



NanoEC™ SPU™ (Smart Pane Unit)

By replacing an outboard lite with Heliotrope's NanoEC™ SPU™, IGUs in transportation will gain all the benefits of current solutions with blinds/shades (glare and lighting control, sound insulation, security, and UV projection) without disturbing the view for passenger.

Key Features

- * Electronically modulates visible light transmission through the window from <3% to >50% in less than 5 minutes.*
- * Maintains aesthetically pleasing neutral gray appearance over the entire dimming range
- * Delivers best in class sound performance of STC >42 as well as >99% effective UV and EMF shielding
- * Offers flexible electrical connectivity (wired or wireless)
- * Low power consumption (< 3V) with memory function (no power required when desired visible light transmission level reached)

Advantages

- * Offers enhanced on-demand passenger comfort (heat, glare, etc.) and riding experience without obstructing view or altering view of outside

- * Eliminates installation, maintenance and replacement costs associated with blinds/shades
- * Ability to tie-into transit ecosystem (HVAC, real-time passenger information, schedules, stops, etc.)
- * Upgrades value of premium passenger experience (first class vs. coach)

Benefits

- * Justifies instant investment payback through elimination of blinds and associated installation and maintenance costs (HVAC, etc.)
- * Creates clear competitive differentiation based on unparalleled aesthetic appearance and on-demand passenger control
- * Balances energy performance with natural light transmission to meet and exceed energy codes in all major markets
- * Provides weight neutrality vs. standard laminated IGU with mechanical blinds/shades
- * Enables path to increased Revenue per Passenger (RPP) by offering a premium and differentiated passenger experience, operators can create a new and higher premium class within the train for cars that have EC windows
- * Superior value vs. other dynamic glass technologies (monolithic EC, SPD, PDLC, TC, etc.)

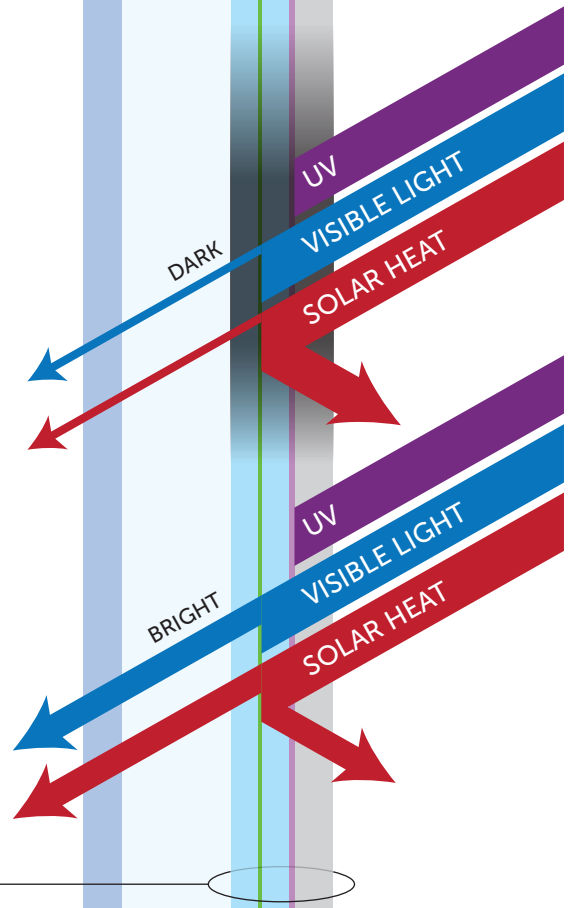
* Exact dynamic range values and switching times depend on specific product configuration

Optimized Performance

NanoEC™ SPU™ can be custom configured in multiple IGU designs to reach target light transmission, heat gain and insulation performance. While outboard positioned NanoEC™ SPU™ is generally recommended for hotter climate zones, inboard positioning in the IGU stack allows for a greater solar heat gain in the colder climate areas. Double and triple glazed IGU configurations are also possible.

NanoEC™ SPU™

- Security & natural disaster protection
- Tempered glass for impact protection
- Sound insulation
- Total UV Protection
- On-demand glare & shade protection



IGU Configurations

Outboard 9mm NanoEC™ SPU™ – 10mm Air gap – 5mm Inboard HP 50/32 on SF7

	%Tvis	%Rout	%Rin	%Tsol	SC	SHGC	U-Factor	%Tuv	%Tdw-K	Trans Col	Ref Col
Bright	30%	10%	17%	18%	0.89	0.34	2.03	0%	7%		
Dark	2%	6%	15%	1%	0.89	0.16	2.03	0%	2%		

Outboard 9mm NanoEC™ SPU™ – 10mm Air gap – 5mm Inboard HP 60/40 on SF7

Bright	33%	12%	25%	19%	0.89	0.33	1.8	0%	7%		
Dark	3%	6%	23%	1%	0.89	0.15	1.8	0%	1%		

Outboard 9mm NanoEC™ SPU™ – 10mm Air gap – 5mm Inboard EN2 on SF7

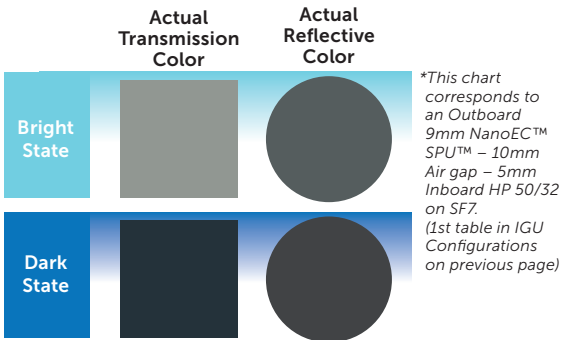
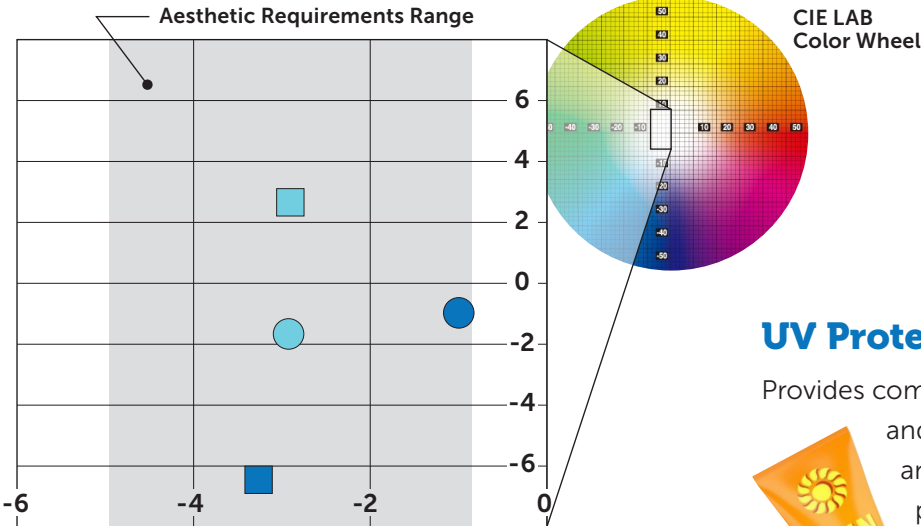
Bright	48%	11%	14%	28%	0.89	0.38	1.8	0%	10%		
Dark	4%	6%	9%	2%	0.89	0.15	1.8	0%	1%		

Typical IGU Construction

- Low-E Glass
- Air or Argon Gap
- Clear Glass
- Electrochromic Variable Light Transmission Layer
- Clear Glass
- UV Blocking Interlayer
- Tempered Glass

Desired Aesthetics

NanoEC™ SPU™ uniquely satisfy both operators and passengers by maintaining neutral transmitted as well as reflected color with the stringent requirements in both dark and bright states.



UV Protection

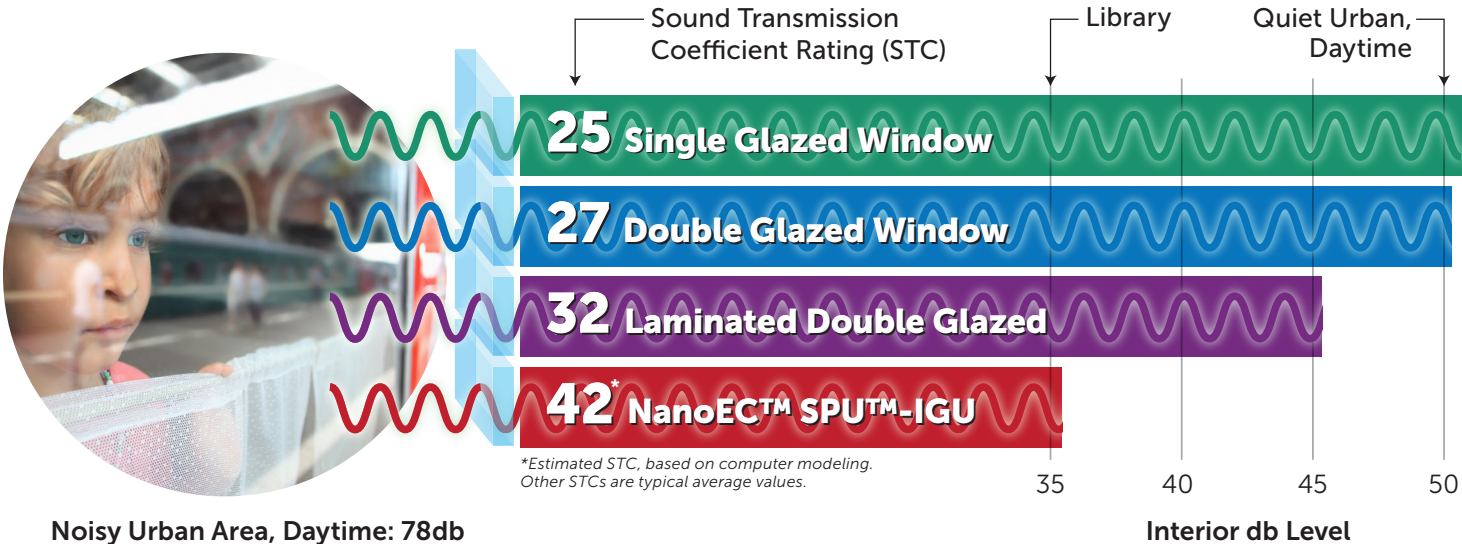
Provides complete protection (>99%) from harmful UV-A and UV-B rays that cause irreversible fading and sun damage to cabin interiors and passengers.



	NanoEC™ SPU™-IGU	Double-Silver Low-E IGU	Clear Glass IGU
UV Protection	>99%	85%	43%
Damage Weighted Transmittance (Tdw-K)	8%	30%	52%
Fade Protection Factor (FPF)	50+	7	2

Sound Insulation

The unique, double-laminated construction of a NanoEC™ SPU™ into an IGU allows for best-in-class shielding from outside noise, resulting in enhanced rider comfort and privacy.





NanoEC™ SPU™

Heliotrope NanoEC™ SPU™ electrochromic devices are competitive and superior in many areas to other dynamic glazing technologies currently in the market.

Performance Attributes	Dynamic Glass Technology				
	EC (Heliotrope)	EC (Others)	SPD	PDLC	TC
Transmission Dynamic Range (Bright, Dark)	40%	50%	60%	70%	50%
SHGC Range (Bright, Dark)	0.38 – 0.09	0.41 – 0.09	0.40 – 0.35	None	0.31 – 0.11
Memory Function?	Yes	Yes	No	No	No
Transparent without Power?	Yes	Yes	No	No	No
Reflected Color	Neutral Gray	Blue/Magenta	Blue	Milky White	Tint Dependent
Transmitted Color	Neutral Gray	Yellow	N/A	N/A	N/A
Haze	< 1%	< 1%	4 – 8%	4 - 8%	1%
Dynamic Control	Active	Active	Active	Active	Passive
Power Consumption	1 W/sqm	1 – 3 W/sqm	2-3 W/sqm	2 – 3 W/sqm	None
Operating Voltage	1 -3V (DC)	1 – 5V (DC)	50 – 100V (AC)	24 – 100V (AC)	None
Control States	Variable	4	Variable	Variable	None
EC Device COGS	Lowest	2x	2x	2x	1.5x



The Next Generation in Transportation Glazing

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The information provided in this data sheet is believed to be reliable and provides a reasonable estimate of expected performance, however, Heliotrope Technologies Inc., (Heliotrope) is yet to complete the final design of the NanoEC™ SPU™ product line. As a result, Heliotrope does not warrant that performance data presented in the data sheet could be obtained and reserves the right to change the estimates presented herein at any time and without notice.