LS-SAL

Multi channel calibrated VIS-SWIR light source

Fig. 2. Photo of two LS-SAL50 and LS-SAL150 light sources

1 Typical light sources

There are many reference light sources that emit light in VIS-SWIR spectral band offered on the market that can be potentially used for testing/calibration of VIS-SWIR imagers (SWIR imagers or expanded band VIS-SWIR imagers). They are typically called integration spheres because due to design concept of a high reflectivity integration sphere integrated with a halogen bulb. More advanced integration spheres are equipped with special mechanical attenuators that allow to regulate continuously intensity of these light sources. These high end integration spheres are also typically calibrated in photometric/radiometric units.

There are two main ways of use of such light sources (integration spheres) in testing/calibration VIS-SWIR imagers. First, a part of an image projector (source located at collimator focal plane) that project reference images during testing VIS-SWIR imagers (measurement NER, MTF, resolution, Signal Transfer Function). Second, a stand alone large light source facing directly tested imager during calibration (two point NUC) of tested imager. Due to these differences a small light source is acceptable for systems for testing SWIR imagers but large light source is needed for calibration of these imagers (especially in case of calibration of long range imagers of large optics.

However, even high end integration spheres have a series of disadvantages. First, the integration spheres having large size emitters (over 100mm) are very bulky, slow and expensive. This drawback makes it difficult to such light source for calibration of imagers having narrow/medium FOV and large optics but small integration spheres can be technically used as parts of systems for testing such imagers. Second, typical integration spheres cannot offer realistic simulation of light conditions from dark, moonless nights to ultra bright days in VIS-SWIR spectral band duet too low dynamic of regulation of light intensity. Typical real dynamic (external manual neutral filters not counted) is not better 10^4 when ratio light intensity day/night can be as high as 10^{10}). It means that such typical light sources cannot simulate ultra bright days or dark night conditions. Third, typical light sources are basically broadband halogen sources of unknown or poorly known spectrum. These broadband sources calibrated in photometric/radiometric units) are perfectly acceptable for two point NUC of VIS-SWIR imagers. However, narrow band (monochromatic) light sources are needed for measurement of radiometric parameters of SWIR imagers (manufacturers often specify performance of such sensors/imagers at 1550nm wavelength).

2 What is LS-SAL light source?

The LS-SAL light source is a multi-channel calibrated light source that imitates reference large target emitting variable intensity, variable spectrum light in spectral band from about 400nm to about 2000nm. In contrast to typical light sources (integration spheres) LS-SAL light source offers:

1. emitter size as high as 150mm (optional 250mm) – virtually all imagers can be calibrated (two point NUC),
2. variable spectrum due to use of halogen bulb, LEDs, and spectral filters – the source can work in both broadband modes or monochromatic modes,
3. ultra high dynamic of regulation of light intensity (as high as as 1010 – both dark night and ultra bright day can be simulated,
4. precision photometric/radiometric calibration for both broadband modes and monochromatic modes,
5. compact design (all blocks inside a mechanical case),
6. it is possible to converts LS-SAL from reference light emitting source (calibrated in W/sr m^2 unit) to reference irradiator at specified plane (calibrated in W/m^2).

These advanced simulation capabilities make LS-SAL light source a unique solution on international market.

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3 How LS-SAL works?

The LS-SAL source is built an integrated switchable light emitter that allow emission of variable spectrum light due to use of combination of three modules: halogen bulb, LED, set of filters. Intensity of the halogen bulb is regulated using an opto-mechanical attenuator that changes light intensity but does not change light color temperature (light spectrum). Intensity of the LED sources is regulated electronically using advanced electronic regulation/stabilization system. Manual/motorized of change of spectral filters allows to convert LS-SAL into a monochromatic light source.
The source works as a true Lambertian source at emission angles in relatively narrow angle (up to 15° for LS-SAL50 and up to 7° for LS-SAL150). It means that LS-SAL sources can be used for calibration of VIS-SWIR imgers (two point NUC calibration) but only of imagers having narrow/medium FOV (light source must fill totally camera FOV). This limitation is perfectly acceptable in case of more expensive/bigger SWIR imagers.

4 Spectral modes

LS-SAL can work in four spectral modes:

1. Halogen bulb: broadband light source from 400nm to 2200nm (color temperature equals to 2856K in spectral band from 400nm to 1300nm and non greybody spectrum up to 2200nm). Light source is calibrated in cd/m^2 units or W/sr m^2. It is also possible to calibrate the source for only SWIR spectral band from about 900nm to about 2200nm.
2. White LED: visible light source of color temperature over 5000K. Light source is calibrated in cd/m^2 units.
3. Mixed mode: halogen and LED. Spectrum of emitted light depends on proportion of regulated halogen intensity to LED intensity. Light source is calibrated in cd/m^2 units.
4. Monochromatic mode (halogen bulb with an exchangeable narrow band filter). Light source is calibrated in W/sr m^2 units. Number filters and ways to exchange the filters vary depending on model of LS-SAL source.

5 Versions

LS-SAL is offered in two main version:SAL50 and SAL150.
LS-SAL50 – source having emitter approximately as high as 50mm,
LS-SAL150 – source having emitter approximately as high as 150mm.
LS-SAL50 is targeted to be used as small light source in image projectors used for testing VIS-SWIR imagers and for two point NUC of small VIS-SWIR imagers. LS-SAL150 is targeted to be used for two point NUC of large narrow FOV VIS-SWIR imagers. It can be also used as radiation source for image projectors based on collimator of long focal length.
There are also some other differences:
LS-SAL50 – manual exchange of up to 4 spectral filters,
LS-SAL150 - automatic exchange of up to 8 spectral filters.
Attention: only one filter is included in basic version. It it 1550nm narrow band filter. The number of filters can be optionally increased.
Number of filters is determined by adding X value in code LS-SAL source. For example LS-SAL-150-5 means the source with five spectral filters.

6 Other Infrared light sources

LS-SAL can be treated as modification of LS-DAL light source. Basically LS-DAL is optimized for testing/calibration of VIS-NIR imagers when LS-SAL is optimized for testing/calibration of VIS-SWIR imagers. Modifications of LS-SAL: special coating of internal integrating block for expanded VIS-SWIR spectral band, additional monochromatic filters, no UV LED. Due to wide spectral band LS-SAL can be used for testing/calibration not only SWIR imagers/VIS-SWIR imagers but also color VIS cameras/monochrome VIS-NIR cameras like typical LS-DAL.

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SPECIFICATIONS

Parameter	Value	
	LS-SAL-50	**LS-SAL-150**
	Performance parameters	
Light source active diameter[1]	48 mm	150 mm
Light projection angle	>15°	>7°
Basic modes of work:	1) broadband halogen bulb - no filter 2) visible broadband LED 3) mixed (halogen and LED) 4) variable monochromatic mode (halogen bulb and of a set of monochromatic filters)	
Temporal stability	<1% (all modes)	
	Halogen bulb-no filter	
Type of light source	halogen bulb as a polychromatic source of light of color temperature about 2856K up to about 1300nm and non greybody spectrum up to 2200nm	
Spectral band	From about 400nm to about 2200nm	
Regulation type	continuous	
Regulation method	opto-mechanical attenuator	
Luminance range	At least 10µcd/m^2 - 2000 cd/m^2	
Regulation resolution	10µcd/m^2 (at low intensity range)	
Stabilization time	<90 sec	
	Visible LED mode	
Light source	white LED	
Color temperature	>5000K	
Spectral band	0.4-0.72 µm	
Regulation method	Electronic regulation	
Luminance range	At least 0.001 cd/m^2 - 10000 cd/m^2	
Regulation resolution	0.001 cd/m^2	
Stabilization time	<30 sec	
	Mixed mode	
Light source	halogen bulb and white LED	
Spectrum of emitted light	depends on proportion of regulated halogen intensity to LED intensity	
Regulation method	Electronic regulation mixed with opto-mechanical regulation	
Luminance range	20 µcd/m^2 – 12 kcd/m^2	
Regulation resolution	10 µcd/m^2 (at low luminance range)	
Stabilization time	<120 sec	
Temporal stability	<1%	
	Monochromatic mode	
Type of light source	halogen bulb with a set of exchangeable monochromatic filters Basic version: one 1550nm filter Optional versions:	
Filters	SAL50-up to 4 filters manually exchanged (typical set: 900nm, 1100nm, 1300nm, 1550nm) SAL150-up to 8 filters – motorized exchange	
Radiance range	At least 0.1 mW/sr m^2 – 1 W/sr m^2 for 1550nm filter	
Regulation resolution (at low range)	0.05 mW/sr m^2	
	General features	
Work temperature	+5°C to +35°C	
Storage temperature	-5°C to +55°C	
Humidity	Up to 90% (non condensing)	

*specifications are subject to change without prior notice

Version 5.2

1 Light source active diameter can be different than two presented in the table and specified for customer application. Please contact Inframet via info@inframet.com for more information.

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