Navigator™ II

OPERATOR'S MANUAL

FOR STATIC AND PAN/TILT CONFIGURATIONS

FLIR

TABLE OF CONTENTS

FLIR Systems, Inc.
CVS World Headquarters
FLIR Systems, Inc.
70 Castilian Dr.
Goleta, CA 93117
USA
PH: + 1 888 747 3547
PH: + 1 805 964 9797
FX: + 1 805 685 2711
sales@flir.com

EUROPE
CVS Eurasian Headquarters
FLIR Systems CVS BV
Charles Petitweg 21
4847 NW Teteringen -
Breda
Netherlands
PH: + 31 (0) 765 79 41 94
FX: + 31 (0) 765 79 41 99
flir@flir.com

FLIR Systems, Inc.
Corporate Headquarters
FLIR Systems, Inc.
27700A SW Parkway Ave.
Wilsonville, OR 97070
USA
PH: + 1 888 747 3547
FX: + 1 503 498 3904
sales@flir.com

www.flir.com

CONGRATULATIONS ON BUYING YOUR NAVIGATOR II...

Welcome to the pioneering world of maritime thermal imaging! The Navigator II is a state-of-the-art thermal imager that lets you see at night, through smoke and haze, without any lighting at all. FLIR has been building thermal imagers for decades, and we are confident that you will see why FLIR is the #1 name in infrared around the world.

Thermal imaging technology has been a staple of military operations for years, but FLIR has recently made it available to the public, and only to a select few at that! By purchasing a FLIR thermal imager, you have established yourself as a mariner on the leading edge of technological advancement. Remember to register your Navigator II by filling out the Registration card, and we will send you a nice "thank you" gift in return.

You will find that the Navigator II is simple to use. There are two versions of the Navigator II: a Static version and a Pan/Tilt version. This manual covers both products. Both versions use the same thermal imaging camera, but the fixed version is simplified in that it offers an "On" switch only, and an automatically optimized grayscale video output. The Pan/Tilt version allows for 360° viewing, and has a number of added features like: color palettes, on-screen information, running modes and a programmable "home" position. We encourage you to review the Fundamentals of Infared section, which will help you to understand and interpret the Navigator II's thermal images.

If you have any questions, comments or concerns, give us a call at 888.747.3547 – we'd love to hear from you. So, plug in your new Navigator II and watch the infrared world unfold before your eyes.

CAUTIONS

In the Navigator II Operator's Manual, **CAUTION** notices indicate a potential hazard, which, if not avoided, may harm you, someone else, or the Navigator II. For greater safety, and to achieve the highest levels of performance from your Navigator II, always follow these cautions when handling and operating your Navigator II camera system.

CAUTION!

The Navigator II imaging system is controlled by US export laws. There are special versions of this system that are approved for international distribution and travel. Please contact FLIR Systems if you have any questions.

CAUTION!

Failure to follow the caution may result in damage to the Navigator II.

CAUTION!

- Do not use the Navigator II imaging system as your primary navigation system. Use it in conjunction with other navigation aids and a primary manual navigation system.
- Do not open the Navigator II camera body for any reason. Disassembly of the camera (including removal of the cover) can cause permanent damage and will void the warranty.
- When cleaning your Navigator II, be very careful not to leave fingerprints on the Navigator II's infrared camera optics. They are treated with a special coating that can be permanently damaged by the oils in your skin. Refer to the Caring For Your Navigator II section for instructions.
- The Navigator II runs off of 12 VDC. Plugging it in to any other power level will damage the system.
- Do not use the thermal imager to look at high-intensity radiation sources like the sun, lasers, arc welders, etc., as prolonged exposure can damage the imagers.
- Navigator II is designed to withstand the shocks and vibrations commonly encountered in the normal maritime environment. Don't expose the camera to excessive impacts.
- Only a qualified marine electronics technician should install your Navigator II. FLIR assumes no responsibilty for improper installation.

OPERATION

NAVIGATOR II OPERATION

FLIR makes two versions of the Navigator II: the Static version, which stays pointed in one direction relative to the vessel (usually straight ahead), and the Pan/Tilt version that can look up and down (+/- 45° relative to the horizon), and 360° around. This manual contains operating instructions for both versions. Make sure you use the instructions that apply to your configuration of Navigator II.

Operating Your Navigator II (STATIC version)

The static Navigator II is simple to install and operate. (See the Installation Guide for installation procedures.) The system operates on 12 volts DC, outputs standard composite video (NTSC or PAL formats are available), and requires no camera adjustments. Follow this simple procedure to operate:

• Turn on the camera using the On/Off switch.

• Turn on your FLIR display.

Make sure you've selected the Navigator II as the source for your display, and start looking at your Navigator II's infrared video. (Most multi-function displays (MFDs) allow you to select from various available inputs. This is a reminder to select the proper input when operating your Navigator II.)

The Navigator II is completely sealed and very rugged. The camera is qualified for operation in all types of weather conditions over the specified operating temperature range and includes an automatic window heater that will prevent icing under most conditions.

Operating Your Navigator II (PAN/TILT version)

The Pan/Tilt version of the Navigator II is a little more complicate to use than the Static version, but not much. The qualified technician who installed your Navigator II isolated it from vessel power with a customer-supplied switch or circuit breaker tied-on to your vessel's power bus. Before you turn on the Navigator II, make sure that this switch or circuit breaker is turned on, then turn on your display, and select the Navigator II as the video source for your display. From there, use the controls of the Joystick Control Unit (JCU) to operate and configure your Navigator II.

CAUTION!

If you choose to operate your Navigator II with your vessel's engines off, be aware that this may drain power from your batteries unless the vessel is connected to shore power and equipped with a suitable battery tender.

Dual JCU Operation

You may want to have operating stations at two different locations on your vessel. To do this, you'll need the Dual JCU Kit installed by a qualified technician (see the Installation Manual, FLIR document number 432-0001-00-12 for installation instructions).

Operating the Navigator II with a dual JCU configuration is the same as operating it with one JCU. You can run your Navigator II from either control station, and the controls are exactly the same. Read on to learn more about the JCU.

JOYSTICK CONTROL UNIT (JCU)

JCU DESCRIPTION

ON/OFF – turns the Navigator II on and off. When the On/Off switch is turned to the On position, 2 FLIR splash screens will display for 5 seconds each. After this, the infrared image will display, and the system is ready for operation. Note that the Navigator II will still draw a small amount of power when off.

JOYSTICK – allows the operator to control where the Navigator II is looking. Move the Joystick to the left or right to rotate the camera in the corresponding direction; tilt it forward and back to tilt the camera up and down.

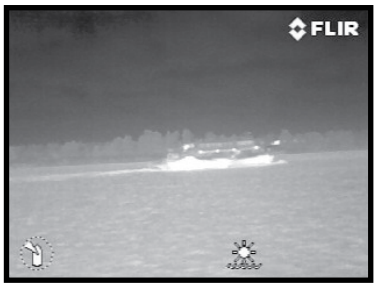
DIM – controls the brightness of the JCU panel; this control is active any time power is on. Dimming the control helps to protect the operator's night vision. Simply press the button to cycle through the four preset brightness levels.

HOME – the Home position is a user-programmable set of pointing angles, usually 0°-0° (straight ahead and level with the horizon), that operators can use as a reference and as a rest position when navigating for long periods. To set the Home position, use the Joystick to point the camera's line of sight to the position you want to set as "Home," press and hold the HOME button for 4 seconds, and the Navigator II will save this position as Home. (When the Home symbol flashes, the new Home position has been saved to memory.) When you want to drive the camera to this Home position, press and release the HOME button.

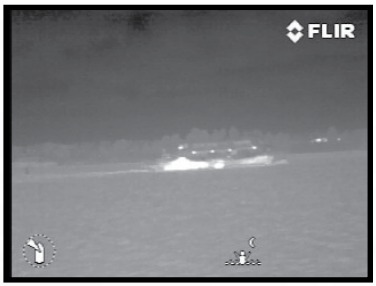
ZOOM – toggles the 2X zoom setting on and off. The Navigator II Pan/Tilt has a 2X electronic zoom. Press the Zoom button to select and de-select this option. A "2X" icon will appear when this control is active.

SCENE – cycles through Night Running, Day Running, Man Overboard, or Night Docking settings, which change the brightness and contrast of the image. Varying environmental conditions may make one setting more appropriate than the others for a given operation. Experiment with the different settings and choose the one that gives you the best image for your conditions.

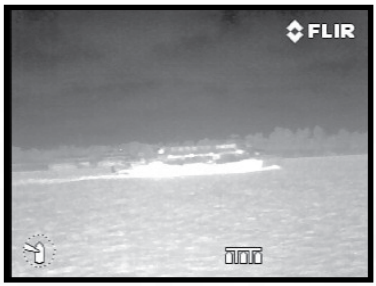
Night Running



Day Running



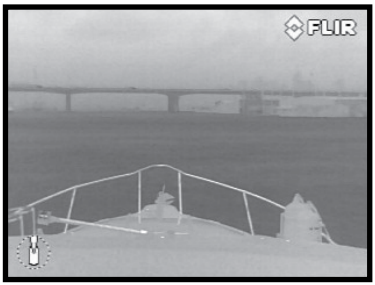
Man Overboard



Night Docking

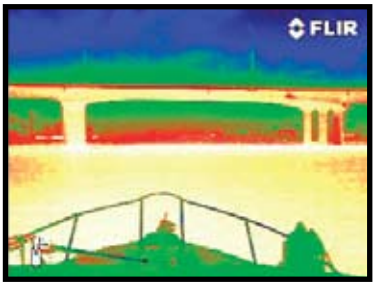
B/W – toggles between the available image presentation modes: white hot, black hot, red hot, rainbow and fusion. Hot objects appear white, black, or red respectively depending on the selected mode. The choice of video image mode is strictly a personal preference, and you should experiment to find your preferred mode.

White Hot



Black Hot

Red Hot



Rainbow

Fusion

CARE AND MAINTENANCE

TROUBLESHOOTING

CAUTION!

Do not open the camera body for any reason. Disassembly of the camera (including removal of the cover) can cause permanent damage and will void the warranty.

The Navigator II is a simple yet sophisticated device, built to provide years of trouble-free use. If you do run into problems with your Navigator II, try these simple steps:

- If the camera will not produce an image, check the fuse first. The fuse is on the main power line in a rubberized cover. Remove the fuse and check to see if it is still intact (see instructions below). If the fuse has blown, determine the cause of the blown fuse, fix the problem, and replace with a 5-Amp fuse.
- Check the wiring at both the electrical panel and at the termination to the JCU. Ensure that the contacts are clean, dry and free from corrosion. Refer to the Navigator II Installation Guide for proper wiring instructions. If maintenance on the wiring connection is required, have an authorized service representative make the appropriate repairs.
- If the camera still 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, have an authorized service representative make the appropriate repairs.

REPLACING THE FUSES

CAUTION!

Replace system fuses with the same value and type provided at the time of purchase. Using fuse values other than the ones supplied by FLIR Systems may cause permanent damage to the unit and may void the warranty.

To replace the fuse, ensure power is off, remove the fuse from the fuse holder, remove the fuse and replace with one of the supplied 5-Amp fuses.

CLEANING

CAUTION!

Improper care of the camera window can cause damage to its anti-reflective coating, degrade the camera's performance, and void the camera warranty. Clean the camera window only with low-pressure fresh water and a soft cloth. If the front window of the camera gets water spots, wipe it with a clean lens cloth folded in fourths and dampened with fresh water.

INTRO TO INFRARED TECHNOLOGY

The Navigator II detects differences in heat and displays them as black and white TV video. It may look like a black and white version of what your eyes see, but it's not. The Navigator II sees heat, not light. The sooner you can understand and get comfortable with that difference, the more you will enjoy this incredible technology.

Why things look the way they do

The Navigator II's thermal imager makes video images from differences in heat, not from the light you see every day. It senses the minute differences in heat between objects, and (in white hot mode) displays the warmer objects as white (or lighter shades of gray), and colder objects as black (or darker shades of gray).

Everything you encounter in your day-to-day existence gives off heat – even ice! Chances are that the hotter something is, the easier it will be to see.

While most things give off their own heat, some things actually reflect the heat given off by other things. Water and polished metal, for example, aren't as hot as they appear when they reflect sunlight, or the heat generated by other vessels.

What's more, some things that are the same temperature (or close to it) look different because of their different surface textures.

IR energy doesn't go through glass or water efficiently, so Navigator II won't let you see well through glass.

Thermal imagers are passive – they only receive incoming energy. They don't "see through" anything. While you might think you are seeing through a vessel's hull to see the bulkheads and heat from the engine, you're not. These elements are actually changing the temperature of the hull itself, allowing you to see the bulkheads and the hot engine room.

As you experiment with your Navigator II, you will begin to see a world of heat. Consider every object you view in terms of how it will look "thermally", as opposed to how it looks in the visible spectrum.

Weather

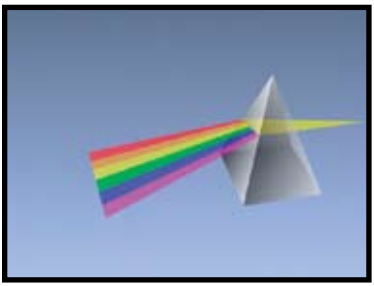
Environmental conditions, including time of day, humidity, and precipitation, will affect image quality and contrast. Fog, smog and rain will decrease the range at which you can detect a given target. After sunset, objects warmed by the sun during the day will radiate their stored heat for several hours. Early in the morning, many of these objects will appear cooler than their surroundings, so be sure to look for subtle temperature differences in the scene, not just hot (white) targets.

MORE ABOUT INFRARED

At first blush, new technologies can appear intimidating. Infrared cameras may seem imposing, but they are not so different from digital camcorders. In fact, you can get years of enjoyable, productive use out of your Navigator II without knowing anything in this section. But, if you would like to learn more about thermal imaging – how it was discovered and developed – read on.

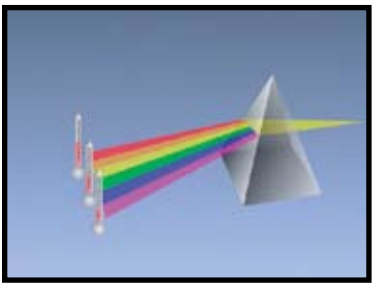
Infrared – the early years

The road to modern thermal imaging began way back in 1666, when Sir Isaac Newton used a prism to split white light into the colors of the rainbow. Today, we call this rainbow the "Visible Light Spectrum."

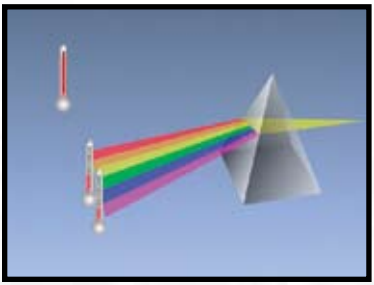


Newton's experiment proved that sunlight was not an indivisible whole, as was once thought, but was made of a range of subtly different light energies.

In 1800, Sir William Herschel took this discovery one step further, when he found that the different colors of the Visible Light Spectrum have different temperatures, which increase from the violet band of the spectrum to the red.



He did this by splitting sunlight with a prism and placing the darkened bulb of a thermometer in each color band. When he moved a thermometer past the red color band, Herschel found that the energy beyond visible red light was warmer than the red light itself. His name for this energy was "Calorific Rays." Today we call it "infrared radiation" or "thermal energy," and use the two terms interchangeably.



High school physics revisited

Infrared radiation combines with Gamma rays, X-rays, Ultra Violet, Visible Light, Microwaves and Radio Waves to form a range of energy called the Electromagnetic Spectrum.

These are not exotically independent types of energy – in fact, the primary difference between each of these types of radiation is wavelength: Radio Waves have the longest wavelength and Gamma Rays have the shortest. Wavelengths are measured in micrometers, or "microns" (μ), which are equal to one millionth of a meter.

Infrared radiation wavelengths are longer than those of visible light. Visible light wavelengths range from 0.4μ to 0.75μ, while infrared is between 1μ and 15μ. Thermal imagers make pictures from either the 3-5μ range (called mid wave IR [MWIR]), or the 8-12μ range (called long wave IR [LWIR]).

Thermal images may look like black & white photographs, but the two types of images are actually quite different. Photographic cameras create images from reflected light energy, while infrared cameras create images from radiated thermal energy.

The amount of radiated thermal energy that reaches the Navigator II imager is a function of the viewed object's temperature and emissivity. This relationship between temperature and emissivity can be a complex one, but we'll sum it up with two basic rules:

1) The hotter an object gets, the more infrared energy it radiates. Even a small increase in temperature can result in a dramatic increase in the amount of radiated thermal energy.

2) At a given temperature, the amount of thermal energy radiated by an object depends on its emissivity. Emissivity is the measure of an object's efficiency at radiating thermal energy. For example, shiny metals are poor emitters. Instead of radiating their own thermal energy, they tend to reflect radiation from their surroundings.

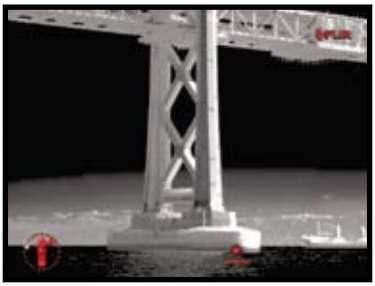
Infrared, from theory to practical application

Infrared imagers operate by detecting the relative intensities of thermal energy radiated from the surfaces of objects, and displaying these intensities in black and white video as shades of gray. They do not show a "heat picture." Even if an object is very hot, it may not display well if there is little or no temperature contrast between the object and its surroundings.

Thermal imagers primarily detect thermal energy radiated from an object's surface; thermal imagers can't "see through" much of anything, except some plastics and nylon materials.

As you look at the thermal images created with your Navigator II, you will see multiple sources of thermal energy in addition to your main object of interest. When looking at a scene with a large number of heat sources, it can get confusing trying to sort it all out. Kirchhoff's Law is an easy way to account for the different sources of thermal radiation you see in your images. Kirchhoff says that all of the thermal radiation in an image has been Emitted (given off by an object), Transmitted (passed through an object), or Reflected (bounced off an object).

Most of the strong energy sources you will see in a given scene are from "emitted" energy. That is, they are giving off heat energy. Examples of strong emitters of thermal energy include people and boat engines.



Thermal energy doesn't pass through much, but it does "transmit" through some plastics. When a material is not transparent to infrared radiation, it is said to be "opaque." Most commonly viewed materials are opaque to infrared radiation.

Materials that mirror the infrared signatures around them are "reflective." Everything is reflective to one degree or another, but the most highly reflective objects are those made of polished, unpainted metal. Painted metals, glass, and even wood can display greater or lesser degrees of reflectivity, but this becomes dependent upon myriad factors like their surface coatings, textures, and the angles from which they are viewed. Reflections can appear hotter or colder than they really are, based on what they are reflecting. Sun reflecting off of polished chrome looks quite bright, and a common mistake is to think that this section of chrome has suddenly become very hot. It hasn't, it is just reflecting energy from the sun. Look also at the two images on the previous page, and note the reflections of thermal energy from the bridge and boat off the water, which can readily reflect thermal energy.

Another reason to care about the weather

The time of day and weather conditions in which you use your Navigator II can have a significant influence on how objects look on the screen. Remember that thermal imagers detect and display differences in infrared radiation. If an object and its background do not display any appreciable temperature difference, that object will be very difficult to detect. Therefore, the time of day during which your Navigator II is used can have a direct impact on your ability to detect and recognize objects.

When things are exposed to the sun, they absorb infrared radiation. As the duration of this exposure increases throughout the day, thermal contrast between targets decreases.

When the sun begins to set, objects begin to cool. In doing so, they radiate some of this stored thermal energy back into the atmosphere, and a certain degree of thermal contrast is restored. This increase in contrast continues until the sun comes up the following morning. This daily sequence of heating and cooling is called the "Diurnal Cycle."

Atmospheric conditions can limit the range and imaging performance of your Navigator II. Under ideal conditions, most of the infrared energy radiated from an object gets through the atmosphere and to the imager. Under typical

conditions however, atmospheric moisture and dust scatter can absorb some of the radiated energy before it reaches the imager. The effect of this is to weaken the overall thermal signal and shorten the range at which you can detect it.

The weather can impact more than just the range at which the Navigator II can detect a specific object – it can also affect an entire scene's thermal contrast and affect overall system performance.

Cloud cover affects the diurnal cycle in two ways:

First, cloud cover decreases the amount of solar radiation allowed to strike the earth's surface, keeping days cooler and nights warmer.

Second, clouds form a layer of insulation over the earth, prevent heat from being radiated back into space at night.

Like clouds, humidity tends to reduce contrast and wash out the effects of the diurnal cycle. While humidity doesn't block out solar radiation during the day, it does tend to keep nights warmer.

Rain acts differently because water tends to cool the surfaces it touches. Remember that thermal imagers only detect differences in thermal energy radiated from an object's surface; therefore, rain can markedly reduce a scene's contrast. While rain reduces contrast between objects with no heat source, it will allow objects with a heat source (like, people, animals, running vehicles, some structures) to show up with even more contrast to their now-cooler surroundings.

Conclusion

Tired? Confused? No problem. If you see something through your Navigator II that looks suspicious, don't get too hung up on trying to figure out why it looks the way it does. Just remember: if something is in your way, play it safe and steer clear!

APPENDIX A
PARTS AND ACCESSORIES

APPENDIX

Parts List

The Navigator II includes the following thermal imaging components:

If the components you have are different from those enumerated in this Parts List, please call us immediately at 888.747.3547.

STATIC NAVIGATOR II		FLIR Part Number
Navigator II camera with attached 25' cable and wired On/Off switch with fuse holder. The camera and switch plate come with gaskets attached.	white color, NTSC	432-0001-01-00
	white color, PAL	432-0001-03-00
Navigator II slow video (9 Hz) camera with attached 25' cable and wired On/Off switch with fuse holder. The camera and switch plate come with gaskets attached.	white color, NTSC	432-0001-01-00S
	white color, PAL	432-0001-03-00S
Two sets of mounting hardware for the camera, one set of mounting hardware for the On/Off switch, 5-amp fuses, 10 cable clips and wood screws, and a BNC to RCA adapter.		
Navigator II Operator's Manual		432-0001-00-11

Accessories

FLIR Systems makes a family of extension cables and remote video/control station kits for Navigator II systems. The cables may be combined to a total length of 100 feet. The part numbers are as follows:

	FLIR Part Number
25' Extension Cable for Static Navigator II	308-0128-00
50' Extension Cable for Static Navigator II	308-0130-00
Video Extension Kit, contains: Video amplifier, 25' video cable, 50' video cable, and wiring instructions	432-0001-14-01
FLIR lens cleaning kit	

PAN/TILT NAVIGATOR II

		FLIR Part Number
Navigator II camera with attached 25' cable and wired Joystick Control Unit with fuse holder. The camera and Joystick come with gaskets attached.	white color, NTSC	432-0001-09-00
	white color, PAL	432-0001-11-00
Navigator II slow video (9 Hz) camera with attached 25' cable and wired Joystick Control Unit with fuse holder. The camera and Joystick come with gaskets attached.	white color, NTSC	432-0001-09-00S
	white color, PAL	432-0001-11-00S
Two sets of mounting hardware for the camera, one set of mounting hardware for the Joystick Control Unit, 5-amp fuses, 10 cable clips and wood screws, and a BNC to RCA adapter.		
Navigator II Operator's Manual		432-0001-00-11

Accessories

FLIR Systems makes a family of extension cables and remote video/control station kits for Navigator II systems. The cables may be combined to a total length of 100 feet. The part numbers are as follows:

	FLIR Part Number
25' Extension Cable for Pan & Pan Tilt Navigator II	308-0129-00
50' Extension Cable for Pan & Pan Tilt Navigator II	308-0131-00
Video Extension Kit, contains: Video amplifier, 25' video cable, 50' video cable, and wiring instructions	432-0001-14-01
Dual Station Accessory Kit, contains: Joystick with 50' cable and installation instructions	432-0001-14-03
"Deluxe" Dual Station Accessory Kit, contains: Joystick with 50' cable, a Video Extension Kit, and installation instructions	432-0001-14-02
FLIR lens cleaning kit	

SPECIFICATIONS

System Overview	Static	Pan/Tilt
Size	7.3" x 4.0" x 7.4"	7.3" x 4.0" x 9.5"
Weight	6lb	7lb
Thermal Imaging Performance		
Sensor type	320 x 240 Microbolometer	320 x 240 Microbolometer
FOV	36° x 27°	36° x 27°
E zoom	N/A	2x
System Specifications		
Pan/Tilt Coverage	N/A	360° Az/ +/-45°
Video Output	NTSC or PAL	NTSC or PAL
Power Requirements	12VDC	12VDC
Environmental		
Operating Temp	-25°C to 55°C	-25°C to 55°C
Joystick Control Unit (JCU)		
Dimensions	N/A	3.25" x 6.13"

Document Number: 432-0001-00-11, Rev 100

The Navigator II imaging system is controlled by US export laws. There are special versions of this system that are approved for international distribution. Please contact FLIR Systems if you have any questions.

FLIR Systems, Inc.
70 Castilian Drive
Goleta, CA 93117
Phone: +1.888.747.FLIR (+1.888.747.3547)
www.flir.com