



RobotEye REHS25

Ultrafast Broadband Spectral Scanner User Manual

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Revision Table

Date	Notes
10/03/2016	Initial Release
09/11/2016	Mechanical Dimensions Updated

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1 Introduction

**IMPORTANT**

READ CAREFULLY BEFORE USE
KEEP FOR FUTURE REFERENCE

The REHS25 User Manual is provided as a guide to the connection, configuration and safe use of the Ocular Robotics REHS25 Hyperspectral Ultrafast Broadband Spectral Scanner. For development of custom software applications for use with the REHS25 system see the RobotEye API Reference Manual, RobotEye Network Interface Manual, or contact Ocular Robotics.

Chapter 2 Basics, describes the initial setup and basic use of the REHS25 including information on cleaning, maintenance and safety. Chapter 3 General Description, presents a system description in terms of the system's Mechanical and Electrical properties and its communication and power interfaces. Chapter 4 Software Integration, describes methods of software integration of the REHS25 and a connected spectrometer to form a coordinated 2 axis spectral measurement system.



CAUTION - USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN RISK OF INJURY. IT WILL ALSO VOID YOUR WARRANTY

2 Basics



IMPORTANT – Before connecting the power to this system or attempting to operate it in any way, read and follow all instructions regarding safe operation of this system contained in Section 2.5.

2.1 System Components

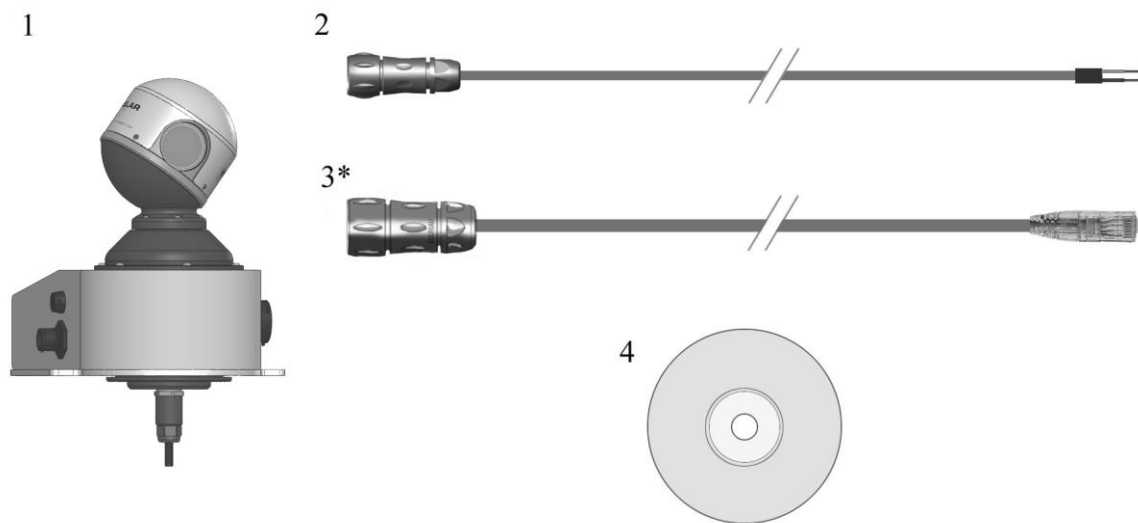


Figure 2-1 – REHS25 Hyperspectral Packing List

The Ocular Robotics RobotEye REHS25 Hyperspectral is supplied standard with the following components, each of which can be seen in Figure 2-1:

1. The RobotEye REHS25 Hyperspectral
2. REHS25 Power Cable.
3. IP68 LAN cable (*optional).
4. Installation & documentation disk.

2.2 What You Need

In order to operate the REHS25 Hyperspectral, you will need:

1. Power supply – A 24 volt DC 10 Amp power supply with a continuous current capacity of 10 Amps.
2. A suitable Spectrometer - Any spectrometer with an SMA fiber optic connector can be paired with the REHS25.
3. Ethernet cable – A standard Ethernet cable (Cat5e or Cat6) is needed for control and communication with the REHS25 system.
4. A computer with a Windows or Linux operating system with one free 100 Megabit Ethernet port.

2.3 Handling and Transportation

Avoid handling the RobotEye using the scanning head. This may result in mechanical damage and misalignment of the sensor.

When transporting, make sure the RobotEye head will not be subject to large external loads and stresses.

AVOID EXTERNAL FORCES

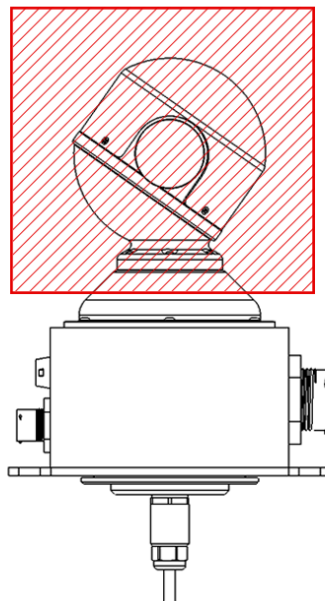


Figure 2-2 – REHS25 Handling Zones

2.4 Initial Setup



NOTE – The RobotEye head must be handled with care during transport and installation. External loads exerted on the head should be avoided.

Follow the steps below to set the REHS25 system up for use on a computer with a Windows or Linux operating system. The library version number and system IP address shipped with your system should be noted on the supplied *Certificate*.

1. Connect one end of the Ethernet cable to the network port on the PC or Switch. Connect the other end to the REHS25 Ethernet Control port. Refer to Figure 2-3.

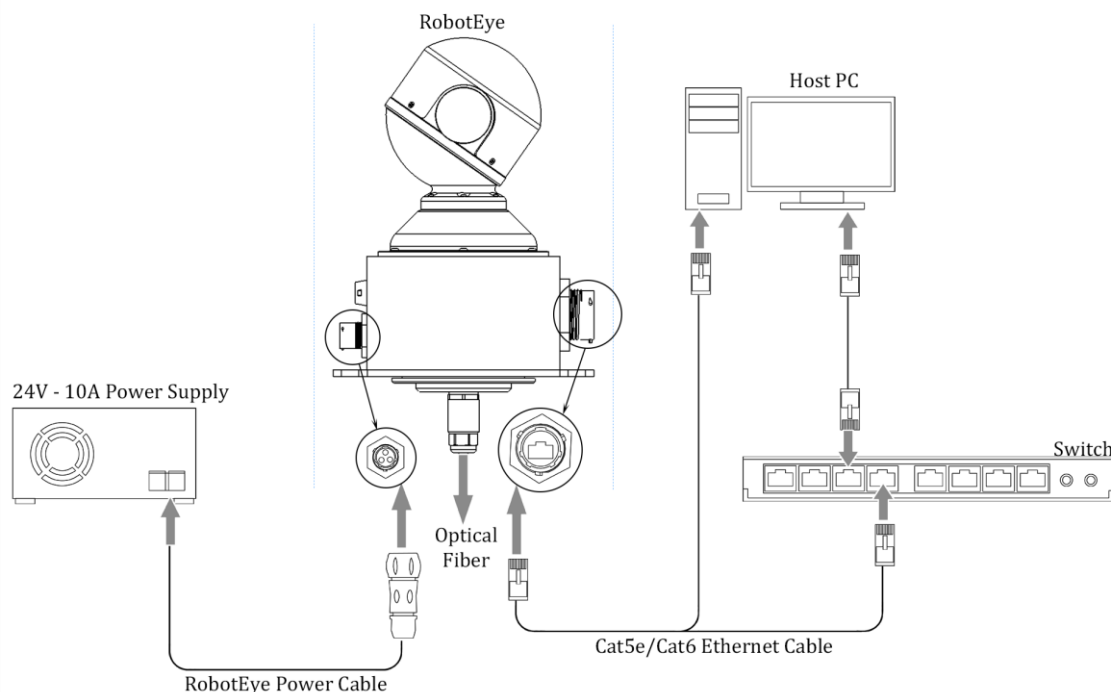


Figure 2-3 Wiring and connections for the REHS25 System

2. Make sure the 24 volt power supply is switched OFF. Connect the supplied power cable to the 24 volt power supply. On the unterminated end of the cable you will find two wires one black and one with a red sheath on it. The black wire should be connected to the negative terminal on the power supply. The cable with the red sheath should be connected to the positive terminal on the power supply. The green and yellow cable should be connected to a ground reference.



WARNING - Make sure the power supply is not powered before connecting the cables.

3. Connect the power supply cable to the corresponding plug on the REHS25 system. Ensure the correct orientation by aligning the polarization keys on the panel connector and the plug. If forced in the incorrect orientation, damage to the system is likely to result. Refer to Section 3.2 Power for further details.

2.5 Safety

The RobotEye REHS25 Hyperspectral is a high speed device. All instructions regarding safe operation of this system should be strictly followed.



Protection Class 3. The device operates with a separated extra low voltage (SELV) of 24 Volts DC.



The device may only be operated as intended and in faultless condition. Safety and warning signs must not be removed.



The REHS25 Hyperspectral is in accordance with Ingress Protection 65 (IP65). The device is protected against dust and jet water.

All instructions regarding safe operation of this system should be strictly followed.

- The user is responsible for the safe operation and maintenance of this system at all times.
- The REHS25 is NOT intended for use by inexperienced personnel.
- Installers of the sensor are responsible for ensuring their safe use in accordance with all applicable regulations in the state, country or territory of use.
- The device's rotating head is not designed to accommodate for any alterations or additions. High speed projectiles may result.
- The device must be securely mounted during operation to prevent unstable motions.
- Ensure that the Robot Eye head will not contact anything while operating in its full range of movement.
- **Do not try to hold or touch the Robot Eye head while operating.**
- **Do not attempt to disassemble the sensor.** Improper disassembly will destroy the optical alignment of the sensor and necessitate factory repairs. Tampering with any enclosure will void warranty coverage.
- The manufacturer will not accept liability for any resulting damages caused by the non-observance of this manual or any unauthorized modification to the system.

2.6 Operation

Special precautions for when operating the device.

- **DO NOT** attempt to touch or impede the Robot Eye head during operation.
- Avoid strands of fabric or long exposed hair from being in the vicinity of the Robot Eye head during operation. Significant injury and/or mechanical damage may result.
- The REHS25's RobotEye head must be protected from direct impact.

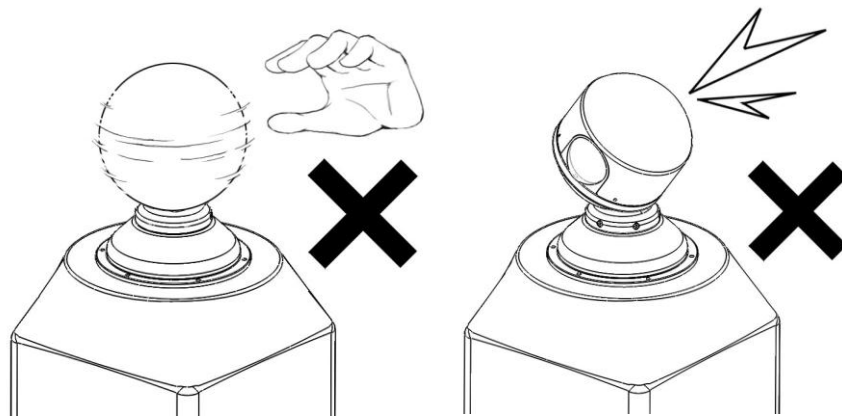


Figure 2-4 Do not touch RE Head while in operation. Avoid impacts.

General considerations for when operating the device.

- The REHS25 should not be put into operation when the aperture is fogged or dirty. The aperture should not be touched with bare hands. Refer to Section 2.7 for cleaning the device.

2.7 Cleaning and Maintenance



CAUTION – Power must be disconnected from the REHS25 system before any cleaning or maintenance is carried out.

User performable cleaning and maintenance of the RobotEye REHS25 is limited to cleaning of the exterior housing and the aperture window. For ANY other maintenance or repair the unit should be returned to the factory. Unauthorized opening of the system enclosure will void warranty. Use the following guidelines for cleaning of the system enclosure and aperture window.

- It is **VERY** important not to abrade or scratch the system window during cleaning or at any other time as it has the potential to significantly degrade system performance.
- Use a soft non-abrasive cloth to clean the window, make sure there are no foreign abrasive particles on the window before performing cleaning, as this may damage the window.
- **DO NOT** use solvents. If a cloth alone is not sufficient, water or Isopropyl Alcohol may be used.
- The rest of the REHS25 Hyperspectral housing can be cleaned with a soft damp cloth.

2.7.1 Replacement Parts

Replacement parts can be ordered directly through Ocular Robotics.

- 1) *RobotEye REHS25 power cable.*
- 2) *IP68/IP69K Data cable*
 - a) An optional 5m or 10m IP68 Cable can be purchased from Ocular Robotics
- 3) *5mmx20mm 16A Slow Blow Fuse*
 - a) The fuse is located in the Fuseholder located above the power connector.

3 General Description

The RobotEye REHS25 Hyperspectral is a high performance broadband spectral scanner with unprecedented speed and flexibility in the acquisition and mapping of spectral data. RobotEye hyperspectral scanners transform any single point fiber optic spectrometer into a mapping hyper-spectrometer. The REHS25 couples the unmatched range of motion, flexibility and pointing precision of the RobotEye with any commercial off-the-shelf single point spectrometer to achieve rapid imaging with both high spatial and spectral resolution.

The RobotEye core technology on which the REHS25 is based enables the view of the spectrometer to be steered with simultaneous speed and precision while the spectrometer itself remains completely stationary.

3.1 Electrical

The REHS25 Hyperspectral requires a 24 Volt DC power supply that has a continuous current capacity of 10 amps. The output voltage of the 24 VDC power supply used with the REHS25 System should not vary by more than $\pm 15\%$ from the nominal 24V under any circumstances otherwise damage to the REHS25 System may result.

3.2 Power

Power is delivered to the REHS25 System with the supplied 5 metre power cable. The unterminated end of the power cable has two wires, one black and one with a red sheath on it. The black wire should be connected to the negative terminal on the power supply. The cable with the red sheath should be connected to the positive terminal on the power supply.

During connection of the power supply cable to the corresponding plug on the REHS25 system, ensure the correct orientation by aligning the polarization keys on the panel connector and the plug. If forced in the incorrect orientation, damage to the system is likely to result.

A 16A rated slow blow fuse is housed in the fuse holder to prevent potential damage to internal electrical components from power surges.



Figure 3-1 – Fuseholder on the REHS25 Enclosure

3.3 Mechanical

The REHS25 Hyperspectral has an environmental protection rating of IP65 when both power and IP68/IP69K Ethernet cables are fitted. The REHS25 can operate in ambient temperatures of up to 70°C making it suitable for use in a wide range of industrial environments.

The bounding dimensions and positions of mounting holes for the REHS25 System are shown in Figure 3-2 to Figure 3-5. Units are in mm [inches].

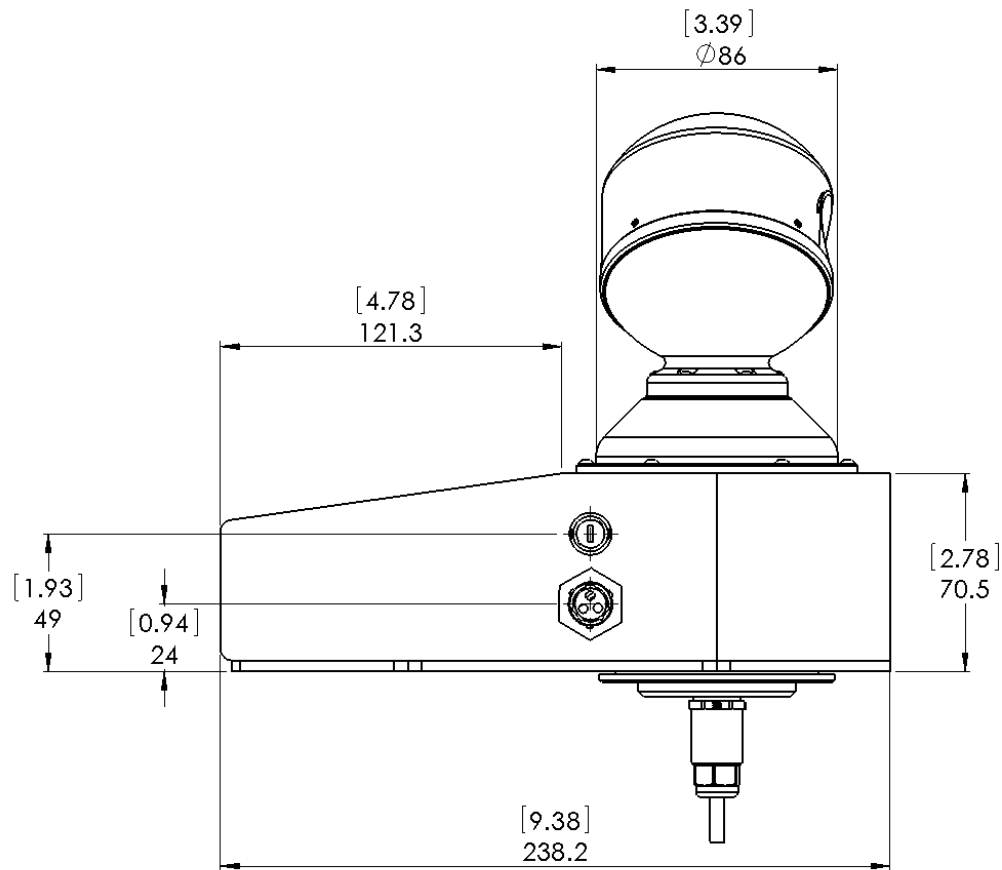


Figure 3-2 - REHS25 System Mechanical Dimensions

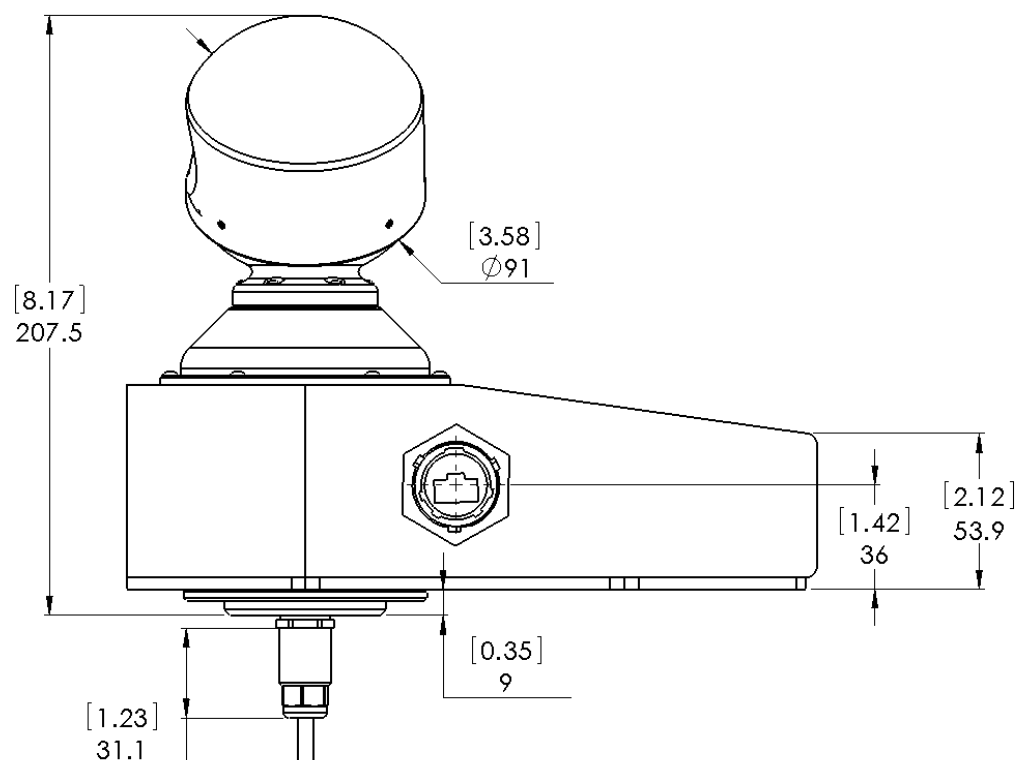


Figure 3-3 - REHS25 System Mechanical Dimensions

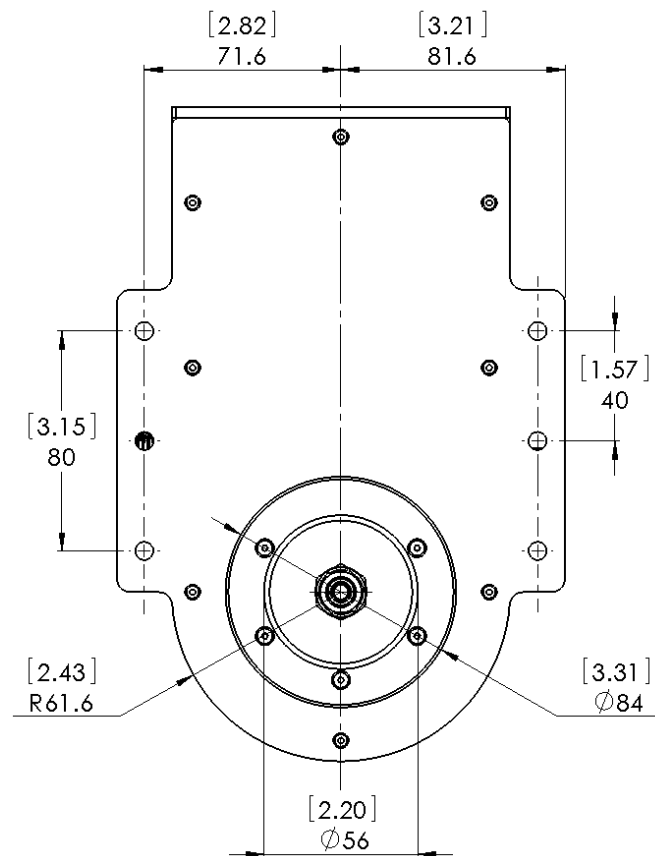


Figure 3-4 - REHS25 System Mechanical Dimensions

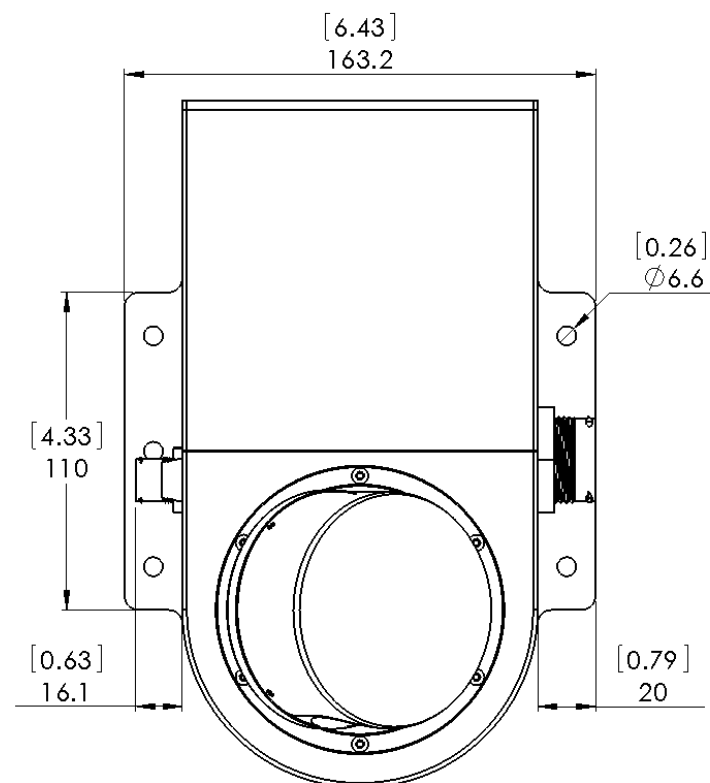


Figure 3-5 - REHS25 System Mechanical Dimensions

3.4 Ethernet

The REHS25 Hyperspectral interfaces with a computer via a standard Ethernet cable. The REHS25 supports Gigabit connectivity however a 100 Megabit connection is sufficient for all operation under all conditions.

3.4.1 Network Topology

Multiple REHS25 Ultrafast Broadband Spectral Scanners can be connected on a single network. However this should be done using a switch to avoid data collisions on the network (see Figure 3-7). Users are responsible for managing access if multiple users are connected to a single RobotEye REHS25.

For a more detailed explanation of the network behaviour of the REHS25 System see the RobotEye UDP Communications Specification available for download from the Ocular Robotics website.

In most situations use of a Cat5e Ethernet cable will be sufficient for operation of the REHS25, however it is recommended that a Cat6 cable be used over long distances.

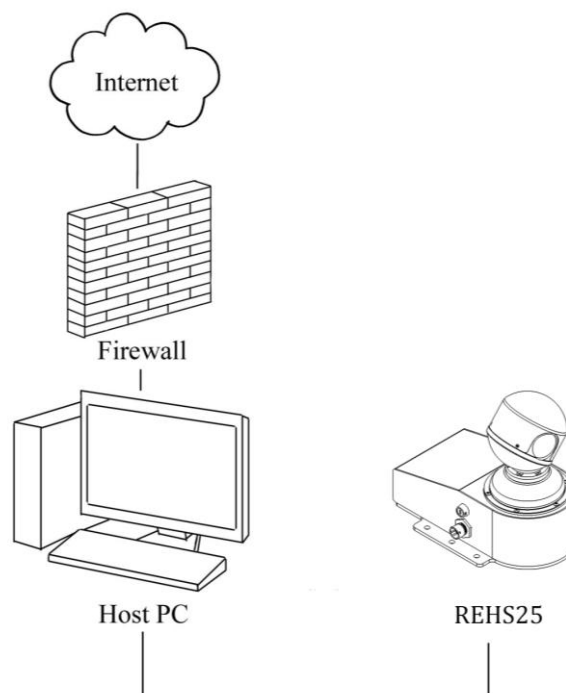


Figure 3-6 – Network Schematic for Single Host PC to Single REHS25

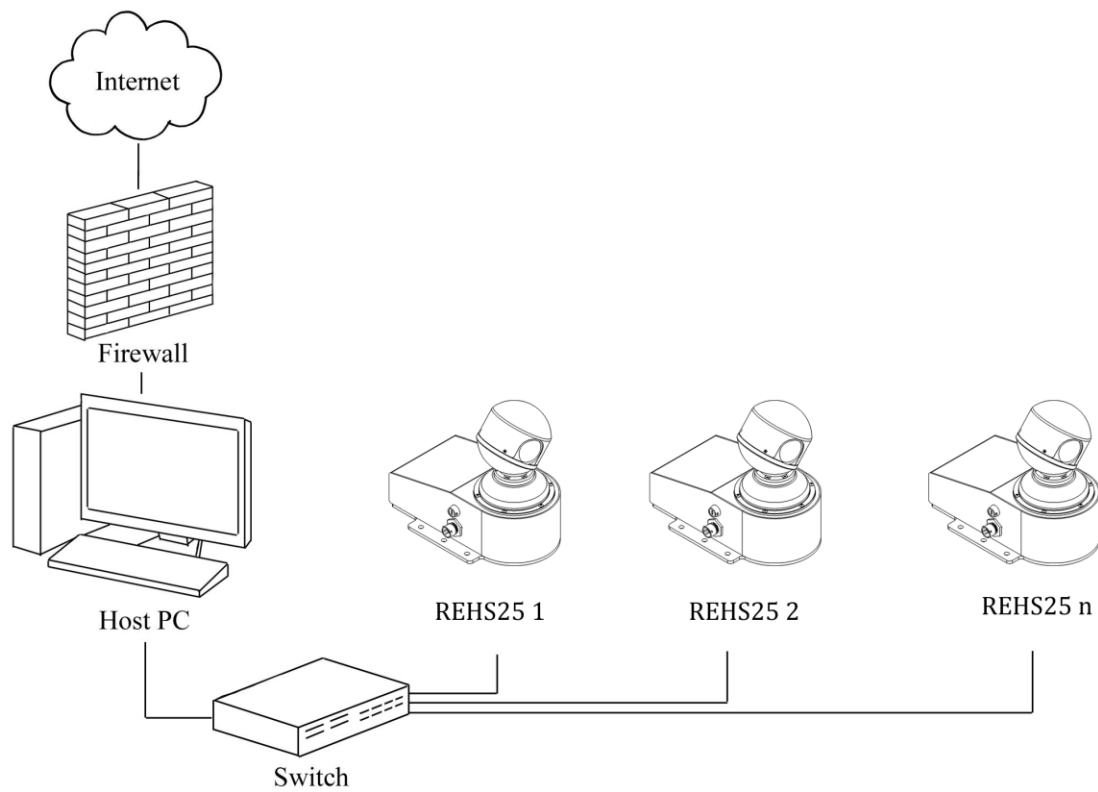


Figure 3-7 – Network Schematic for Single Host PC to Multiple REHS25s

3.5 Optical

3.5.1 Spectrometer Connection

Refer to Figure 3-8 and the following steps on how to connect the spectrometer to the REHS25 system.

1. Loosen the Lower Gland Nut and insert the SMA optical fiber connector into the Fiber Adaptor
2. Gently push the SMA optical fiber connector until properly seated. When seated, the tip of the fiber opening will be inserted approximately 160mm, measured from the base of the Lower Gland Nut.
3. Keeping some light pressure on the optical fiber in order to keep it in position, tighten the Lower Gland Nut



NOTE – This operation should be avoided in dusty environments.

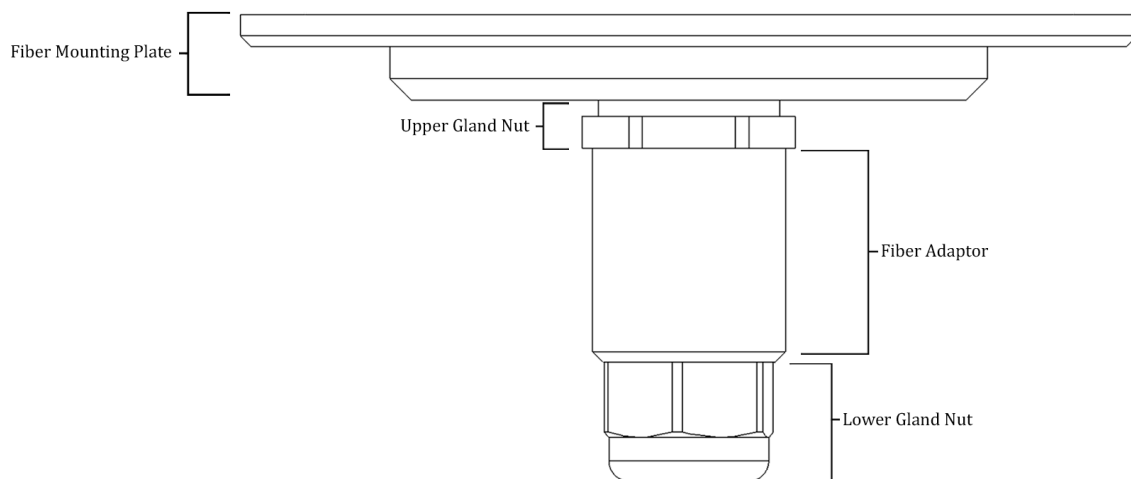


Figure 3-8 - Spectrometer Connection

3.5.2 Field of View

The REHS25's Field of View (FOV) can be adjusted by varying the distance of the Fiber Adaptor from the Fiber Mounting Plate. The steps below should be used in conjunction with Table 1.

1. Loosen the Upper Gland Nut.
2. Using a ruler, lower/raise the Fiber Adaptor under control to the desired distance measured from the base of the Fiber Mounting Plate, to the shoulder of the Fiber Adaptor as shown in Figure 3-9.
3. Tighten the Upper Gland Nut.

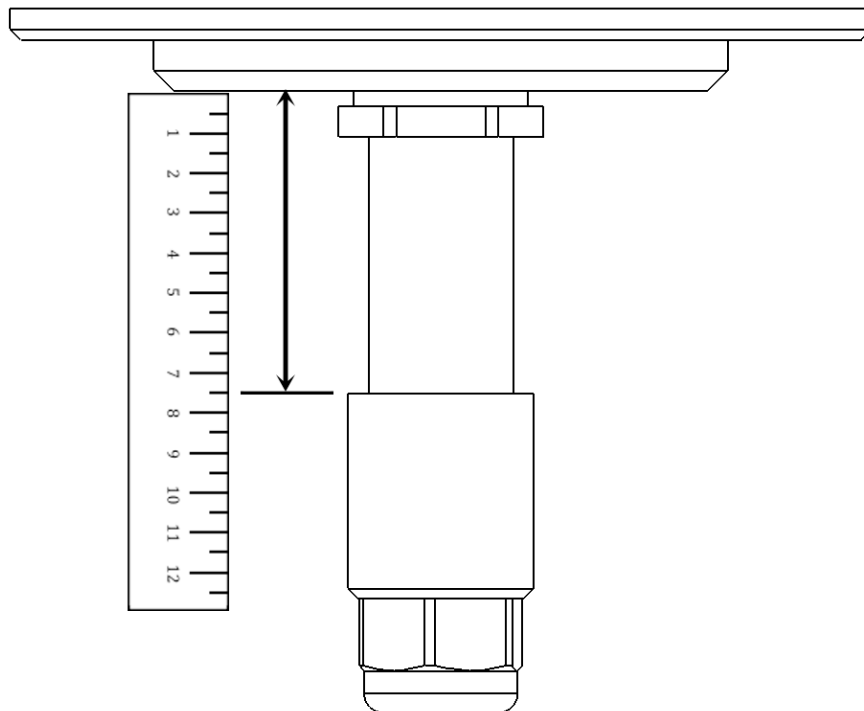


Figure 3-9 - Field of View Adjustment (Not to Scale)

Table 1 - Approximate Spot Sizes at 10 m

Backset* (mm)	Spot Size for 100 μ m Fiber (mm)	Effective FOV for 100 μ m Fiber	Spot Size for 200 μ m Fiber (mm)	Effective FOV for 200 μ m Fiber
5	190	0.96°	355	1.91°
7	150	0.72°	270	1.43°
9	120	0.57°	220	1.15°
12	100	0.44°	175	0.88°
14	90	0.38°	155	0.76°
16	80	0.33°	140	0.67°
20	70	0.27°	115	0.55°
25	60	0.22°	100	0.44°
35	50	0.16°	80	0.32°
44	45	0.13°	65	0.25°
56	40	0.10°	55	0.20°
79	35	0.07°	45	0.14°
*Distance is measured as shown in Figure 3-9				
NOTE: Above data is for a distance to target of 10m, spot size varies linearly with distance from base of 25mm				



NOTE – Due to the continuous, rather than discrete, nature of the adjustment, Table 1 should be taken as a guide only

4 Software Integration

This section discusses the two primary methods by which the REHS25 can be used to acquire spectral data. These methods differ in the way in which motion is commanded to the REHS25 head.

A scanned motion behaviour is generally appropriate when the integration time is short, it is desirable that the REHS25 pointing system moves at a constant velocity, and it is desirable that the REHS25 pointing head is controlled in a set-and-forget manner. A point-to-point motion behaviour is generally appropriate when the integration time of the spectrometer being used is long relative to the motion speed of the REHS25. It is also appropriate when spectra are desired from a discrete set of points in a specific pattern.

4.1 Scanned Motion

The REHS25 can operate in a number of scanned motion patterns. When operating in this configuration. The command to initiate the scan pattern is only sent to the REHS25 once, and the spectrometer is then constantly queried for the latest available spectrum. When a spectrum is received, the REHS25 is queried for its current position and this position is associated with the acquired spectrum.

The disadvantage to this operating mode is that the head is in motion whilst the spectrometer is capturing the spectrum. As a result, there will be some motion blur, depending on the integration time of the spectrometer and the commanded motion speed of the head. Calculations of the effect of this motion blur should be made to ensure this method of spectral acquisition is appropriate.

This algorithm is intended for use in conditions where the motion blur has been

```
For a desired scan region, select from the most appropriate scan pattern:
```

- *FullFieldScan*(nLines, speed)
- *BoundedElevationScan*(elMin, elMax, nLines, speed)
- *RegionScan*(azMin, azMax, elMin, elMax, nLines, speed)

```
Send scan command to REHS-25
```

```
Set spectrometer to free-running acquisition
```

```
while running
```

```
    Wait for spectrum acquisition
```

```
    Sample current REHS-25 head position:
```

```
        point = GetApertureAngles()
```

```
    Associate acquired spectrum with point.Az and point.El
```

```
end while
```

Algorithm 1- Scanned Motion Sample

confirmed to be insignificant, either due to short integration times or slow commanded head speed. If these conditions cannot be met, Ocular Robotics recommends that the desired scan area is generated as a set of discrete points, and the point-to-point motion pattern described below is used.

4.2 Point-to-Point mode

A point-to-point style motion behaviour is most useful when the integration time of the spectrometer is relatively long as compared to the motion speed of the REHS25 head.

In the point to point mode, it is assumed that there is a set of specific targets that spectral observations are desired of. These targets are specified as Azimuth-Elevation pairs in the control space of the REHS25.

```
Let Points be a vector of <Az,El> pairs for which spectral
observations are desired.

for each point in Points
  SetApertureAngles(point.Az, point.El, speed)
  Wait for acknowledgment from REHS-25
  Trigger spectrometer
  Wait for spectrum acquisition
  Associate acquired spectrum with point.Az and point.El
end for each
```

Algorithm 2 - Point-to-Point motion sample

This algorithm can be used for two primary purposes. Firstly, it may be used to acquire a set of spectra in a grid pattern, enabling the creation of a hyperspectral image, where the spectral depth of each pixel is determined by the properties of the chosen spectrometer.

Secondly, it may be used to acquire spectra from a set of arbitrary locations, such as taking one or more spectra of the outflow of exhaust stacks or other targets of spectral interest.


5 Specifications

Mechanical	
Azimuth Axis Resolution	0.010°
Elevation Axis Resolution	0.010°
Azimuth Range	360° Continuous
Elevation Range	70° ($\pm 35^\circ$)
Accuracy	0.05°
Weight	2.5 kg

Electrical	
Communication (minimum 100 Megabit)	Ethernet
Supply Voltage	24 VDC
Power Consumption — Typical (average)	< 40 W
— Transient	200 W

Spectral	
Spectral Range	400 - 2500nm
Spectrometer Connector Type	SMA Fiber Optic Adaptor

Software	
RobotEye C++ Development Library	Windows/Linux

Environmental	
Operating Temperature Range	-20°C - +70°C
IP Class Rating	65
 <i>Note: IP Rating valid only when both supplied power & optionally supplied Ethernet cable connectors are fitted.</i>	