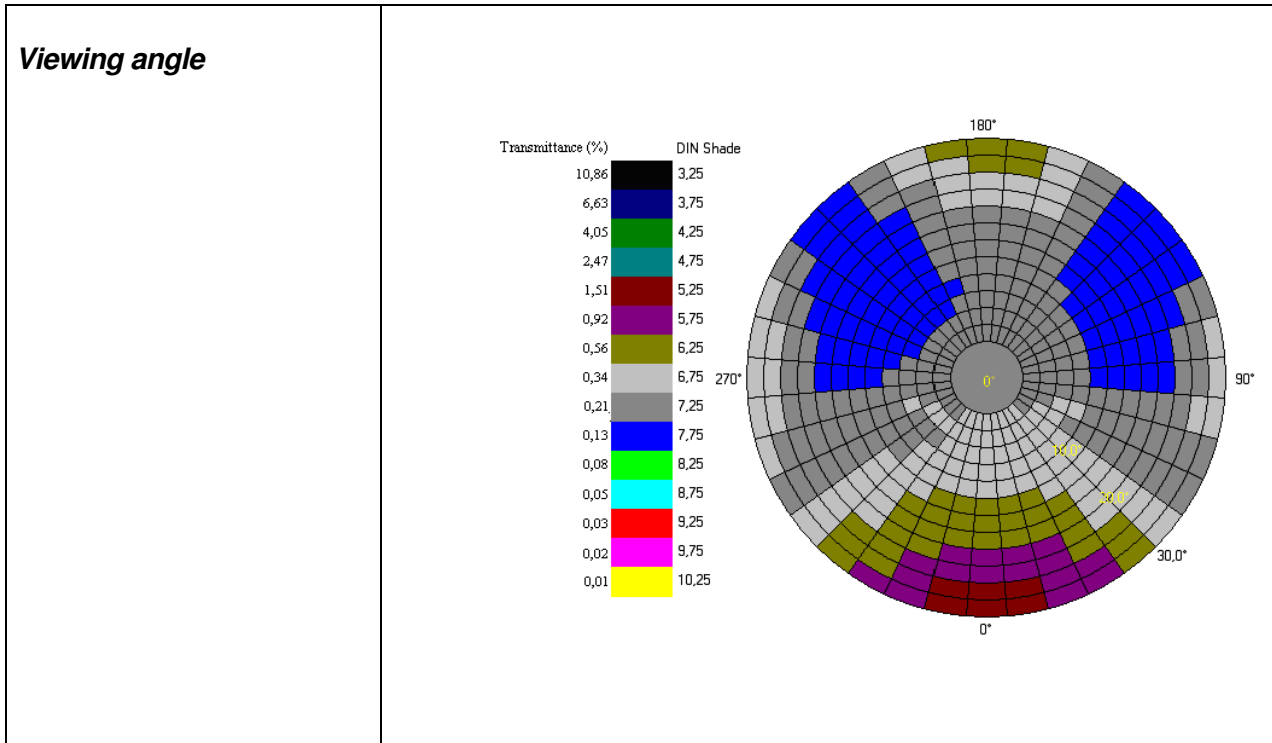
Temperature ($^{\circ}C$)
RELAXATION time (ms)

RELAXATION switching speed is independent of the driving voltage (V_{Don})



Electro-optic response (Transmission at 550 nm)





ELECTRO-OPTICAL CHARACTERISTICS ARE MEASURED VALUES BUT NOT GUARANTEED

DEFINITIONS

<p>Driving voltage</p>	
<p>Viewing direction</p>	<p>θ: Angle between Viewer Direction and Normal. ($-90^\circ \leq \theta \leq 90^\circ$)</p> <p>$\phi$: Angle between Projection of Viewer Direction to X-Y plane and Y axis. ($0^\circ \leq \phi \leq 360^\circ$)</p>
<p>Contrast ratio</p>	$CR = \frac{\text{Transmission through shutter in CLEAR state}}{\text{Transmission through shutter in DARK state}}$
<p>Response time <i>(normally white mode of operation)</i></p>	

HANDLING PRECAUTIONS

The following provides recommendations for handling of this product.

(1) CAUTION OF LCD HANDLING & CLEANING

- Since the polarizer is made of easily scratchable material, please be careful not to touch or place objects on the display surface. Guard against scratching.
- A protective film is supplied on both side of the display and should be left in place until product is required for operation.
- Keep the display surface clean. Do not touch without protective attire.
- Should the surface become contaminated, wipe lightly with a soft cloth moistened with solvent (isopropyl alcohol or ethyl alcohol) in order to clean the display surface.
- Do not wipe the display surface with dry or hard materials that may damage the polarizer surface. Do not use the following solvents for cleaning: water, ketone, aromatics or acetone.
- Since this product contains glass substrates, avoid applying mechanical shock or pressure to this product. Do not drop, bend, twist or press the display.

(2) STORAGE

- Avoid exposure to direct sunshine or high temperature and humidity. Recommended storage conditions: temperature range +5 to +45 °C and humidity range 30% to 60% RH
- Do not store this product near organic solvents or corrosive gases.
- Keep this product (including accessories) protected from vibration, shock and pressure.
- Keep this product out of direct sunlight or direct exposure to ultraviolet (UV) light. Store this product in a dark place away from direct sun light and fluorescent lighting.

(3) CAUTION FOR OPERATION

- It is important to operate this product within the specified voltage limits; higher voltages may significantly reduce the life-time of this product.
- The use of direct current drive (DC voltage) should be avoided since an electrochemical reaction stimulated by direct current drive (DC voltage) significantly reduces the life-time of this product.
- The switching speed of this product will be reduced at lower temperatures, and the optical-shutter will show a dark colour at higher temperatures. However, the product will revert to normal operation once the temperature returns to the recommended temperature range for normal operation.

(4) SAFETY

- Should this product become damaged and the skin be exposed to liquid crystal material, it is recommended to immediately wash off liquid crystal material using soap and water.
- If the liquid crystal material should come into contact with the eye, flush the eye using running water for at least five minutes.