

**ThermalVideo.com**

# **SR-Series Thermal Camera**

## **Installation and Operation Manual**



**Camera  
Models:**  
SR-100  
SR-100P  
SR-50  
SR-35  
SR-19  
VSR-6

**ThermalVideo.com**  
Your Source for Modern Thermal Imaging Systems  
P.O. BOX 4242  
Middletown, NY 10941  
PH: + 1 888 919 2263  
PH Intl: + 1 845 343 4077  
FX: + 1 845 343 4299  
support@thermalvideo.com

January 2008

[www.thermalvideo.com](http://www.thermalvideo.com)

**ThermalVideo.com****PO BOX 4242****Middletow, NY 10940****Toll Free: 1-888-919-2263****Intl.: +1-845-343-4077****Fax: 1-845-343-4299****www.thermalvideo.com****Document Number: 427-0014-00-10****Revision Number: 150****Date: January 2008****EXPORT RESTRICTIONS**

The information contained in this document may be controlled for export purposes by the United States Government. Diversion contrary to US law is prohibited. For more information, contact FLIR Systems, Inc. This document and data disclosed herein or herewith is not to be reproduced, used, or disclosed in whole or in part to anyone without the permission of FLIR Systems, Inc.

**PROPRIETARY**

The data in this publication shall not be disclosed without permission and shall not be duplicated, used, or disclosed in whole or in part except to the extent provided in any contract of which this document is made a part. This restriction does not limit the customer's right to use information contained in this document if it is obtainable from another source without restriction. The data subject to this restriction are contained in all sheets of this document and related drawings and document specifications herein. FLIR reserves the right to make changes to its products or specifications at any time, without notice, in order to improve design or performance and to supply the best possible product.

**COPYRIGHT**

Copyright © 2007 by FLIR Systems, Inc. All rights reserved. This publication, or any parts thereof, may not be reproduced in any form without the express written permission of FLIR Systems, Inc.

Pelco is a registered trademark of Pelco. Windows is a registered trademark of Microsoft Corporation.

## **TABLE OF CONTENTS**

<b>1.0 WARNINGS AND CAUTIONS .....</b>	<b>5</b>
<b>2.0 INTRODUCTION .....</b>	<b>6</b>
2.1 Advantages of Thermal Imaging.....	7
2.2 Serial Remote Control .....	8
2.3 Camera Enclosures .....	9
2.4 Package Contents .....	10
<b>3.0 INSTALLATION .....</b>	<b>11</b>
3.1 Accessing the Electrical Connections.....	11
3.2 Ground Connection .....	12
3.3 Input Power .....	13
3.4 Sealed Cable Glands.....	13
3.5 Analog Video Output .....	14
3.6 Camera Mounting .....	14
<b>4.0 SR-100 INSTALLATION .....</b>	<b>15</b>
<b>5.0 SR-100P INSTALLATION.....</b>	<b>17</b>
<b>6.0 VSR-6, SR-19, SR35, SR-50 INSTALLATION.....</b>	<b>20</b>
<b>7.0 OPERATING THE SR-SERIES THERMAL CAMERA.....</b>	<b>23</b>
7.1 Thermal Imaging.....	23
7.2 Configuration and Control.....	23
7.3 Pelco Keyboard Control.....	24
7.4 Flat Field Correction (FFC).....	24
<b>8.0 CARING FOR YOUR SR-SERIES THERMAL CAMERA.....</b>	<b>25</b>
8.1 Temperature .....	25
8.2 Maintenance .....	25
8.3 Troubleshooting Problems.....	26
<b>9.0 SR-SERIES CAMERA SPECIFICATIONS.....</b>	<b>28</b>
9.1 SR-Series Camera Dimensions.....	29
9.2 SR-100P Specifications.....	31
<b>10.0 KBD300 COMMANDS FOR USE WITH SR-100 AND SR-100P.....</b>	<b>32</b>
<b>11.0 SR-100 &amp; SR-100P CONTROL USING TVIS-7 USER INTERFACE ...</b>	<b>33</b>
<b>12.0 REFERENCES.....</b>	<b>40</b>

## TABLE OF FIGURES

---

Figure 1: Thermal image from SR-Series camera .....	4
Figure 2 : Daylight camera on left; Thermal image on right .....	6
Figure 3: Backlit daylight camera on left; thermal image on right .....	7
Figure 4: White Hot palette on left, Black Hot palette on right .....	9
Figure 5: SR-35 Camera with and without the Environmental Enclosure .....	9
Figure 6: SR-100P with Sun Shroud .....	10
Figure 7: Rear view of SR-Series camera .....	11
Figure 8: Earth Ground Connection .....	12
Figure 9: SR-100 Connection Terminal .....	15
Figure 10: Screw Terminal Connector .....	16
Figure 11: SR-100P with Sun Shroud .....	17
Figure 12: SR-100P Enclosure Rear .....	19
Figure 13: Mating connector as seen from end of cable .....	18
Figure 14: Front view of SR-Series camera .....	20
Figure 15: SR-Series Connections (VSR-6, SR-19, SR-35, and SR-50) .....	21
Figure 16: Tongue and Groove Alignment .....	22
Figure 17: Camera Side View .....	29
Figure 18: Camera Rear View .....	29
Figure 19: Enclosure Mounting Foot (all cameras except for SR-100P) .....	30



**Figure 1: Thermal image from SR-Series camera**

## 1.0 WARNINGS AND CAUTIONS

**Caution!** This guide uses the term **Caution!** to indicate a potentially hazardous situation, which, if not avoided, may result in bodily harm or injury, damage to the camera, or other property damage.

### **Protect Your Investment**

The camera should be installed by a trained professional according to local codes and industry-standard safe practices.

Proper ESD protocol should be followed while working inside the unit.

The camera is a precision optical instrument and should not be exposed to excessive shock or vibration.

When not in use, replace the lens cap over the objective lens. When the lens cap is not in place, avoid pointing the system directly at extremely high-intensity radiation sources, such as the sun, lasers, arc welders, etc. This warning applies whether or not the system is powered.

Great care should be used with your camera's optics. They are delicate and can be damaged by improper cleaning. Only clean the lens in the manner described in section 8.0 [Caring for your SR-Series Thermal Camera](#).

### **Legal Considerations**

Camera and audio surveillance may be prohibited by laws that vary from country to country. Check the laws in your local region before using this product for surveillance purposes.

### **Support**

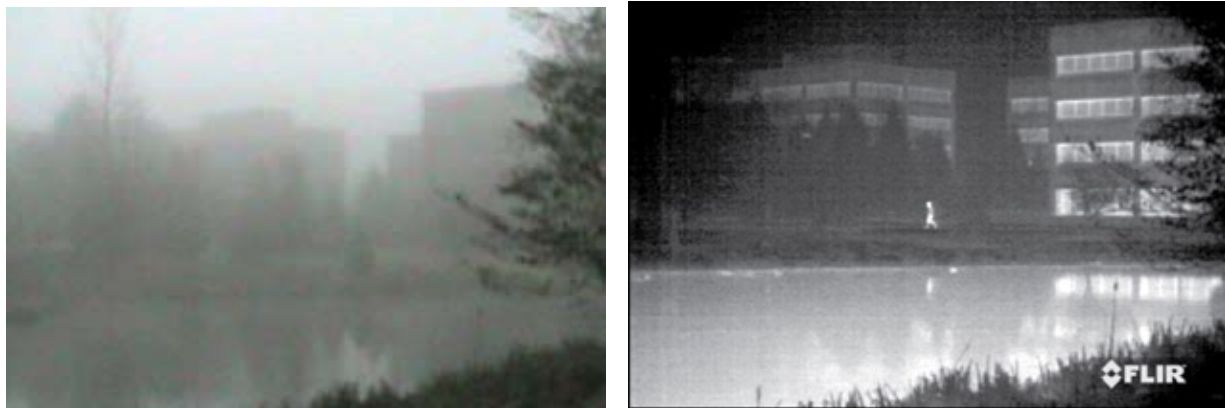
If you have questions that are not covered in this manual, or need service, contact FLIR Customer Support at (805) 964-9797 for additional information prior to returning your SR-Series Thermal Camera. In the US, you can also reach FLIR Customer Support at (888) 747-FLIR (747-3547).

*All thermal imaging systems are subject to export control. Please contact FLIR for export compliance information concerning your application or geographic area.*

## 2.0 INTRODUCTION

The SR-Series Thermal Camera you have purchased is a sophisticated thermal imaging camera that provides excellent night visibility and situational awareness, even in absolute darkness. The camera has a standard video output that works with digital video recording devices, video motion detection software or off-the-shelf video encoders.

FLIR's powerful SR-Series thermal security cameras compliment and complete your security camera network. They turn night into day, allowing you to see intruders invisible to the naked eye. SR-Series cameras create video images from infrared thermal energy (heat), and perform well at night and day, in good weather and bad. The SR Series thermal surveillance camera system is intended for various commercial and industrial applications, including security and surveillance.



**Figure 2 : Daylight camera on left; Thermal image on right**

Observe that the image on the left from an ordinary daylight camera is obscured by fog; the thermal image on the right provides clear details.

The SR-Series camera is designed for simple, intuitive installation and operation. Each camera is based on FLIR's widely-deployed uncooled microbolometer imaging core. All cameras include FLIR's advanced image processing techniques which deliver excellent contrast regardless of scene dynamics. Unlike other night vision systems that require low amounts of light to generate an image, the SR-Series thermal imagers need no light at all. The cameras are available with a choice of lenses for short-, medium- and long-range surveillance capability.

### **SR-100**

The 7° horizontal field of view of the SR-100 provides long range surveillance with high visual acuity of distant targets. The camera features a motorized lens for adjustable focus. Like all SR-series cameras, the SR-100 can be used on a fixed mount or pan/tilt platform and provides crisp, clear thermal imagery in total darkness, light fog or smoke.

### **SR-100P**

The SR-100P camera features a pressurized enclosure for added environmental protection and the same focal length as the SR-100 camera (100mm, 7° FOV). This camera has a sealed and pressurized outdoor enclosure that is designed to protect the camera and lens components in adverse environmental conditions. The pressurized enclosure increases the camera reliability and reduces the cost of maintenance.

## SR-50

Utilizing a 50mm lens, the SR-50 serves as a medium- to long-range surveillance camera and provides a 14° HFOV. This focal length is widely deployed because it provides an even balance between situational awareness and detailed perspective.

## SR-35

The SR-35 camera features a focal length of 35mm, providing a short to medium field of view of 20° and is well-suited for short range threat detection in all circumstances.

## SR-19

The SR-19 camera features a focal length of 19mm (36° HFOV) and, like the other SR-series cameras, has a standard resolution Focal Plane Array (FPA) with 320 (H) x 240(V) pixels. It gives you an extremely wide field of view, so that you can cover a large area and keep excellent situational awareness.

## VSR-6

The VSR-6 is an extremely affordable thermal imager with a focal length of 6.3mm (52° Horizontal Field of View or HFOV). It features the same thermal imaging technology found in many of FLIR's most sophisticated security and surveillance systems, but is packaged for users who have short-range security and surveillance as their primary application. The camera has a standard resolution FPA that is windowed down to 160(H) x 120(V) pixels. The wide field of view allows it to cover a large area and provide excellent situational awareness.

## 2.1 Advantages of Thermal Imaging

Originally developed for the military, thermal imaging cameras are now deployed in numerous commercial applications where it is impractical or too expensive to use active illumination (lights). It is perfect for wide-area surveillance in critical infrastructure or high-value residence installations where lighting is unwelcome or impractical. The camera also provides improved daytime surveillance in environments where traditional CCTV security camera performance suffers, such as in shadows, backlit scenes or through foliage.



*Figure 3: Backlit daylight camera on left; thermal image on right*

Observe that the setting sun in the backlit image on the left makes it difficult to discern any objects of interest; the thermal image on the right is not affected by the bright sun and therefore provides detail and contrast.

The SR-Series is designed to be a drop-in replacement for current systems employing daylight cameras. Initial setup of the system includes connecting power supply leads for the input power and a BNC cable for monitoring output video. Optionally, a serial cable can be connected to allow control of the camera settings and focus (focus control available on SR-100 and SR-100P only, all other cameras are fixed focus).

## 2.2 Serial Remote Control

The SR-Series cameras have serial communication leads to connect for control of camera focus and other features. Each camera is pre-configured at the factory to support either RS-232 or RS-422 protocol (the serial protocol is not user-configurable). Users can control the camera using devices that support the Pelco® D protocol<sup>1</sup> or through a Windows®-based graphical user interface.

Camera	Available Protocol
VSR-6	RS-232
SR-19	RS-232
SR-35	RS-232
SR-50	RS-232
SR-100	RS-422 Standard, RS-232 optional
SR-100P	RS-422

The remote control can be used to operate the following functions or features:

- Camera focus (SR-100 and SR-100P only)
- Digital zoom (2X and 4X)
- Selectable Automatic Gain Control (AGC) and Dynamic Detail Enhancement (DDE) settings for optimization of video imagery
- Camera Palette (also known as Polarity) - by default the White Hot palette is used; alternatively the Black Hot palette displays warmer objects as black or dark rather than white or light shades. Additional pseudo color palettes are available using the application software supplied with the camera.

---

<sup>1</sup> The "Pelco Digital Coaxitron" protocol is commonly known as the "Pelco D" protocol.



**Figure 4: White Hot palette on left, Black Hot palette on right**

## 2.3 Camera Enclosures

SR-Series cameras are packaged in environmental enclosures that meet IPX6 test standards. Refer to section 0 [SR-Series Camera Specifications](#) for additional information. The camera's sun shroud around the enclosure helps regulate the camera temperature in direct-sun installations. Each camera uses an athermalized lens and a lens heater to provide sharp imagery in all temperature and weather conditions, ensuring a clear lens and high-quality infrared video, even in extremely cold environments.



**Figure 5: SR-35 Camera with and without the Environmental Enclosure**

The SR-100P camera uses an enclosure that is sealed and pressurized for additional outdoor protection in adverse conditions. The pressurized enclosure increases the camera reliability and reduces the cost of maintenance. The enclosure is pressurized with dry nitrogen to prevent impurities from contaminating the camera and lens components. The camera can be pressurized in the field, and a pressure relief valve prevents overcharging of the enclosure.



*Figure 6: SR-100P with Sun Shroud*

## 2.4 Package Contents

Refer to the Shipping Check List that is shipped with each camera for a description of the parts and components that are included with the camera. If there is any discrepancy between the list and the contents of your shipment, please contact FLIR Systems Customer Support immediately using the contact information at the front of this manual.

## 3.0 INSTALLATION

General installation information for all SR-series cameras is given below. While the general installation procedure is the same for all cameras, there are some differences in the interfaces and connections between various models. The instructions that are specific to certain models are provided following the general procedures in the following sections:

4.0 [SR-100 Installation](#)

5.0 [SR-100P Installation](#)

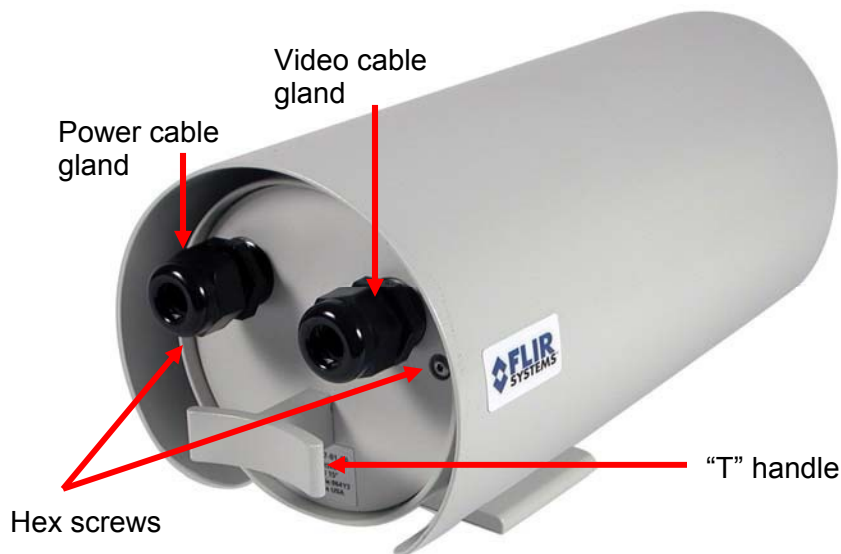
6.0 [VSR-6, SR-19, SR35, SR-50 Installation](#)

If you have a question regarding installation or operation of your SR-Series camera, contact FLIR Systems, Inc Customer Support, using the contact information at the front of this manual. Check out our training web site (<http://www.flir.com/training/>) to get information on courses offered and to learn how you can become a FLIR-authorized Installer.

**Caution!** Be sure to leave the lens cap on during the installation process so the lens does not get damaged or dirty. Do not forget to remove the lens cap once the installation is complete, especially if the camera is being installed in a remote or difficult-to-reach location (such as on top of a pole).

Do not expose the camera to direct sun for long periods without the sun shroud installed.

### 3.1 Accessing the Electrical Connections



*Figure 7: Rear view of SR-Series camera*

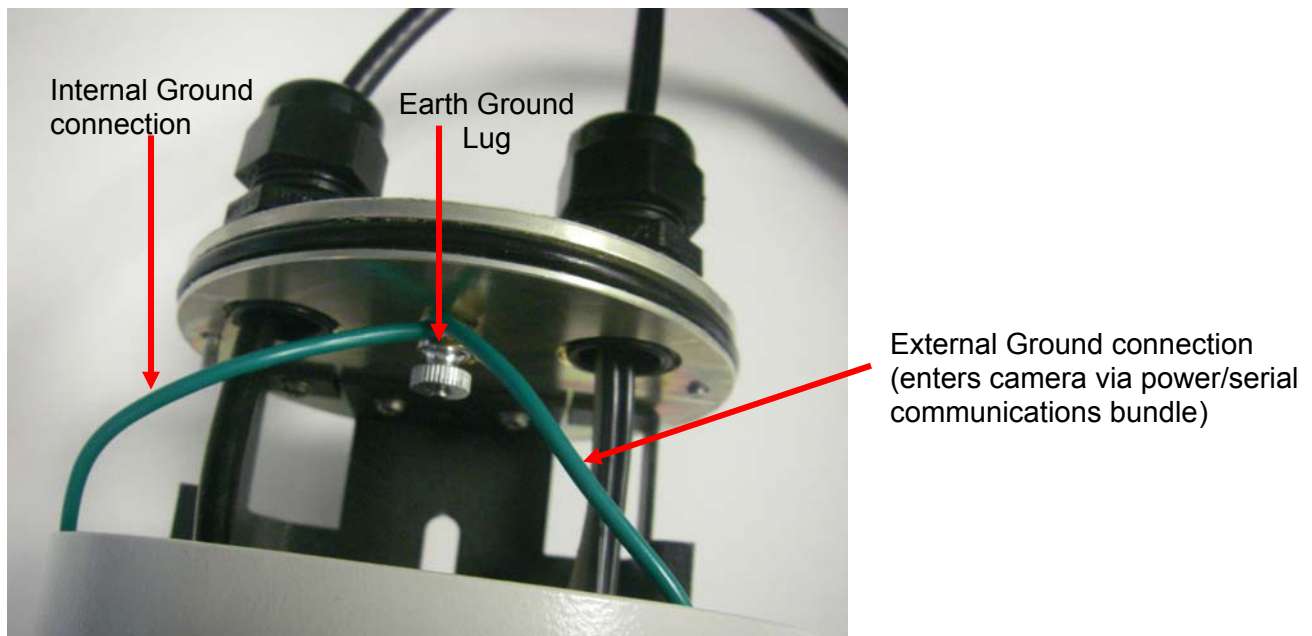
In order to access the electrical connections for the VSR-6, SR-19, SR -35 and SR-50 cameras, the camera must be removed from its enclosure. With the SR-100 camera, it is only necessary to remove the rear of the enclosure (refer to section 4.0 [SR-100 Installation](#)). No disassembly is required for the SR-100P pressurized camera.

The SR-Series provides electrical contacts in the form of screw-terminal jacks, allowing it to receive 10-28 AWG tinned leads from the power supply and serial communication interface.

## 3.2 Ground Connection

The SR-Series cameras have grounding and surge protection to provide further immunity from high current transients that can occur in installations that are subject to electrical storms and/or nearby lightning events. **In order to ensure CE and FCC compliance as well as to protect against these high current events**, installers are required to provide an Earth connection to a specific connection on the camera. Note: a ground connection to the exterior of the camera (for example, to the mounting foot) is insufficient.

When the camera is shipped from FLIR, an internal ground wire (green) connects the interface board to the Earth Ground Lug, located on the inside of the rear of the enclosure<sup>2</sup>. If it is disconnected during the installation, it must be reconnected. For proper installation, a ground connection from an external Earth ground must be connected to the Earth Ground Lug as shown in Figure 8: Earth Ground Connection. Typically the Earth ground connection will be part of the power cable bundle.



**Figure 8: Earth Ground Connection**

**Caution!** The camera must be installed according to industry-standard practices and local electrical codes. Failure to properly connect the enclosure and the electrical interface board to ground could result in damage to the camera and possible bodily injury.

<sup>2</sup> On the SR-100P camera, the Earth Ground Lug is located on the outside of the rear of the enclosure. Refer to section 5.0 [SR-100P Installation](#) for SR-100P installation details.

### 3.3 Input Power

The SR-Series cameras operate on either 24VDC or 24VAC power (nominal). Refer to section 0 [SR-Series Camera Specifications](#) for additional power requirements. The cameras provide screw-terminals for receiving tinned leads for input power. For details on how to connect the leads, refer to the installation section for each specific camera below.

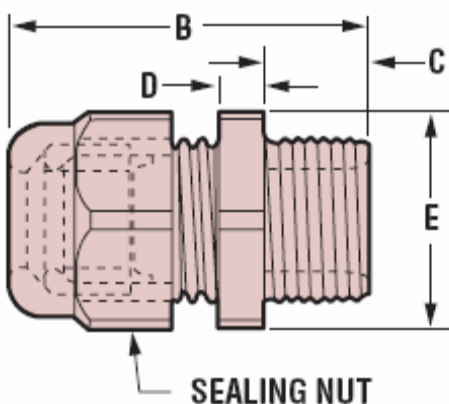
The system is fuse-protected against over-voltage conditions. A blown fuse is an indication either that the circuit has been overloaded or that a short circuit has occurred somewhere in the circuit. A wiring problem may be placing too much of a load on the circuit if a fuse blows after plugging in or turning on the camera. Before replacing the fuse it is important to identify what has caused it to fail.

Prior to changing a fuse, turn off the electrical circuit or completely disconnect the camera. Make certain that no dangerous condition exists before restoring power. Replace the fuse with a fuse that is of the same rating and proper for the circuit. Never use anything other than a fuse of proper rating.

**Caution!** Failure to disconnect power to the camera while replacing a fuse could result in accidental injury or death.

### 3.4 Sealed Cable Glands

With the exception of the SR-100P, cables enter the SR-Series cameras through liquid-tight compression glands. Be sure to insert the cables through the cable glands on the rear of the enclosure before terminating and connecting to the camera (the terminated video cable will not fit through the cable gland). The camera power cable (and serial cable, if used) should be inserted through the cable gland on the left of the rear of the enclosure, and the video cable should be inserted through the cable gland on the right. Leave the glands loosened until the cable installation has been completed.



PART DIMENSIONS									
A Clearance Hole		B Max. O.A. Length		C Thread Length		D Wrenching Nut Thk.		E Wrenching Flats	
in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
.875	22,2	1.72	43,7	.62	15,7	.20	5,1	.95	24,1

In order to maintain a proper seal, each cable gland should contain a single cable sheath. Installing more than one cable bundle in the cable seal will compromise the seal. FLIR Systems, Inc. recommends a minimum cable diameter of 1/4" through the cable glands in order to maintain adequate environmental sealing.

### **3.5 Analog Video Output**

The analog video signal is accessed via a standard coaxial cable BNC connector and meets the requirements of NTSC or PAL video standards, depending on the configuration ordered. The analog video signal is intended to drive video coaxial cable and is designed to transmit a 75 ohm load with minimum signal loss. Excessive signal loss and reflection occurs if cable rated for other than 75 ohms is used. Cable characteristics are determined by a number of factors (core material, dielectric material and shield construction, among others) and must be carefully matched to the specific application. Moreover, the transmission characteristics of the cable will be influenced by the physical environment through which the cable is run and the method of installation.

In video security systems, camera signals must travel from the camera to the monitor. Proper termination of cables is essential to a system's reliable performance. The end point of any video cable run must be terminated in 75 ohms. Usually, the cable run will end at the monitor, which will ensure that this requirement is met.

### **3.6 Camera Mounting**

Mounting the SR-Series camera is accomplished using the 1/4x20 tripod mount holes on the underside of the enclosure foot. FLIR Systems recommends using the supplied hardware. The dimensions of the camera mounting foot are provided in section 0 [SR-Series Camera Specifications](#) for reference. Note, the SR-100P mounting foot dimensions are different than the other SR-Series cameras.

The enclosure can be mounted via the enclosure foot to a wall mount, ceiling or pedestal mount, or a pan/tilt mechanism on a wall or ceiling. The enclosure should be attached by a minimum of two 1/4x20 fasteners. For further mounting instructions, see the documentation accompanying the fixed or pan/tilt mount. The screws that attach the camera enclosure to its foot are 3/32" head hex screws. The screws that attach the sun shield to the foot are 9/64" hex head screws.

## 4.0 SR-100 INSTALLATION

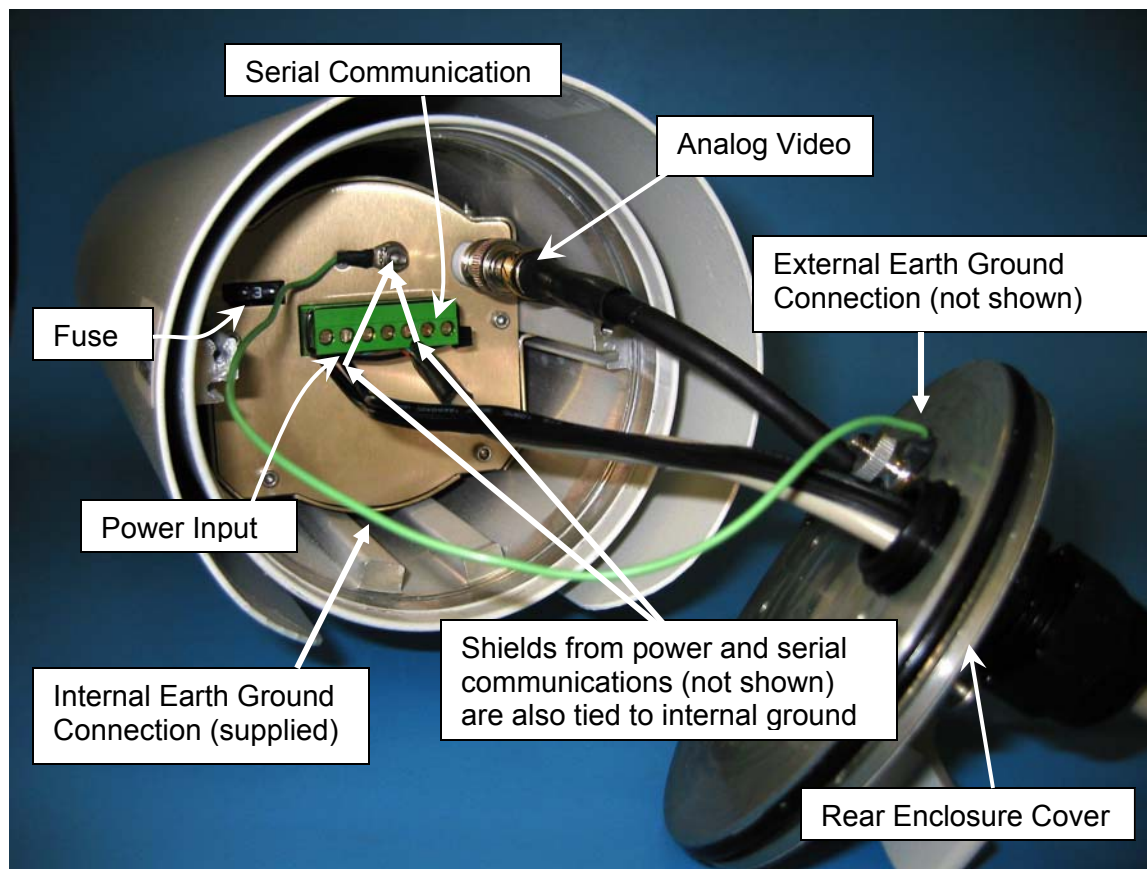
Prior to installing the SR-100, be sure to review the general installation procedures given above. In particular, be sure to review section 3.2 [Ground Connection](#).

The SR-100 camera provides a removable screw-terminal connector for receiving tinned leads for input power and serial communication leads. In order to access these interfaces, the rear panel of the camera must be removed (using the two hex screws). The front panel does not need to be removed. An example of the SR-100 with rear panel removed is shown in Figure 9.

**Caution!** Proper ESD protocol should be followed while working inside the unit.

**Caution!** If the green terminal block is removed during installation, be extremely careful to maintain the proper orientation when connecting the leads and reinserting the connector to the camera.

**Caution!** Do not connect leads or remove/reinsert the terminal block when power is active.

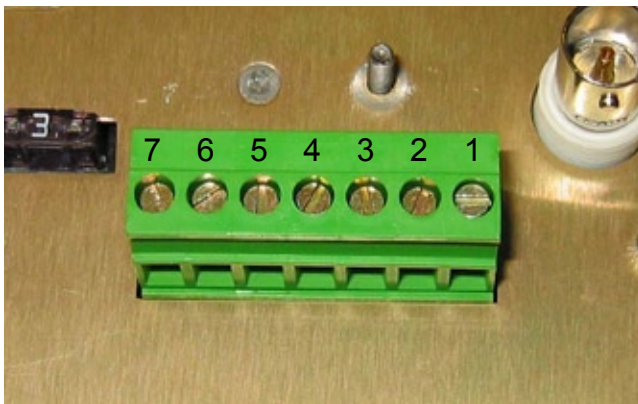


**Figure 9: SR-100 Connection Terminal**

Refer to [Table 1: SR-100 Screw Terminals](#) below for terminal definitions.

1. Loosen or remove the cable gland sealing nuts. Remove the rear enclosure cover using the included 5/64" hex wrench to reveal the green screw-terminal connector. This connector can be detached from the unit by gently pulling on it. Be careful to maintain the proper orientation when connecting the leads and reinserting the connector to the camera.

2. Route the cable with power/ground and serial leads through the left-hand gland on the rear enclosure cover (as viewed from the rear of the enclosure).
3. Connect the two power leads according to Table 1: SR-100 Screw Terminals. Connect the shield of the power cable to the Internal Earth Ground Connection as indicated in the figure above.
4. Connect the serial communication leads, keeping in mind the protocol for which the system has been configured (RS-422 standard, RS-232 optional). Connect the shield of the serial communications cable to the Internal Earth Ground Connection as indicated in the figure above.
5. Route the video cable through the right-hand gland (when viewing from the rear) on the rear enclosure cover and crimp the connector to the end of the cable.
6. Connect the cable to the BNC bulkhead connector on the rear of the SR-100.
7. Connect the External Earth Ground lead to the Earth Ground Lug on the inside of the rear of the enclosure (refer to Figure 8: Earth Ground Connection) The Internal Earth Ground connection should already be connected to the Earth Ground Lug.
8. Make sure that the O-rings supplied on the rear cover of the camera enclosure are seated properly and free of dirt and debris before reassembly. The O-rings are lubricated with silicone grease. Replace the rear enclosure cover and tighten the captive screws appropriately to ensure the system environmental specifications are maintained.
9. Tighten the sealing nut around the cable on each cable gland.



**Figure 10: Screw Terminal Connector**

Pin number	Description	Direction	Comments
1	RS232 Tx or RS422 Tx-	Output from camera	PC Data Receive(232), RS422 TX-, RS422 TX(A)
2	RS422 Tx+	Output from camera	RS422 TX+, RS422 TX(B)
3	RS232 Rx or RS422 Rx+	Input to camera	PC Data Transmit(232), RS422 RX+, RS422 RX(B)
4	RS422 Rx-	Input to camera	RS422 RX-, RS422 RX(A)
5	Ground	N/A	GND
6	-Voltage In	N/A	DC Negative or AC Neutral
7	+Voltage In	N/A	DC Positive or AC Line

**Table 1: SR-100 Screw Terminals**

## 5.0 SR-100P INSTALLATION

Prior to installing the SR-100P, be sure to review the general installation procedures given above.

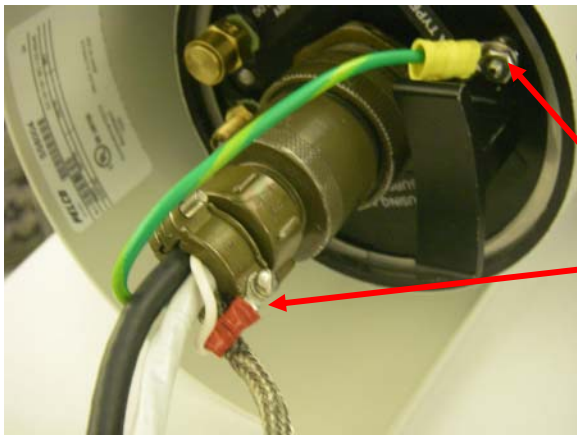
The SR-100P camera utilizes a 16-pin jam nut, panel-mount receptacle (Souriau 85107E2016P) as the power and serial input connector, and an MS-type mating connector (Souriau 85106EC2016S) is supplied with the camera. The leads are first connected to the mating connector and the mating connector is then inserted into the receptacle on the rear of the camera.



**Figure 11: SR-100P with Sun Shroud**

On the SR-100P camera, the shielding and Earth grounding are critical parts of the interface cable construction. Both are required in order to control radio frequency emissions and protect from high energy outdoor events such as the indirect effects of lightning.

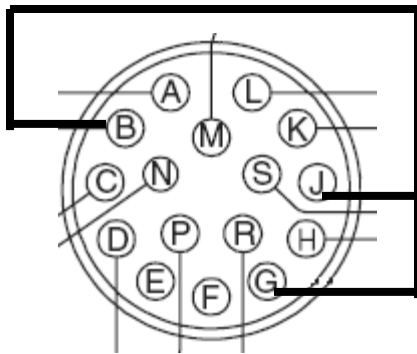
The following cable example shows two ground connection points. Both ground leads are internally connected to all of the shields of the cabling and terminated externally with lugs. One terminal lug (white lead in this example) is to be connected to the connector shell and the other (green with yellow stripe) is to be connected to the Earth connection point on the rear of the camera system. The Earth connection point is then required to be connected to Earth Ground.



Cable shields from all cables (video, power, serial) are joined and connected to two ground leads (white and green) with terminal lugs.

Attach one ground here, as shown, and also attach the Earth Ground connection here (not shown).

The other ground should be attached to the connector shell, as shown here.



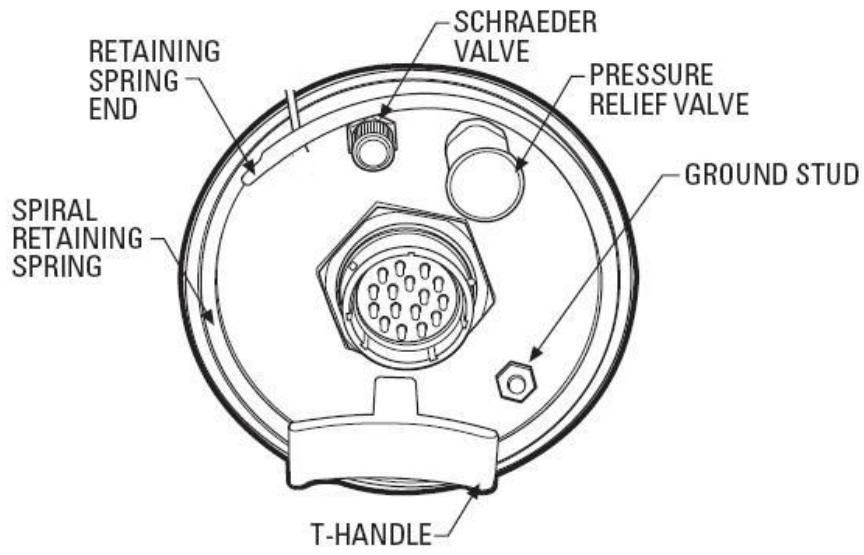
Pins B, G and J are tied together for proper ground and shield protection.

**Figure 12: Mating connector as seen from end of cable**

The following table describes the pin designations for video, power, and communications signals.

Signal Name	Pin Designation	Comment
VID OUT	A	Center (core) of coax video
VID RTN	B	Coax shield
Not Connected	C	
Not Connected	D	
CAM POWER	E	
CAM POWER RTN	F	
Shield	G	Power, Serial communications, and Video - Tied to pin J
AC LINE	H	For enclosure heaters
GND	J	Tied to pin G
RS422 TX-	K	Camera transmit
RS422 TX+	L	Camera transmit
RS422 RX+	M	Camera receive
RS422RX-	N	Camera receive
AC NEUTRAL	P	For enclosure heaters
Not Connected	R	
Not Connected	S	

**Table 2: SR-100P Connector pin designations**



**Figure 13: SR-100P Enclosure Rear**

## 6.0 VSR-6, SR-19, SR35, SR-50 INSTALLATION

Prior to installing the SR-Series camera, be sure to review the general installation procedures given above.

The VSR-6, SR-19, SR-35, and SR-50 camera systems each have a fixed-focus lens (focused at infinity at the factory) and the lens focus is not field adjustable.

Be sure to insert the cables through the cable glands on the rear of the enclosure before terminating and connecting to the camera (the terminated video cable will not fit through the cable gland).

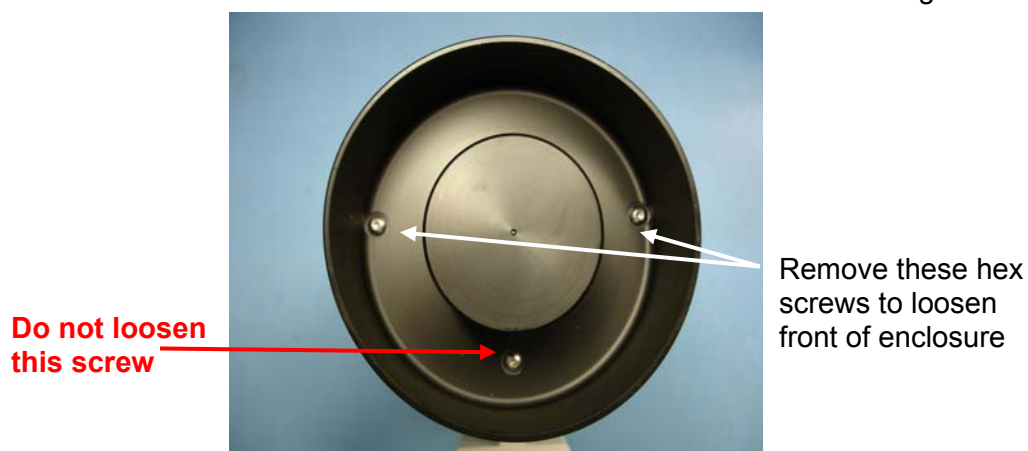
Be sure to properly ground the camera according to the information provided in section 3.2 [Ground Connection](#).

**Caution!** Proper ESD protocol should be followed while working inside the unit.

The power leads are attached directly to the connector on the interface board, as shown in Figure 15: SR-Series Connections (VSR-6, SR-19, SR-35, and SR-50).

Remove the camera from the enclosure:

1. Loosen the two captive hex screws from the rear of the camera enclosure using the included 5/64" hex wrench as shown in Figure 7.
2. Pull the back of the environmental enclosure off using the "T" handle.
3. Remove the two screws on the front of the enclosure as indicated in the figure below.

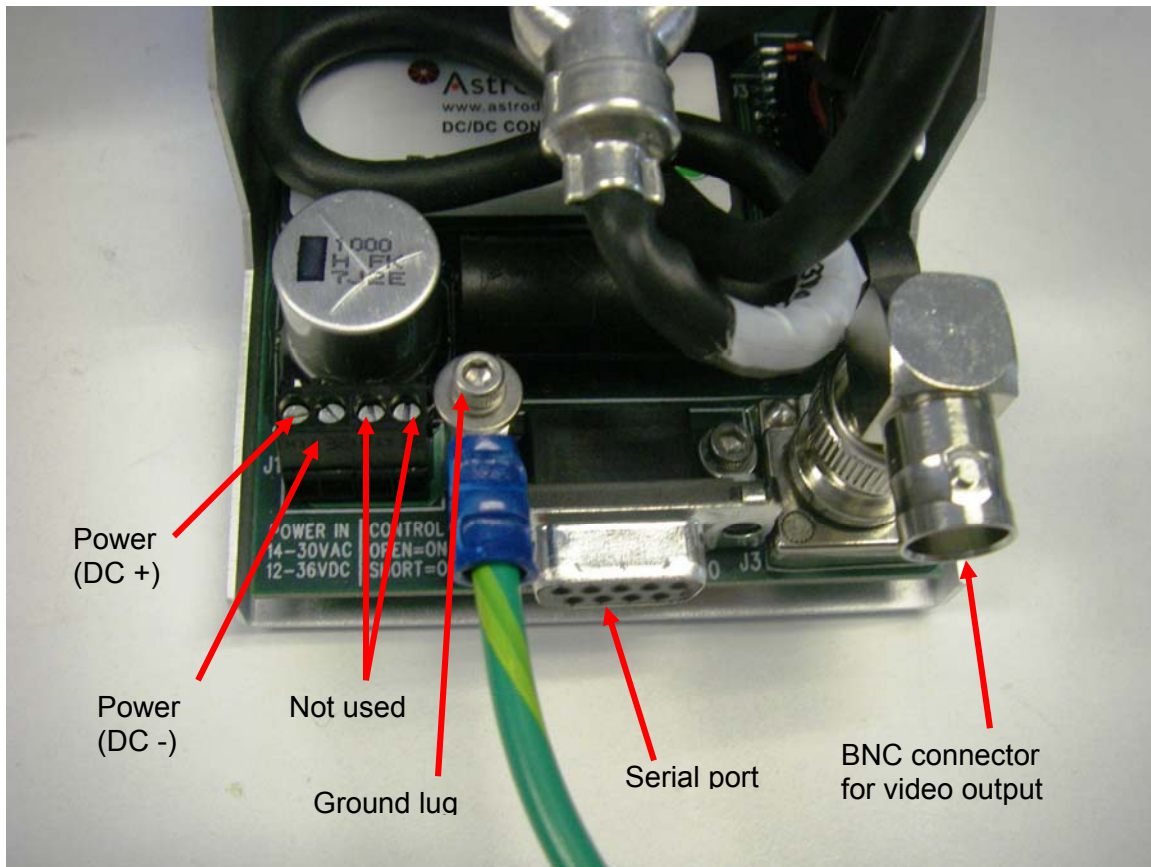


**Figure 14: Front view of SR-Series camera**

4. Push the camera assembly out of the front of the enclosure from the back using the lower left and right parts of the chassis as push points. The ground cable inside the enclosure may have to be temporarily disconnected from the rear plate before removing the camera.

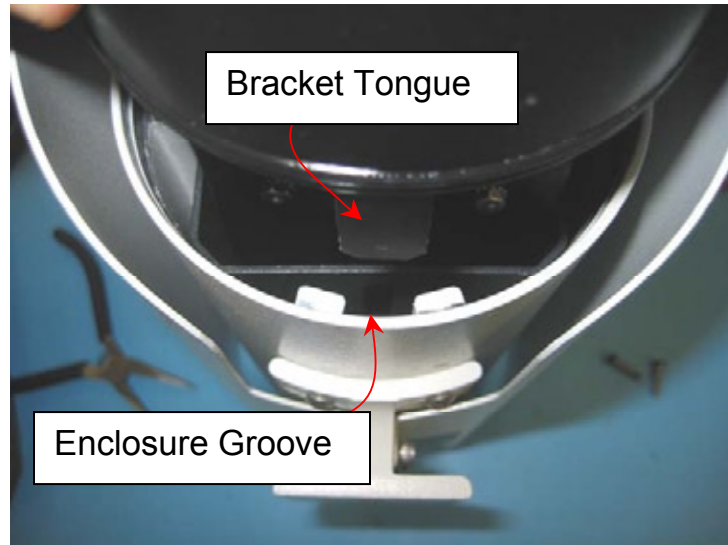
Instructions for connecting the power, video and communication leads to the camera are given below.

1. When using AC power, connect the two leads to the two screw terminals on the left end, as indicated in the photographs. If using DC power, be sure to install the positive lead in the first (leftmost) terminal and the negative lead in the second terminal, as indicated in Figure 15 (reference the left-most terminal on the block as viewed from the rear of the interface board). Connect the negative lead to the terminal immediately to its right. The two screw terminals on the right of the terminal block are not used. The two screw terminals on the right of the terminal block are not used.



**Figure 15: SR-Series Connections (VSR-6, SR-19, SR-35, and SR-50)**

2. Route the RG-59 video cable through the right-hand gland (when viewing from the rear) on the rear enclosure cover and crimp the connector to the end of the cable. Connect the cable to the BNC bulkhead connector.
3. Make sure that the O-rings supplied on the front and rear covers of the camera enclosure are free of dirt and debris before reassembly. The O-rings are lubricated with silicone grease.
4. Insert the SR Series camera assembly into the front of the enclosure aligning the tongue on the underside of the interface board bracket with the groove on the inside bottom of the enclosure, as shown in Figure 16. Press the two components together and ensure the O-ring is seated properly.



**Figure 16: Tongue and Groove Alignment**

5. Secure the front cover to the enclosure using the 6-32 hex head screws.
6. If the ground cable inside the enclosure was disconnected, reconnect it to the ground lug on the rear plate of the enclosure. Connect the Earth Ground lead to the Earth Ground Lug on the inside of the rear of the enclosure (refer to Figure 8: Earth Ground Connection).
7. Insert the enclosure sled and rear plate into the enclosure body. Press the two components together and ensure the O-ring is seated properly. Secure the rear plate to the enclosure with the captive 5/64" 6-32 hex head screws.
8. Eliminate almost all of cable slack inside the enclosure. Now tighten the cable glands on the rear of the enclosure to create an appropriate seal.

## 7.0 OPERATING THE SR-SERIES THERMAL CAMERA

### 7.1 Thermal Imaging

The SR-Series camera is a state-of-the-art thermal imaging system that will provide you with excellent night visibility and situational awareness, without any form of natural or artificial illumination. The SR-Series camera is easy to use, but you should take a moment to carefully read this section so you fully understand how to interpret what you are seeing on your display and how to use the controls.

While the imagery you will see on the monitor may at first look similar to ordinary black and white daylight video, as you get familiar with the camera you will appreciate the characteristics that make thermal imaging distinct. A few tips on how to interpret some of the imagery will help you to make the most of your system.



The thermal imager inside the camera does not sense light like conventional cameras; it senses heat or temperature differences. As you experiment with the system during daylight and nighttime operation, you will notice differences in the picture quality; this is normal. The camera senses small “differences” in apparent radiation from the objects in view, and, in **white hot** mode, displays them as either white (or lighter shades of gray) for warmer objects, and black (or darker shades of gray) for colder objects.

Your thermal imaging camera relies on the fact that all objects, even very cold objects like ice, emit thermal energy in the portion of the infrared spectrum that this camera can “see”, the long wave infrared (LWIR). Therefore, unlike an illuminated infrared camera, a thermal imaging camera does not need an additional active illumination source and images based on directly radiated rather than reflected energy.

This is why you will see hot objects such as exhaust stacks or vehicle engines that appear white (or black, or red depending on the video image mode selected), while the puddles of water and other cold objects appear dark (or cool). Scenes with familiar objects will be easy to interpret with some experience. The camera automatically optimizes the image to provide you with the best contrast in most conditions.

FLIR Systems, Inc. offers a comprehensive selection of training courses to help you to get the best performance and value from your thermal imaging camera. You can find out more at the FLIR training web page: <http://www.flir.com/training>.

### 7.2 Configuration and Control

Through a serial communications interface, there are various settings available to the user in order to optimize image quality for particular applications. These settings are accessible using a standard, straight-through serial cable.

In addition to these configuration settings which are typically set at the time of installation, the SR-100 and SR-100P have an electronically controlled focus mechanism for use during ongoing operation. This focus mechanism is also controlled through the serial interface.

The SR-Series may be controlled by a PC running a Windows-based software application. One software application (known as the TVIS-7 PC User Interface Software) is used for the SR-100 and SR-100P cameras. For information on how to use the software, refer to the section 11.0 [SR-100 control using TVIS-7 User Interface](#). Another application (known as the TV-IS Photon OEM GUI) is used for the other cameras. For information on how to use the software, refer to the user guide included with the software. The user manual is also available from the FLIR Core By Indigo web site: [http://www.corebyindigo.com/products/core\\_photon.cfm](http://www.corebyindigo.com/products/core_photon.cfm).

### **7.3 Pelco Keyboard Control**

The SR-100 and SR-100P cameras can also be controlled with a Pelco Universal Keyboard (for example KBD300A). An example of the user commands for use with the KBD300A is shown in section 10.0 [KBD300 commands for use with SR-100 and SR-100P](#).

Note: The SR-Series camera comes pre-configured for either RS-232 or RS-422 communication from the factory, and the RS-422 protocol is only available on the SR-100 and SR-100P cameras. Use with the Pelco Universal Keyboard requires RS-422. Also, the baud rate for the Pelco Keyboard must be set to 2400 and the Pelco device id must be correct. Both the baud rate and the Pelco device id may be changed using the GUI.

### **7.4 Flat Field Correction (FFC)**

Periodically the image will momentarily freeze for a fraction of a second while the camera performs a flat field correction. A shutter activates inside the camera and provides a target of uniform temperature, allowing the camera to correct for ambient temperature changes and provide the best possible image. Through the software user interface, the frequency of the FFC can be modified.

## 8.0 CARING FOR YOUR SR-SERIES THERMAL CAMERA

**Caution!** Do not attempt to service the camera or make modifications to the camera core or electronics for any reason. Doing so can cause permanent damage and will void the warranty.

Your SR-series camera images through a lens that is made from material that is transparent to long-wave infrared energy. This lens is designed for the harsh outdoor environment and has a coating for durability, but may require occasional cleaning. FLIR Systems Inc. suggests that you clean the lens when image quality degradation is noticed or excessive contaminant build-up is seen on the lens.

The camera housing has a durable coating and the rugged protective window is designed to withstand normal cleaning. Rinse the camera housing with low pressure fresh water to keep it clean. If the front window of the camera gets water spots, wipe it with a clean soft cotton cloth dampened with fresh water. If the window requires further cleaning, use a soft moist cotton-based cloth with isopropyl alcohol or dish soap.

Do not use abrasive materials, such as paper or scrub brushes as this will possibly damage the lens by scratching it. Only clean the lens when you can visually see contamination on the surface.

### 8.1 Temperature

The SR-Series camera has an operating temperature range of -32 to 55°C. Choose an installation location so that the camera is not subject to temperature extremes that exceed this range. Do not expose the camera to direct sun without the sun shroud installed.

### 8.2 Maintenance

If you have a problem with your thermal camera, do not attempt to repair it yourself. The SR-Series camera core is a sealed unit and can not be opened or serviced in the field. Consult your installation dealer or FLIR Systems Inc. for repair information.

#### Lens Cleaning

Materials:

- Optical-grade tissue (e.g. Edmund Industrial Optics P/N 52105 or any similar product)

- Pure water (de-ionized or other)

- Isopropyl alcohol (IPA)

Saturate a piece of the lens tissue with the water and drape it over the lens. Let the surface tension of the water pull the tissue onto the lens surface and then drag the tissue across the lens surface. Repeat several times with different pieces of tissue.

Repeat the same step using IPA instead of water. Drag the final piece of tissue over the lens several times to prevent pooling, which could leave a residue behind.

## 8.3 Troubleshooting Problems

### Video not displayed on monitor

If the camera will not produce an image, check the video connection at the camera and at your display. If the connectors appear to be properly engaged but the camera still does not produce an image, ensure that power has been properly applied to the camera and the fuse is not blown. If the camera still does not produce an image, have an authorized service representative make the appropriate repairs.

### Noisy image

A noisy image is usually attributed to a cable problem (too short or inferior quality) or the cable is picking up electromagnetic interference (EMI) from another device. Although coax cable has built-in losses, the longer and smaller the cable is, the more severe the losses become; and the higher the signal frequency, the more pronounced the losses. Unfortunately this is one of the most common and unnecessary problems currently plaguing video security systems as a whole.

Cable characteristics are determined by a number of factors (core material, dielectric material and shield construction, among others) and must be carefully matched to the specific application. Moreover, the transmission characteristics of the cable will be influenced by the physical environment through which the cable is run and the method of installation. Use only high quality cable and be careful to match the cable to the environment (indoor or outdoor).

### Image out of focus

The SR-100 and SR-100P have an electronically controlled focus mechanism for use during ongoing operation. This focus mechanism is controlled through the serial interface.

The VSR-6, SR-19, SR-35, and SR-50 camera systems each have a fixed-focus lens (focused at infinity at the factory) and the lens focus is not field adjustable.

Each camera has a minimum focus distance, as listed in the specifications section (0 [SR-Series Camera Specifications](#)). An out-of-focus object may be too close to the camera and within the minimum focus distance.

### Image too dark or too light

By default the SR-Series cameras use an Automatic Gain Control (AGC) setting that has proven to be superior for most applications, but a particular installation may require an adjustment to the AGC settings. For example, a very cold background (such as the sky) could cause the camera to use a wider range than appropriate. Refer to section 7.2 [Configuration and Control](#) for information about how to make adjustments to the image generated by the camera.

### Performance varies with time of day

You may observe differences in the way the camera performs at different times of the day, due to the diurnal cycle of the sun. Recall that the camera produces an image based on temperature differences. At certain times of the day, such as just before dawn, the objects in the image scene may all be roughly the same temperature, compared to other times of the day. Compare this to imagery right after sunset, when objects in the image may be radiating heat energy that has been absorbed during the day due to solar loading. Greater temperature differences in the scene generally will allow the camera to produce high-contrast imagery.

## Image freezes

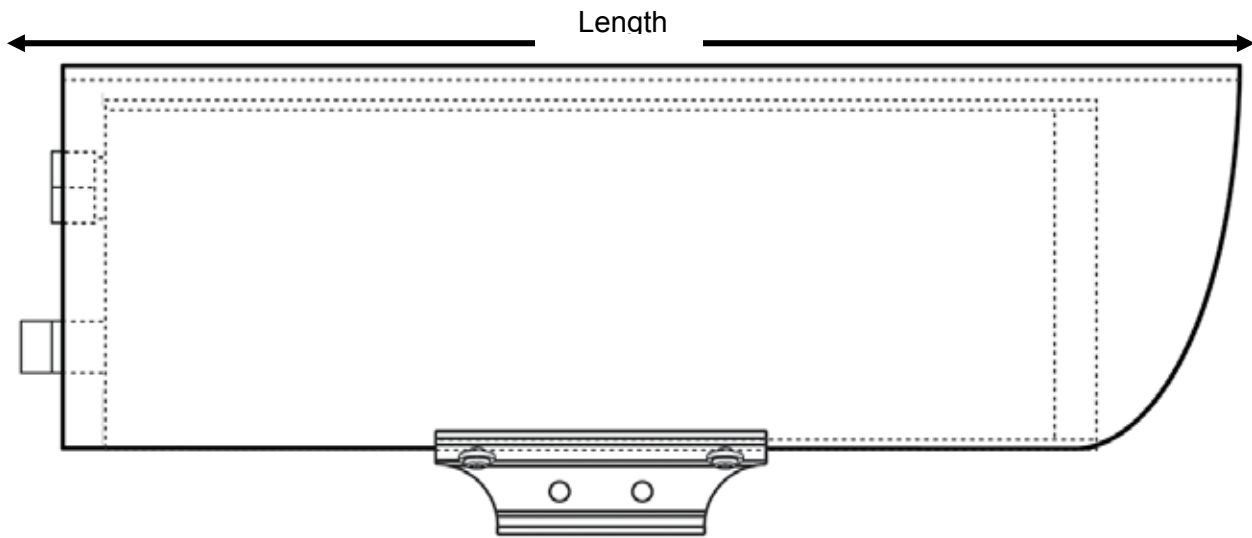
By design, the camera image will freeze momentarily on a periodic basis during the Flat Field Correction (FFC) cycle. It is possible to change the interval used for FFC; refer to section 7.4 [Flat Field Correction \(FFC\)](#).

## 9.0 SR-SERIES CAMERA SPECIFICATIONS

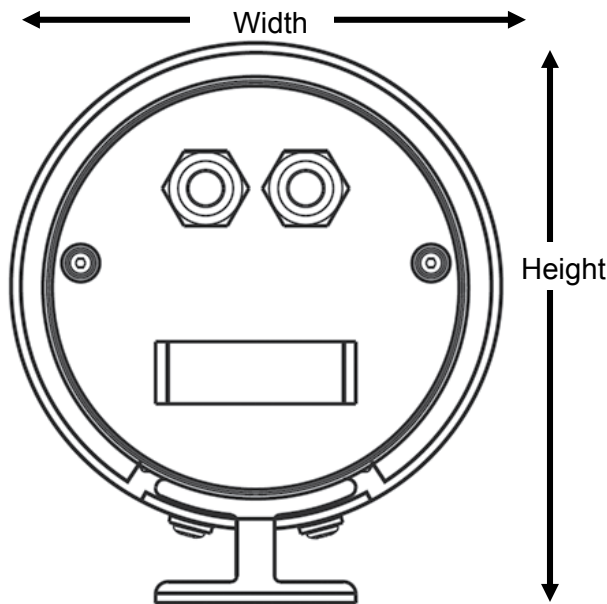
Feature	VSR-6	SR-19	SR-35, SR-50	SR-100	SR-100P
FPA size (HxV)	160x120	320x240	320x240	320x240	320x240
Weight	4.6 lbs, 2.1 kg	4.6 lbs, 2.1 kg	5.0 lbs, 2.7 kg	7.2 lbs, 3.3 kg	11.5 lbs, 5.2 kg
Dimensions	Refer to detailed drawings below in section 9.1				
Sensor type	Uncooled Microbolometer				
Spectral range	7.5 to 13 $\mu$ m				
Pixel pitch	38 microns				
Input power range	14V to 32VDC      Voltages as measured at the input to the electrical 18V to 27VAC      interface board.				
Nominal/Peak Power Req.	6/16 W at 24VDC		4/6 W at 24VDC	8 /36 W at 24VDC	8 /36 W at 24VDC
Operating Temp. Range	-32°C to 55°C (-25°F to 131°F)				
Storage Temperature	-50° to 85°C				
Lens Heater	Thermostat controlled				
Analog video	NTSC or PAL (EIA-170 or CCIR 624, respectively).				
Camera focus	Fixed focus (no adjustment needed)			Motorized focus mechanism	
Minimum Focus	0.1 meters	0.1 meters	1 meter, 4 meters	7 meters	7 meters
Serial remote interface	RS-232			RS-422 (RS-232 avail.)	RS-422
User Control	Via devices supporting Pelco-D protocol or Windows-based application program (Windows-based GUI)				
Connector Style	Screw terminals (accepts tinned wire leads)				16-pin mating connector

**Note:** These specifications are subject to change without notice. Additional SR-100P specifications provided in section 9.2 [SR-100P Specifications](#).

**9.1 SR-Series Camera Dimensions**



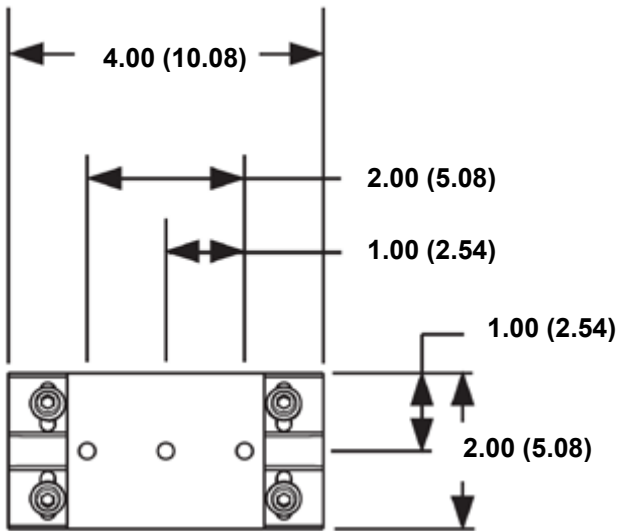
**Figure 17: Camera Side View**



**Figure 18: Camera Rear View**

Dimension	VSR-6	SR-19	SR-35, SR-50	SR-100	SR-100P
Length	10.5" (26.7)				18" (45.7)
Width	5.0" (12.7)				4.5" (11.4)
Height	5.68" (14.4)				5.5" (13.9)

**Note: Values in parentheses are in centimeters, all others in inches.**

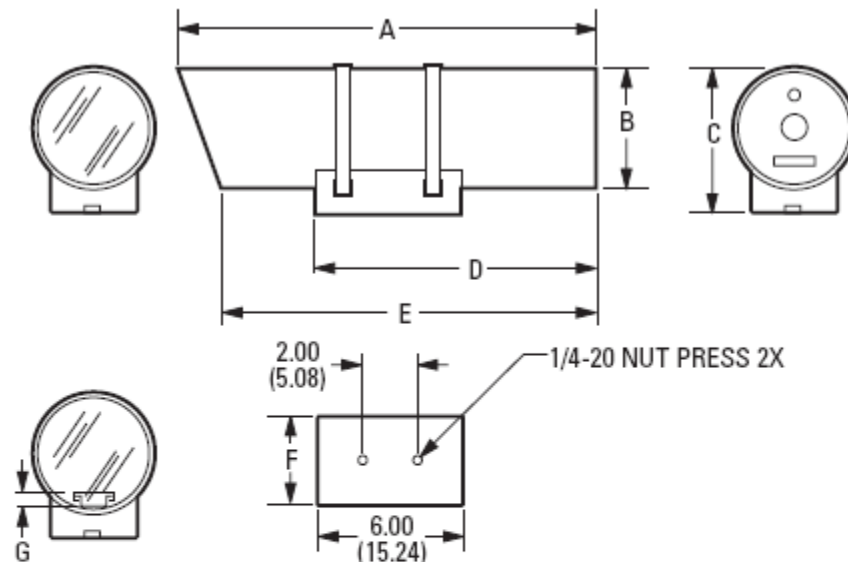


**Figure 19: Enclosure Mounting Foot (all cameras except for SR-100P)**

## 9.2 SR-100P Specifications

Ambient Operating Temperature	-40° to 122°F (-40° to 50°C) with heater(s)
Purge Fitting	Standard Schraeder valve to allow enclosure to be filled with dry nitrogen
Purge Relief Fitting	Prevents over pressurization of enclosure
Enclosure Mounting	Adjustable cradle secured with stainless steel bands
Humidity	Up to 100% relative humidity. Standard Schraeder and pressure relief valves provide positive internal pressure with dry nitrogen

### SR-100P Dimensions



A	B	C	D	E	F	G
18.00 (45.72)	4.50 (11.43)	5.50 (13.97)	12.50 (31.57)	17.00 (43.18)	3.00 (7.62)	0.92 (2.33)

NOTE: VALUES IN PARENTHESES ARE CENTIMETERS;  
ALL OTHERS ARE INCHES.

## 10.0 KBD300 COMMANDS FOR USE WITH SR-100 AND SR-100P

Note: To start, type the device id (99 is the universal id) and then press CAM

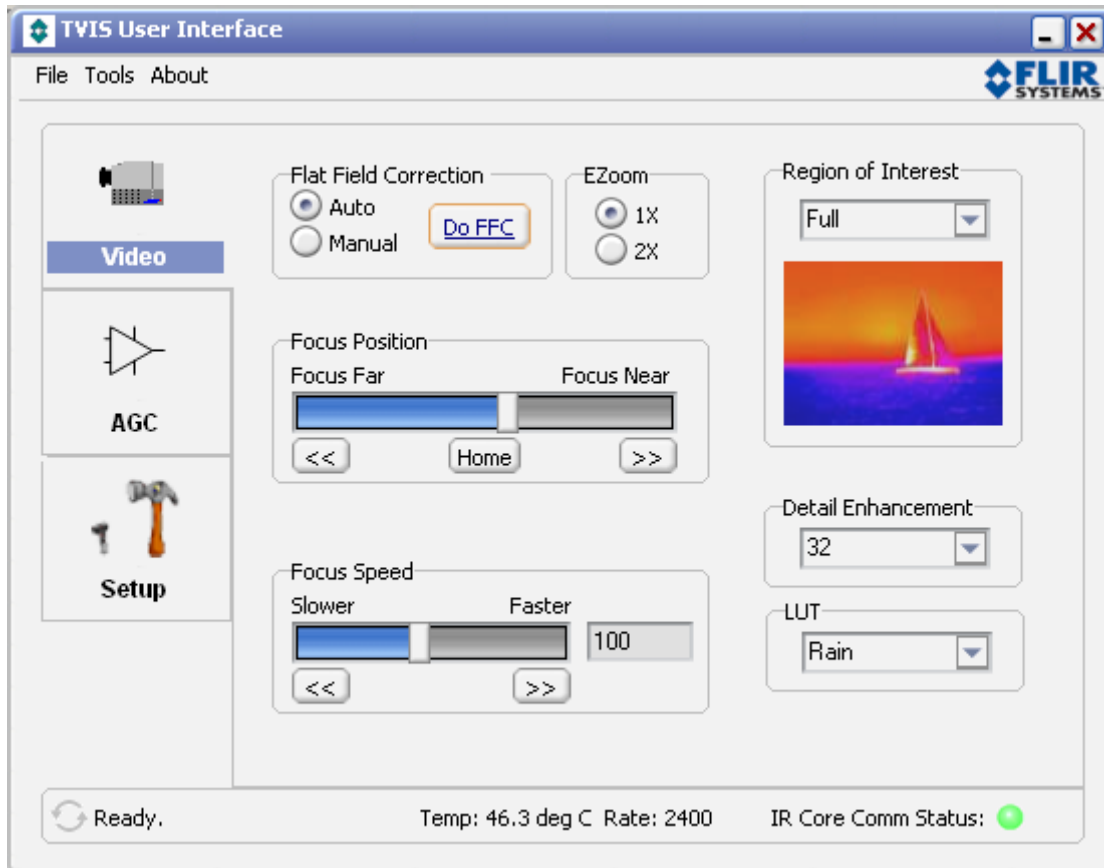
Keystrokes	TVIS-7 Function	Toggle Values (default to first value)
Near button	Increments Focus closer	Note: Holding the Near or Far button down continuously will only move the focus for three seconds. The button must be let go and depressed for further motion.
Far button	Increments Focus farther	
CW Joystick	Turns on 2X Electronic zoom	
CCW Joystick	Turns off 2X Electronic zoom	
1, Aux On	IR Polarity to Black Hot	
1, Aux Off	IR Polarity to White Hot	
2, Aux On	Turns on 2X Electronic zoom	
2, Aux Off	Turns off 2X Electronic zoom	
3, Aux On	Toggle: Plateau Values	250, 300, 400, 50, 150, 200
3, Aux Off	Toggle: AGC Type	Plateau, AutoBright, Linear, Plateau, AutoBright, Linear
4, Aux Off	IR Flat Field Correction	
5, Aux Off	Toggle: LUT Palette	White, Black, Sepia, Color1, Firelce, Rain
6, Aux On	Toggle: DDE gain in photon	32, 64, 96, 128, 16, 24
6, Aux Off	Toggle: AGC ROI	Full, Horizon, Sky, Ground, Center, Center (smaller)
7, Aux On	Toggle: MID ITT in Photon	140, 160, 200, 60, 100, 120
7, Aux Off	Toggle: Max gain value	8, 10, 12, 2, 4, 6

Some Pelco keyboards can produce very rapid commands when both of the focus buttons are pressed simultaneously. These back to back commands can cause the SR camera to continue to change its focus even when the focus buttons are released. Pressing and releasing either of the focus buttons again will cause the camera to stop changing its focus and regular focusing operations can be resumed.

## 11.0 SR-100 & SR-100P CONTROL USING TVIS-7 USER INTERFACE

The SR-100 (formerly known as the TVIS-7°) and the SR-100P may be controlled through various sources including the TVIS-7° User Interface GUI which provides a Windows-based control program (Graphical User Interface) for the SR-100P. Detailed descriptions for using these controls are described in this section.

### Video Control



**Flat-Field-Correction:** The Photon camera core includes internal mechanisms for periodically improving image quality via a process called “flat-field correction” (FFC). During FFC, a small calibration flag rotates in front of the detector array, presenting a uniform temperature (i.e. a “flat field”) to every detector element. While imaging the flat-field, the camera updates correction coefficients, resulting in a more uniform array output. The video image is frozen during the entire process, which takes approximately half a second, and it resumes automatically thereafter. Repeating the FFC operation often prevents the imagery from appearing “grainy”. This is especially important when camera temperature is fluctuating, such as immediately after turn-on and/or when ambient temperature is drifting. FFC can be commanded manually at any time using the “Do FFC” button.

1. Automatic. In the Automatic FFC mode, the camera performs FFC whenever its temperature changes by a specified amount or at the end of a factory specified period of time (whichever comes first).

2. Manual. In Manual FFC mode, the camera does not perform FFC automatically based on specified values of temperature change or an expired time.

**EZoom:** Electronically multiplies the pixel array by 2, effectively doubling the image size displayed on the monitor. 1X is turned off and 2X is turned on.

**Region Of Interest (ROI)** is used to define the region of the display used to generate the AGC parameters. Full Screen ROI indicates pixel values from the entire array are used in the AGC algorithm. The Horizon Optimized setting applies all pixel values horizontally across the screen but uses only the middle third in the vertical direction. The Sky Optimized applies all pixel values horizontally across the screen but only the top half in the vertical direction. The Ground Optimized applies all pixel values horizontally across the screen but only the lower half in the vertical direction. The other modes apply a percentage of pixel values based on the entire array size. The ROI is centered on pixel position 0, 0 (which is the geometric center of the array).

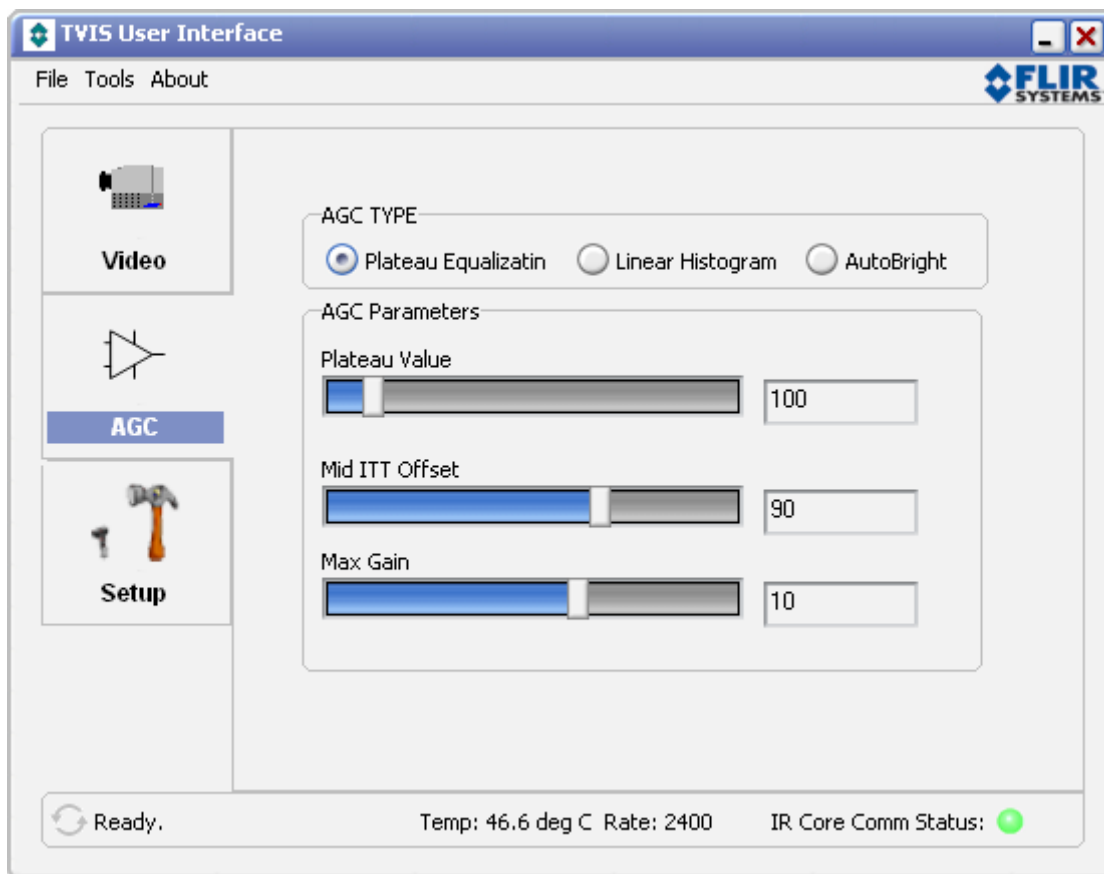
**Focus Position** is adjusted by using the slider bar or the arrow keys for fine adjustment. The "Home" button can be set by adjusting the desired focus position and then saved through the "Save Current Settings to Power Defaults" button on the Setup Control Tab.

**Focus Speed** is adjusted by using the slider bar or the arrow keys for fine adjustment. The relative set values are between 50 and 160.

**Detail Enhancement** or DDE: Each time this command is sent it increments the Dynamic Display Enhancement value to the next higher setting. Default setting is 32. Valid values are 16, 24, 32, 64, 96 and 128.

**LUT:** The LUT or Look Up Table is a series of tables that map individual pixel values to various color schemes or palettes. Available color palettes are White Hot, Black Hot, Sepia, Color 1, Fire Ice, and Rain.

## AGC Control



## TVIS-7° AGC Control

**AGC TYPE:** The AGC or Automatic Gain Control defines the type of function that determines the brightness and contrast of the analog video image. These functions can be non-linear such as the Plateau Equalization or a linear such as in the Linear Histogram and AutoBright selections.

1. Plateau Equalization uses a histogram equalization algorithm. This algorithm analyzes the scene content in real time and redistributes the dynamic range of the scene. The goal of this redistribution is that every one of the 256 bins of the dynamic range should have an equal number of pixels in it. The Plateau Equalization method tends to give better scene contrast under conditions where the scene statistics are bimodal (for example, a hot object that subtends significantly more than 10% of the ROI, with a colder background). Plateau Equalization does not evenly divide gray levels across the displayed A/D count range. Instead, this AGC algorithm looks at the scene statistics and weights the distribution of gray levels according to the number of pixels that have a specific A/D count value. Using the case of a hot target against a colder background, this AGC algorithm would assign the target a number of displayed gray levels that is in proportion to the number of total pixels that the target subtends. There can also be a significant number of A/D counts in the displayed range that have no pixels at those levels. Those A/D counts would not receive any gray levels, reserving those gray levels for A/D counts that correspond to pixels in the scene. Then the A/D counts that correspond to pixels in the background would again have their gray levels allotted in proportion to the number of scene pixels at those levels.

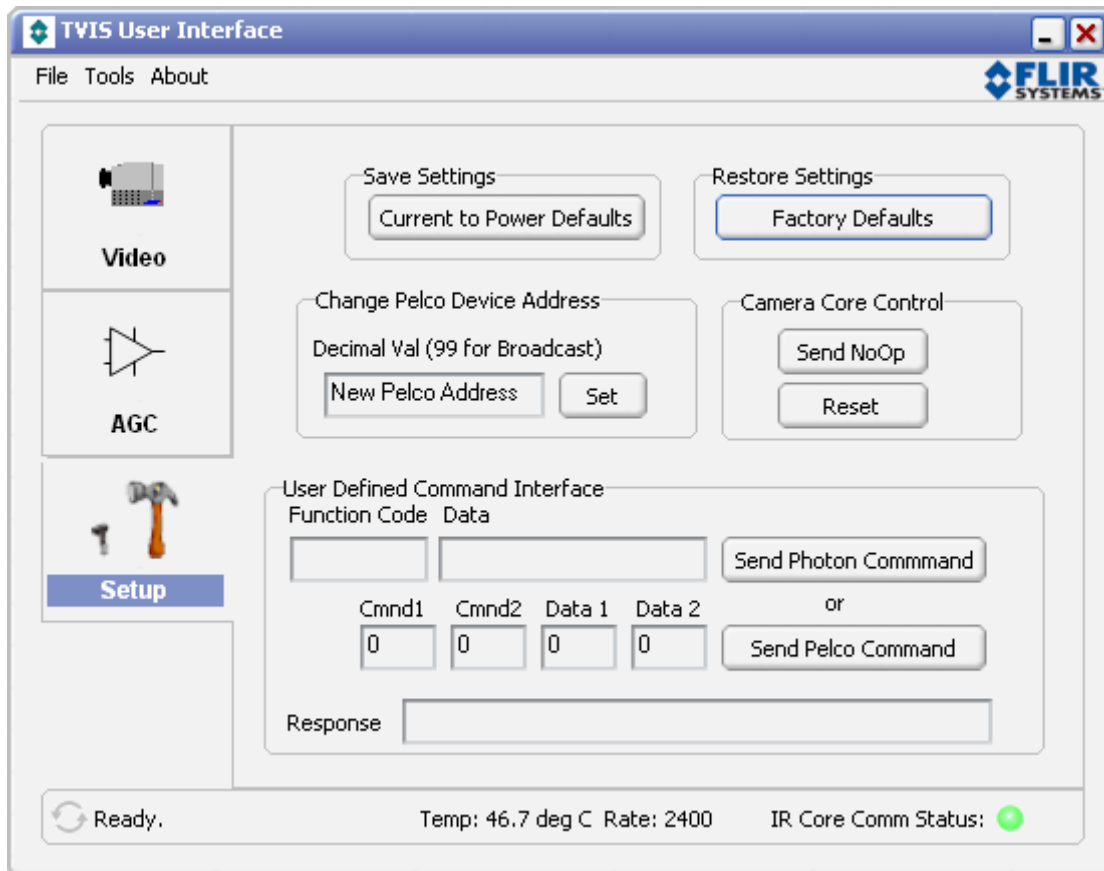
The Plateau Value specifies a limit to the number of pixels that can be associated with a particular output count value.

2. Linear Histogram algorithm uses scene statistics to set a global gain and offset (contrast and brightness) for the image. This AGC setting linearly adjusts the full 14 bit video bandwidth over the 256 levels of analog video displayed on the monitor.
3. AutoBright algorithm will automatically optimize the brightness as the scene varies.

**AGC Parameters:** The AGC Parameters allow for customization of each AGC type.

1. Plateau Value specifies a limit to the number of pixels that can be associated with a particular output count. This value would apply regardless of the contents of the scene. It acts to spread the pixel count over bins below and above the bin that has a higher pixel count than the Plateau Value parameter allows. The lower the value, the fewer pixels are allowed to be in a given bin, resulting in a darker image
2. Mid ITT Offset helps reduce the artificial darkness of the image due to a small max gain value. The lower the value, the darker the image.
3. Max Gain allows control of the noise in the image. If the dynamic range of the scene is low then a larger max gain will cause a noisier image.

## Setup Control



### TVIS-7° Setup Control

**Save Settings:** The Save Current Settings to Power On Defaults will save all settings defined in the User Interface. The TVIS-7° will default to these settings upon power-up.

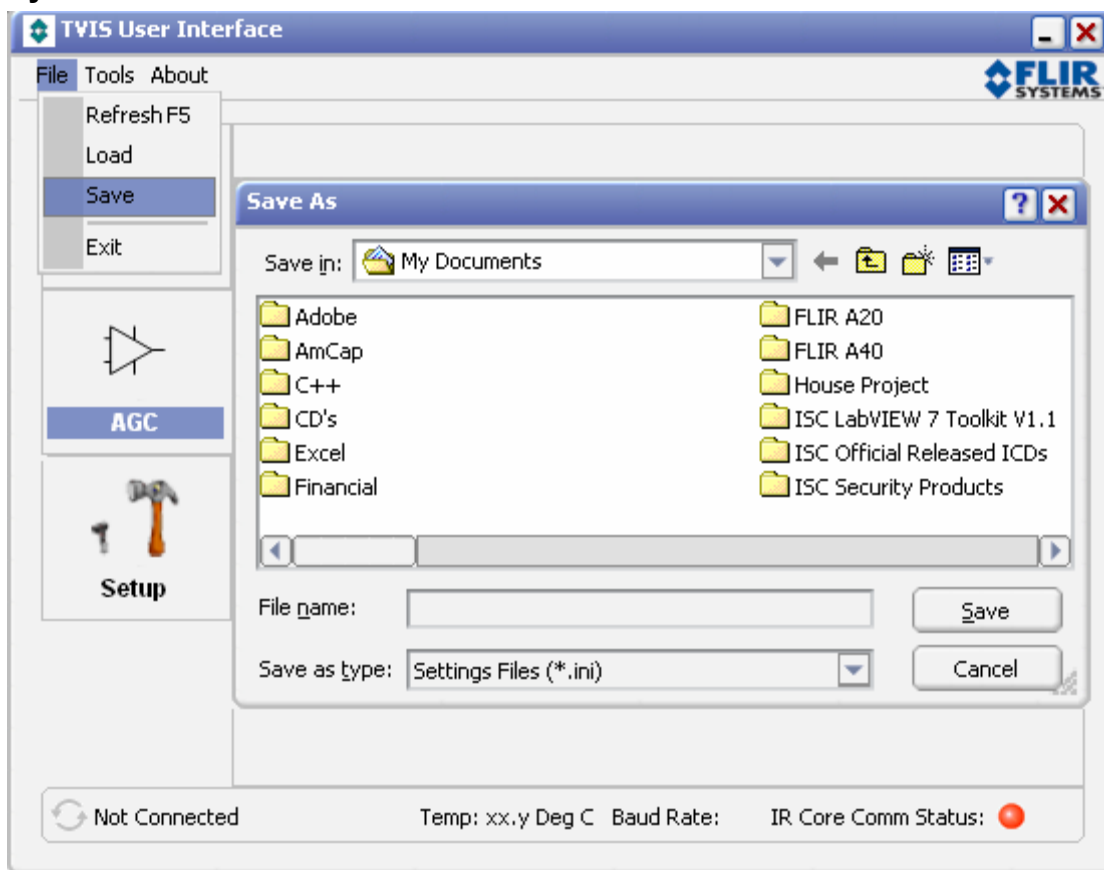
**Factory Defaults** will set the TVIS-7° to factory default settings.

**Change Pelco Device Address** allows for users to define the Pelco Device Address. The device will only accept commands under its new Pelco address or the global address of 99. The TVIS GUI will only communicate using then assigned Pelco address. To query or view the current Pelco Device Address select Tools->Options.

**Camera Core Control** allows the user to send a “NoOp” or No Operation command to the Photon Core as well as “Reset” the Photon Camera. Note this Reset command does not apply to the entire system, just the IR core.

**User Defined Command Interface** allows the user to send raw Photon and Pelco Commands. For a list of Photon Commands refer to the Photon Interface Control Document (ISC Doc 102-1238-41) and for a list of Pelco Commands refer to the ThermoVision Integration Series 7 Degree Software Interface Control Document (ISC Doc. 427-007-05-21).

## System Initialization Files



### TVIS-7° Saving System Files

**Refresh:** The screen will refresh. The device will be queried and all values will be updated.

**File Save/Load:** The system settings can be saved to an “.ini “ file and then loaded later. Once the settings have been loaded Save Settings to Current Power Defaults button to store the data n the camera.

**Exit:** This will exit the application.

## Configuration Control

The screenshot shows a 'Configuration' dialog box with the following settings:

- Communications Port:**
  - Serial Port: COM3
  - Baud Rate: 2400
  - Pelco Address: 99
- Logging:**
  - Enable Logging
  - Log Send/Recv

### TVIS-7° Configuration

**Communications Port:** The serial communication settings should match those on the PC for communication. The Pelco Address is also displayed. On initial power up, the system will automatically search for the appropriate baud rate. This dialog configures the PC comm. Port that will be used to communicate with the device.

- Serial Port – select the port which has a physical connection to the device
- Baud Rate – select the desired baud rate. If the device is configured for a different rate, the software will hunt until it determines the correct rate. Once connected it will request that the device change to the rate selected by the user.
- Pelco Address – this is the address that the User Interface will use to communicate with the device. It must either match the address configured in the device or use the global value of “99”.

**Logging** The logging will open a window that a message log for each command sent to the TVIS-7°. If Log Send/Recv is selected, then all messages sent between the host and the device will be logged. If Enable Logging is exclusively selected, only error messages will be display. This window is useful in resolving technical issues. The data from the window can be copied and pasted to a text file using the right mouse button.

## About Tab



### TVIS-7° About Screen (Version on Screen not current)

The About tab will display the version information and system information.

## 12.0 REFERENCES

FLIR Standard Resolution Product Specification Document Number: 427-0014-00-09

FLIR Photon GUI User Guide Document Number 412-0035-00-10

FLIR TVIS 7 Degree Software Interface Control Document (ISC Doc. 427-007-05-21)

Pelco EH8100 Series Enclosure Product Specification

Pelco EH2500 Series Enclosure Product Specification

Pelco Standard TF-002 Pelco “D” Protocol Manual

Pelco SS2508 Sun Shield EH2584405COMP\_A

NTSC EIA-170

PAL CCIR 624

MIL-STD-810E Environmental Testing

MIL-STD-188-124B, Grounding, Bonding and Shielding

IEC 60529 IPX6

IEC 60068-2-64, Environmental Testing Part 2 Vibration testing

Cenelec EN61326 CE Mark (Class A)

FCC Part 15; Subpart A EMI/EMC

Grounding Practices: IEEE Std. 1100 (The Emerald Book).

National Electrical Code, NEC-70-1996