



# Specification

## Multispectral Imaging System

### MSIS-AGRI-1-A



MSIS-AGRI-1-A

Specifications subject to change

Revised April 25, 2024

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# Background Information

## Trademarks

Spectral Devices Inc., MSC2, MSIS-AGRI-1-A

## Sales and Support

Contact Type	Contact Information
Email	<a href="mailto:sales@spectraldevices.com">sales@spectraldevices.com</a> <a href="mailto:support@spectraldevices.com">support@spectraldevices.com</a>
Knowledge Base and Downloads	<a href="http://www.spectraldevices.com">www.spectraldevices.com</a>
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# 1. Description

The MSIS-AGRI-1-A is a multispectral imaging system incorporating an MSC2-AGRI-1-A snapshot multispectral camera, a 4-channel LED illuminator and a control box with embedded vision computer and software.

The MSIS does not require additional computers or hardware to operate. The MSIS can be powered with an 18V to 75V DC power source such as a battery system. A separate AC power supply is included for operation from a 110-240 V AC power source.

The camera head, control box and cabling are waterproof and dustproof (IP67 rated). The system is constructed from durable CNC-machined aluminum components.

The system saves multispectral images to a micro-SD card for quick and reliable data transfer. A text-based configuration file on the SD card allows users to easily configure camera and LED settings. Image acquisition is started and stopped from a pushbutton on the front of the control box. A second push button allows users to shut down the MSIS to remove the SD card.

There are several built-in integration options that allow the MSIS to synchronize with other equipment. In addition to manual operation through the front panel, users can control image acquisition using simple commands over a network connection, and digital signals from an external clock timing source. Detailed logs of system operation are written to the SD card and available to users for offline analysis.

# 2. Key Features

- Snapshot Operation (capture spectral images simultaneously)
- Captures 4 Bands (580, 660, 735, 820 nm)
- Anti-X-Talk™ Technology (enhances contrast and spectral performance)
- High Frame Rate (up to 180 FPS at full frame)
- High Performance (4MP Global Shutter CMOS Sensor)
- USB3 Vision & GenICam Compliant
- High power pulsed LED light source
- Compact waterproof and dustproof camera head (IP67)
- Water-resistant control box with PC included

# 3. Applications

The camera is suitable for remote sensing in agriculture. The 580 nm band is known as chlorophyll reflectance peak in the visible light spectrum. The Red, Red Edge and NIR bands can be used to assess plant health, detect diseases early, and optimize crop yields using such metrics as Normalized Difference Vegetation Index (NDVI) and Normalized Difference Red Edge

Index (NDRE). Table 3.1. lists example metrics that can be used for multispectral analysis using MSC2-AGRI-1-A.

An NDVI image obtained with the MSIS-AGRI-1-A system of a cotton plant is shown in Figure 3.1. The MSC2-AGRI-1-A camera outputs 4 spectral images (Fig.3.1a), the NIR (820 nm) and Red (660 nm) bands were used to calculate the NDVI (Fig.3.1b).

Combined with Spectral Devices SBC-1 miniature vision computer, the MSC2-AGRI-1-A offers an easy-to-use lightweight and modular imaging solution for UAV users.

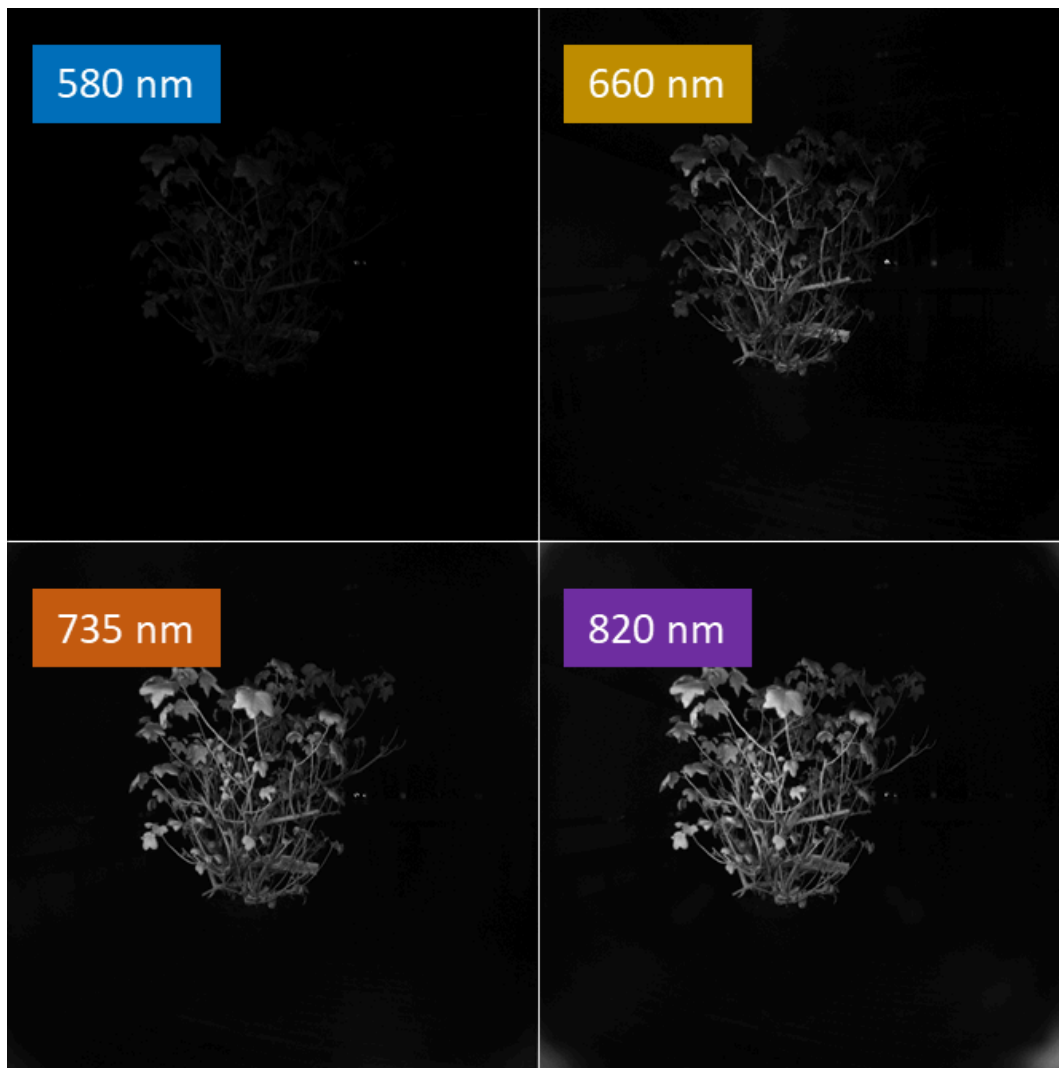
Other possible applications:

- Greenhouse monitoring of plants
- Research and development
- Industrial machine vision
- Tractor-mounted imaging applications
- CCTV-like monitoring
- Biomedical research
- Time-lapse multispectral imaging

**Table 3.1.** Example metrics for multispectral analysis using MSC2-AGRI-1-A camera

METRIC	FULL NAME	BANDS	EQUATION	INTERPRETATION
NDRE	Normalized Difference Red Edge Index	NIR, Red Edge	$NDRE = (NIR - RedEdge) / (NIR + RedEdge)$	<p>Range from -1 to +1. A higher NDRE indicates greater plant health, reflecting denser and greener vegetation. This is crucial for assessing crop vitality and identifying areas needing attention.</p> <p>This metric performs better in crops at late stages of growth.</p>
EVI	Enhanced Vegetation Index	NIR, Red, Blue	$EVI = G * ((NIR - Red) / (NIR + C_1 * Red - C_2 * Blue + L))$ , where $C_1$ and $C_2$ are coefficients for atmospheric resistance, L - value to adjust for canopy background	<p>Range from -1 to +1. Higher EVI values generally indicate healthier and more vigorous vegetation, while negative values may indicate non-vegetated surfaces or water bodies.</p> <p>This metric corrects for atmospheric conditions and canopy background noise. Compared to previously listed metrics it is more sensitive in areas with dense vegetation and to canopy structural variations such as leaf size and canopy type.</p>

MSAVI2	Modified Soil Adjusted Vegetation Index	NIR, Red	$\text{MSAVI2} = \frac{2 \cdot \text{NIR} + 1 - \sqrt{(2 \cdot \text{NIR} + 1) - 8(\text{NIR} - \text{Red})}}{2}$	<p>Ranges from -1 to +1. Higher MSAVI values generally indicate healthier and more vigorous vegetation, while negative values may indicate non-vegetated surfaces or soil.</p> <p>Used when a lot of soil is present, in early crop development stages.</p>
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(a)



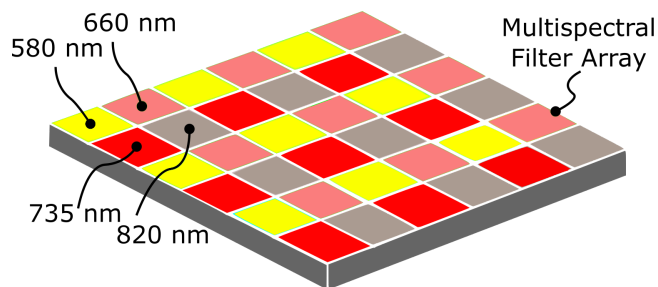
$$\text{NDVI} = \frac{\text{820nm} - \text{660 nm}}{\text{820nm} + \text{660 nm}}$$

(b)

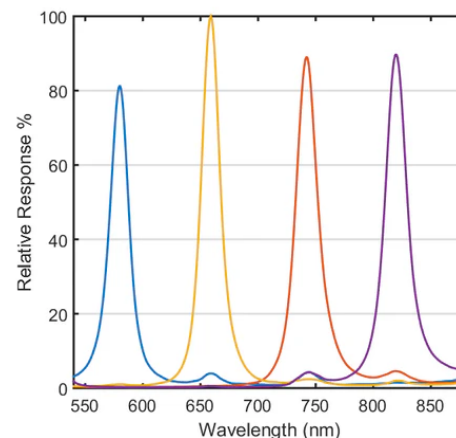
**Figure 3.1.** (a) Multispectral Image of a cotton plant captured with MSIS-AGRI-1-A system. (b) NDVI image produced by using the displayed equation. High NDVI (pink) indicates healthy plant parts, while low NDVI value (blue) indicates distressed parts.

## 4. Camera Sensor and its Spectral Characteristics

The MSC2-AGRI-1-A camera has 4 distinct bands centered at 580, 660, 735, 820 nm (FWHM ~25 nm). The sensor of the camera is covered with a multispectral filter array providing each sensor element (pixel) its own spectral response (Fig.4.1a). Spectral response of the MSC2-AGRI-1-A camera sensor is displayed in Fig.4.1b.



(a)



(b)

**Figure 4.1.** (a) Example of MSC2-AGRI-1-A multispectral filter array structure (note: band arrangement can vary between cameras) (b) Spectral response of the MSC2-AGRI-1-A camera.

## 5. Anti-X-Talk™ Technology

Anti-X-Talk™ technology is a unique Spectral Devices Inc. on-chip technology working at the filter level and preventing light leakage between individual filters. Without Anti-X-Talk™ technology, stray light between spectral channels is significant, often exceeding the light leakage due to spectral overlap between adjacent filters. As a result images suffer from low contrast and spectral ambiguity.

Spectral Devices invented Anti-X-Talk™ technology to overcome these problems. It works by blocking stray light between adjacent filters, making the pixel response more predictable and directly related to the actual spectral response of the overlying pixelated filter. The result is multispectral images with better spectral discrimination and higher contrast.

Furthermore, high quality image data from the MSC2-AGRI-1-A can be used as is without the need for proprietary post-processing algorithms and the camera can be used with a wide range of lens types even at large apertures (e.g. f/2).

## 6. Specifications

Camera	MSC2-AGRI-1-A (see spec. for more info) Sensor size: 1" Bands: 580 nm, 660 nm, 735 nm, 820 nm
Lens	C-mount, 8.5 mm to 50 mm focal lengths available Manual iris, manual focus, locking screws Optional electronic focus and iris
Number of LED channels	4
Number of LEDs per channel	8 (80W per channel)
LED control	Each channel is controllable via software configuration file on SD card. Strobe output from the camera flashes all 4 LED channels simultaneously. Other sequences customizable by user.
LED channels	580, 660, 735, 820 nm
Exposure Modes	Timed exposure (22 $\mu$ s – 1.5 s). Timed interframe interval (5.6 ms – years).
Camera Trigger	Hardware triggers a 5-24 V DC signal (rising or falling edge), pre-wired to LED controller or externally triggerable through M12 connector.
Network	Wifi (IEEE 802.11ac) and 1Gb Ethernet (RJ45)
Operating System	Linux
Software	Preconfigured image acquisition software on board control box
External construction	6061 aluminum, polycarbonate, and 316 stainless steel hardware



Surface finish	black anodization, polycarbonate
Power Requirement	18-75 V DC (60 W) A separate AC power supply is included for operation from a 110-240 V AC (250 W) power source. Optional 24V DC operation for solar powered applications
Dimensions	Camera head: 200 mm diameter x 170 mm deep Control module: 146 mm x 200 mm x 270 mm (HxWxD)
Weight	Camera head: 2.5 kg Control box: 6 kg

## 7. Package Contents

The MSIS is shipped with several items including the camera head, control box, 48V DC power adaptor, power cord, mounting bracket, micro-SD card, and several M12 cables. All components are shipped in a waterproof case.

Camera Head



Control Box



48V DC power adaptor



AC power cord



Mounting bracket & hardware



MicroSD card and adaptor



Camera trigger cable

LED power cable

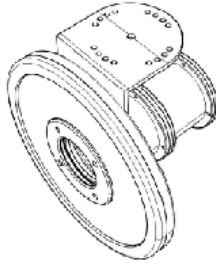
Network cable



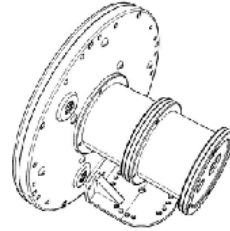
**Figure 7.1.** Items shipped with the MSIS

## 8. Drawing: Camera Head

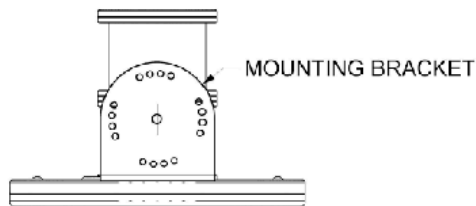
RENDERED TOP VIEW



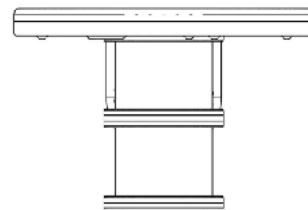
RENDERED BOTTOM VIEW



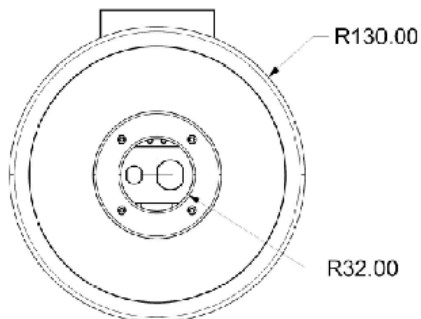
TOP VIEW



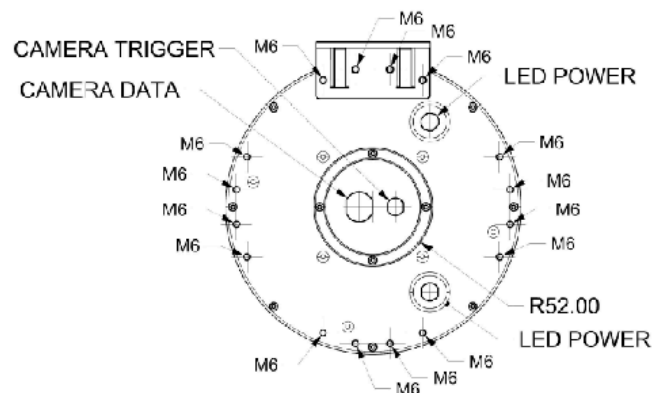
BOTTOM VIEW



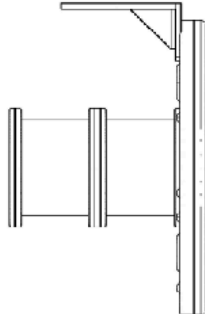
FRONT VIEW



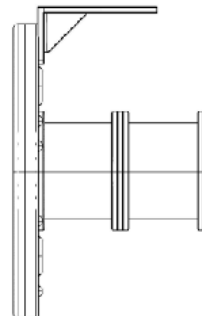
BACK VIEW



LEFT VIEW



RIGHT VIEW



## 9. Photos: Camera Head

Front View



Back View



Side View



Perspective View



**Figure 9.1.** Camera head photos

## 10. Photos: Control Box

Front View



Back View



Front View (open)

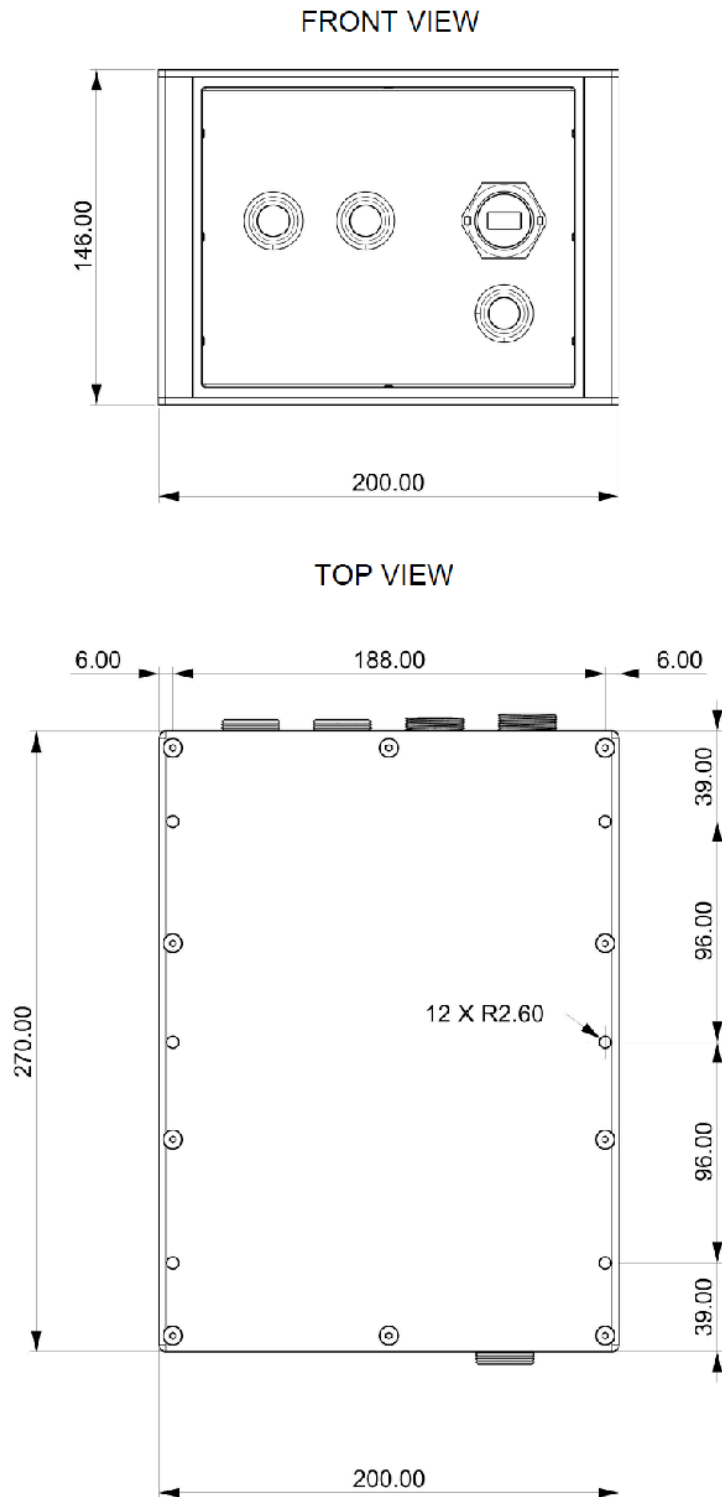


Back View (open)



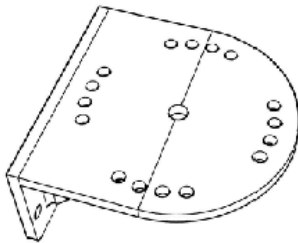
Figure 10.1. Control Box photos

## 11. Drawing: Control Module

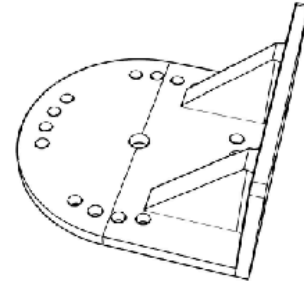


## 12. Drawing: Mounting Bracket

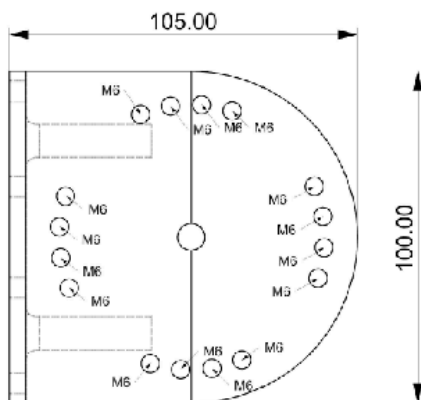
RENDERED TOP VIEW



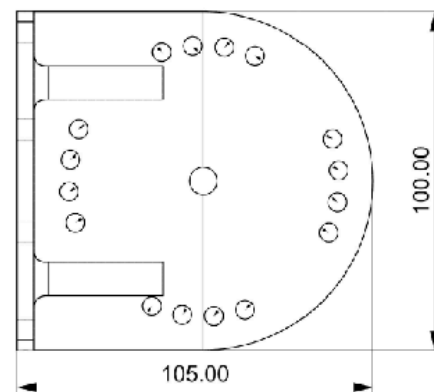
RENDERED BOTTOM VIEW



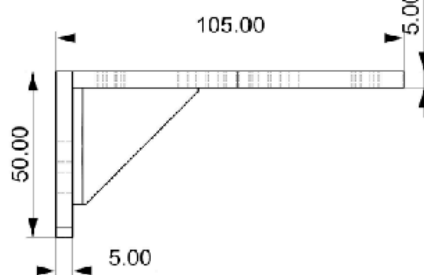
TOP VIEW



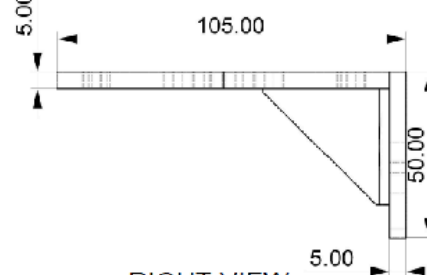
BOTTOM VIEW



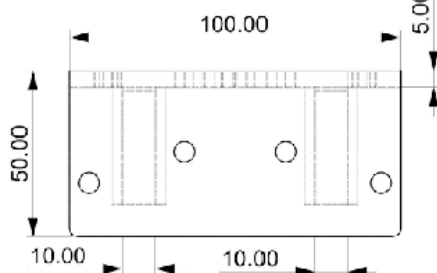
FRONT VIEW



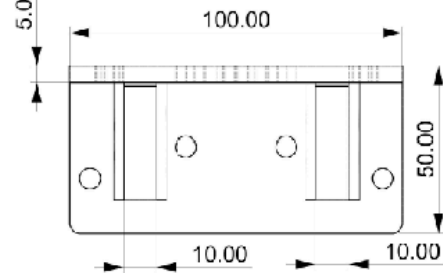
BACK VIEW



LEFT VIEW

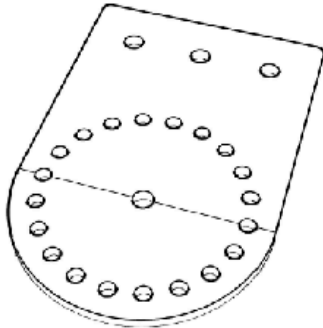


RIGHT VIEW

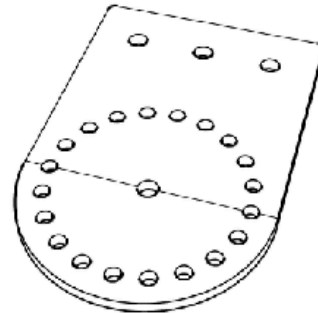


## 13. Drawing: Mounting Plate

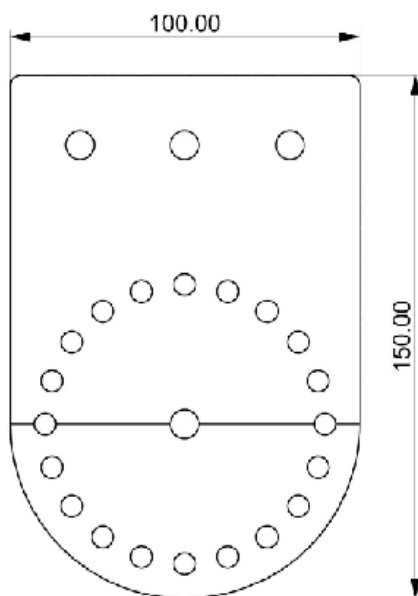
RENDERED TOP VIEW



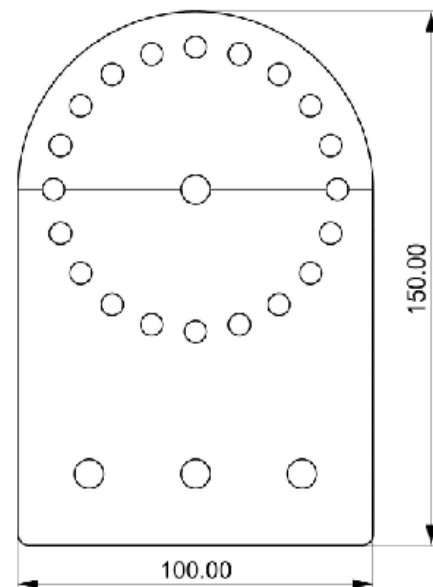
RENDERED BOTTOM VIEW



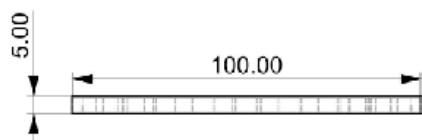
TOP VIEW



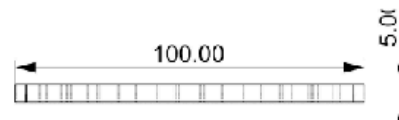
BOTTOM VIEW



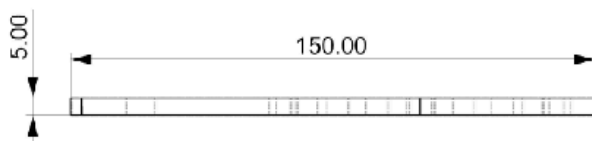
FRONT VIEW



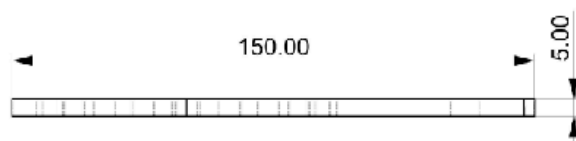
BACK VIEW



LEFT VIEW

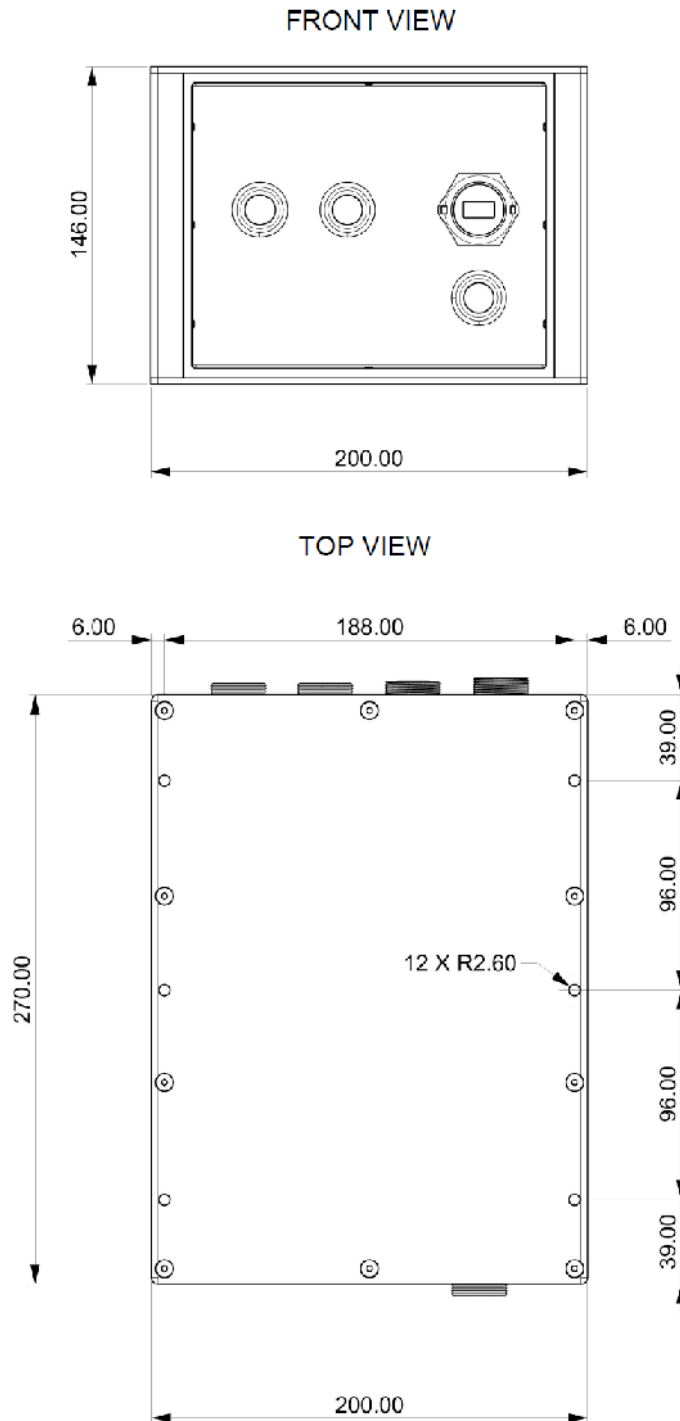


RIGHT VIEW





## 14. Drawing: Control Module Dimensions





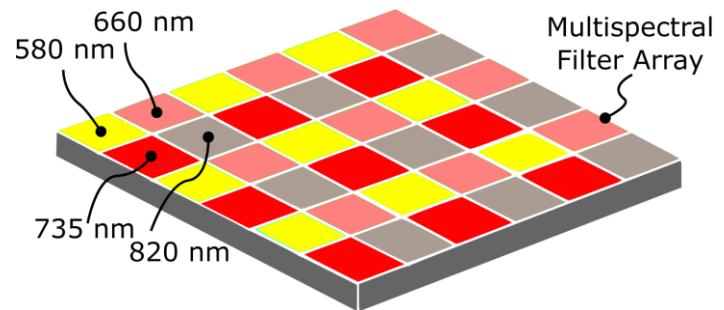


The MSIS AGRI is a multispectral imaging system incorporating an MSC2-AGRI-1-A snapshot multispectral camera and a 4-channel LED illuminator into a single waterproof and dustproof camera head.

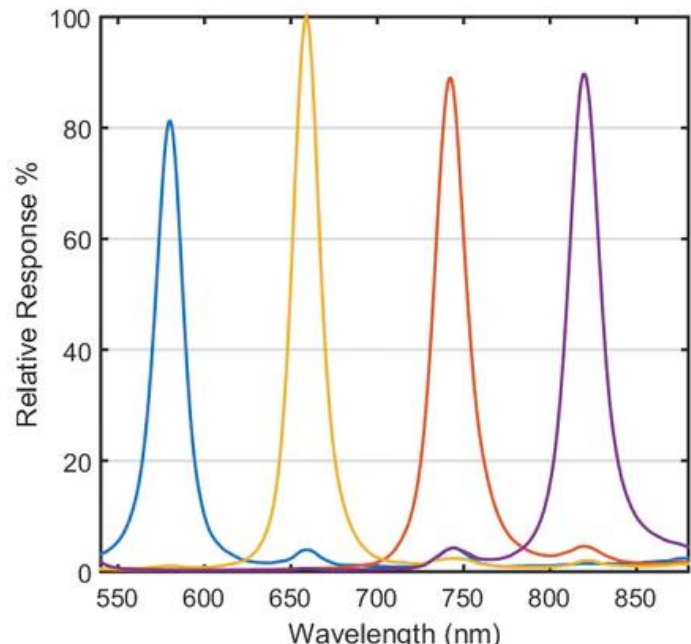
## FEATURES

- Captures co-registered spectral images simultaneously
- 4 bands – 580, 660, 735, 820 nm
- Anti-X-Talk™ Technology - enhances contrast and spectral performance
- Sustained frame rates @ 10 FPS
- 4MP Global Shutter CMOS sensor
- High power pulsed LED light source
- Compact waterproof and dustproof camera head and control unit
- Accommodates c-mount lenses
- Camera head: 2.5 kg, Control box: 4 kg

## SENSOR



## SPECTRAL RESPONSE

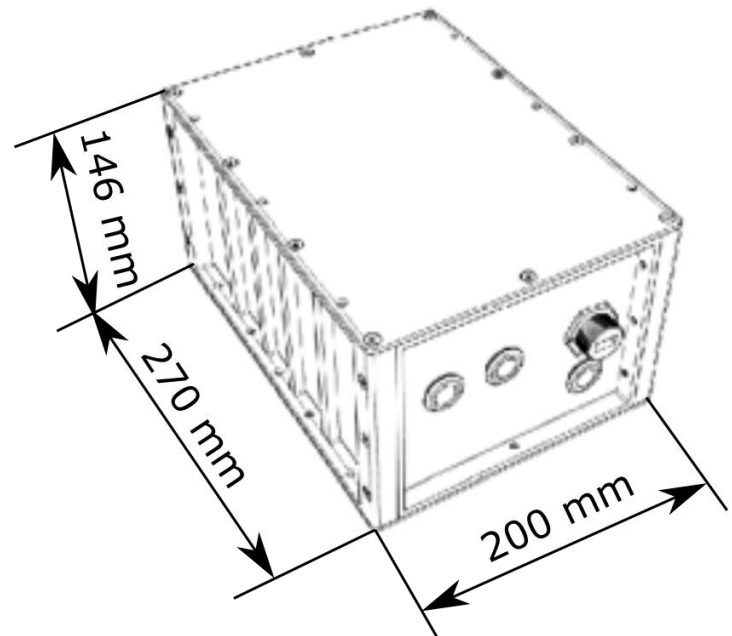


## TECHNICAL SPECIFICATIONS

Feature	Description
# of bands	4
Band Locations for LED and Camera	580, 660, 735, 820 nm
# of LEDs per band	8
Camera Spectral Bandwidth	~25 nm
Pixels/band	512x512
Camera	MSC2-AGRI-1-A, 1-inch, CMOS
Effective pixel size	5.5 x 5.5 $\mu\text{m}$
Shutter Type	Global
Exposure Time	22 $\mu\text{s}$ to 16.77 s
Lens Compatibility	c-mount, 8.5 mm to 50 mm focal lengths available, manual iris, manual focus, locking screws. Optional electronic focus and iris
Power Requirements	18-75 V DC (60 W) 110-240 V AC power source
Surface finish	black anodization, polycarbonate

## DIMENSIONS

Control box



Camera head

