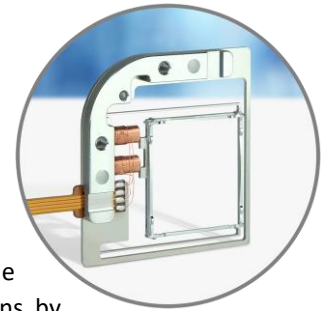


Reluctance force-based laser speckle reducer LSR-4C



A way to reduce speckle noise from a laser-based system is by dynamically diffusing the laser beam. Optotune's LSR-4C speckle reducer averages multiple speckle patterns by dynamically displacing a diffuser, and by doing so creates a more homogeneous, speckle-free beam. The LSR-4C has an aperture of 18.5x18.5 mm and is especially suitable for laser-based cinema projectors where high laser powers and large beam diameters are used. The diffuser is mounted in a metallic frame and is set into motion by the reluctance force generated in the oscillating magnetic field of a driving coil.

If required, the LSR-4C can combine two oscillating diffusers rotated by 90°, realizing optimized despeckling in both directions. The compact driving electronics, assembled on a flexible plastic substrate, stabilizes the resonance frequency in closed-loop mode and includes an error signal.

For further details on the despeckling performance of the LSR-4C, please refer to our LSR [application note](#).

Mechanical specifications

Clear aperture	18.5 x 18.5	mm
External dimensions	35.2 x 37.9 x 5.8	mm
Housing diameter	30.0	mm
Height	14.5	mm
Weight	Full device: 11.0 Diffuser: 0.29	g
Mechanical clamping	2x M2 screws	
Minimal weight of anchor mass	500	g

Performance specifications

Oscillation amplitude (peak to peak)	Min: 0.6 Typical: 0.8 Max: 2.0	mm
Oscillation frequency	120 ± 10	Hz
Device start-up time (typical)	40	s

Optical specifications

Material ¹	Fused silica	
Diffusion angle (FWHM) ¹	8.5	°
Transmission wavelength	VIS coated: 440-660 Uncoated: approx. 200-2200	nm
Transmission	VIS coated: >98 Uncoated: >94	%
Depolarization	< 0.1	%
Coating	High power, double-sided	

¹ Custom diffusers made of polycarbonate available upon request, with diffusion angles up to 20°.

Damage threshold	> 600	W/cm ²
Scratch/dig	60/40	Over full clear aperture of diffuser

Electrical specifications

Power supply (micro-USB or solder pads) ²	3.4-5	VDC
Power consumption (with std. electronics)	50	mW

Environmental specifications

Operating temperature at fixed startup temperature T _s ³	T _s -5 to T _s +55	°C
Storage temperature	-40 to +85	°C
Start-up temperature	-30 to +85	°C
Mechanical shock	500	g
Cycle life	>40 000	hours

Overview of available standard products

Standard Product	Coating	Diffusion angle
LSR-4C-L-18x18-9-T2-VIS	VIS-coated	8.5°
LSR-4C-L-18x18-9-T2-NOC	uncoated	8.5°

Accessories	Description
Bracket kit LSR-4	Bracket for single and double diffusor configuration
LSR-4C-LL-mounting kit	Mounting kit for double diffusor configuration
PS-5V-US	5V DC micro-USB power supply with US plug
PS-5V-EU	5V DC micro-USB power supply with EU plug

Assemblies	Components to order
LSR-4C-L (no bracket)	1x LSR-4C, 1x Power supply
LSR-4C-L (with bracket)	1x LSR-4C, 1x Bracket-kit LSR-4, 1x Power supply
LSR-4C-LL (double diffusor configuration with bracket)	2x LSR-4C, 1x Bracket-kit LSR-4, 1x LSR-4C-LL-mounting kit, 2x Power supply

Control

The LSR-4C is driven using a 5 V DC power supply. No further driver electronics are needed; the device settles into its optimal trajectory once powered on.

² 100-230 VAC to 5 VDC micro-USB power supply available.

³ Outside this temperature range, the speckle reduction efficiency may decrease. This is due to possible changes in resonance frequency, and therefore oscillation amplitude, of the device.

Optotune additionally offers a brass mechanical holder (bracket kit) that allows for mounting the LSR into an existing setup, see Figure 3. With this holder, a rigid mechanical integration is guaranteed. It further allows for mounting two crossed LSR-4C (rotated by 90°) for even higher speckle reduction. See Figure 4. For this, an additional LSR-4C-LL-mounting kit needs to be purchased separately.

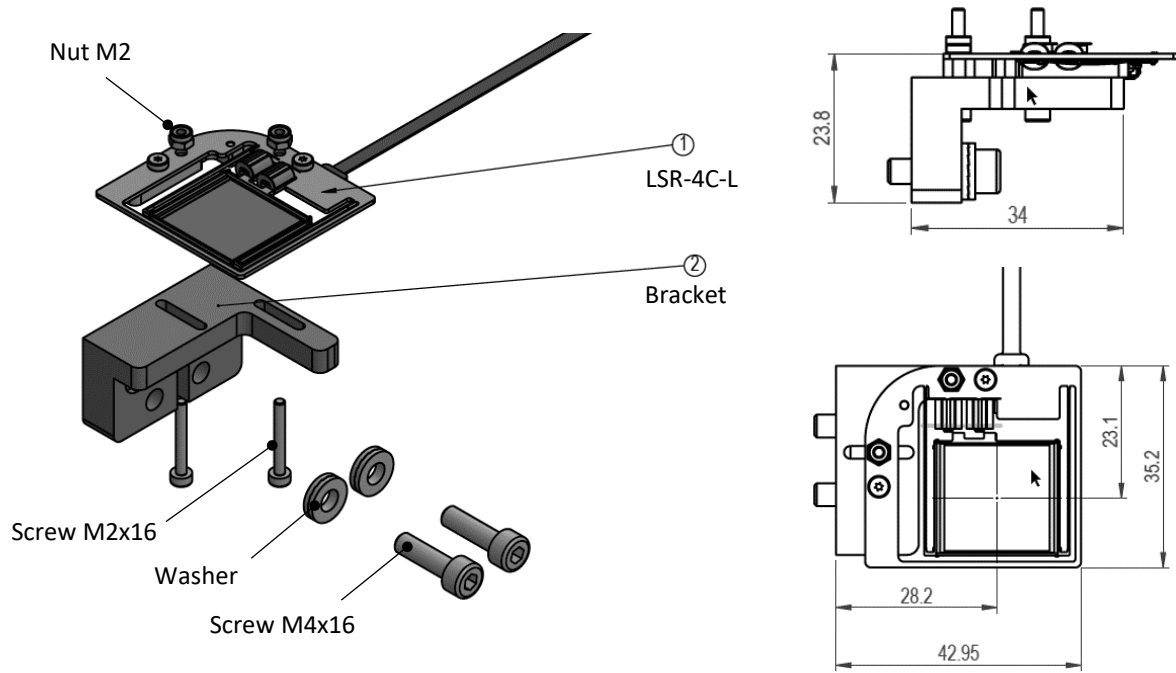


Figure 3: Mechanical layout of the LSR-4C-L (with bracket) assembly. The LSR-4C is mounted onto the bracket which in turn can be mounted into an existing setup. The weight of the bracket is 43 g.

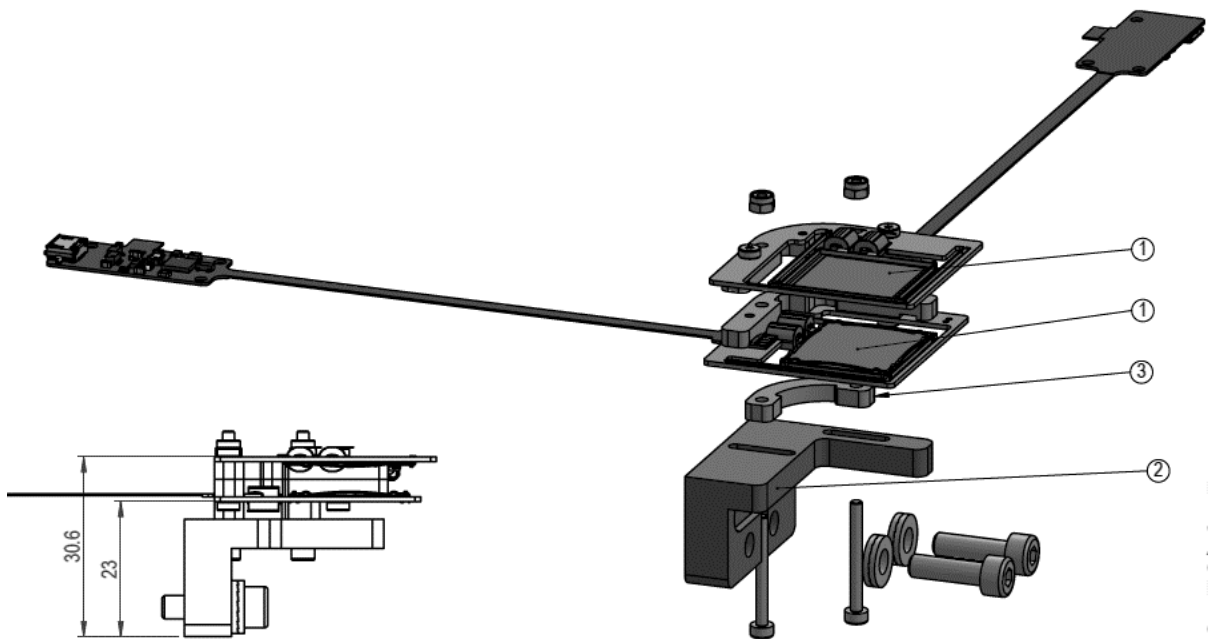


Figure 4: Mechanical layout of the LSR-4C-LL (double diffusor with bracket) assembly:
(1) LSR-4C, (2) Bracket kit LSR-4, (3) LSR-4C-LL-mounting kit.

Custom products

Optotune offers customized versions of the LSR-4C. Diffusors with different diffusion angles can be incorporated into the device and special coatings are available on request. In order not to affect the device dynamics negatively, a custom diffuser needs to have a mass within -6% to +16% of the standard diffuser.

The diffusion angle of the LSR-4C is defined as the full width half maximum (FWHM) of the profile of the emerging beam, see Figure 5.

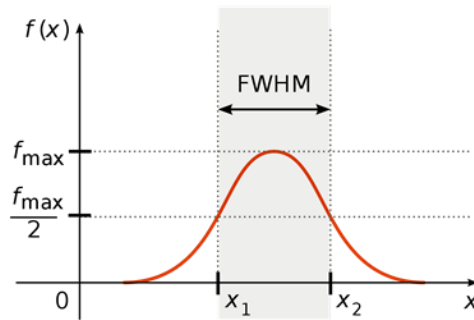


Figure 5: Definition of the diffusion angle as the FWHM of a given profile.

The required outer dimensions and tolerances for a diffuser to be mounted in the LSR-4C are shown in Figure 6.

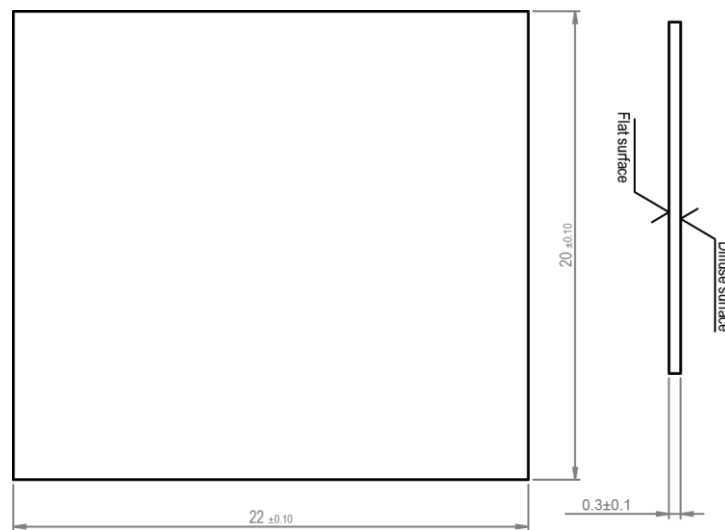


Figure 6: LSR-4C diffuser dimensions.

Electrical layout

A micro-USB connection is available on the LSR-4C to provide the needed 5 V supply voltage. Instead of using the USB connector, the LSR-4C can be driven directly by a voltage source using the GND and Vcc (3.4 V to 5 V) soldering pad. See Figure 7.

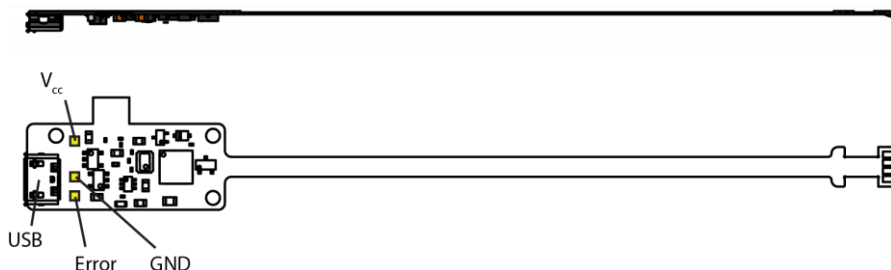


Figure 7: Electrical layout of the LSR-4C.

For visual indication, there is an LED on the flex electronics that lights up when the LSR-4C is operating without errors and is turned off otherwise. The same signal is given to the Error pin. For stable operation, the signal is “low”. If e.g. the LSR-4C oscillation amplitude is outside of a certain range, the error signal switches to “high”. The error signal is realized as an open collector output.

Transmission

Figure 8 shows the transmission spectrum of the LSR-4C with the coated VIS-standard diffuser. The transmission stays above 98% over the specified range of wavelengths from 440 to 660 nm. Figure 9 shows the transmission spectrum of the LSR-4C with the uncoated standard diffuser.

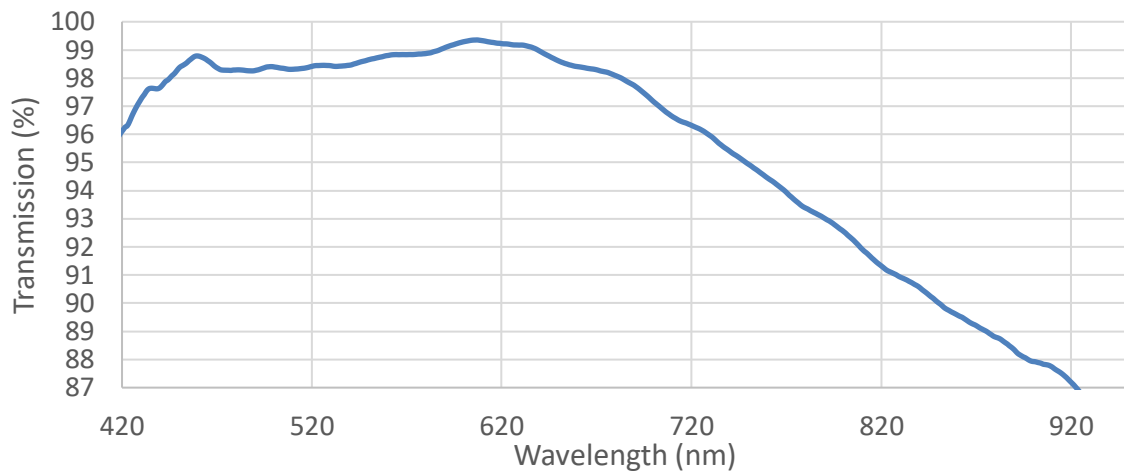


Figure 8: Transmission spectrum of the LSR-4C with the coated standard diffuser.

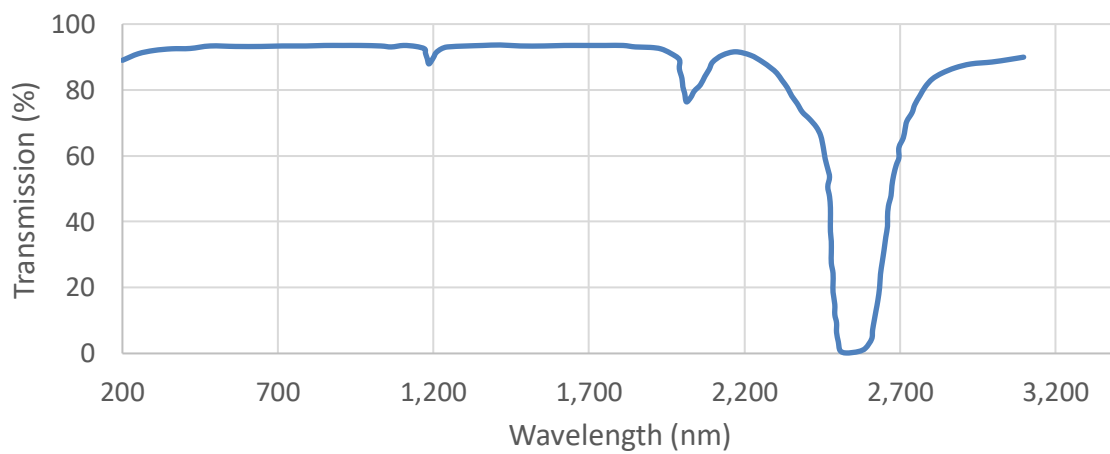


Figure 9: Transmission spectrum of the LSR-4C with the uncoated standard diffuser.

Environmental testing

The LSR-4C has passed the following reliability tests:

Test	Test procedure	Remark
Operating lifetime test (ongoing)	120 Hz, 25±5°C	40 000 hours without failure
High temperature (non-operational)	85±2°C, 16 hours, 5% relative humidity	Oscillation amplitude change of less than 11%
Low temperature (non-operational)	-40±3°C, 16 hours, 50% relative humidity	Oscillation amplitude change of less than 11%
Temperature cycling (operational)	-30 to 85°C, 30 min for each high/low temperature	
Mechanical shock	500 g, 1 ms duration, 5 shocks per axis	JESD22 B104-A/B
Damp heat cycling (operational)	25 to 55°C, 92-95% relative humidity, 2 hours dwell, <1°C/min, 5 cycles	IEC 60068-2-30 Db amended

Packaging

Single LSR-4C units ship in membrane boxes. Larger volumes ship in ESD-safe and stackable PET trays of 10 LSR-4C units each, sealed in vacuum bags (Figure 10).

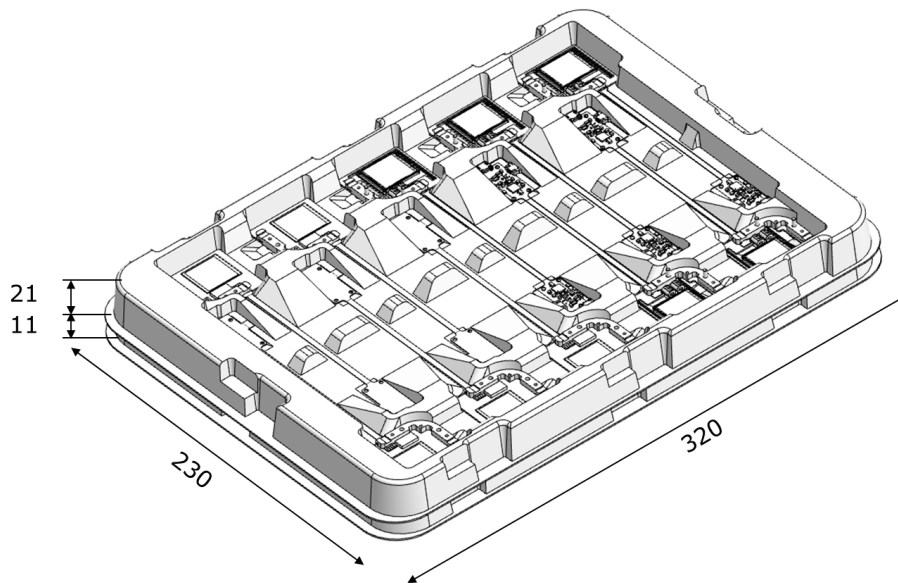


Figure 10: LSR-4C tray design.

Safety and compliance

The product fulfills the RoHS, REACH, CE and flammability UV94 V-0 compliance standards. The customer is solely responsible for complying with all relevant safety regulations for integration and operation, including EMC compliance.

For more information on optical, mechanical, and electrical parameters, please contact sales@optotune.com.