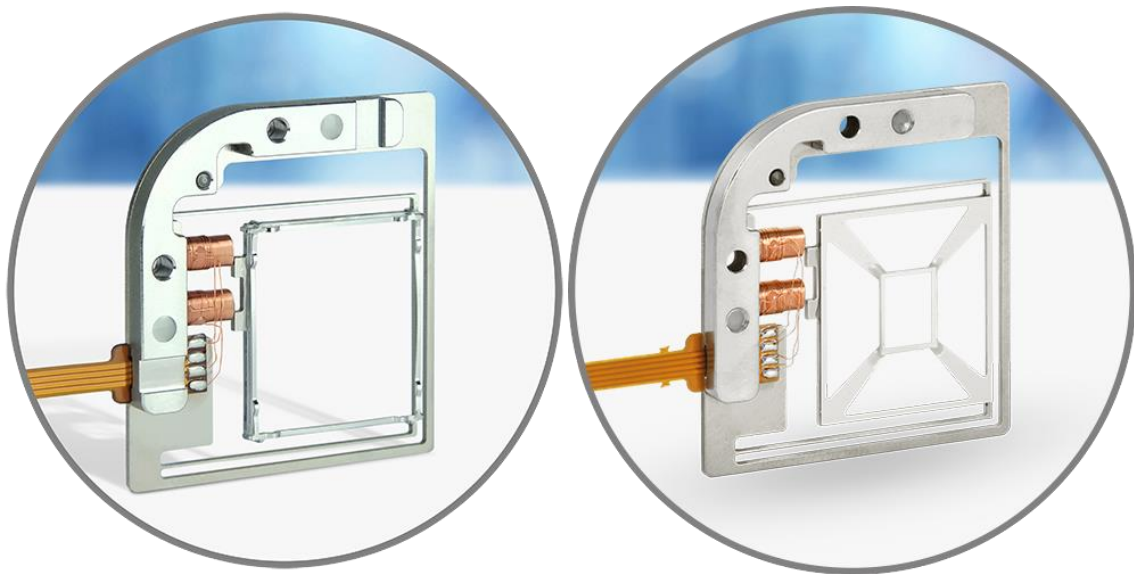


Reluctance force-based laser speckle reducers LSR-4C and LSR-5

Handling Instructions



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1. General

1.1. Safety

The LSR-4C and LSR-5 are intrinsically safe and does not expose the user and operators to significant harm, even if powered and in operation.

Follow general laser safety guidelines when using the LSR in laser applications.

1.2. Do's and Don'ts



Use gloves when touching the housing of the LSR.
Do not touch the diffuser or spring of the LSR.



Always use ESD protection (e.g. wrist strap, anti-static mat) when handling the device.



Do not use aggressive agents such as acetone, ammonia or acids to clean the LSR.
Refer to the section on cleaning below.

2. Manual handling

Packaging

The LSR-4C and LSR-5 ship in ESD-safe stackable PET trays sealed in an ESD bag. See Figure 1.



Figure 1: Tray packaging of the LSR-4C/LSR-5.

- Check the correct orientation of the tray (“Open this side”) when removing the tray from the sealed ESD bag.
- Use gloves when handling the LSR and only grab it by the edges, without touching the spring or diffuser. See Figure 2.
- Avoid scratches to the diffuser. When unmounted, position the LSR such that the diffuser is not touching surfaces or other objects.
- Ensure a dust-free environment for storage of the LSR.

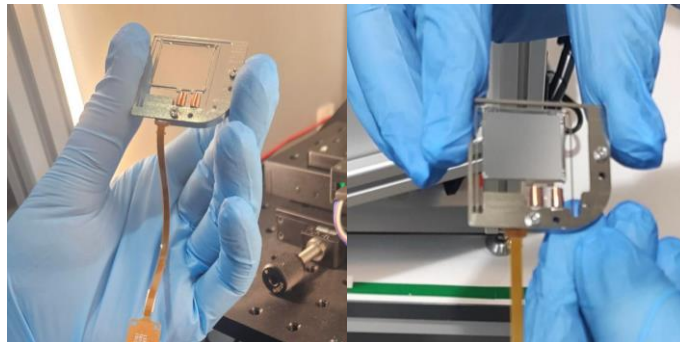


Figure 2: Manual handling of the LSR. Avoid touching the diffuser and only hold the device by the edges.

3. Cleaning

3.1. Dust and particles

In the case of dust and particles on the surface of the LSR diffuser, we recommend cleaning as follows:

- Use an air gun (filtered, oil-free, ideally ionized) to blow a **slow** air stream onto the glass.

Make sure there is no strong pulse of pressurized air which can damage the actuator (pressure should be <2 bar).

Individual particles may also be removed using a silicone gel swab.

3.2. Stains and fingerprints

In case of contamination that cannot be removed with the air gun, the LSR diffuser can be wet-cleaned using a cleaning solution.

Only the flat side of the diffuser can be wet-cleaned as described below. Contamination of the structured side of the diffuser may result in the need for device replacement.

- Use the following cleaning solution: 85% ethanol mixed with 15% diethyl ether.
- Soak a clean optical tissue with a small amount of the cleaning solution.
- Move the tissue slowly with very slight pressure over the glass. Always use a fresh edge/part of the tissue.
- Repeat with a different part of the clean tissue if required.

Wet cleaning is not simple and may end up contaminating the LSR more than cleaning it. It is recommended to test the cleaning procedure on a similar piece of glass.

4. Mounting

The LSR-4C / LSR-5 can be purchased in two different configurations: LSR-4C-L / LSR-5-L (single device) and LSR-4C-LL / LSR-5-LL (two devices assembled together). The following sections describe the mounting of both versions, together with general recommendations on the mounting orientation and placement with respect to an incoming laser beam.

4.1. General recommendations

For efficient laser speckle reduction and maximal transmission, it is generally advised to

- position the LSR perpendicular to the optical axis
- illuminate the LSR by a collimated beam

The recommended direction of light is indicated in Figure 3. Here, a laser beam will pass through the flat side of the diffuser before passing through the structured side of the diffuser. If an application is sensitive to back-reflections from the device, the LSR can be tilted slightly with respect to the incoming beam.

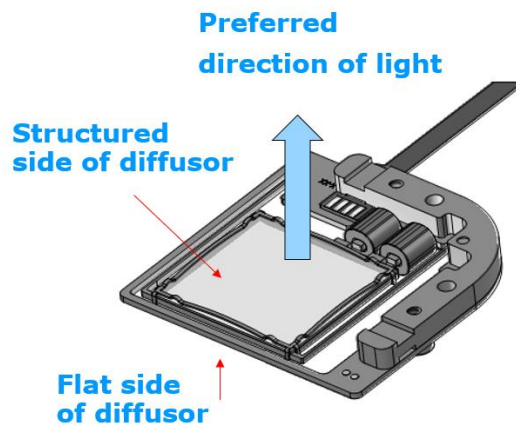


Figure 3: Recommended direction of light passing through the LSR-4C.

For further recommendations on integrating the LSR together with other optics in a laser system, please refer to Optotune's LSR [application note](#).

4.2. Mounting a single unit (-L configuration)

To guarantee optimal performance and maximum oscillation amplitude, it is recommended to mount the LSR onto a rigid mechanical holder. The LSR needs to be tightly screwed to this counter mass. For that purpose, two mounting holes for M2 screws are available. Optotune recommend a minimum anchoring mass of 500 g and offers a brass mechanical holder - the LSR-4 Bracket kit -that allows for mounting the LSR into an existing setup. With this holder, a rigid mechanical integration is guaranteed.

When purchased together with the LSR-4 Bracket kit, the mounting of the LSR-4C-L (or the LSR-5-L) goes as follows:

1. Attach the LSR-4C-L (6) to the bracket (1) using the supplied M2X16 screws (4) and M2 nuts (5).
2. Mount the LSR-4C Bracket kit on e.g. an optical post using the M4x16 screws (3) and washers (2).

The numbering refers to Figure 4, which shows the individual parts in the assembly together with the preferred direction of light passing through the device.

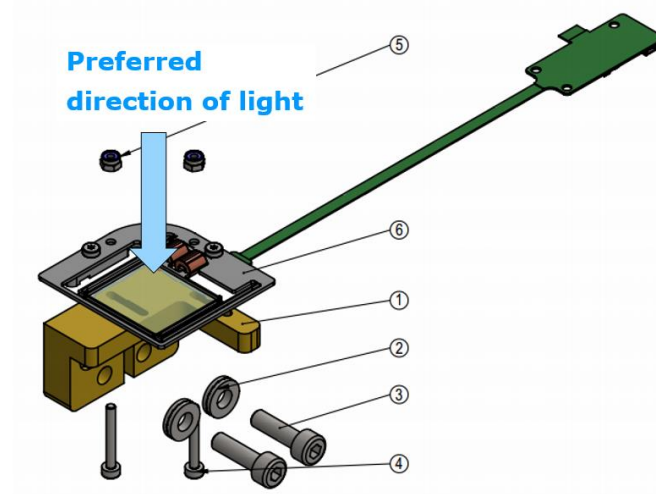


Figure 4: Recommended direction of light passing through the mounted LSR-4C-L.

4.3. Mounting two units together (-LL configuration)

In the LSR-4C-LL or LSR-5-LL configuration, two LSR devices are mounted together, rotated 90 degrees with respect to each other. This allows for higher speckle reduction, as the second unit oscillates in a perpendicular direction to the first one and adds more randomization of the speckle pattern. This configuration requires the LSR-4C-LL Mounting Kit (same name for both LSR types).

Figure 5 shows the individual parts in the assembly together with the preferred direction of light passing through the device. In this configuration, an incoming laser beam will pass through the flat side of the first diffuser first and then through the structured side of the second diffuser.

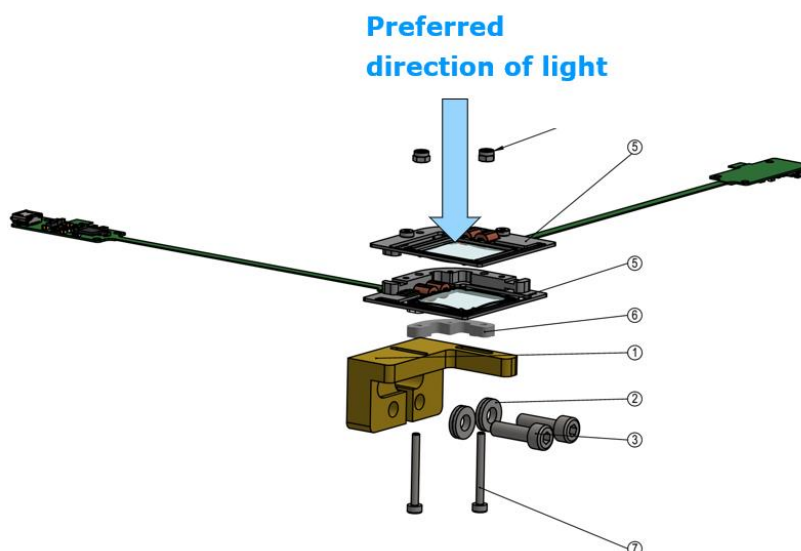


Figure 5: Recommended direction of light passing through the mounted LSR-4C-LL.

When purchased together with the LSR-4C-LL Mounting Kit, the assembly and mounting of the LSR-4C-LL (or LSR-5-LL) goes as follows. The individual parts are shown in Figure 6 and the individual assembly steps in Figure 7.

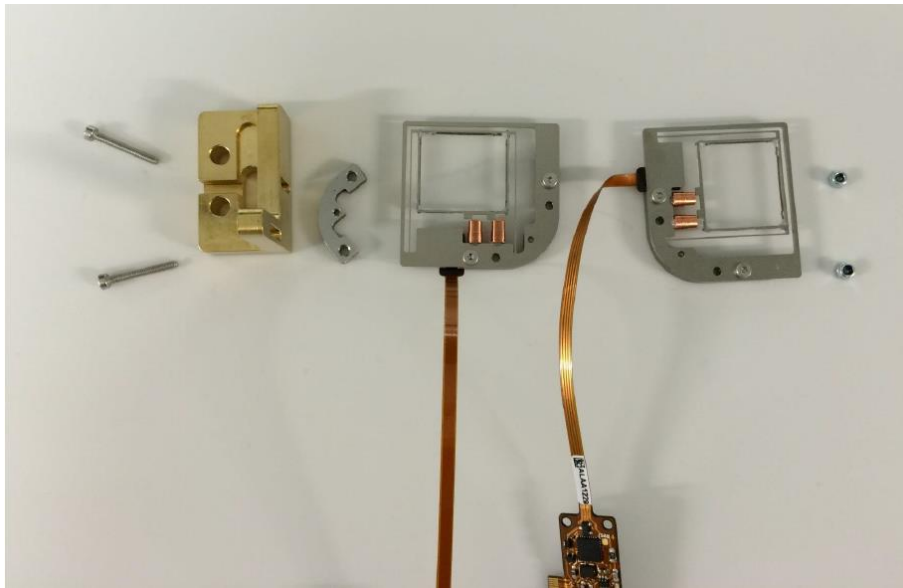


Figure 6: Parts delivered when purchasing the LSR-4C-LL together with the LSR-4C-LL mounting kit and LSR-4 Bracket kit.

1. Attach the mounting kit (6) to the bracket (1) using the supplied M2x16 screws (7).
2. Attach the first LSR-4C-L (5) to the mounting kit (6) by threading it onto the M2x16 screws (7). Take care to orient the device according to Figure 7.
3. Attach the second LSR-4C-L (5) to the mounting kit (6) by threading it onto the M2x16 screws (7), flush against the first LSR-4C-L. Take care to orient the device according to Figure 7. Fix the devices with the M2 nuts (-). Tighten all screws such that the LSR-4C units are rigidly fixed to the respective parts.
4. Mount the complete setup on e.g. an optical post using the M4x16 screws (3) and washers (2).

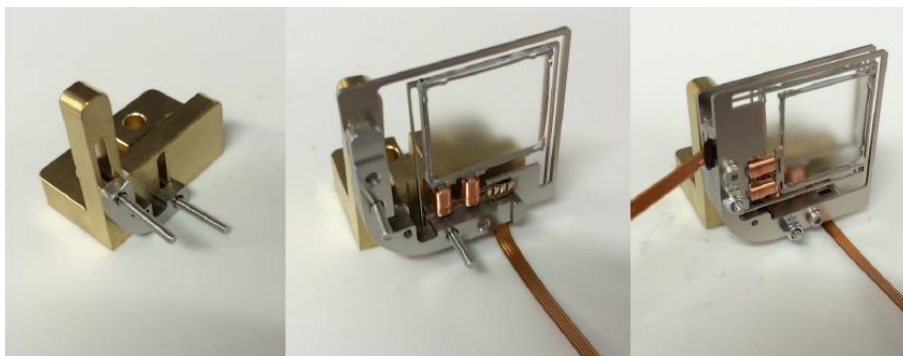


Figure 7: Assembly steps for the LSR-4C-LL.

Optotune offers an alternative mounting of the LSR-4C-LL that allows for displacing the two LSR-4C units vertically with respect to each other. In this assembly, the LSR-4C units are positioned on either side of the bracket. The second unit can then be displaced with respect to the first by up to ± 5 mm. See Figure 8.

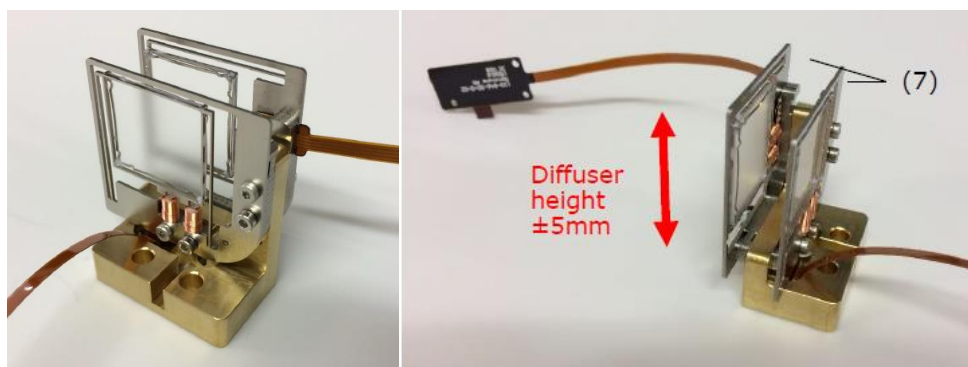


Figure 8: Final assembly of the alternative mounting of the LSR-4C-LL. The alternative mounting allows for vertical displacement of the two LSR-4C units with respect to each other.

Figure 9 shows the LSR-4C-LL fully assembled and mounted on a ½" optical post held by a post holder. This is a typical setup for initial testing of the device.

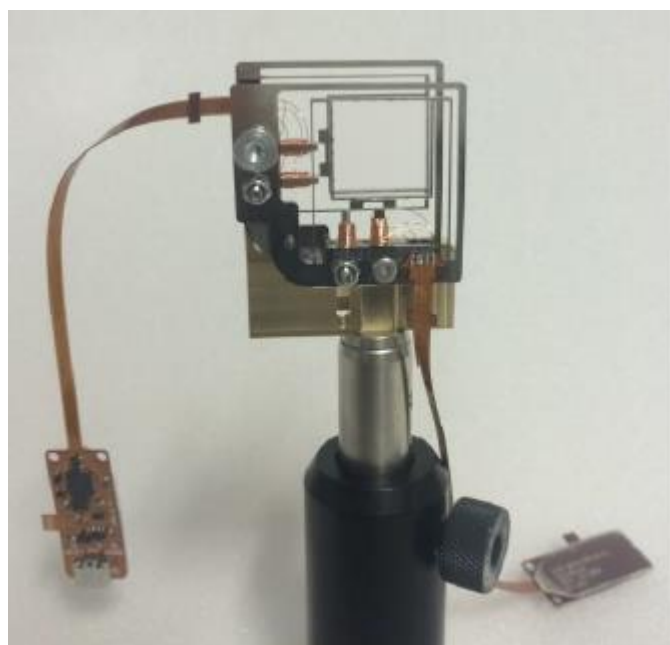


Figure 9: LSR-4C-LL mounted on a post.

5. Electronics and connection

The LSR-4C / LSR-5 has one actuator coil and one sensor coil. Together, they ensure that the device achieves the required amplitude and continuously adjusts the driving frequency with respect to the resonance such that the oscillation amplitude stays constant.

A micro-USB connection is available on the LSR to provide the 5 V supply voltage needed. No further driver electronics are needed; the device settles into its optimal trajectory once powered on. 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 (Figure 10).

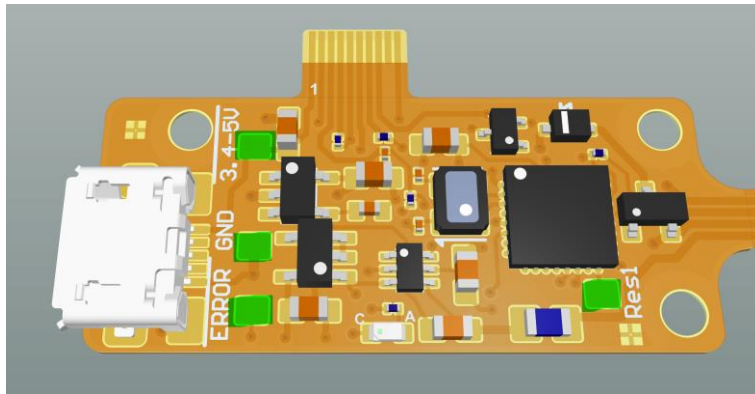


Figure 10: LSR-4C / LSR-5 FPC with four available test and supply points indicated in green.

For visual indication, there is an LED on the flex electronics that lights up when the LSR is operating without errors. The same signal is given to the Error pin. For stable operation, the signal is LOW. If e.g. the LSR oscillation amplitude is outside of a certain range, the error signal switches to HIGH. The error signal is realized as an open collector output.

The connection of the micro-USB power supply is done as shown in Figure 11. During startup, the LSR undergoes an autocalibration process (taking approximately 40 seconds) during which the status LED blinks. Once the nominal amplitude has been reached, the LED stays on.

The FPC is fragile. Kinks or excessive bends of the cable can lead to corrupted device operation. Do not stress the FPC when inserting / removing the USB connector.

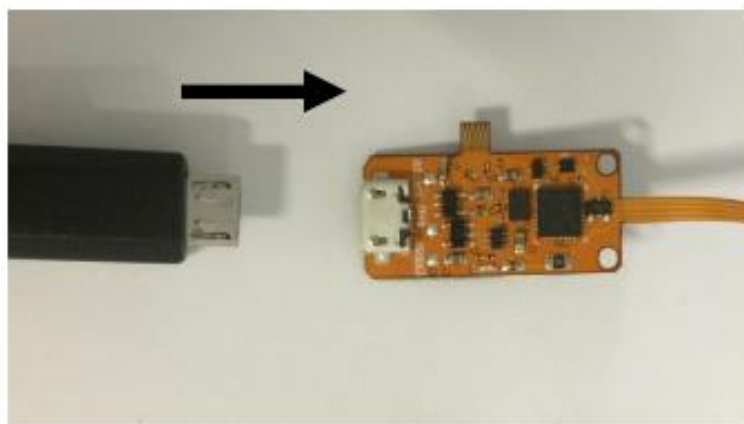


Figure 11: Connecting the LSR to a 5V supply via the micro-USB connector.

6. FAQ and troubleshooting

For more information on the LSR specifications, despeckling performance and setup configurations, please refer to the respective datasheet and the laser speckle reduction [application note](#).

6.1. The LSR does not move

If the LSR does not move after powering on the device:

- Check the supply voltage – the 5V need to be supplied either with the kit power adapter, from a computer, or directly via a voltage source.
- Check that the micro-USB connector is inserted all the way in.
- Check the flex cable for kinks and broken lines.
- Check that the LED on the PCB is on.

If no damage can be found on the flex cable and the appropriate supply voltage is confirmed, please contact sales@optotune.com to issue an RMA.

6.2. The LSR LED is permanently off

If this occurs when the device is powered via the USB connector, contact sales@optotune.com to issue an RMA.

6.3. The output beam does not exhibit sufficient speckle reduction

If the output beam does not exhibit sufficient speckle reduction, the first step is to confirm whether the LSR diffuser is moving. This can be done by placing the diffuser in the focal point of a light source in front of a screen. This will create a magnified image of the diffuser structure on the screen. Owing to the magnification, the diffuser movement should be visible.

If the diffuser is oscillating, and the speckle reduction is still insufficient, further steps can be taken. It is important to note that the achieved speckle reduction depends on both the diffuser characteristics, oscillation amplitude and frequency, as well as the optical setup that is used for the speckle contrast evaluation.

The first steps to improve the despeckling performance without changing the optics is to

- Increase the size of the input beam to match the size of the clear aperture of the LSR.
- Optimize the collimation of the input beam and the position of the LSR with respect to the beam.
- Increase the exposure time of your camera.

If the speckle reduction after implementing the above steps is still insufficient, an LSR with a larger diffusion angle, oscillation amplitude or frequency might be needed.