Ranger HRC MS™

Operator's manual

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Contact details

Postal address	FLIR Systems AB Sweden • P. O. Box 3 • SE-182 11 Danderyd • Sweden
Telephone	+46 (0)8 753 25 00
Telefax	+46 (0)8 731 05 30
Web site	www.flir.com
E-mail	imagingsweden.sales@flir.se

For contact details for regional offices, see the back cover of this manual.

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System overview

Ranger HRC MS is a high performance, long range surveillance system with multiple sensors.

Ranger HRC MS is a modular system that can be equipped with IR and TV cameras and additional sensors such as Laser Range Finder, Digital Magnetic Compass and GPS unit. The IR and TV cameras are available in a number of versions, with different range and field-of-view capabilities. Ranger HRC MS can be operated as a transportable stand-alone system, or configured into an IP network with multiple systems.

FLIR controls the entire supply chain for the critical technology inside the Ranger HRC MS system, ensuring fast service and long term support.

1.1 Main features

The Ranger HRC MS system offers the following main features:

- Cooled thermal detector for long range performance; designed for man-size target detection above 10 km and vehicle detection above 20 km.
- Large format thermal detector for wide range performance and high image quality.
- 12.5 x continuous infrared optical zoom, with clear image over the full zoom range.
- Auto focus functionality, proving an immediate clear and focused IR image.
- Digital Detail Enhancement (DDE) for high contrast images, even in the most challenging thermal conditions.
- TV camera options for powerful daylight imaging.
- Optional eye-safe Laser Range Finder unit for distance measurements.
- Optional GPS unit, for advanced GPS based geomapping.
- Optional Digital Magnetic Compass.
- Integrated pan and tilt mechanism, with precise positioning and variable control.
- Programmable autoscan functionality, which automatically moves the system from point to point in a preset autoscan list.

- Stand-alone configurations for transportable, fixed or legacy installations.
- IP network configuration for integration into existing IP based surveillance networks.
- Rugged, fully MIL qualified system, designed for harsh environments and operation 24/7/365.
- Compact, long range optics, which combines low weight and small size with high performance.

1.2 Applications

The Ranger HRC MS system is used in applications such as force protection, border surveillance, tactical reconnaissance, training range, fixed and mobile security, target tracking and long-range surveillance.

Ranger HRC MS is designed to meet the needs of the operator. The system offers the following operator benefits:

- Advanced and high performance thermal imaging enables situational awareness in the wide field-of-view, while maintaining detailed recognition capabilities in the narrow field-of-view.
- By seeing further and being able to recognizing more details, the operator can react quickly to security threats.
- As opposed to systems with a rotating lens system, there is no switching or swapping between the different images. The operator can gradually zoom in on a target, while keeping his focus all the time.
- The accurate and fast pan and tilt mechanism allows for easy tracking and following of fast moving objects.
- Repeatable position feedback and both fast and slow slew rates gives the operator full control also at maximal zoom.
- If connected to a radar system, Ranger HRC MS can automatically turn to a detected object. The visual image allows the operator to instantly see what the blip on the radar screen really means.
- The Ranger HRC MS can be configured for field transport and fast deployment. A single operator can set up the system in minutes, making it ideal for mobile operations and quick deployments.

General Safety Warnings

Before switching the power ON make sure that:

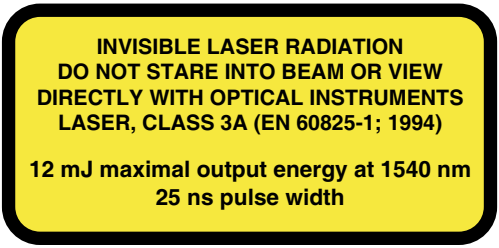
- All connectors are fastened properly
- All personnel is in a safe distance from moving parts
- The Pan/Tilt is free from obstacles

Before starting work on system components:

- Turn power off and disconnect the system cable before starting work on any system components.
- The operator must press the PRK button (on JCU Keypad) for more than 3 seconds to manually enable the pan/tilt.

When using a Laser:

- When using a system equipped with the optional Laser, be sure and read the Laser Warning Label (sample below).



- Do not open the Laser – Danger of high voltage electrical shock.
- Do not aim the Laser at highly reflective objects or surfaces (windows, mirrors or reflective sign boards) within a radius of <100 m since the powerful laser reflection will damage the laser's sensitive detector.

3 System description

Ranger HRC MS is a high performance, long range thermal imaging surveillance system with multiple sensors. Ranger HRC MS can be operated as a transportable stand-alone system, or configured into an IP network with multiple systems.

This chapter describes the Ranger HRC MS sub systems; cameras, sensors and other system components. Typical system configurations are described in chapter 4.

3.1 Cameras and sensors

The Ranger HRC MS is a modular system, which can be equipped with IR and TV cameras and additional sensors; such as Laser Range Finder, Digital Magnetic Compass and GPS unit. Both the IR and TV camera are available in a number of versions, with different range and field-of-view capabilities.

For detailed technical data of the cameras and sensors, see section 15.1.

3.1.1 IR Camera

The IR Camera is equipped with a cooled mid-wave detector, which offers long range performance in all weather conditions, through smoke and dust. The cooled detector also makes it possible to clearly see details in the image. The detector is designed for man-size target detection above 10 km and vehicle detection above 20 km.

The IR Camera has a continuous zoom, with clear image over the full zoom range. As opposed to systems with a rotating lens system, there is no switching or swapping between the different images. The operator can gradually zoom in on a target, while keeping his focus all the time. The camera is also equipped with a digital zoom and multiple preset field-of-view positions.

The IR Camera contains an auto focus feature that provides an immediate clear and focused image. Focus to a preset distance and manual focus is also provided.

The IR Camera has a set of automatic functions that ensure a high contrast image even in the most challenging thermal conditions, such as level and span adjustments, histogram equalization and Digital Detail Enhancement processing.

The IR Camera is a rugged and sealed unit, designed for harsh environments. There are heaters for defrosting of the front lens.

3.1.2 TV Camera

The TV Camera is a sensitive, high-magnification, color quality daylight camera, used for additional target identification when conditions permit.

The TV Camera is a standard item mounted in a rugged FLIR housing.

3.1.3 LRF

The Laser Range Finder (LRF) unit is an optional system component.

The LRF unit is a light weight eye-safe laser range finder, radiating in the 1.54µm Erbium glass wave length. The unit consists of a laser transmitter, a laser receiver, power supplies and control and signal processing electronics.

The LRF unit determines the distance to a target by measuring the time it takes for a laser pulse to go the target and back again. This time is converted to a distance.

For more information about distance measurements, see section 11.5.

3.1.4 GPS

The Global Positioning System (GPS) unit is an optional system component.

The Global Positioning System is a network of satellites that transmit accurate time and position information worldwide. GPS receivers receive signals from these satellites and use the information to determine an exact location. Satellites orbit the earth at around 12,000 miles. While a GPS receiver can detect signals from up to 12 satellites at any time, only

three signals are needed to provide a position or “GPS fix” (latitude and longitude) for vehicle navigation systems.

The GPS unit is an advanced device for GPS based geomapping, which is used to determine the exact position of the system.

The GPS unit consists of two parts, the external antenna and the internal electronics. In order to allow the GPS antenna to receive the GPS signals, the antenna must be outdoors with an unobstructed view of the sky. The GPS unit can operate in all weather types, except for heavy snowfall.

3.1.5 Digital Magnetic Compass

The Digital Magnetic Compass (DMC) unit is an optional system component.

The DMC unit is a high sensitivity precision instrument, which measures magnetic fields in three dimensions. The intention is to measure the geomagnetic field, in order to find magnetic north. However, also other magnetic fields near the DMC unit will be included in the result and have effect on the readings. For that reason, it is important that the system is placed away from any sources of magnetic interference; such as transformers, motors, radars, power lines and steel vehicles.

The geomagnetic field also has a declination (also referred to as variation or deviation) between magnetic north and true north. Each geographical location has its own fixed declination, in the order of a few to several degrees. A common situation is that there also is a variable declination over 24 hours in the order of tenths of degrees. In order to find true north, the local magnetic declination between magnetic north and true north must be entered into the system when the DMC unit is calibrated. A negative number corrects toward west and a positive number towards east.

For more information about DMC calibration, see section 10.3.1.

3.2 System components

In addition to the cameras and sensors, the system includes components for pan/tilt, signal distribution, power supply, etc.

For part numbers of the cables, please refer to the Parts list in section 15.2. For an overview of the location of the connectors, see section 15.4.

3.2.1 Pan/Tilt

The Pan/Tilt unit is a rugged two axis pan and tilt mechanism. The Pan/Tilt unit is equipped with a left and a right mounting plate, where the IR and TV and cameras are mounted. On top of the Pan/Tilt unit, there is a housing for the LRF, DMC and GPS units.

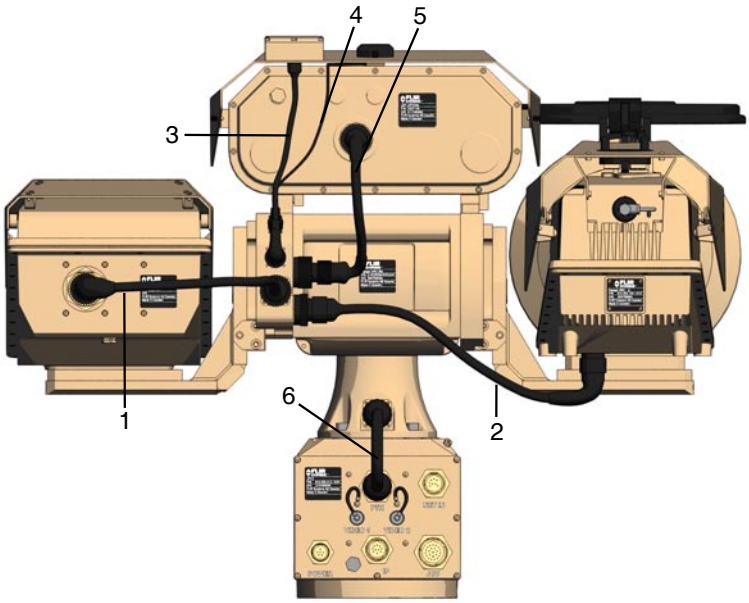


Figure 3.1 Pan/Tilt connections.

Pan/Tilt connections	
Callout	**Description**
1	**TV camera cable** The TV Camera cable is connected to the X3 connector on the Pan/Tilt unit and to the TV Camera.
2	**IR camera cable** The IR Camera cable is connected to the X2 connector on the Pan/Tilt unit and to the IR Camera.
3	**GPS antenna cable** The GPS antenna cable is connected to the X4 connector on the Pan/Tilt unit and to the GPS unit.
4	**DMC cable** The DMC is connected to the X5 connector on the Pan/Tilt unit and to the DMC unit.
5	**LRF cable** The LRF cable is connected to the X6 connector on the Pan/Tilt unit and to the LRF unit.
6	**System cable** The System cable is connected to the X1 connector on the Pan/Tilt unit and to the PTH connector (J15) on the JPC2 unit.

3.2.2 Junction Protocol Converter (JPC2)

The Junction Protocol Converter (JPC2) is the system control unit. The System Software is executed from the JPC2 unit. The JPC2 can be configured for stand-alone operation or configured into an IP network.

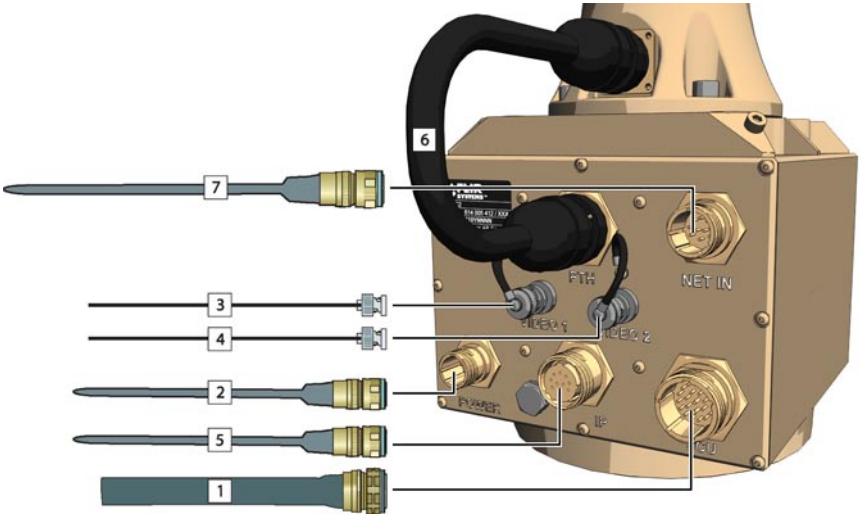


Figure 3.2 JPC2 connections.

JPC2 connections	
Callout	**Description**
1	**System cable** or **JCU cable** When the system is controlled from a remotely located Joystick Control Unit, the System cable is connected to the JCU connector (J1) on the JPC2 unit and to: • the J5 connector on the Junction Box, or • the J5 connector on the Power Box. When the system is controlled from a directly connected Joystick Control Unit, the JCU cable is connected to the JCU connector (J1) on the JPC2 unit and to the J10 connector on the Joystick Control Unit.
2	**Power cable** The Power cable is connected to the POWER connector (J2) on the JPC2 unit and to the Power Supply unit. **NOTE:** The POWER connector (J2) on the JPC2 unit must not be used when power is supplied via the System cable from the Junction Box or Power Box.

JPC2 connections	
Callout	**Description**
3	**Video cable** The Video cable is used to connect a video monitor directly to the JPC2 unit. The Video cable is connected the VIDEO 1 connector (J3) on the JPC2 unit. **NOTE:** The VIDEO 1 connector (J3) corresponds to the J6 connector on the Junction Box.
4	**Video cable** The Video cable is used to connect a video monitor directly to the JPC2 unit. The Video cable is connected to the VIDEO 2 connector (J11) on the JPC2 unit. **NOTE:** The VIDEO 2 connector (J11) corresponds to the J7 connector on the Junction Box.
5	**Ethernet cable** The Ethernet cable is used to connect a LAN switch in an IP network to the JPC2 unit. The Ethernet cable is connected to the IP connector (J14) on the JPC2 unit. **NOTE:** The maximum cable distance between the JPC2 and the LAN switch is 100 m/ 328 ft. **NOTE:** The possibility to connect the system an IP network is an extra option. The IP connector (J14) is only available if the IP network option has been chosen.
6	**System cable** The System cable is connected to the PTH connector (J15) on the JPC2 unit and to the X1 connector on the Pan/Tilt unit.
7	**Host cable** The Host cable is used when the system is controlled from an external computer. The Host cable is connected to the NET IN connector (J16) on the JPC2 unit. **NOTE:** The possibility to connect an external computer to the JPC2 unit is an extra option. The NET IN connector (J16) is available on request.

3.2.3 Junction Box

The Junction Box is the central power and signal distribution hub for the system. Through this unit, power (+28VDC) is distributed to the main sub systems. Command, data and control signals are distributed to the appropriate sub systems for processing. The Junction Box also provides interface connections to other systems, such as Host Control Systems (HOST). The Junction box has a standard set of features, such as video output buffers and host communication signal conditioning.

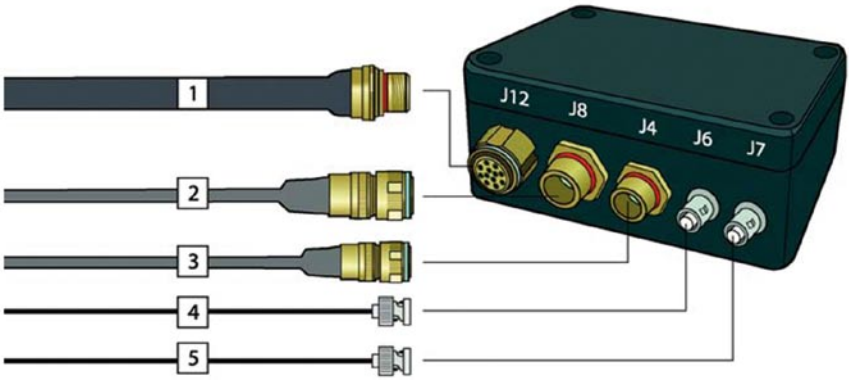


Figure 3.3 Junction Box connections, front side.

Junction Box connections, front side	
Callout	**Description**
1	Reserved for future capabilities.
2	**Host cable** The Host cable is used when the system is controlled from an external computer. The Host cable is connected to the J8 connector on the Junction Box.
3	**Power cable** The Power cable is connected to the J4 connector on the Junction Box and to the Power Supply unit.
4	**Video cable** The Video cable is connected to the J6 connector on the Junction Box and to an external video monitor. **NOTE:** The J6 connector corresponds to the VIDEO 1 connector (J3) on the JPC2 unit.

Junction Box connections, front side	
Callout	**Description**
5	**Video cable** The Video cable is connected to the J7 connector on the Junction Box and to an external video monitor. **NOTE:** The J7 connector corresponds to the VIDEO 2 connector (J11) on the JPC2 unit.

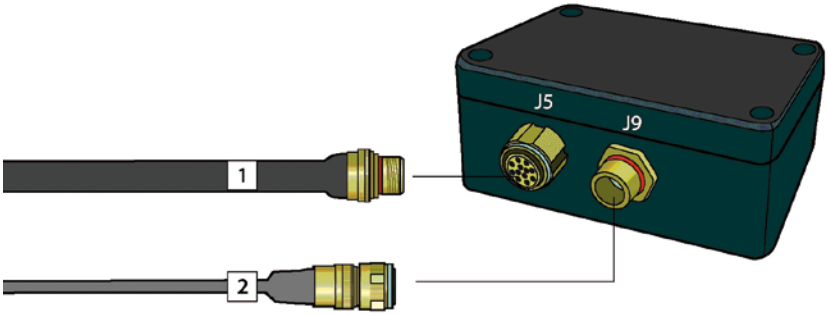


Figure 3.4 Junction box connections, rear side

Junction Box connections, rear side	
Callout	**Description**
1	**System cable** The System cable is connected to the J5 connector on the Junction Box and to the JCU connector (J1) on the JPC2 unit.
2	**JCU cable** The JCU cable is connected to the J9 connector on the Junction Box and to the J10 connector on the Joystick Control Unit (JCU).

3.2.4 Power Supply

The Power Supply unit converts AC mains (85–264 VAC, 47–440 Hz) to +28 VDC, which is used by all sub systems. The Power Supply unit is either connected to the Junction Box or directly to the JPC2 unit.

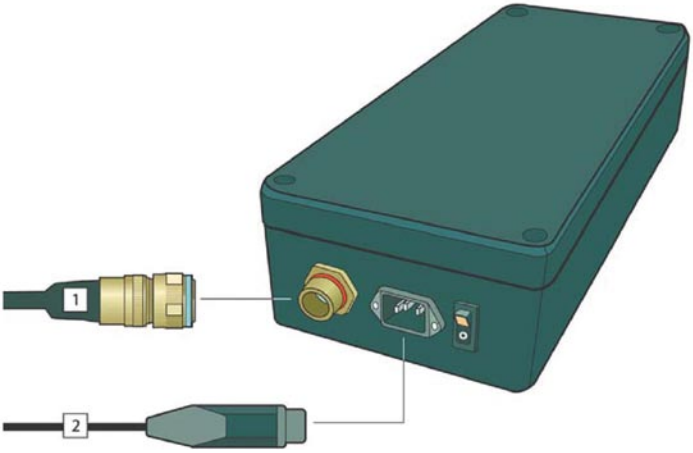


Figure 3.5 Power Supply connections

Power Supply connections	
Callout	**Description**
1	**Power cable** The Power cable is connected to the Power Supply unit and to: • the J4 connector on the Junction Box, or • the POWER connector (J2) on the JPC2 unit.
2	**AC Mains cable** The AC Mains cable is connected to the power inlet on the Power Supply unit and to the AC mains supply. The Power cable is shipped either with a European or a US standard AC power plug.

3.2.5 Power Box

The Power Box is the Junction Box and the Power Supply unit integrated in a 19” case.

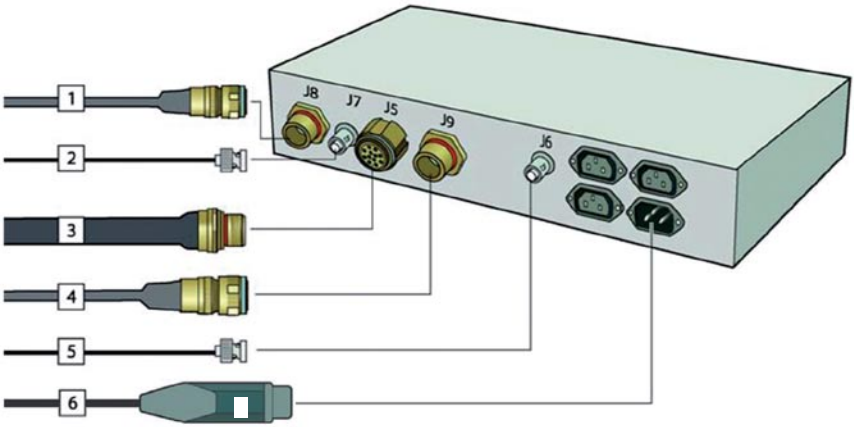


Figure 3.6 Power Box connections.

Power Box connections	
Callout	**Description**
1	**Host cable** The Host cable is used when the system is controlled from an external computer. The Host cable is connected to the J8 connector on the Power Box.
2	**Video cable** The Video cable is connected to the J7 connector on the Power Box and to an external video monitor. **NOTE:** The J7 connector corresponds to the VIDEO 1 connector (J3) on the JPC2 unit.
3	**System cable** The System cable is connected to the J5 connector on the Power Box and to the JCU connector (J1) on the JPC2 unit.
4	**JCU cable** The JCU cable is connected to the J9 connector on the Power Box and to the J10 connector on the Joystick Control Unit (JCU).

Power Box connections	
Callout	**Description**
5	**Video cable** The Video cable is connected to the J6 connector on the Power Box and to an external video monitor. **NOTE:** The J6 connector corresponds to the VIDEO 2 connector (J11) on the JPC2 unit.
6	**AC Mains cable** The AC Mains cable is connected to the power inlet on the Power Box and to the AC mains supply. The Power cable is shipped either with a European or a US standard AC power plug. **NOTE:** The three power outlets can be used to connect for instance the video monitors and other equipment.

3.2.6 Joystick Control Unit

The Joystick Control Unit (JCU), with its joystick and keypad buttons, is used to control the system. The joystick provides continuously variable cross-coupled (X to Y axis) control of the system's azimuth and elevation position. With the keypad buttons, frequently used functions are quickly executed. The JCU is also used to navigate in the menu system of the System Software.

For more information about the JCU, see chapter 6.

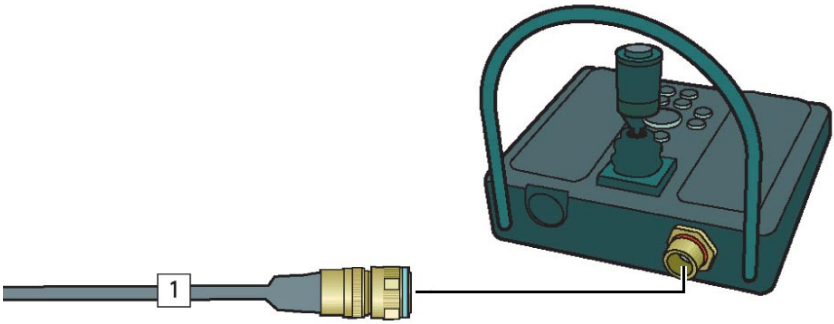


Figure 3.7 Joystick Control Unit.

Joystick Control Unit connections	
Callout	**Description**
1	**JCU cable** The JCU cable is connected to the J10 connector on the Joystick Control Unit and to: • the JCU connector (J1) on the JPC2 unit, or • the J9 connector on the Junction Box, or • the J9 connector on the Power Box.

3.2.7 Remote Power Controller

The external Remote Power Controller (RPC) unit is an optional unit that is used to reduce the power consumption of the system. When the system is equipped with the RPC unit, it is possible to power off the entire system with a simple keypad button sequence on the JCU, see section 11.1.3.

NOTE: The system has a remote power control function also without the RPC unit. However, in this case only the cameras and the sensors are powered on/off with the keypad button sequence.

3.3 System control

The Ranger HRC MS system can be configured for stand-alone operation or for operation in an IP network with multiple systems. With the stand-alone configuration, the system is controlled via the System Software running on the JPC2 unit. With the IP network configuration, a standard PC running a security and surveillance application – such as the FLIR Nexus application – is used to control the Ranger HRC MS systems. The Joystick Control Unit can be used in both configurations.

It is possible to access the IR Camera software, which offers advanced features for optimization of the IR image, from both the System Software and from the FLIR Nexus application.

The System Software is described in detail in chapter 7. The IR Camera software is described in detail in chapter 8.

For information about the IP network configuration, see section 15.9. For information about the FLIR Nexus application, please refer to the Nexus manual.

4 System Configurations

The Ranger HRC MS is a modular system, which can be equipped with IR Camera, TV Camera, optional sensors and system components.

IR cameras:	Ranger HRC-U Ranger HRC-S
TV cameras:	LR-TV UR-TV SR-TV
Sensors:	Laser Range Finder (LRF) Digital Magnetic Compass (DMC) GPS
System components:	JPC2 Pan/Tilt

For detailed technical data of the cameras, sensors and system components, see section 15.1.

There are six main configurations of the Ranger HRC MS system, as shown in the figures below.

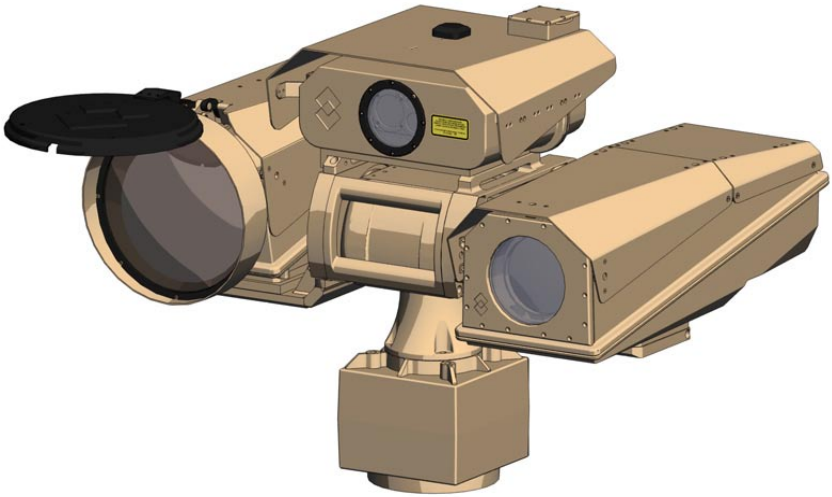


Figure 4.1 Ranger HRC-U, LR-TV, LRF, DMC, GPS, JPC2 and Pan/Tilt.

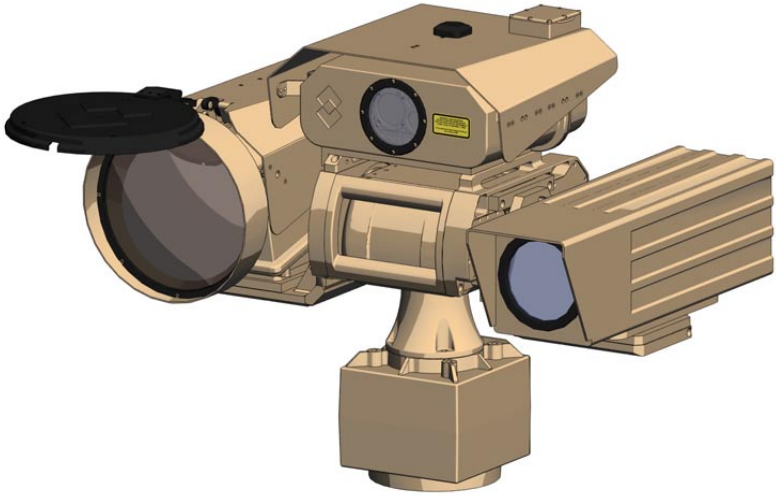


Figure 4.2 Ranger HRC-U, UR-TV, LRF, DMC, GPS, JPC2 and Pan/Tilt.

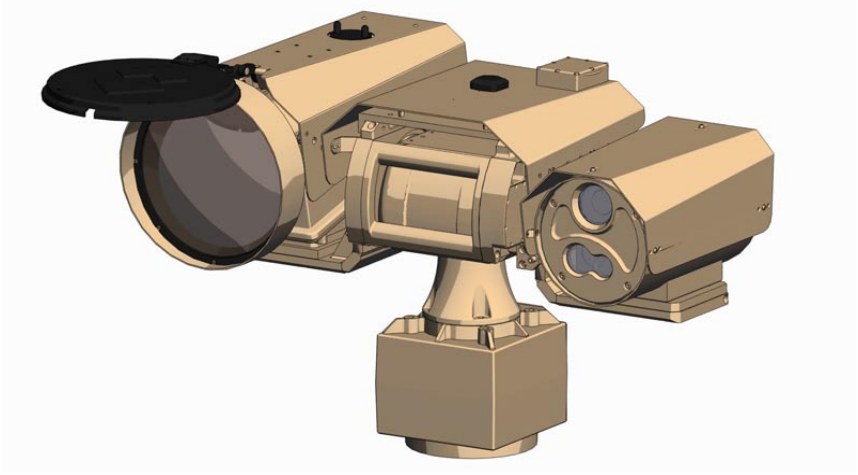


Figure 4.3 Ranger HRC-U, SR-TV, DMC, GPS, JPC2 and Pan/Tilt.

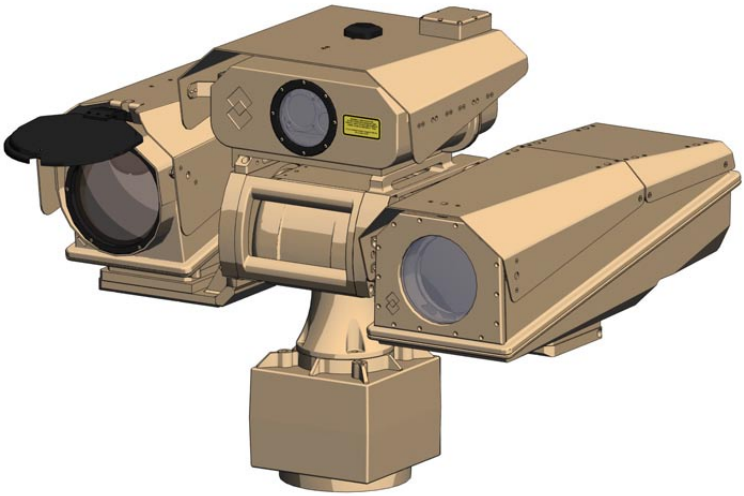


Figure 4.4 Ranger HRC-S, LR-TV, LRF, DMC, GPS, JPC2 and Pan/Tilt.

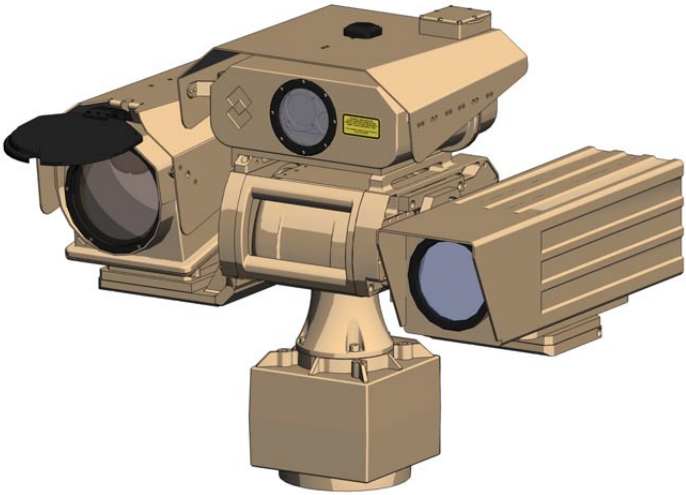


Figure 4.5 Ranger HRC-S, UR-TV, LRF, DMC, GPS, JPC2 and Pan/Tilt.

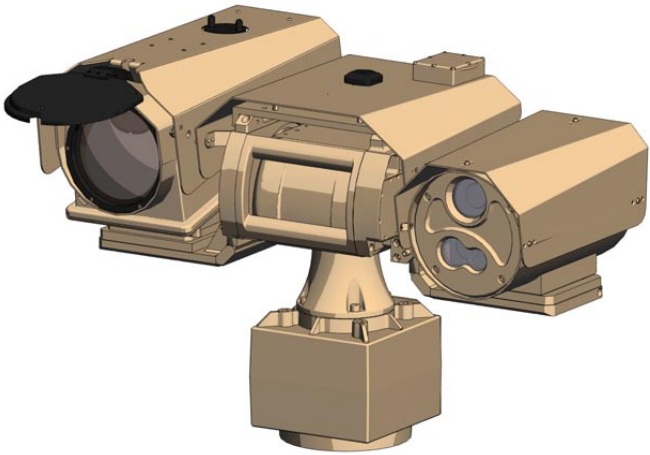


Figure 4.6 Ranger HRC-S, SR-TV, DMC, GPS, JPC2 and Pan/Tilt.

5 Functions and features

This chapter provides more detailed information about some of the functions and features of the Ranger HRC MS system.

5.1 Operating modes

The Ranger HRC MS system operates in six different operating modes; NORMAL, AUTOSCAN, PARK, LRF, MENU and PROG POSITION mode. Each mode is a combination of settings and functions designed to assist the operator in performing a particular task.

The functions of the joystick and the keypad buttons on the Joystick Control Unit (JCU) depend on the operating mode of the system, see chapter 6.

5.1.1 NORMAL mode

NORMAL mode is the default mode.

In NORMAL mode, the JCU is used to pan and tilt the system, to move the system to the preset field-of-views, to zoom in and out, to focus, etc.

5.1.2 AUTOSCAN mode

In AUTOSCAN mode, the system is automatically moved from point to point in a preset autoscan list.

While the system is in AUTOSCAN mode, it tracks the preset position during changes in azimuth, elevation, field-of-view, focus and zoom settings. The autoscan points are programmed when the system is in PROG POSITION mode. It is possible to define up to 32 autoscan points, in up to five autoscan lists. For instructions on programming of autoscan points and management of autoscan lists, see section 11.4.

AUTOSCAN mode can be entered from NORMAL and PARK mode, by pressing the **SCN** button on the JCU. AUTOSCAN mode can also be entered from the menu system, with the *Start autoscan* feature. If autoscanning is started by pressing the **SCN** button, the system will resume

the autoscan from the currently selected autoscan point (if the scan was previously stopped or if the operator has used the LEFT/RIGHT buttons to step through the different positions). When AUTOSCAN mode is entered from the menu system, autoscanning will start with the first autoscan point in the current autoscan list. If no autoscan points have been defined, it is not possible to enter AUTOSCAN mode.

When the system is in AUTOSCAN mode, “Autoscan” is displayed in the upper left corner of the monitor.

5.1.3 PARK mode

In the PARK mode, the system is parked either in the home position or in the mechanical home position.

The home position is defined by the operator. It can for example be true north, which is obtained with a calibration of the Digital Magnetic Compass (DMC), or a specific target, such as a gateway or an entrance door. For instructions on how to define the home position, see section 10.3.

When the system is in the mechanical home position, the cameras and sensors are directed straight forwards. This position is recommended before the system is turned off.

When the **PRK** button is pressed > 1 second, the system is sent to the mechanical home position, the lens cover of the IR camera is closed and PARK mode is entered.

When the **PRK** button is pressed < 1 second, the system is sent to the home position. If the **PRK** button is pressed < 1 second again when the system is in home position, the lens cover of the IR camera is closed and PARK mode will be entered.

PARK mode can also be entered from the menu system. The *Park pan/tilt* feature in the **Pan/Tilt** menu sends the system to the home position. If the *Park pan/tilt* feature is selected a second time when the system is in home position, the lens cover is closed and PARK mode is entered

When the system is in PARK mode, “Parked” is displayed in the center of the monitor.

5.1.4 LRF mode

When the system is in LRF mode, the Laser Range Finder (LRF) unit is active and can be used to measure the distance to a target.

For instructions on how to measure distances with the LRF unit, see section 11.5.

LRF mode is entered by pressing the **FCN** + **INV** buttons simultaneously in NORMAL mode or by selecting the *Activate laser* feature in the **LRF** menu.

When the system is in LRF mode, “Laser ready”, “Laser charging” or “Laser not ready” is displayed in the upper left corner of the monitor.

5.1.5 MENU mode

When the system is in MENU mode, the menu system of the System Software is displayed, which gives access to the features of the system. The JCU is used to navigate in the menu system and to execute actions.

MENU mode is entered by pressing the ENTER button in NORMAL or PARK mode.

5.1.6 PROG POSITION mode

When the system is in PROG POSITION mode, new autoscan points can be defined and existing points can be edited.

For instructions on how to define and edit autoscan points, see section 11.4.

PROG POSITION mode is entered by pressing the **FCN** button in AUTOSCAN mode or via the *Go to position*...feature in the **Pan/Tilt** menu.

When the system is in PROG POSITION mode, “Prog position” is displayed in the upper left corner of the monitor.

5.2 IR image optimization

The quality of the IR image depends on many factors, such as target temperature, ambient temperature, distance to target, etc. The IR Camera has a number of functions – automatic and manual – that are used to control the image quality.

5.2.1 Non-Uniformity Correction

Non-Uniformity Correction (NUC) is a function that performs an internal calibration of the IR camera.

NUC can be performed in three different ways. With Internal NUC, the image is calibrated against a shutter inside the camera (Internal shutter). With External NUC, either the lens cover (External shutter) or the scene (Shutter off) is used as thermal reference.

The normal procedure is to start with an Internal NUC. If an acceptable image quality is not achieved, an External NUC against the lens cover or against the scene may improve the image.

At startup of the system, NUC has to be performed frequently (every 5 minutes) as the temperature of the IR Camera changes. After about 30 minutes, NUC is only needed when the quality of the image is degenerated.

5.2.2 Adjustment area

The IR Camera automatically adjusts the image based on the scene contents. By selecting different adjustment areas, it is possible to control which part of the scene that shall be used when adjusting the image.

The selected area has an impact on the adjustments of level (brightness), span (contrast) and color distribution, as illustrated in the figures below.

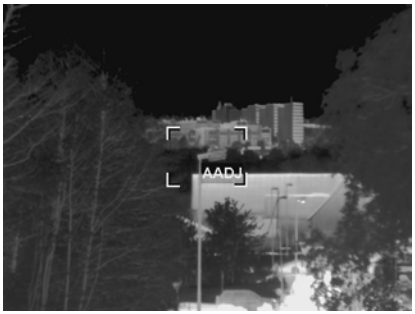


Figure 5.1 Adjust Area 1.

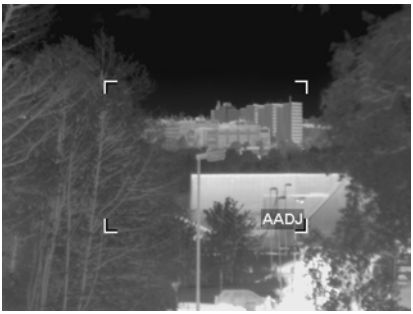


Figure 5.3 Adjust Area 2.

Figure 5.2 Adjust Area 3.

Figure 5.4 Adjust Area 4.

Figure 5.5 Adjust Area 5.

5.2.3 Adjustment modes

There are four adjustment modes selectable via the IR Camera menu system; Auto Level, Auto Level-Span, DDE and Manual.

- In Auto Level mode, level is automatically adjusted.
- In Auto Level-Span mode, both level and span are automatically adjusted.
- DDE (Digital Detail Enhancement) is an automatic adjustment mode for level and span, which also enhances the visibility of details in the scene.
- In Manual mode, level and span adjustments are made manually.

The most suitable mode depends on many factors. Auto mode normally gives a good image quality, but in scenes with low or high contrast DDE and/or Manual mode may be better.

5.2.4 Adjust image

Adjust image is a feature that allows manual adjustments of the image with regards to level and span, or the corresponding brightness and contrast.

In Auto Level-Span and DDE mode, level and span are automatically adjusted. The *Adjust image* feature makes it possible to tune the automatic values, by adjusting brightness and contrast with a percentage offset.

In Auto Level mode, level is automatically adjusted. The *Adjust image* feature is used to manually adjust the span value. The *Adjust image* feature also makes it possible to tune the automatic level value, by adjusting brightness with a percentage offset.

In Manual mode, both level and span are adjusted manually. Frequent adjustments and fine-tuning are needed to achieve a good image quality.

5.2.5 Color Distribution

There are two Color Distribution modes; Linear and Histogram.

- In Linear mode, the colors are distributed linearly from the darkest to the brightest pixel in the image.
- In Histogram mode, the colors are distributed based on the contents of the image.

The Histogram mode normally gives the best image, but for small details the Linear mode may be better. The Linear mode also gives a more intuitive perception of the temperature contents.

5.2.6 Digital Detail Enhancement

Digital Detail Enhancement (DDE) is a function that enhances the visibility of details in the IR image.

In principle, DDE separates the image signal into two parts:

- The background image, which contains the low frequency, high amplitude part if the image.
- The detail image, which contains the high frequency, low amplitude part of the image.

The two parts can be scaled separately, before they are merged to produce an output image. This allows the system to output an image where fine details are visible even in a very high dynamic range scene.

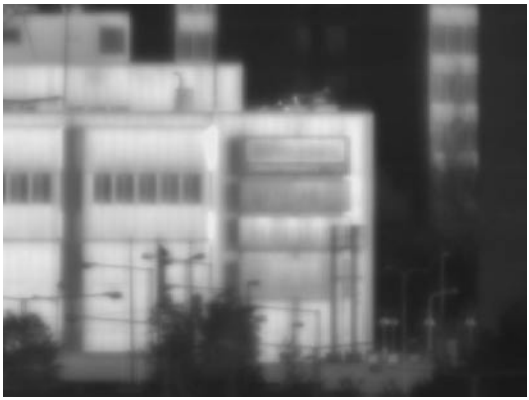


Figure 5.6 DDE turned off.

Figure 5.7 DDE turned on.

5.2.7 DDE filter

The DDE filter enables control of details, separated from the control of the dynamic range of the background. The filter operates as a powerful noise filter at one end and as very strong detail enhancing filter at the other end.

The *DDE Control* feature allows tuning of the DDE filter. The setting of the DDE filtering function (1-100%) allows a continuous control from softening filter with noise reduction (low value) to sharpening filter with detail enhancement (high value).

The DDE Control setting under normal conditions is a matter of personal taste. In low contrast scenes, for example in rainy and foggy weather, a low DDE Control value is recommended (0–20). In high contrast scenes, for example a sunny day in the desert, a high DDE Control value is recommended (60–100). The default DDE Control value is 60.

Figure 5.8 DDE is turned off.

Figure 5.9 DDE is set to 1%. Noise and fine details are removed.

Figure 5.10 DDE is set to 70%.

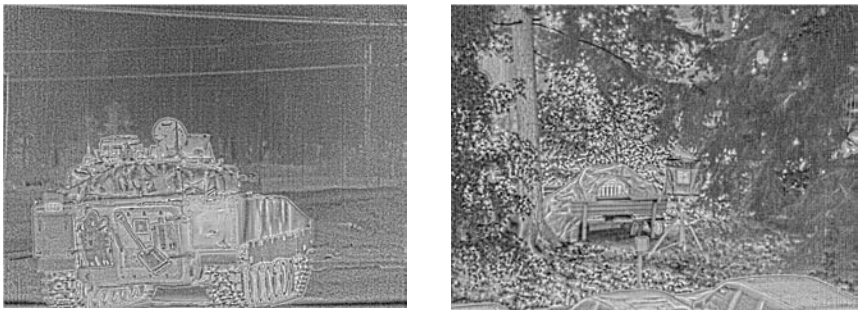


Figure 5.11 DDE set to 100%. The filter functions as an extreme detail booster.

5.2.8 Filter

Filter is a function that reduces the noise visible in the image in low contrast scenes. Low and high filtering is available

Normally the Filter shall be set to Off. In low contrast scenes, the Filter shall be set to Low or High to improve the image.

Filtering is normally not suitable for moving targets, as it may cause smearing in the image presentation.

5.2.9 IR palette

There are four different IR palettes:

- Rainbow
- Rainbow HC
- Gray
- Iron

The default IR palette is Gray. Changing the palette from Gray to Rainbow may improve the perception of details in low contrast scenes.

All IR palettes are possible to invert. With the Gray palette for example, white or black can be set to represent hot (whitehot is default). Inverting the palette may have an effect on how the image is perceived.

5.2.10 Zoom interpolation

Zoom interpolation is a function that has effect when the digital zoom is used.

Interpolation is a mathematical process used to estimate values between known point observations. The camera software interpolates the resolution by mathematically analyzing what would be the most plausible value of the closest neighbor of a pixel.

- Zoom interpolation On gives a smoother image.
- Zoom interpolation Off gives a pixilated image.

The default setting of Zoom interpolation is On.

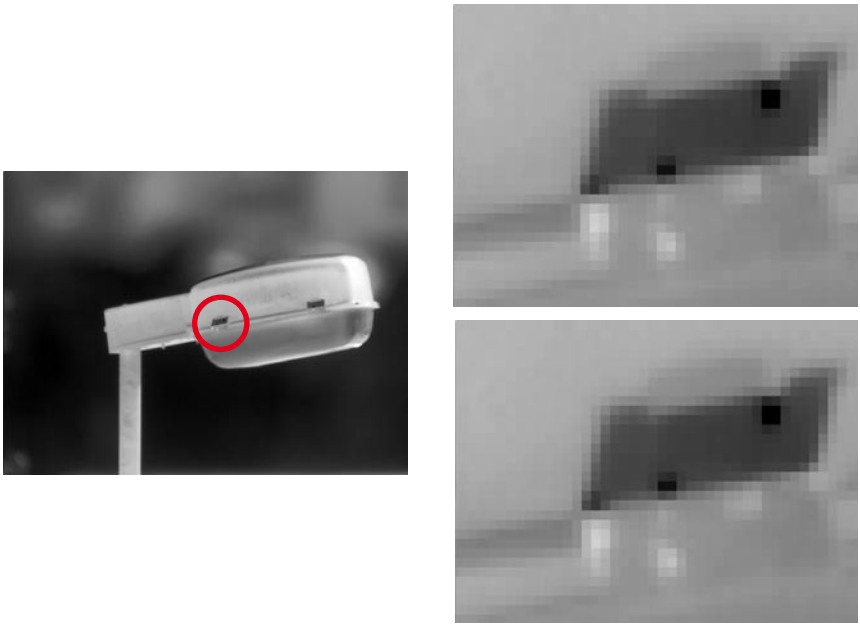


Figure 5.12 Digital zoom with interpolation turned on (upper right image) and with interpolation turned off (lower right image).

Joystick Control Unit

The Joystick Control Unit (JCU), with its joystick and keypad buttons, is used to control the Ranger HRC MS system.

6.1 Overview

The main parts of the Joystick Control Unit are the joystick (with a rotating collar and a push button) and the keypad with push buttons. All buttons are back-lit for operator convenience. There is also a control for the backlight and two LED indicators.

Figure 6.1 Joystick Control Unit.

Joystick Control Unit	
Callout	**Description**
1	Joystick with rotating collar and push button.
2	FCN button
3	SCN button
4	Reserved for future capabilities.
5	Reserved for future capabilities.
6	TV/IR button

Joystick Control Unit	
Callout	**Description**
7	INV button
8	C button/CANCEL button
9	Backlight control. Turn the control left/right to increase/decrease the backlight of the push buttons.
10	NUC button
11	Status indicator for communication between the Joystick Control Unit and the imaging unit. At start up, the indicator has a flashing light. During normal use, the light is steady.
12	System heater indicator. If the system heaters are on, the indicator is lit.
13	PRK button
14	Navigation keypad
15	FRZ button
16	ENTER button

6.2 Joystick and keypad buttons

The functions of the joystick and the keypad buttons depend on the system mode. The functions for the NORMAL, AUTOSCAN, PARK, LRF, MENU and PROG POSITION modes are described in the tables below.

For more information about the system operating modes, see section 5.1.

6.2.1 NORMAL mode

NORMAL mode is the default mode.

There are two different settings for the JCU – Original and Alternative – with somewhat different functions for the joystick and the keypad buttons. The setting is made in the *Setup – Maintenance* dialog box, see section 7.6.1.6. The functions for both the Original and the Alternative settings are described in the table.

JCU joystick and keypad – NORMAL mode		
Feature	**ORIGINAL setting**	**ALTERNATIVE setting**
Joystick	Move the joystick to the left/right to pan the system left/right. Move the joystick forwards/backwards to tilt the system up/down. **NOTE**: The default tilt behavior (above) can be inverted in the *Setup -Pan/Tilt* dialog box, see section 7.6.1.3.	
Joystick collar	Turn the joystick collar to the left/right to focus near/far.	Turn the joystick collar to the left/right to zoom out/in. Press the **FCN** button and turn the joystick collar to the left/right to focus near/far.
Joystick button	Press the joystick button < 1 second to go to the next field-of-view. Press the joystick button > 1 second toggle between Slave mode on/off, see section 7.5.1.	Press the joystick button < 1 second to perform a one-shot auto focus adjustment. Press the joystick button > 1 second to toggle between Slave mode on/off, see section 7.5.1.
FCN	Button **FCN** is used together with other buttons to provide additional functionality.	
SCN	Press the **SCN** button to enter AUTOSCAN mode. If there are no autoscan points, there will be no action.	
ID	Reserved for future capabilities.	
TV/IR	Press the **TV/IR** button to toggle between TV imaging and IR imaging.	
INV	Press the **INV** button to toggle between White hot and Black hot IR palette. Press the **FCN** + **INV** buttons to activate the LRF unit and enter LRF mode.	
C	Button **C** is used together with other buttons to provide additional functionality.	
NUC	Press the **NUC** button < 1second to perform an Internal NUC. Press the **NUC** button > 1second to perform a one-shot auto focus adjustment. Press the **FCN** + **NUC** buttons < 1second to perform an External NUC against the lens cover. Press the **FCN** + **NUC** buttons > 1second to go to the fixed focus position. Press the **C** + **NUC** buttons < 1second to perform an External NUC against the scene. Press the **C** + **NUC** buttons > 1second to perform a one-shot auto focus adjustment. **NOTE**: The default behavior (above) of the **NUC**, **FCN** + **NUC** and **C** + **NUC** buttons can be inverted in the *Setup-Image* dialog box, see section 7.6.1.1.	

JCU joystick and keypad – NORMAL mode

Feature	ORIGINAL setting	ALTERNATIVE setting
PRK	Press the **PRK** button < 1 second to send the system to the home position. If the **PRK** button is pressed < 1 second again when the system is in home position, the lens cover of the IR Camera will be closed and PARK mode will be entered, see section 5.1.3. Press the **PRK** button > 1 second to send the system to the mechanical home position, close the lens cover of the IR Camera and enter PARK mode, see section 5.1.3.	
	NOTE: At system start up, the **PRK** button has to be pressed for more than 3 seconds to activate the Pan/Tilt unit.	
▲ ▼	Press the ▲ button to zoom in. Press the ▼ button to zoom out.	When the adjustment mode is set to DDE (linear or full), see section 11.3.2: Press and hold down the ▲ button to increase the DDE value. Press and hold down the ▼ button to decrease the DDE value. If the adjustment mode is set to AUTO (linear of full) or MANUAL, the ▲ and ▼ buttons have no function.
	Press and hold down the **FCN** + ▲ buttons to increase the level value. Press and hold down the **FCN** + ▼ buttons to decrease the level value. **NOTE**: When the level value is changed, the system enters the Manual adjustment mode, see section 11.3.2. Press the **C** + ▲ buttons to manually open the lens cover. Press the **C** + ▼ buttons to manually close the lens cover.	
◀ ▶	Press the ◀ button to go to previous active autoscan point position. Press the ▶ button to go to next active autoscan point position. If there are no autoscan points, there will be no action. **NOTE**: This function of the buttons can be disabled, see section 7.6.1.3. Press and hold down the **FCN** + ◀ buttons to decrease the span value. Press and hold down the **FCN** + ▶ buttons to increase the span value. **NOTE**: When the span value is changed, the system enters the Manual adjustment mode, see section 11.3.2.	
FRZ	Press the **FRZ** button to freeze/unfreeze the image.	
ENTER	Press the ENTER button to enter MENU mode.	

6.2.2 AUTOSCAN mode

The AUTOSCAN mode is entered by pressing the **SCN** button in NORMAL or PARK mode. (If no autoscan points have been defined, the system will stay in NORMAL or PARK mode when the **SCN** button is pressed.)

JCU joystick and keypad – AUTOSCAN mode	
Feature	**Description**
Joystick	Move the joystick in any direction to enter NORMAL mode.
FCN	Press the **FCN** button to enter PROG POSITION mode.
SCN	No function in AUTOSCAN mode.
ID	Reserved for future capabilities.
TV/IR	Press the **TV/IR** button to toggle between TV imaging and IR imaging.
INV	Press the **INV** button to toggle between White hot and Black hot IR palette.
C	Press the **C** button to enter NORMAL mode.
NUC	Press the **NUC** button < 1 second to perform an Internal NUC. Press the **NUC** button > 1 second to perform a one-shot auto focus adjustment. Press the **FCN** + **NUC** buttons < 1 second to perform an External NUC against the lens cover. Press the **FCN** + **NUC** buttons > 1 second to go to the fixed focus position. Press the **C** + **NUC** buttons < 1 second to perform an External NUC against the scene. Press the **C** + **NUC** buttons > 1 second to perform a one-shot auto focus adjustment.
	NOTE: The default behavior (above) of the **NUC** and **FCN** + **NUC** buttons can be inverted in the *Setup-Image* dialog box, see section 7.6.1.1.
PRK	Press the **PRK** button < 1 second to send the system to the home position. If the **PRK** button is pressed < 1 second again when the system is in home position, the lens cover of the IR Camera will be closed and PARK mode will be entered, see section 5.1.3. Press the **PRK** button > 1 second to send the system to the mechanical home position, close the lens cover of the IR Camera and enter PARK mode, see section 5.1.3.
	NOTE: At system start up, the **PRK** button has to be pressed for more than 3 seconds to activate the Pan/Tilt unit.
▲ ▼	No function in AUTOSCAN mode.

JCU joystick and keypad – AUTOSCAN mode	
Feature	**Description**
	Press the ◀ button to go to previous active autoscan point position and then enter NORMAL mode. Press the ▶ button to go to next active autoscan point position and then enter NORMAL mode. **NOTE**: This function of the buttons can be disabled in the *Setup-Pan/Tilt* dialog box, see section 7.6.1.3.
FRZ	Press the **FRZ** button to freeze/unfreeze the image.
 **ENTER**	No function in AUTOSCAN mode.

6.2.3 PARK mode

The PARK mode is entered by pressing the **PRK** button in NORMAL, AUTOSCAN or PROG POSITION mode.

In PARK mode, most keypad buttons are disabled. These are not included in the table below.

JCU joystick and keypad – PARK mode	
Feature	**Description**
Joystick	Move the joystick in any direction to return to NORMAL or PROG POSITION mode.
SCN	Press the **SCN** button to return to AUTOSCAN mode.
 **ENTER**	Press the ENTER button to enter MENU mode.

6.2.4 LRF mode

The LRF mode is entered by pressing the **FCN** + **INV** buttons simultaneously in NORMAL mode.

In LRF mode, most buttons are disabled. These are not included in the table below.

JCU joystick and keypad – LRF mode	
Feature	**Description**
SCN	Press the **FCN** + **SCN** buttons to fire a shot, see section 11.5.2.
C	Press the **C** button to deactivate the LRF unit and exit the LRF mode.
NUC	Press the **NUC** button < 1 second to perform an Internal NUC. Press the **NUC** button > 1 second to perform a one-shot auto focus adjustment. Press the **FCN** + **NUC** buttons < 1 second to perform an External NUC against the lens cover. Press the **FCN** + **NUC** buttons > 1 second to go to the fixed focus position. Press the **C** + **NUC** buttons < 1 second to perform an External NUC against the scene. Press the **C** + **NUC** buttons > 1 second to perform a one-shot auto focus adjustment. **NOTE**: The default behavior (above) of the **NUC**, **FCN** + **NUC** and **C** + **NUC** buttons can be inverted in the Setup- Image dialog box, see section 7.6.1.1.

6.2.5 MENU mode

The MENU mode is entered by pressing the ENTER button in NORMAL or PARK mode.

In MENU mode, certain keypad buttons are used to navigate in the System Software menu system. The other buttons are disabled and are not included in the table below.

JCU joystick and keypad – MENU mode

Feature	Description
 **ENTER**	Use the ENTER button to: • enter the MENU mode • open the dialog box of the highlighted feature • activate the highlighted feature and exit MENU mode
C **CANCEL**	Use the CANCEL button to: • exit the active dialog box • exit MENU mode without changing the current menu settings
UP **DOWN**	Use the UP/DOWN navigation buttons to navigate up/down in menus and dialog boxes.
LEFT **RIGHT**	Use the LEFT/RIGHT navigation buttons to: • navigate left/right in the Main menu • display different dialog box options • change values in dialog boxes **NOTE**: Hold down the LEFT/RIGHT button for a while to decrease/increase a value with larger increments.
FCN	The **FCN** button is used in some dialog boxes to enable certain actions.

JCU joystick and keypad – MENU mode	
Feature	**Description**
NUC	Press the **NUC** button < 1 second to perform an Internal NUC. Press the **NUC** button > 1 second to perform a one-shot auto focus adjustment. Press the **FCN** + **NUC** buttons < 1 second to perform an External NUC against the lens cover. Press the **FCN** + **NUC** buttons > 1 second to go to the fixed focus position. Press the **C** + **NUC** buttons < 1 second to perform an External NUC against the scene. Press the **C** + **NUC** buttons > 1 second to perform a one-shot auto focus adjustment. **NOTE**: The default behavior (above) of the **NUC**, **FCN** + **NUC** and **C** + **NUC** buttons can be inverted in the Setup- Image dialog box, see section 7.6.1.1.

6.2.6 PROG POSITION mode

The PROG POSITION mode is entered by pressing the **FCN** button in AUTOSCAN mode. The PROG POSITION mode can also be entered from the System Software menu system.

NOTE: For full functionality of the JCU when programming autoscan points, the *MMI Control mode* in the *Setup – Maintenance* dialog box shall be set to Original, see section 7.6.1.6.

JCU joystick and keypad – PROG POSITION mode	
Feature	**Description**
Joystick	Move the joystick to the left/right to pan the system left/right. Move the joystick forwards/backwards to tilt the system up/down.
Joystick collar	Turn the joystick collar to the left/right to focus near/far.
Joystick button	Press the joystick button < 1 second to go to the next field-of-view. Press the joystick button > 1 second toggle between Slave mode on/off, see section 7.5.1.
FCN	Press the **FCN** button to open the Edit pos # dialog box, see section 7.4.1.2.2.
SCN	No function in PROG POSITION mode.
ID	Reserved for future capabilities.
TV/IR	Press the **TV/IR** button to toggle between TV imaging and IR imaging.

JCU joystick and keypad – PROG POSITION mode	
Feature	**Description**
INV	Press the **INV** button to toggle between White hot and Black hot IR palette.
C	Press the **C** button to quit programming and enter NORMAL mode.
NUC	Press the **NUC** button < 1 second to perform an Internal NUC. Press the **NUC** button > 1 second to perform a one-shot auto focus adjustment. Press the **FCN** + **NUC** buttons < 1 second to perform an External NUC against the lens cover. Press the **FCN** + **NUC** buttons > 1 second to go to the fixed focus position. Press the **C** + **NUC** buttons < 1 second to perform an External NUC against the scene. Press the **C** + **NUC** buttons > 1 second to perform a one-shot auto focus adjustment. **NOTE**: The default behavior (above) of the **NUC**, **FCN** + **NUC** and **C** + **NUC** buttons can be inverted in the Setup- Image dialog box, see section 7.6.1.1.
PRK	Press the **PRK** button < 1 second to send the system to the home position. If the **PRK** button is pressed < 1 second again when the system is in home position, the lens cover of the IR Camera will be closed and PARK mode will be entered, see section 5.1.3. Press the **PRK** button > 1 second to send the system to the mechanical home position, close the lens cover of the IR Camera and enter PARK mode, see section 5.1.3. **NOTE**: At system start up, the **PRK** button has to be pressed for more than 3 seconds to activate the Pan/Tilt unit.
▲ ▼	Press the ▲ button to zoom in. Press the ▼ button to zoom out.
◀ ▶	Press the ◀ button to go to previous active autoscan point position. Press the ▶ button to go to next active autoscan point position. If there are no autoscan points, there will be no action. **NOTE**: This function of the buttons can be disabled, see section 7.6.1.3.
FRZ	Press the **FRZ** button to freeze/unfreeze the image.
↵ **ENTER**	Press the ENTER button to open the New pos # dialog box, see section 7.4.1.2.1.

System software

The System Software is used to control the Ranger HRC MS system.

The System Software menus give access to the system features and make it possible to enter or change system constants and values. The software also provides the operator with information about the system.

This chapter describes features available in the System Software version 1.4.5.

7.1 System information

System information is displayed on top of the IR or TV image on the monitor.

The system information is mode and function dependent. It is possible to select which information to display. It is also possible to temporarily hide the system information.

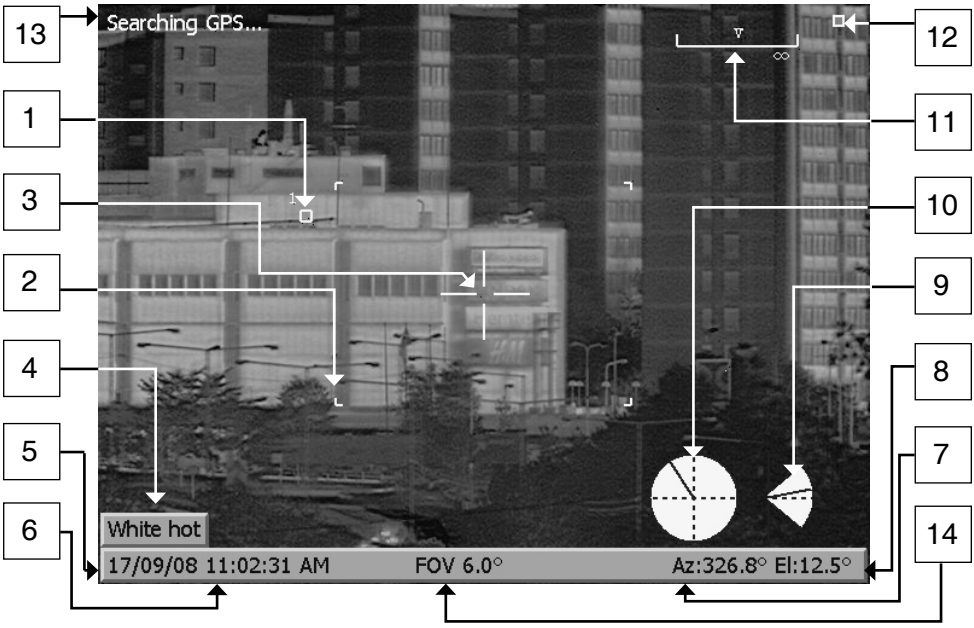


Figure 7.1 System information.

System information

Callout	Description
1	The *Autoscan point number* indicator (1 through 32) shows the locations of any currently set autoscan points.
2	The *FOV brackets* indicator shows the image area that will be covered by the next field-of-view (FOV). When the next FOV is the widest FOV, no *FOV brackets* are shown.
3	The *Crosshair reticle* indicator shows the center of the current field-of-view. When autoscan points are being set, the *Crosshair reticle* shows the location of the point to be entered.
4	The *Image polarity* indicator indicates if white or black is set to represent hot.
5	The *System date* indicator shows the date, in the format defined in the **Setup** menu, see section 7.6.1.4.
6	The *System time* indicator shows the time, in the format defined in the **Setup** menu; see section 7.6.1.4.
7	The *Digital azimuth* indicator provides a numeric readout of the system's azimuth, relative to the reference position entered in the *Setup – Pan/Tilt* dialog box, see section 7.6.1.3.
8	The *Digital elevation* indicator provides a numeric readout of the system's elevation.
9	The *Analog elevation* indicator provides a graphical presentation of the system's elevation.
10	The *Analog azimuth* indicator provides a graphical presentation of the system's azimuth, relative to the reference position entered in the *Setup – Pan/Tilt* dialog box. The indicator looks like a small clock, with the reference position at 12.
11	The *Focus position* indicator provides an indication of the focus travel, from near (left) to distant (right).
12	The *Active channel* indicator is shown on the screen to indicate which channel – TV or IR – that is active.
13	The *Status text* indicator displays status information for various functions, when these are trigged. See section 7.1.1. When no other status information is displayed, the *GPS* indicator shows the present position of the system in DMS format (Degree, Minute, Second); °N/S + °W/E. If the received antenna signal is too weak or if fewer than three satellites are found, the status text "Searching GPS" is displayed.
14	The *FOV* indicator provides a numeric readout of the current field-of-view (FOV).

7.1.1 Status text

A status text is displayed when the function it represents is trigged.

The status text is displayed in the upper left corner of the monitor, except for “Parked” and “Press PRK > 3 sec”, which are displayed in the center of the monitor.

The following status texts are available:

- Zooming in
- Zooming out
- Focus far
- Focus near
- Frozen
- Autoscan
- Adjusting
- Connecting
- Saving
- Laser ready (6)
- Searching GPS
- Parked
- Slave Mode On
- Slave Mode Off
- Press PRK > 3 sec
-  (Zoom box)

7.1.2 Show/hide system information

In the *Setup – Symbology* dialog box it is possible to select which information to display on the monitor, see section 7.6.1.2.

With the *Declutter* function, it is possible to temporarily hide the display information, see section 7.5.1 and 7.5.2.

7.2 Menu system

The System Software menu system gives access to the system features. The menu system is displayed when the system is in MENU mode. The MENU mode is entered by pressing the ENTER button on the Joystick Control Unit (JCU).

When the system is in MENU mode, a menu bar is displayed in the top of the monitor, with the currently selected menu and feature highlighted. The menu options are somewhat different depending on if IR or TV is selected.

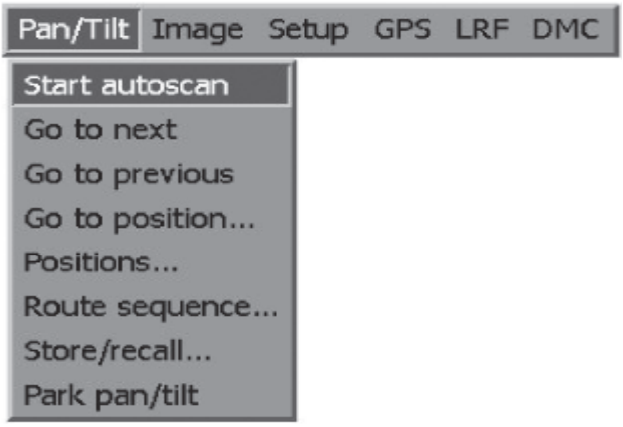


Figure 7.2 Menu bar with Pan/Tilt menu selected.

Features that directly perform an action are displayed as a command, for example *Start autoscan* in the figure above. Features that open up a dialog box are displayed with three dots after the feature title, for example *Go to position...*. Features that currently are disabled and not available for selection are shaded in the menu.

7.2.1 Navigation in menu system

The Joystick Control Unit (JCU) is used to navigate in the menu system and to execute actions.

- The UP/DOWN/LEFT/RIGHT keypad buttons are used to navigate in the menu system. The keypad buttons are also used to select features and to enter values.

- The ENTER button is used to activate selected features and to confirm actions.
- The CANCEL button is used to exit without changing.

The functions of the keypad buttons in MENU mode are described more in detail in section 6.2.5.

7.2.1.1 Example

The example below describes how the JCU is used in the menu system to select which autoscan point the system shall be moved to.

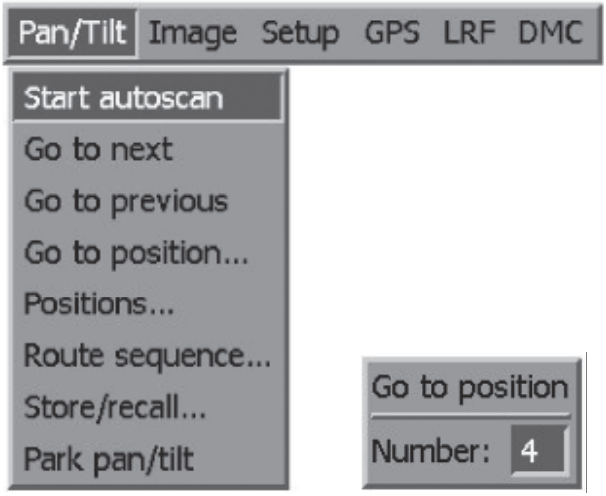


Figure 7.3 Pan/Tilt menu and Go to position dialog box.

Example	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Use the LEFT/RIGHT navigation buttons to select **Pan/Tilt** in the Main menu.
3	In the **Pan/Tilt** menu, use the UP/DOWN navigation buttons to select **Go to position…**. Press the ENTER button. The *Go to position* dialog box will be displayed.
4	Use the LEFT/RIGHT navigation buttons to decrease/increase the autoscan point position number.
5	Press the ENTER button to select the displayed position. The system will exit MENU mode and the system will move to the selected position.

7.3 Main menu

The menu bar gives access to the Main menu of the System Software.

The options and features of some of the menus are somewhat different, depending on if IR or TV is selected.

Figure 7.4 Main menu.

Main menu	
Menu	**Description**
Pan/Tilt	The **Pan/Tilt** menu is used to manage the autoscan functionality and to park the system.
Image	The **Image** menu is used to manage the appearance of the image on the monitor.
Setup	The **Setup** menu is used to define system constants and the appearance of the system information indicators.
GPS	The **GPS** menu is used to control the GPS unit.
LRF	The **LRF** menu is used to control the LRF unit.
DMC	The **DMC** menu is used to control the DMC unit.

7.4 Pan/Tilt menu

The **Pan/Tilt** menu is used to manage the autoscan functionality; program and manage autoscan points and lists of points, to move the system to autoscan points and to set the system to AUTOSCAN or PARK mode.

The **Pan/Tilt** menu options and features are somewhat different, depending on if IR or TV is selected.

NOTE: At system start up, the Pan/Tilt menu is disabled until the PRK button has been pressed for 3 seconds.

7.4.1 Pan/Tilt menu when IR is selected

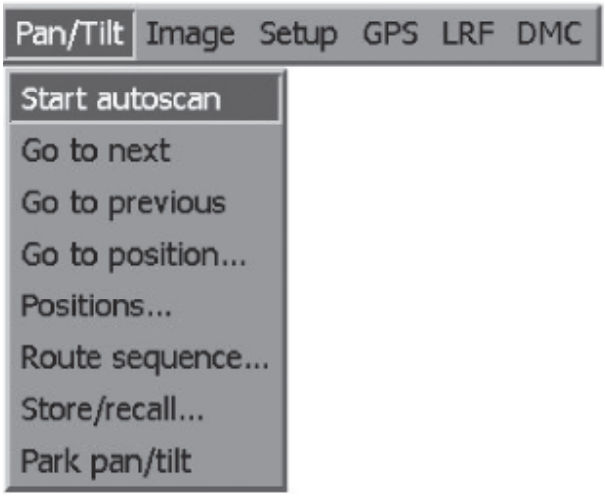


Figure 7.5 Pan/Tilt menu when IR is selected.

Pan/Tilt menu when IR is selected

Feature	Description
Start autoscan	The *Start autoscan* feature is used to enter the system into AUTOSCAN mode.
Go to next	The *Go to next* feature is used to move the system as fast as possible to the next point in the currently active scan routine.
Go to previous	The *Go to previous* feature is used to move the system as fast as possible to the previous point in the currently active scan routine.
Go to position…	The *Go to position…*feature opens the *Go to position* dialog box, see section 7.4.1.1.
Positions…	The *Positions…*feature opens the *Current position list* dialog box, see section 7.4.1.2. If no current list exists, the *New pos #* dialog box is opened instead, see section 7.4.1.2.1.
Route sequence…	The *Route sequence…*feature opens the *Route sequence* dialog box, see section 7.4.1.3.
Store/recall…	The *Store/recall…*feature opens the *Store/recall* dialog box, see section 7.4.1.4.
Park pan/tilt	The *Park pan/tilt* feature is used to send the system to the home position and enters the system into PARK mode.

7.4.1.1 Go to position

The *Go to position* dialog box is used to move the system to the position of the selected autoscan point (1 to 32).

It is possible to select also autoscan points that are defined as inactive in the *Route sequence* dialog box, see section 7.4.1.3. (An inactive autoscan point is still available, but it is excluded from the autoscan route sequence.)

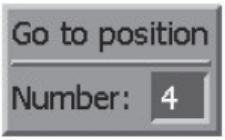


Figure 7.6 Go to position dialog box.

Go to position dialog box	
Feature	**Description**
Number	The *Number* feature is used to select autoscan point.

7.4.1.2 Current position list

The *Current position list* dialog box is used to append autoscan points to the current autoscan list and to define new autoscan lists.

If no current position list exists, the New pos # dialog box is opened directly, see section 7.4.1.2.1.

Figure 7.7 Current position list dialog box.

Current position list dialog box	
Feature	**Description**
Append	The *Append* feature is used to append new autoscan points to the current autoscan list. The procedure for appending autoscan points is described in section 11.4.
New	The *New* feature is used to create a new autoscan list. The procedure for creating autoscan lists is described in section 11.4. **NOTE**: When New is selected, the current autoscan list is replaced. To save the current list before *New* is selected, see section 11.4.2.7.

7.4.1.2.1 New pos #

The *New pos #* dialog box is used to define the Speed and Dwell settings of new autoscan points.

The *New pos #* dialog box is opened as a part of the procedures *Creating autoscan lists* and *Appending autoscan points*, see section 11.4.2.4.

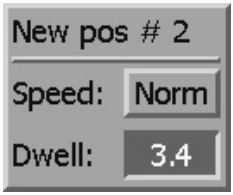


Figure 7.8 New pos # dialog box.

New pos # dialog box

Feature	Description
Speed	The *Speed* feature is used to select the rate with which the system shall move to next autoscan point: • **Fast** • **Normal** • **Slow** The speed rates are set in the *Setup – Pan/tilt* dialog box, see section 7.6.1.3.
Dwell	The *Dwell* feature is used to set the dwell time (in seconds); that is, how long the system shall stay on this autoscan point before moving on to the next point.

7.4.1.2.2 Edit pos #

The *Edit pos #* dialog box is used to edit autoscan point settings.

The *Edit pos #* dialog box is opened as a part of the procedures *Editing autoscan points settings* and *Moving autoscan points*, see section 11.4.2.5.

Figure 7.9 Edit pos # dialog box.

Edit pos # dialog box	
Feature	**Description**
Speed	The *Speed* feature is used to select the rate with which the system shall move to next autoscan point: • **Fast** • **Normal** • **Slow** The speed rates are set in the *Setup – Pan/tilt* dialog box, see section 7.6.1.3.
Dwell	The *Dwell* feature is used to set the dwell time (in seconds); that is, how long the system shall stay on this autoscan point before moving on to the next point.

7.4.1.3 Route sequence

The *Route sequence* dialog box is used to define the sequence in which the autoscan points in the currently loaded autoscan list shall be scanned.

The *Route sequence* dialog box is also used to inactivate autoscan points; that is, to exclude the point from the currently loaded autoscan list. Inactivated autoscan points are still available and can be activated again at any time.

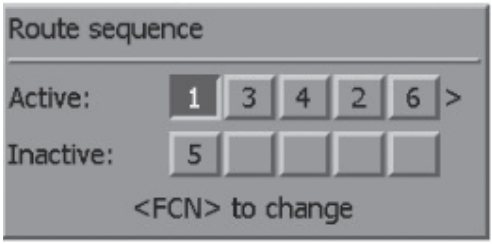


Figure 7.10 Route sequence dialog box.

Route sequence dialog box

Feature	Description
Active	The *Active* item displays the current sequence of the autoscan points and is used to manage the route sequence. The procedure for managing the route sequence is described in section 11.4.2.6.
Inactive	The *Inactive* item displays the inactive autoscan points and is used to activate/deactivate autoscan points. The procedure for activating/deactivating autoscan points is described in section 11.4.2.6.

7.4.1.4 Store/recall position list

The *Store/recall position list* dialog box is used to store, recall and delete autoscan lists. It is possible to store up to four different lists (A, B, C and D), with up to 32 autoscan points in each list.

The currently loaded and active autoscan list is possible to store. Previously stored autoscan lists are possible to recall and load as the active autoscan list. It is also possible to delete previously stored autoscan lists.

NOTE: When an autoscan list is recalled, the currently active autoscan list is overwritten. If the operator wants to store the currently active autoscan list, it must be done before recalling another list.

Figure 7.11 Store/recall position list dialog box.

Store/recall position list dialog box

Feature	Description
Action	The *Action* feature is used to select which action to apply to the selected *List no*. The procedures for storing, recalling and deleting autoscan lists are described in section 11.4.2.7. • **Store**: Stores the currently loaded autoscan list, with the list name displayed in the *List no* item. • **Recall**: Recalls and loads the autoscan list with the list name displayed in the *List no* item. • **Delete**: Deletes the autoscan list with the list name displayed in the *List no* item.
List no	The *List no* feature shows the currently selected list name (A, B, C or D) and the list status. • **Used**: Indicates that there is an autoscan list stored with that name, which can be recalled or deleted. • **Free**: Indicates that this list name is free and can be used to store a new autoscan list.

NOTE: When the autoscan list is stored, the text Saving is displayed on the monitor. ***Do not*** shut down the system until the saving is completed.

7.4.2 Pan/Tilt menu when TV is selected

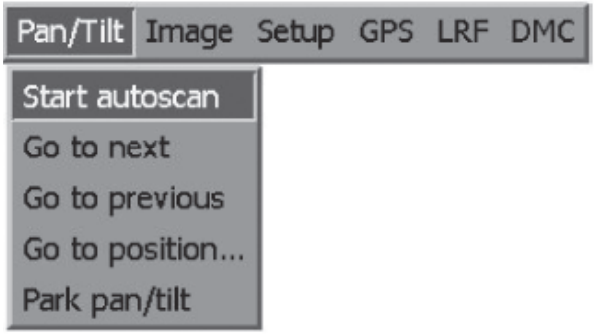


Figure 7.12 Pan/Tilt menu when TV is selected.

Pan/tilt menu when TV is selected

Feature	Description
Start autoscan	The *Start autoscan* feature is used to enter the system into AUTOSCAN mode.
Go to next	The *Go to next* feature is used to move the system as fast as possible to the next point in the currently active scan routine.
Go to previous	The *Go to previous* feature is used to move the system as fast as possible to the previous point in the currently active scan routine.
Go to position…	The *Go to position…*feature opens the *Go to position* dialog box, see section 7.4.1.1.
Park pan/tilt	The *Park pan/tilt* feature is used to send the system to the home position and enters the system into PARK mode.
	NOTE: If the Park pan/tilt feature is selected a second time when the system is in home position, the lens cover will be closed and the PARK mode will be entered.

7.5 Image menu

The **Image** menu is used to manage the appearance of the image on the monitor.

The **Image** menu options and features are somewhat different, depending on if IR or TV is selected.

7.5.1 Image menu when IR is selected

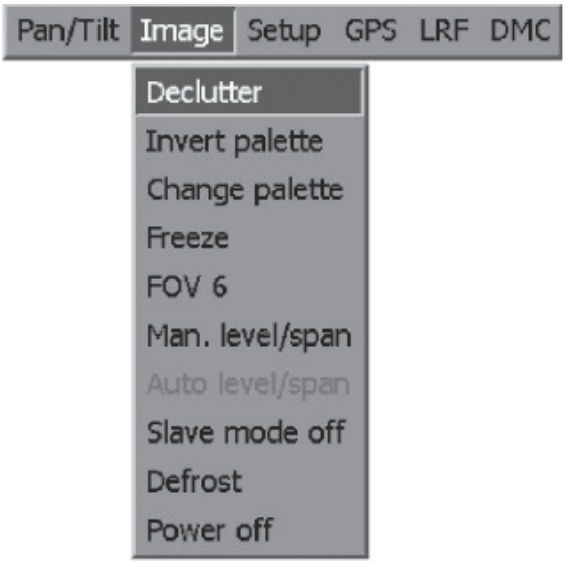


Figure 7.13 Image menu when IR is selected.

NOTE: For features with on/off alternatives, the displayed feature (for example *Power off*) is the action that will be performed if the feature is selected, and not the current status. For example, *Power off* means that the power is currently On and that it will be turned Off if the feature is selected.

Image menu when IR is selected	
Feature	**Description**
Declutter	The *Declutter* feature is used to temporarily remove the system information from the monitor. When the ENTER button is pressed, the system information is shown again.
Invert palette	The *Invert palette* feature is used to invert the current IR palette: • **Gray (white hot)** to **Inv Gray (black hot)** or vice versa. • **Rainbow** to **Inv Rainbow** or vice versa. • **Rainbow HC** to **Inv Rainbow HC** or vice versa. • **Iron** to **Inv Iron** or vice versa. **NOTE:** The IR palette can also be inverted in the **Setup** menu, see section 7.6.1.1.
Change palette	The *Change palette* feature is used to cycle trough the IR palette options: • **Gray** • **Rainbow** • **Rainbow HC** • **Iron** **NOTE:** The IR palette can also be changed in the **Setup** menu, see section 7.6.1.1.
Freeze/Live	The *Freeze/Live* feature is used to change the monitor from live to frozen image or vice versa. When the image is frozen, the text *Frozen* is displayed on the monitor.
FOV	The *FOV* feature is used to move the system to the next preset field-of-view (FOV). **NOTE:** The available preset fields-of-view depend on the type of IR camera. The preset fields-of-view are the same for the IR and TV cameras.
Man. level/span	The *Man. level/span* feature opens the *Man. level/span* dialog box, see section 7.5.1.
Auto level/span	The *Auto level/span* feature is used to enter the automatic adjustment mode (Auto (linear) or Auto (full)), as set in the *Setup – Image* dialog box, see section 7.5.1. The *Auto level/span* feature is only enabled when the system is in *Man. level/span* mode.

Slave mode on/off	The *Slave mode on/off* feature is used to activate/deactivate *Slave mode*. When *Slave mode* is active, changes in field-of-view will apply to both the IR and TV camera.
Defrost	The *Defrost* feature is used to activate the lens defroster. When *Defrost* is selected, the lens defroster is turned on for 10 minutes. The defroster is automatically turned off after 10 minutes or when the joystick is moved. The *Defrost* feature is only enabled at freezing ambient temperature.
Power on/off	The *Power on/off* feature is used to turn on/off the IR camera. When the IR camera is turned off, a colored image is displayed on the monitor and all features in the **Image** menu, except *Power on*, are disabled.

7.5.1.1 Man. level/span

The *Man. level/span* dialog box is used to manually adjust the level and span settings.

Figure 7.14 Man. level/span dialog box.

NOTE: The system will remain in MANUAL mode until the feature *Auto level/span* is selected.

Man. level/span dialog box

Feature	Description
Level	The *Level* feature is used to adjust the level setting.
Span	The *Span* feature is used to adjust the span setting.

7.5.2 Image menu when TV is selected

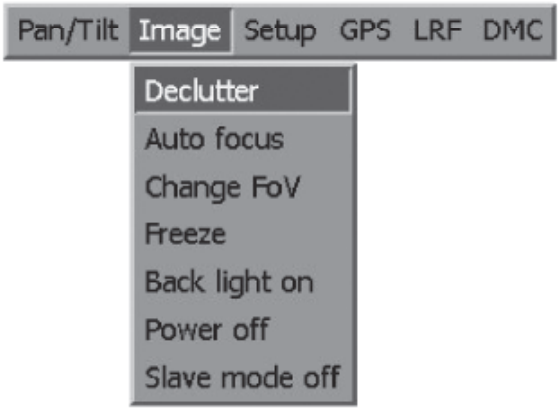


Figure 7.15 Image menu when TV is selected.

NOTE: For features with on/off alternatives, the displayed feature (for example *Power off*) is the action that will be performed if the feature is selected, and not the current status. For example, *Power off* means that the power is currently On and that it will be turned Off if the feature is selected.

Image menu when TV is selected	
Feature	**Description**
Declutter	The *Declutter* feature is used to temporarily remove the system information from the monitor. When the ENTER button is pressed, the system information is shown again.
Auto focus	The *Auto focus* feature is used to execute a one-shot auto focus adjustment. (Continuous auto focus is not provided, because of the risk for mechanical wear.)
	NOTE: The *Auto focus* feature is not supported by all TV cameras. If not supported, the *Auto focus* feature is disabled in the **Image** menu.
Change FoV	The *Change FoV* feature is used to move the system to the next preset field-of-view (FOV).
	NOTE: The available preset fields-of-view for the TV camera are the same as for the IR camera (if supported by the TV camera).

Freeze/Live	The *Freeze/Live* feature is used to change the monitor from live to frozen image or vice versa. When the image is frozen, the text *Frozen* is displayed on the monitor.
Back light on/off	The *Back light on/off* feature turns on/off the backlight compensation. If an object appears in front of a very light background – or if the object is very dark – the backlight will increase the image quality.
Power on/off	The *Power on/off* feature is used to turn on/off the TV camera. When the TV camera is turned off, a colored image is displayed on the monitor and all features in the **Image** menu, except *Power on*, are disabled.
Slave mode on/off	The *Slave mode on/off* feature is used to activate/deactivate *Slave mode*. When *Slave mode* is active, changes in field-of-view will apply to both the IR and TV camera.

7.6 Setup menu

The **Setup** menu is used to define system constants and the appearance of the system information indicators.

The **Setup** menu options and features are somewhat different, depending on if IR or TV is selected.

NOTE: Settings made in the **Setup** menu will apply until the system is turned off. However, the settings are permanently saved when the **PRK** button on the JCU is pressed.

7.6.1 Setup menu when IR is selected

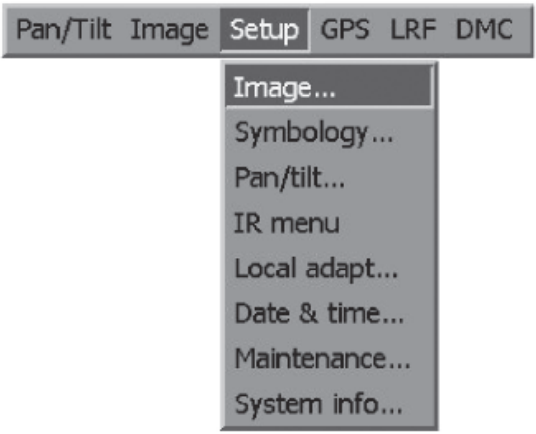


Figure 7.16 Setup menu when IR is selected.

Setup menu when IR is selected	
Feature	**Description**
Image…	The *Image…*feature opens the *Setup – Image* dialog box, see section 7.6.1.1.
Symbology…	The *Symbology…*feature opens the *Setup – Symbology* dialog box, see section 7.6.1.2.
Pan/tilt…	The *Pan/tilt…*feature opens the *Setup – Pan/tilt* dialog box, see section 7.6.1.3.
IR menu	The *IR menu* feature is used to open the menu system of the IR Camera, see chapter 8. To exit the IR Camera menu system, press the CANCEL button. If not in use for a while, the IR Camera menu system is automatically exited.
Local adapt…	The *Local adapt…*feature opens the *Setup – Local adapt* dialog box, see section 7.6.1.4.
Date & time…	The *Date & time…*feature opens the *Setup – Date & time* dialog box, see section 7.6.1.5.
Maintenance…	The *Maintenance…*feature opens the *Setup – Maintenance* dialog box, see section 7.6.1.6.
System info…	The *System info…*feature opens the *System information* dialog box, see section 7.6.1.7.

7.6.1.1 Setup – Image

The *Setup – Image* dialog box is used control the appearance of the IR image.

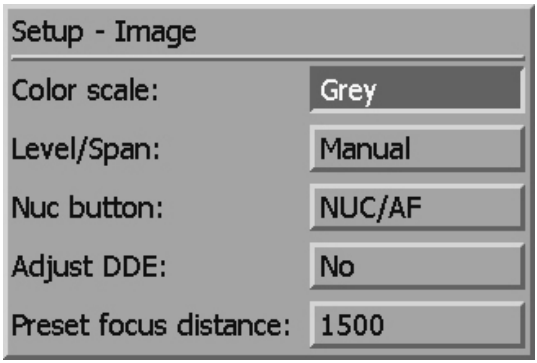


Figure 7.17 Setup – Image dialog box when IR is selected.

Setup – Image dialog box

Feature	Description
Color scale	The *Color scale* feature is used to select IR palette: • **Gray** • **Gray inv** (inverted) • **Rainbow** • **Rainbow inv** (inverted) • **Iron** • **Iron inv** (inverted) • **Rainbow HC** • **Rainbow HC inv** (inverted)
Level/Span	The *Level/Span* feature is used to select adjustment mode. • **Manual**: Manual adjustment of level and span. • **Auto (linear)**: Automatic adjustment of level and span, with Color Distribution in Linear mode. • **Auto (full)**: Automatic adjustment of level and span, with Color Distribution in Histogram mode. • **DDE (linear)**: Automatic adjustment of level and span, with Digital Detail Enhancement and Color Distribution in Linear mode. • **DDE (full)**: Automatic adjustment of level and span, with Digital Detail Enhancement and Color Distribution in Histogram mode.
Nuc button	The *Nuc button* feature is used to change the operational mode of the **NUC** button on the JCU. • **NUC/AF** (this is the default setting): Press button **NUC** < 1 second to perform an Internal NUC Press button **NUC** > 1 second, to perform a on-shot auto focus adjustment and Press buttons **FCN** + **NUC** < 1 second to perform an External NUC. Press buttons **FCN** + **NUC** > 1 second to go to the fixed focus position. and Press the **C + NUC buttons** < 1 second to perform an External NUC against the scene. Press the **C + NUC buttons** > 1 second to perform a one-shot auto focus adjustment.

Setup – Image dialog box	
Feature	**Description**
Nuc button	• **AF/NUC**: Press button **NUC** < 1 second to perform a on-shot auto focus adjustment Press button **NUC** > 1 second, to perform an Internal NUC and Press buttons **FCN** + **NUC** < 1 second to go to the fixed focus position. Press buttons **FCN** + **NUC** > 1 second to perform an External NUC. and Press the **C + NUC buttons** < 1 second to perform a one-shot auto focus adjustment. Press the **C + NUC buttons** > 1 second to perform an External NUC against the scene.
Adjust DDE	The *Adjust DDE* feature is used to adjust the DDE Control value. • **Yes**: Opens the *DDE* dialog box, see section 7.6.1.1.1. • **No**: No action.
Preset focus distance	The *Preset focus distance* feature is used to set the fixed focus distance. If auto focus is not possible, for example when the image has low contrasts between different areas, the system will focus to the fixed focus distance instead.

7.6.1.1.1 DDE dialog box

The *DDE* dialog box is used to adjust the DDE Control value.

Figure 7.18 DDE dialog box.

For more information about DDE Control, see section 5.2.6 DDE – Digital Detail Enhancement.

7.6.1.2 Setup –Symbology

The *Setup – Symbology* dialog box is used to define how the overlaid symbology (system information indicators) is displayed on the monitor.

The *Setup – Symbology* dialog box is the same for IR and TV, except for the *FOV brackets* and *Scan points* features which are not available when TV is selected.

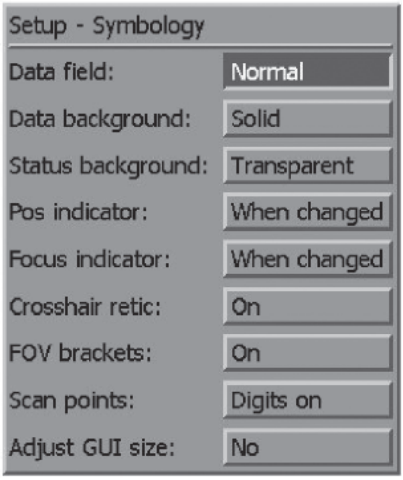


Figure 7.19 Setup – Symbology dialog box when IR is selected.

Setup – Symbology dialog box

Feature	Description
Data field	The *Data field* feature is used to control the appearance of the two lines of system information that is presented at the bottom of the monitor. • **Normal**: Both lines of information are shown. • **Reduced**: Only the bottom line of information is shown; that is, date, time and digital azimuth and elevation. • **None**: Both lines are hidden.
Data background	The *Data background* feature is used to control the appearance of the background of the two lines of system information that is presented at the bottom of the monitor. • **Solid**: Puts a solid background behind the two lines of information, which makes them more visible. • **Transparent**: No background behind the two lines of information.

Setup – Symbology dialog box

Feature	Description
Status background	The *Status background* feature is used to control the appearance of the background of the status text, which is displayed in the upper left corner when the functions they represent are trigged. • **Solid**: Puts a solid background behind the additional system information, which makes them more visible. • **Transparent**: No background behind the additional system information.
Pos indicator	The *Pos indicator* feature is used to control the appearance of the analog azimuth and elevation indicators. • **On**: The analog azimuth and elevation indicators are always shown. • **Off**: The analog azimuth and elevation indicators are always hidden. • **When changed**: The analog azimuth and elevation indicators are only shown when the position of the system is changed.
Focus indicator	The *Focus indicator* feature is used to control the appearance of the focus position indicator. • **On**: The focus position indicator is always shown. • **Off**: The focus position indicator is always hidden. • **When changed**: The focus position indicator is only shown when the focus is changed.
Crosshair retic	The *Crosshair retic* feature is used to control the appearance of the crosshair reticle indicator. • **On**: The crosshair reticle indicator is shown. • **Off**: The crosshair reticle indicator is hidden.
FOV brackets	The *FOV brackets* feature is used to control the appearance of the FOV brackets indicator. • **On**: The FOV brackets indicator is shown. (When the next FOV is the widest FOV, no *FOV brackets* are shown.) • **Off**: The FOV brackets indicator is hidden.
Scan points	The *Scan points* feature is used to control the appearance of the Autoscan point number indicator. • **Digits on**: The autoscan point number (digit) and the targeting square are shown. • **On**: Only the targeting square is shown. • **Off**: No autoscan point information is shown.
Adjust GUI size	The *Adjust GUI size* feature is used to adjust the size of the area where the system software graphics (system information and menu system) is displayed on the monitor. • **Yes**: Opens the *Setup – GUI size* dialog box, see section 7.6.1.2.1. • **No**: No action.

7.6.1.2.1 Setup – GUI Size dialog box

The *Setup – GUI size* dialog box is used to select GUI size.

The crosshair reticle, the FOV brackets and the autoscan point indicators are not affected by the change of GUI size.

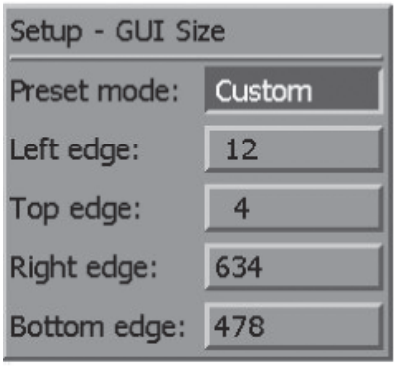


Figure 7.20 Setup – GUI size dialog box.

Setup – GUI Size dialog box

Feature	Description
Preset mode	The *Preset mode* feature is used to select GUI size mode. • **Full**: The full area is used to display the system software graphics. This setting keeps as much as possible of the video image free from overlaid information. However, many monitors cut the video image close to the edges. With such a monitor, some of the graphics may not be visible with this setting. • **Compressed**: The edges of the area where the system software graphics is displayed are adjusted to allow all graphics to be visible. This is a fixed setting that fits most monitors. • **Custom**: Enables manual settings of Left, Top, Right and Bottom edges.
Left/Top/Right/ Bottom edge	The *Left/Top/Right/Bottom edge* items are used to adjust the edges of the area where the system software graphics is displayed. The edges can only be adjusted when **Custom** is selected.

7.6.1.3 Setup – Pan/tilt

The *Setup – Pan/tilt* dialog box is used to define settings and control functions of the Pan/Tilt unit.

The *Setup – Pan/tilt* dialog box is the same for IR and TV.

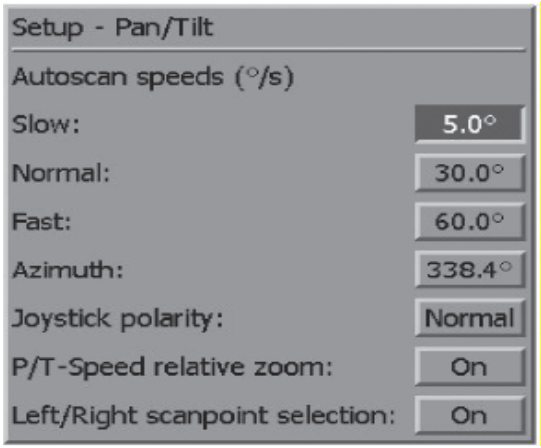


Figure 7.21 Setup – Pan/tilt dialog box.

Setup – Pan/tilt dialog box

Feature	Description
Autoscan speeds	The *Autoscan speeds* feature is used to define the preset autoscan speed rates; **Slow**, **Normal** and **Fast**. The autoscan speed is the speed with which the system moves to the next autoscan point. The **Slow**, **Normal** and **Fast** values are adjustable from 0,1˚/s to 70˚/s (pan) and from 0.1˚/s to 30˚/s (tilt), both in 0.1˚/s increments. The values must follow a logical progression; that is, it is not possible to adjust the normal setting to a value that is less than the slow setting. The same value is used for pan and tilt, up to the maximum value for tilt (30˚/s). If the value is set higher than that, the tilt value will be kept to its maximum.
Azimuth	The *Azimuth* feature is used to define the home position, see section 10.3. The *Azimuth* value is adjustable from 0.0˚/s to 359.9˚/s, in 0.1˚/s increments.

Setup – Pan/tilt dialog box

Feature	Description
Joystick polarity	The *Joystick polarity* feature is used to select the operational mode of the joystick. • **Normal**: When the operator moves the joystick towards himself, the Pan/Tilt unit will move downwards. • **Pilot**: When the operator moves the joystick away from himself, the Pan/Tilt unit will move downwards.
P/T-Speed relative zoom	The *P/T-Speed relative zoom* feature is used to control the speed of the Pan/Tilt unit in relation to the current field-of-view. • **On**: The panning and tilting speeds are lower for narrower fields-of-view. • **Off**: The panning and tilting speeds are the same for all fields-of-view.
Left/Right scan-point selection	The *Left/Right scanpoint selection* feature is used to control the function of the ◀ and ▶ buttons on the JCU. • **On**: The ◀ and ▶ buttons are used to move the system to the previous/next autoscan point. This is the default setting. • **Off**: The ◀ and ▶ buttons can ***not*** be used to move the system to the previous/next autoscan point.

7.6.1.4 Setup – Local adapt

The *Setup – Local adapt* dialog box is used to select language and the date and time formats.

The *Setup – Local adapt* dialog box is the same for IR and TV.

Figure 7.22 Setup – Local adapt dialog box.

Setup – Local adapt dialog box	
Feature	**Description**
Language	The *Language* feature is used to select the system language. **English** is the default language.
Date format	The *Date format* feature is used to select the date format: • **DD/MM/YY** • **YY-MM-DD** • **MM/DD/YY**
Time format	The *Time format* feature is used to select the time format: • **HH:MM:SS** (24 hour format) • **HH.MM.SS** (24 hour format) • **HH:MM:SS** PM (12 hour format)

7.6.1.5 Setup – Date & time

The *Setup – Date & time* dialog box is used to set the system date and time.

The *Setup – Date & time* dialog box is the same for IR and TV.

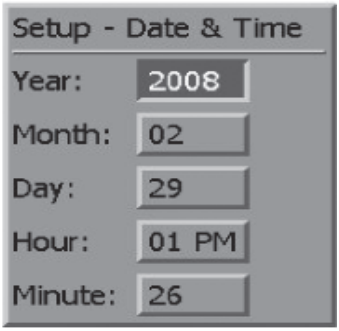


Figure 7.23 Setup – Date & time dialog box.

Setup – Date & time dialog box	
Feature	**Description**
Year	The *Year* feature is used to set the year: • **2003-2038**
Month	The *Month* feature is use to set the month: • **01-12**
Day	The *Day* feature is use to set the day: • **01-31**
Hour	The *Hour* feature is used to set the hour. The Hour format depends on the settings made in the *Setup – Local Adapt* dialog box, see section 7.6.1.4. • 12 hour format: **12 AM-12 PM** • 24 hour format: **01-24**
Minute	The *Minute* feature is used to set the minute: • **00-59**

NOTE: The seconds are set to 00 when the ENTER button is pressed to confirm the settings in the *Setup – Date & time* dialog box.

7.6.1.6 Setup – Maintenance

The *Setup – Maintenance* dialog box is used to define system constants.

The *Setup – Maintenance* dialog box is the same for IR and TV.

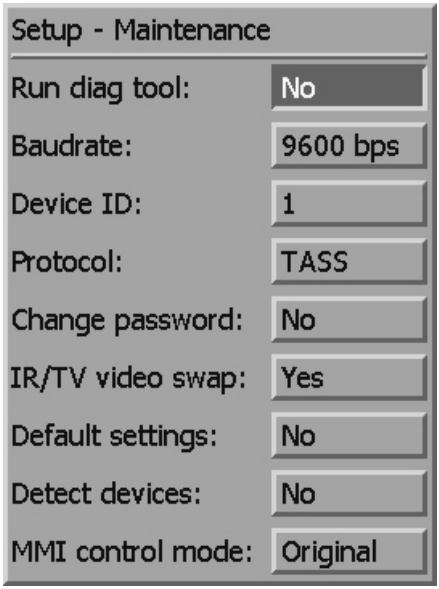


Figure 7.24 Setup – Maintenance dialog box.

If a password other than the default system value 0000 has been set, the *Enter password* dialog box will appear before the *Setup – Maintenance* dialog box is opened. See section 7.6.1.6.1.

Setup – Maintenance dialog box	
Feature	**Description**
Run diag tool	The *Run diag tool* feature is used to start the diagnostic test. • **Yes**: Opens the *Setup – Diag tool* dialog box, see section 15.7. • **No**: No action.

Setup – Maintenance dialog box

Feature	Description
Baudrate	The *Baudrate* feature is used to set the communication speed. • **1200 bps** • **2400 bps** • **4800 bps** • **9600 bps** • **19200 bps** The new Baudrate value will take effect immediately. **NOTE:** If the Baudrate is changed, it will take a few button presses or joystick movements before the JCU is in sync again.
Device ID	The *Device ID* feature is used to set the device ID: • **01-31** **NOTE:** If the 5x0 protocol (see the *Protocol* feature below) is selected, the Device ID feature is disabled.
Protocol	The *Protocol* feature is used to select the type of communication protocol: • **5x0** • **TASS** • Optional protocols, such as PELCO D, are available on request. The new protocol setting will take effect immediately. **NOTE:** If the protocol is changed, it will take a few button presses or joystick movements before the JCU is in sync again. **NOTE:** As 5x0 is a point-to-point protocol, no Device ID can be selected.
Change password	The *Change password* feature is used to enter a password or change the existing password for the *Setup – Maintenance* dialog box. • **Yes**: Opens the *New password* or *Change password* dialog box, see section 7.6.1.6.2 and 7.6.1.6.3. • **No**: No action.

Setup – Maintenance dialog box

Feature	Description
IR/TV video swap	The *IR/TV video swap* feature is used to control the video signal. • **Yes**: The active video signal is swapped between the two video outputs on the JPC2 when the operator toggles between IR and TV. If two monitors are used, the TV and IR images will move between the monitors. • **No**: Only the indicator for active channel will move between the monitors.
Default settings	The *Default setting* feature is used to reset parameters, except for example lists of autoscan points, Baudrate and Protocol, to factory settings. • **Yes**: The default settings are reset. • **No**: No action.
Detect devices	The *Detect devices* feature is used to check for system changes and make required adjustments. • **Yes**: Opens the *Detect devices* dialog box, see section 7.6.1.6.4. • **No**: No action.
MMI Control mode	The Joystick Control Unit (JCU) operates with two different settings, with somewhat different functions for the joystick and the keypad buttons, see section 6.2.1. The *MMI Control mode* feature is used to select the JCU setting. • **Original** • **Alternative** **NOTE**: Another commonly used term corresponding to MMI (Man Machine Interface) is GUI (Graphical User Interface).

7.6.1.6.1 Enter password

The *Enter password* dialog box appears before the *Setup – Maintenance* dialog box is opened, if a password other than the default system value oooo has been set.

Figure 7.25 Enter password dialog box.

Enter password dialog box	
Feature	**Description**
Enter password	The *Enter password* feature is used to enter the password.

If the CANCEL button is pressed, the *Setup – Maintenance* dialog box will be displayed with most features disabled.

Figure 7.26 Setup – Maintenance dialog box with disabled features.

7.6.1.6.2 New password

The *New password* dialog box is used to set a password.

Figure 5.27 New password dialog box.

7.6.1.6.3 Change password

The *Change password* dialog box is used to change an existing password.

Figure 7.28 Change password.

7.6.1.6.4 Detect devices

The *Detect devices* dialog box is used to start a check for system changes. If a change is found, the system will automatically make necessary adjustments.

Figure 7.29 Detect devices dialog box.

7.6.1.7 System information

The *System information* dialog box displays information about the system.

The *System information* dialog box is the same for IR and TV.

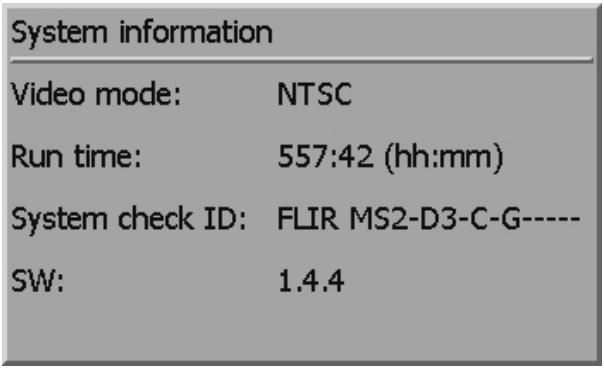


Figure 7.30 System information dialog box.

System information dialog box	
Feature	**Description**
Video mode	The *Video mode* item displays the type of video mode in use: • **NTSC** • **PAL**
Run time	The *Run time* item displays the run time of the IR Camera.
System check ID	The *System check ID* item displays the configuration code.
SW	The *SW* item displays the current software version.

7.6.2 Setup menu when TV is selected

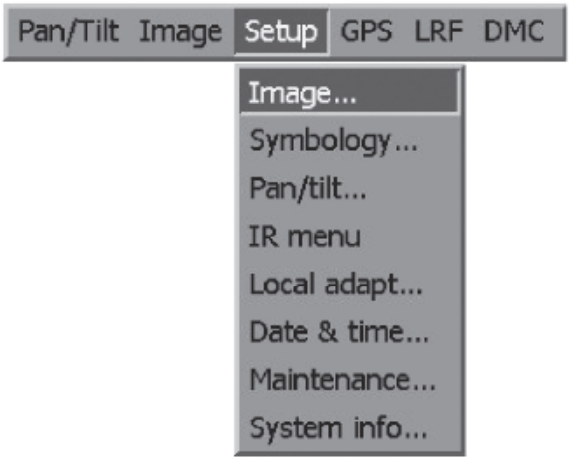


Figure 7.31 Setup menu when TV is selected.

Setup menu when TV is selected	
Feature	**Description**
Image…	The *Image…*feature opens the *Setup – Image* dialog box, see section 7.6.2.1.
Symbology…	The *Symbology…*feature opens the *Setup – Symbology* dialog box, see section 7.6.2.2.
Pan/tilt…	The *Pan/tilt…*feature opens the *Setup – Pan/tilt* dialog box, see section 7.6.1.3.
Local adapt…	The *Local adapt…*feature opens the *Setup – Local adapt* dialog box, see section 7.6.1.4.
Date & time…	The *Date & time…*feature opens the *Setup – Date & time* dialog box, see section 7.6.1.5.
Maintenance…	The *Maintenance…*feature opens the *Setup – Maintenance* dialog box, see section 7.6.1.6.
System info…	The *System info…*feature opens the *System information* dialog box, see section 7.6.1.7.

7.6.2.1 Setup – Image

The *Setup – Image* dialog box is used to control the appearance of the TV image.

NOTE: The features in the *Setup – Dialog* box are not supported by all TV cameras.

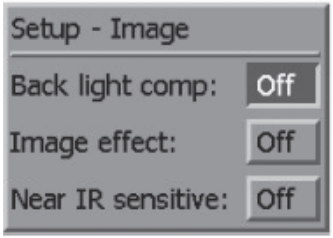


Figure 7.32 Setup – Image dialog box when TV is selected.

Setup – Image dialog box	
Feature	**Description**
Back light comp	The *Back light comp* feature is used to turn on/off the backlight. • **Off**: Turns off the backlight. • **On**: Turns on the backlight compensation. If an object appears in front of a very light background – or if the object is very dark – the backlight will increase the image quality.
Image effect	The *Image effect* feature is used to select Color or Black/White mode. • **Off**: Puts the TV camera in Color mode. • **B/W**: Puts the TV camera in Black/White mode.
Near IR sensitive	The *Near IR sensitive* feature is used to increase the sensitivity to IR radiation by disabling a built-in cut-off IR radiation filter. The feature is especially valuable under twilight conditions. • **Off**: Deactivates the *Near IR sensitive* feature. • **On**: Activates the *Near IR sensitive* feature.

7.6.2.2 Setup – Symbology

The features of the *Setup – Symbology* dialog box when TV is selected are the same as when IR is selected, see section 7.6.1.2, but the *FOV brackets* and *Autoscan point number* indicators are not visible when TV is selected.

7.7 GPS menu

The **GPS** menu is used to control the GPS (Global Positioning System) unit.

Figure 7.33 GPS menu.

NOTE: For features with on/off alternatives, the displayed feature (for example *Power off*) is the action that will be performed if the feature is selected, and not the current status. For example, *Power off* means that the power is currently On and that it will be turned Off if the feature is selected.

GPS menu	
Feature	**Description**
Power on/off	The *Power on/off* feature is used to turn the GPS unit on/off.

7.8 LRF menu

The **LRF** menu is used to control the LRF (Laser Range Finder) unit.

The procedures for measuring distances with the LRF unit is described in section 11.5.

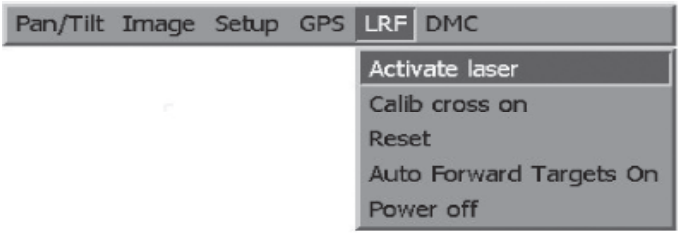


Figure 7.34 LRF menu.

NOTE: For features with on/off alternatives, the displayed feature (for example *Power off*) is the action that will be performed if the feature is selected, and not the current status. For example, *Power off* means that the power is currently On and that it will be turned Off if the feature is selected.

LRF menu

Feature	Description
Activate laser	The *Activate laser* feature is used to activate the LRF unit and to enter the system into LRF mode. When the unit has been activated, the text "Laser ready (6)" is displayed in the upper left corner of the monitor. In LRF mode, most buttons are disabled. Press button **C** to deactivate the LRF unit and to exit the LRF mode.
Calib cross On/Off	The *Calib cross* feature is used calibration.
Reset	The *Reset* feature is used to reset the LRF unit.
Auto Forward Targets On/Off	When the system is used with a remote computer, the distance results can be reported to the remote computer. The *Auto Forward Targets* feature is used to select which results to report; all valid result or approved results. (The operator approves a result by pressing the ENTER button for each result he wants to have reported, see section 11.5.2.) • Auto Forward Targets On: All valid results are reported. • Auto Forward Targets Off: Only approved results are reported.
Power on/off	The *Power on/off* feature is used to turn the LRF unit on/off. When the LRF unit is turned off, all menu items in the LRF menu, except *Power on,* are disabled.

7.9 DMC menu

The **DMC** menu is used to control the DMC (Digital Magnetic Compass) unit.

Figure 7.35 DMC menu.

NOTE: For features with on/off alternatives, the displayed feature (for example *Power off*) is the action that will be performed if the feature is selected, and not the current status. For example, *Power off* means that the power is currently On and that it will be turned Off if the feature is selected.

LRF menu	
Feature	**Description**
Calibrate…	The *Calibrate* feature opens the *DMC Calibration mode* dialog box, see section 7.9.1.
	NOTE: The *Calibrate* feature is disabled until the Pan/Tilt unit is activated, which is done when the **PRK** button is pressed >3 seconds.
Power on/off	The *Power on/off* feature is used to turn the DMC unit on/off. When the DMC unit is turned off, all menu items in the DMC menu, except *Power on,* are disabled.

7.9.1 DMC Calibration mode

The *DMC Calibration mode* dialog box is used to calibrate the DMC unit, in order to find true north. (The DMC unit finds the magnetic north, which can be corrected to obtain true north. See section 10.3.)

Calibration of the DMC unit is typically done once per installation. That is, if the system is not moved, no new calibration is needed. The DMC Calibration procedure is described in section 10.3.1.

NOTE: The Azimuth value in the *Setup – Pan/Tilt* dialog box will automatically be adjusted to correspond with the magnetic north reading of the DMC unit.

NOTE: The IR Camera shall be turned off before the DMC calibration starts, since it may interfere with the magnetic measurements.

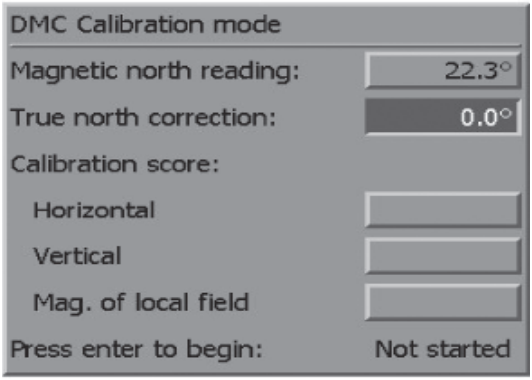


Figure 7.36 DMC Calibration mode dialog box.

DMC Calibration mode dialog box

Feature	Description
Magnetic north reading	The *Magnetic north reading* item displays the magnetic north reading reported by the DMC unit.
True north correction	The *True north correction* feature is used to enter a known deviation between magnetic north and true north. A negative number corrects towards west and a positive number towards east. **NOTE:** The *True north correction* value has to be entered before the calibration is started.
Calibration score	The *Calibration score* indicates the quality of the measurement. A poor score is an indication of magnetic interference, for example iron, vehicles, transformers or power lines. • **Horizontal**: Shall ideally be 9, on a scale from 0 to 9. • **Vertical**: Shall ideally be 9, on a scale from 0 to 9. • **Mag. of local field**: Shall be low, on a scale from 0 to 100.

IR Camera software

The IR Camera software is used to control the IR Camera directly. The IR Camera menu system gives access to all the functions that are used to control the IR image quality. The software also provides the operator with information about the IR Camera.

For most operators, the features for control of the IR image that are available via the System Software menu system and the Joystick Control Unit (JCU) are fully sufficient, see section 11.3.

8.1 IR Camera information

Information from the IR Camera can be displayed on top of the IR image on the monitor. In the *GUI* Setup dialog box it is possible to select which information to display on the monitor, see section 8.3.3.2.

NOTE: When the IR Camera menu system is not opened, the IR Camera information in the bottom line is hidden behind the system information displayed by the System Software.

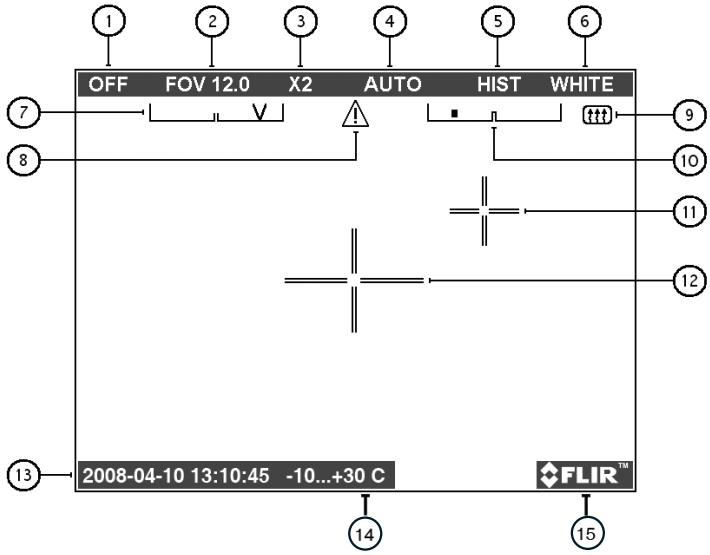


Figure 8.1 IR Camera information.

IR Camera information

Callout	Description
1	Top line status indicator: OFF, LO or HI (current noise filter)
2	Top line status indicator: FOV xx.x (current field of view angle)
3	Top line status indicator: X2, X4 or X1 (zoom indicator; 'X1' will not be displayed)
4	Top line status indicator: • **AUTO** = automatic adjustment mode • **AUTO*** = contrast (span) and/or brightness (level) adjusted with an offset of ± 50 % • **AUTO L** = automatic level adjustment mode • **AUTO L*** = brightness (level) adjusted with an offset of ± 50 % • **MANUAL** = manual adjustment mode • **FREEZE** = image freezed mode • **RECALL** = image recalled mode
5	Top line status indicator: **HIST**, **LIN** (histogram or linear color distribution mode)
6	Top line status indicator: **WHITE** or **BLACK** (polarity selection, i.e. **white = hot** or **black = hot**)
7	Focus position indicator. Indicates the present focus position. Focusing against infinity result in indicator arrow moving towards the right side.
8	Alert indicator. The indicator is displayed when some kind of system failure has occurred. The camera is operating with reduced functionality.
9	Defroster indicator. The indicator is displayed when the defroster (frontlens heater) is active.
10	Dynamic range indicator. The dynamic range indicator shows the dynamic range of the current image in relation to the calibrated range. The position of the bar indicates the level, while the width of the bar indicates the span.
11	Calibration crosshair. User adjustable crosshair.
12	Center position crosshair. Indicates the center of the optical axis.
13	Bottom line status indicator: Present date and time
14	Range
15	Logo type on

8.2 IR Camera menu system

The IR Camera menu system gives access to the features of the IR Camera. The IR Camera menu system is opened from the System Software, with the *IR menu* feature in the **Setup** menu. When the *IR menu* feature is selected, a menu bar with the currently selected IR Camera menu and feature highlighted is displayed.

Features that directly perform an action are displayed as a command, for example *NUC*. Features that open up a dialog box are displayed with three dots after the feature title, for example *Zoom*.... Features that currently are disabled and not available for selection are shaded in the menu.

The Joystick Control Unit (JCU) is used to navigate in the IR Camera menu system and to execute actions, see chapter 6.

The CANCEL button is used to exit the IR Camera menu system. If not in use for a while, the IR Camera menu system is automatically exited.

8.3 Main menu bar

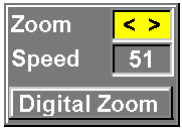
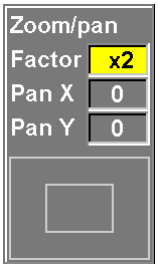
Figure 8.1 Main menu bar.

NOTE: Setup and Tools have no arrow, which means that you can not access these sub-menus without entering an access code.

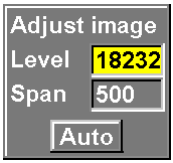
8.3.1 Image menu

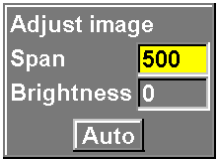
Figure 8.2 Image menu.

Menu choice	Possible choices	Explanation
Zoom in **Zoom out**	–	The camera has four fixed zoom positions. Press the ENTER button on Zoom in or Zoom out, to select the nearest fixed zoom position. **NOTE:** If the camera is already in its most zoomed in or zoomed out position then the corresponding menu selection will be disabled.

Menu choice	Possible choices	Explanation
Zoom…	–	Press the ENTER button to display the **Zoom** dialog box.  • To change the zoom position, select the top button and then press the navigation pad left/right. • To change the zoom speed (0-100) select **Speed** and use the navigation pad to adjust the speed value. Select the **Digital Zoom** button and press the ENTER to show the **Digital Zoom** dialog box.  • To change the digital zoom factor (1x, 2x, or 4x), select the top button and then press the navigation pad left/right. • To move the image area that will be covered select **Pan X** or **Pan Y** and use the navigation pad to move the area.

Menu choice	Possible choices	Explanation
Focus…	–	Press the ENTER button to display the **Focus** dialog box.  • To change the focus, select the top button and then press the navigation pad left/right • To autofocus the camera, select the **Auto** button and press the navigation pad left/right • To set the camera to the fixed focus position, select the Fix button and press the navigation pad left/right • To leave the dialog box, press ENTER
NUC	–	Press the ENTER button to make the camera perform a **NUC**, i.e. a non-uniformity correction. The NUC function performs an internal calibration to correct for image non-uniformities that arise due to the slightly different offset characteristics occurring from detector to detector within the array.
Range…	–	Press the ENTER button to display the **Range** dialog box.  The camera has been calibrated to be used for different temperature ranges. Use the navigation pad to select between the different temperature ranges. • Press the ENTER button to confirm.

Menu choice	Possible choices	Explanation
Freeze	–	Press the ENTER button to freeze the image. When the image is frozen, this menu item will be displayed as **Live**.
Manual adjust **Automatic adjust**	–	To switch between **manual adjustment** and **automatic adjustment** of the image, press ENTER. The current adjustment mode will be displayed in the top line status indicator.
Adjust image…	–	Select **Adjust image** and press ENTER to display the Adjust image dialog box. In this dialog box you can change **level** and **span**, or the corresponding brightness and contrast. The appearance of this dialog box depends on the settings for Adjust mode and Color distribution in the Image Setup dialog box. If **Manual** and **Histogram** or **Linear** are selected in the Image Setup dialog box, you can change level and span by using the navigation pad.You can also carry out an one-shot autoadjust maneuver.  If Level/Span and Histogram or Linear are selected in the Image Setup dialog box, you can change brightness and contrast by using the navigation pad. This will be indicated by **AUTO*** in the top line status bar. 

Menu choice	Possible choices	Explanation
Adjust image... (continue)		If **Level** and **Histogram** or **Linear** are selected in the Image setup dialog box, you can change span and brightness by using the navigation pad.You can also carry out an one-shot autoadjust maneuver. 
Palette…	• **Rainbow** • **Rainbow HC** • **Gray (white hot)** • **Iron**	Use the navigation pad to select different IR palettes. Press the ENTER button to confirm.
Invert Palette	–	Press the ENTER button to invert the current palette
Hide graphics **Show graphics**	–	When graphics are hidden, this command will be Show graphics.

8.3.1.1 To consider when auto focusing

To make it possible for the camera to auto focus properly; there are a few things to consider.

- The default area that the camera uses when auto focusing is a 80×60 pixel box, centered vertically and horizontally on the screen.
- The camera will have difficulties auto focusing when the image has low contrasts between different areas.
- Keep the camera steady when auto focusing.

8.3.2 File menu

Figure 8.3 File menu.

Menu choice	Possible choices	Explanation
Save	–	Press the ENTER button to save the current image to the camera's internal file system.
Open	–	Press the ENTER button to open an image from a file list in the camera's internal file system
Directories	–	Use the navigation pad to browse the directories in the camera's internal file system.
Delete image	–	Press the ENTER button to *delete* an image.

8.3.3 Setup menu

NOTE: The first time you are entering the Setup menu, you have to enter an access code. The default code is 0000. The code will prevent non-authorized personnel from changing the camera settings. Enter the access code by using the arrow buttons. To change the access code, see section 8.3.3.10 – Access code.

Figure 8.4 Setup menu.

8.3.3.1 Image

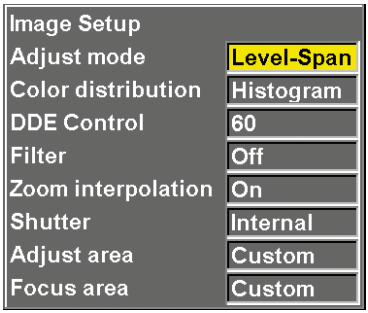


Figure 8.5 Image Setup dialog box.

Menu choice	Possible choices	Explanation
Adjust mode	• **Manual** • **Level** • **Level-Span** • **DDE**	Press the navigation pad left/right to select the image adjustment mode. DDE= Digital Detail Enhancement. This image processing option is primarily used to enhance the visibility of details in difficult scene conditions. Scenes with big contrasts would normally hide objects of interest that have a considerably lower contrast profile. With DDE such objects are brought forward and thus still visible to the degree set by the selected DDE level. **NOTE:** The most suitable settings for a certain imaging situation depends on many different factors, such as target temperature and emissivity, ambient temperature, distance to target etc.
Color distribution	• **Histogram** • **Linear**	Press the navigation pad left/right to select the color distribution mode. **NOTE:** The most suitable settings for a certain imaging situation depends on many different factors, such as target temperature and emissivity, ambient temperature, distance to target etc.
DDE Control		Controls DDE impact from 0 to 100 percent. Moves from smoothening (0–20) to sharpening (21–100) or less contrast to more contrast when amount is increased.

Menu choice	Possible choices	Explanation
Filter	• **Low** • **High** • **Off**	Use the navigation pad to select the filter type – Low, High or Off (no filter). Press the ENTER button to confirm.
Zoom interpolation	• **On** • **Off**	Use the navigation pad to enable or disable the zoom interpolation. *Interpolation* is a mathematical process used to estimate values between known point observations. The camera software *interpolates* the resolution by mathematically analyzing what would be the most plausible value of the closest neighbor of a pixel. The zoom interpolation works only during an digital zoom sequence.
Shutter	• **Off** • **Internal** • **External**	Use the navigation pad to select the shutter type used during a NUC. Press the ENTER button to confirm. *NUC = Non-Uniformity Correction.* *Off* – no shutter is used during the camera calibration. The image is calibrated against the actual scene at which the camera is looking. This method allows for calibration against surfaces with a representative temperature compared to the actual scene temperature. This is normally the preferred method provided that a surface with a homogeneous temperature is used (e.g clear sky, smooth wall surface, a piece of black plastic foam held against the front lens, etc). *Internal* – the image is calibrated against a shutter inside the camera which has an even temperature distribution over its surface – normally warmer than the scene temperature.
Shutter (Continue)		*External* – the external shutter (front lens cover) is used as the thermal reference during calibration. The shutter closes at NUC and re-opens after completed calibration. Normally, the external shutter has a temperature close to the scene temperature and is thus a representative calibration body. **NOTE:** Keep in mind that disabling the shutter may impair the infrared imaging, unless a scene with an even temperature is used for calibration!

Menu choice	Possible choices	Explanation
Adjust area	• **A1** • **A2** • **A3** • **A4** • **A5**	Press the ENTER button and use the navigation pad to select what area the camera should use when adjusting the image with regards to level and span.
Focus area	• **A1** • **A2** • **A3**	Press the ENTER button and use the navigation pad to select what area the camera should use when focusing.

8.3.3.2 Graphical User Interface (GUI)

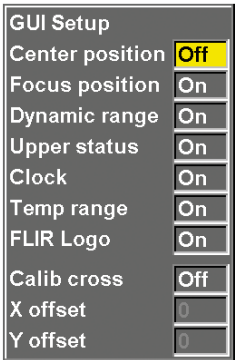


Figure 8.6 GUI Setup dialog box.

NOTE: Hide graphics is the factors default setting.

Menu choice	Possible choices	Explanation
Center position	• **On** • **Off**	Use the navigation pad to display or hide the optical center position crosshair. Press the ENTER button to confirm.
Focus position	• **On** • **Off**	Use the navigation pad to display or hide the focus position indicator. Press the ENTER button to confirm.
Dynamic range	• **On** • **Off**	Use the navigation pad to display or hide the dynamic range indicator. Press the ENTER button to confirm
Upper status	• **On** • **Off**	Use the navigation pad to display or hide the top status line. Press the ENTER button to confirm.
Clock	• **On** • **Off**	Use the navigation pad to display or hide the bottom status line. Press the ENTER button to confirm.
Temp range	• **On** • **Off**	Use the navigation pad to display or hide the bottom status line. Press the ENTER button to confirm.
FLIR logo	• **On** • **Off**	Use the navigation pad to display or hide the bottom status line. Press the ENTER button to confirm.
Calib cross	• **On** • **Off**	Use the navigation pad to display or hide a calibration crosshair in the image. Press the ENTER button to confirm.
X offset	–	Use the navigation pad to move the calibration cross along the X axis. The number indicates the number of overlay pixels (640 x 480) and is calculated from the center of the screen. Press the ENTER button to confirm.
Y offset	–	Use the navigation pad to move the calibration crosshair in Y axis. The number indicates the number of overlay pixels (640 x 480) and is calculated from the center of the screen. Press the ENTER button to confirm.

8.3.3.3 Image save

Figure 8.7 Save Setup dialog box.

Menu choice	Possible choices	Explanation
File format	• **JPEG** • **FFF**	Use the navigation pad to select the file format. *JPEG: Joint Photographic Experts Group* – A compression algorithm named after the committee that defined it. Use this file format when no, or a third-party software, will be used for image post-processing. *FFF: FLIR File Format* – FLIR Systems' propriety file format. Use this file format when FLIR Systems' software will be used for image post-processing. Press the ENTER button to confirm.
Overlay	• **On** • **Off**	Use the navigation pad to select whether or not overlay graphics should be saved when saving images. Press the ENTER button to confirm.

8.3.3.4 Date/time

Figure 8.8 Date/time dialog box.

Menu choice	Possible choices	Explanation
Year	**1970** thru **2036**	Change the year by pressing the navigation pad left/right. Press the ENTER button to confirm.
Month	1 thru **12**	Change the month by pressing the navigation pad left/right. Press the ENTER button to confirm.
Day	1 thru **31 Day**	Change the day by pressing the navigation pad left/right. Press the ENTER button to confirm.
Hour	1 thru **24 Hour**	Change the hour by pressing the navigation pad left/right. Press the ENTER button to confirm
Minute	1 thru **59 Minute**	Change the minute by pressing the navigation pad left/right. Press the ENTER button to confirm.
Second	1 thru **59**	Change the second by pressing the navigation pad left/right. Press the ENTER button to confirm **NOTE:** Date & time will be updated when pressing the ENTER button.

8.3.3.5 Local settings

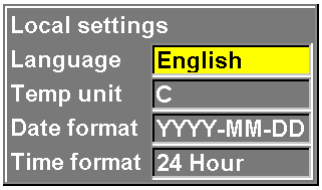


Figure 8.9 Local settings dialog box.

Menu choice	Possible choices	Explanation
Language	**English** + custom choices	Use the navigation pad to select the language. Press the ENTER button to confirm. **NOTE**: The change will take effect and the graphical user interface will be restarted when pressing the ENTER button.
Temp unit	• **°C** • **°F**	Use the navigation pad to select *degrees Celsius* or *degrees Fahrenheit*. Press the ENTER button to confirm.
Date format	• **YYYY-MM-DD** • **YY-MM-DD** • **MM/DD/YY** • **DD/MM/YY**	Use the navigation pad to select the date format. Press the ENTER button to confirm.
Time format	• **24 hours** • **AM/PM**	Use the navigation pad to select the time format. Press the ENTER button to confirm.

8.3.3.6 System

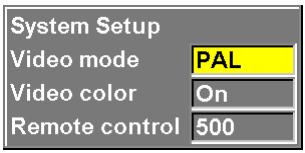


Figure 8.10 System Setup dialog box.

Menu choice	Possible choices	Explanation
Video mode	• **NTSC** • **PAL**	Use the navigation pad to select the video mode. Press the ENTER button to confirm. **NOTE:** The change will take effect and the graphical user interface will be restarted when pressing the ENTER button.
Video color	• **On** • **Off** • **Auto**	Us the navigation pad to select video color should be enabled, disabled or set to Auto. If Auto is selected, the camera will automatically enable video color if a color palette is active. Press the ENTER button to confirm.
Remote control	• **500** • **Sentry**	Use the navigation pad to select the remote control model. Press the ENTER button to confirm. For more information on using the Sentry JCU, contact FLIR Systems.

8.3.3.7 Network

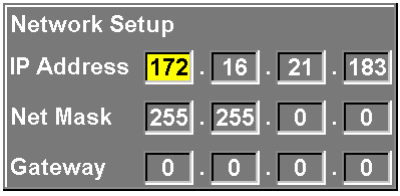


Figure 8.11 Network Setup dialog box.

This dialog box specifies the IP Address, Net Mask and Gateway and affects how the camera works in a network.

8.3.3.8 Real Time Protocol (RTP)

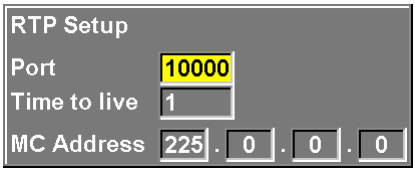


Figure 8.12 RTP Setup dialog box.

RTP stands for *Real Time Protocol*. It is a streaming protocol where data is broken up into a number of smaller packages, appropriately sized with regard to the current bandwidth between the server (in this case the RTP server inside the infrared camera) and the client (a computer in a network). Due to the fact that data is sent as packages, the client software will be able to play the data of one packet at the same time as receiving the data of the second packet. This means that the client software does not need to download an entire file before playing the data.

Menu choice	Possible choices	Explanation
Port	1024–65534	The port the infrared camera is using when streaming the data.
Time to live	1–255	A counter that is decremented each time a packet passes through a router.
MC Address	225.0.0.0– 239.255.255.255	The multicast address to which the server inside the infrared camera is broadcasting.
		NOTE: IP multicast addresses fall within a segment defined by Internet Assigned Numbers Authority (IANA).

8.3.3.9 Camera info

This dialog box shows camera-critical information, such as serial number, software revisions, memory usage etc. No changes can be made.

8.3.3.10 Access code

Figure 8.13 Access code dialog box.

This dialog box specifies the access code. To enter a new access code, use the navigation pad to change the values and press the ENTER button to confirm the new code.

8.3.3.11 Save settings

By selecting **Save settings**, the current system settings will be saved, and loaded when the camera is switched on the next time.

8.3.3.12 Factory default

By selecting **Factory default**, all camera settings are reset to the factory settings.

8.3.4 Tools menu

NOTE: The first time you are entering the Tools menu, you will have to enter an access code. The default code is 0000. The code will prevent non-authorized personnel from changing the camera settings. To change the access code, see section 8.3.3.10 – Access code.

Figure 8.14 Tools menu.

8.3.4.1 Defroster On / Defroster Off

By selecting **Defroster On**, the defroster (front lens heater) is activated. When defroster is active the menu selection will be **Defroster Off**. To turn off the defroster select **Defroster Off**.

8.3.4.2 Ext Shutter On / Ext Shutter Off

By selecting **Ext Shutter On**, the external shutter is moved to cover the front lens. When external shutter is on the menu selection will be **Ext Shutter Off**. To remove the external shutter from the front lens select **Ext Shutter Off**.

8.3.4.3 Reset Optics

By selecting **Reset Optics**, the camera optics will be reset and recalibrated.

8.3.4.4 POST result

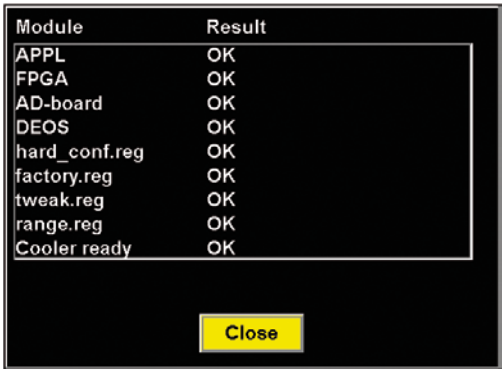


Figure 8.15 POST result log.

When the camera is switched on, it performs a power-on self-test (POST). This log file displays the results of that self-test.

8.3.4.5 BIT result

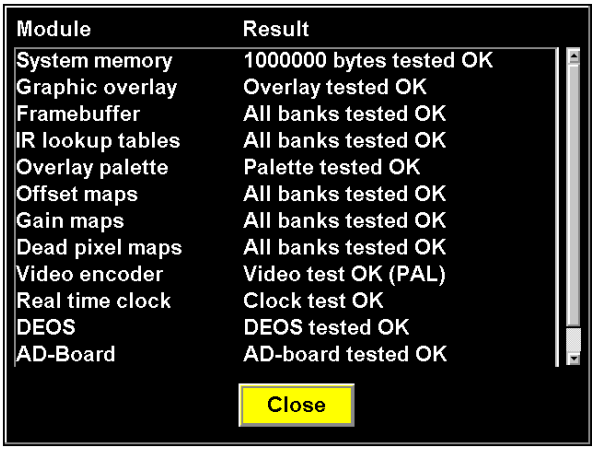


Figure 8.16 BIT result log.

When you select **BIT Start**, the camera performs a number of built-in tests. This log file displays the results of those tests.

8.3.4.6 BIT start

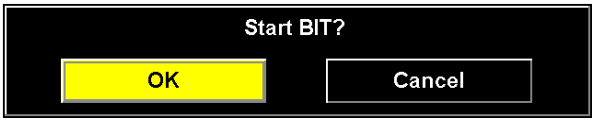


Figure 8.17 Start BIT dialog box.

Select **BIT start** and then press OK to make the camera perform a number of built-in tests (BIT). The results of these tests will be displayed in the **BIT result** log file.

8.3.4.7 Test image

To display an image test pattern, select **Test image** and press the ENTER button. You can use this image test pattern to calibrate your video monitor or computer screen.

Depending on the settings in the **System Setup** dialog box, this image test pattern will be displayed as a grayscale image or a color image.

8.3.4.8 System restart

To restart the camera system, select **System restart** and press the ENTER button.

Hardware installation

This chapter describes the installation of the Ranger HRC MS system.

9.1 Mechanical installation

The top housing (optionally with LRF, GPS and/or DMC units) is mounted on the Pan/Tilt unit when the system is delivered.

NOTE: Do not over torque when tightening screws (max 10 Nm).

9.1.1 JPC2

Ranger HRC MS is a high performance surveillance system, including a very small field-of-view optical device. It is important that the system is mounted and secured on a stable platform; for example a tripod or a rugged tree-top mast.

The mechanical interface of the JPC2 unit is included section 15.6.6.

9.1.2 Pan/Tilt

The Pan/Tilt unit is normally mounted on the JPC2 unit.

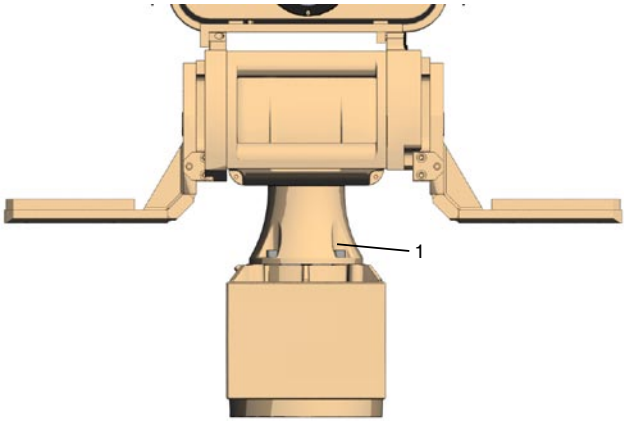


Figure 9.1 Pan/Tilt unit and JPC2

Mounting the Pan/Tilt unit	
Step	**Action**
1	Position the Pan/Tilt unit on the JPC2 unit.
	NOTE: The connector at the bottom of the Pan/Tilt must be on the same side as the connectors on the JPC2 unit.
2	Tighten the four M8 x 20 screws, Figure 9.1, item (1).

9.1.3 IR and TV Camera

The Pan/Tilt unit is equipped with a left and a right mounting plate, where the IR and TV cameras are mounted. Seen from the front side, the IR Camera shall be mounted on the left mounting plate; Figure 9.2, item (1); and the TV Camera on the right mounting plate; Figure 9.2, item (2).

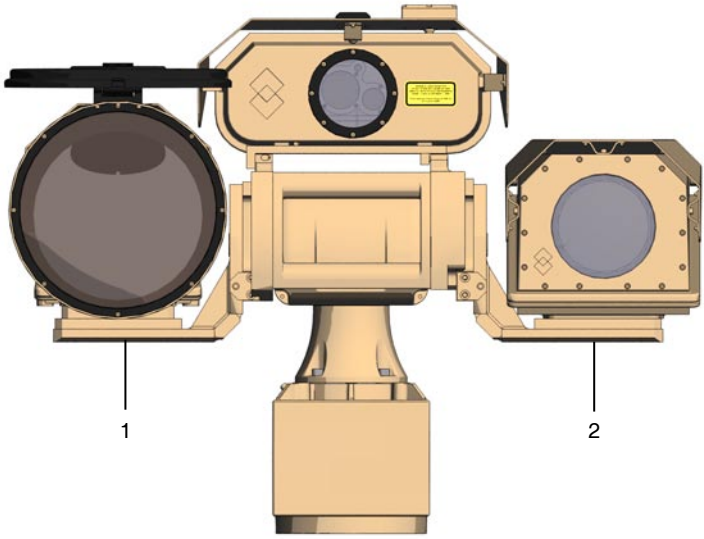


Figure 9.2 Mounting plate for the IR Camera (1) and the TV camera (2)

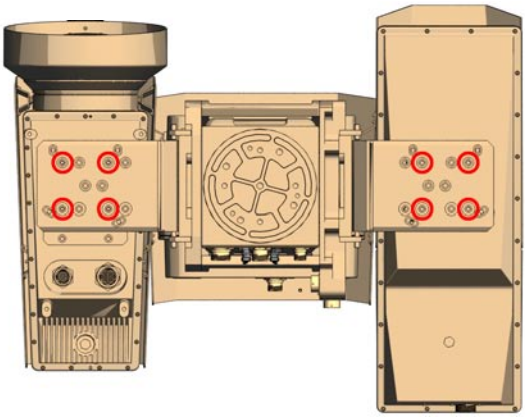


Figure 9.3 Holes to use when mounting the cameras

The TV cameras and the Ranger HRC-U camera is mounted with M6 x 20 screws. The Ranger HRC-S camera is mounted with UNC ¼ x ¾ screws.

Mounting the cameras

Step	Action
1	Fit the cameras in place, one at the time, on the mounting plates, using the two guiding pins. It is easiest to start with the front guiding pin and then fit the rear pin in place.
2	Thread the four M6 x 20 or UNC ¼ x ¾ screws into the holes that are marked in Figure 9.3. Tighten the screws and ensure that the Pan/Tilt unit is fastened properly.
	NOTE: Do not unscrew the other screws in the mounting plate, as that will destroy the alignment of the camera.

9.2 Cable connections

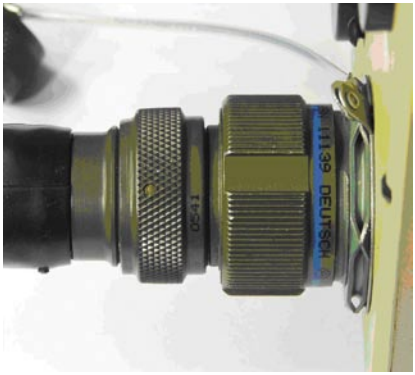
Always ensure that the system is disconnected from the AC power before connecting or disconnecting any cables.

The connectors shall be sealed with protective caps when not in use.

For connections with bayonet sockets, the connector shall be fastened until it is locked (a click sound is heard).

For sockets with a color marking, the connectors shall be fastened until the marking is no longer visible, see Figure 9.4.

Correct (red marking not visible)



Incorrect

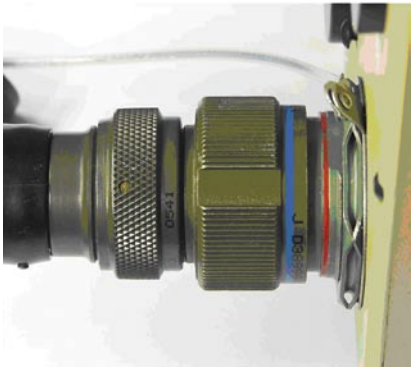


Figure 9.4 Socket with color marking

NOTE: When multiple part numbers are indicated in the tables below, please refer to the Parts list in section 15.2 for more information.

9.2.1 Pan/Tilt unit

The IR and TV cameras and the LRF, DMC and GPS units shall be connected to the Pan/Tilt unit. The Pan/Tilt unit shall be connected to the JPC2 unit.

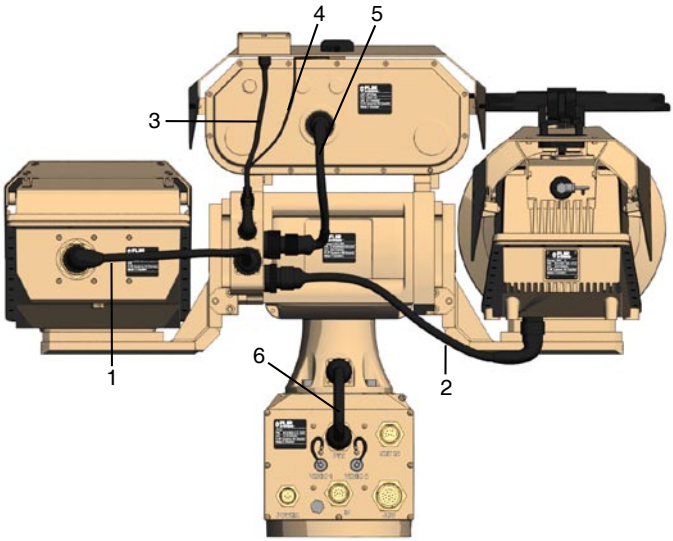


Figure 9.5 Camera and sensor connections

Pan/Tilt connections

Callout	Denomination	Part number	Connections
1	TV Camera cable	614 007 038 G007 858 G007 712	From X3 connector on Pan/Tilt to TV Camera.
2	IR Camera cable	G007 678	From X2 connector on Pan/Tilt to IR Camera.
3	DMC cable	G007 706	From X5 connector on Pan/Tilt to DMC.
4	GPS antenna cable	-	From X4 connector on Pan/Tilt to GPS.
5	LRF cable	G007 887	From X6 connector on Pan/Tilt to LRF.
6	System cable	614 005 888	From X1 connector on Pan/Tilt to PTH connector (J15) on JPC2.

9.2.2 System components

The Ranger HRC MS system can be configured for stand-alone operation or for operation in an IP network with multiple systems. Cable connections for three typical stand-alone configurations are described in the sections below.

NOTE: The control of the video channels (TV and IR) is defined via a setting in the System Software. The recommended setting depends on the number of connected video monitors. For detailed instructions, see section 10.1.

For information about connections in an IP network configuration, see section 15.9.

9.2.2.1 JPC2 configuration

With this configuration, the JCU and monitors are connected directly to the JPC2 unit. The system is powered from the Power Supply unit.

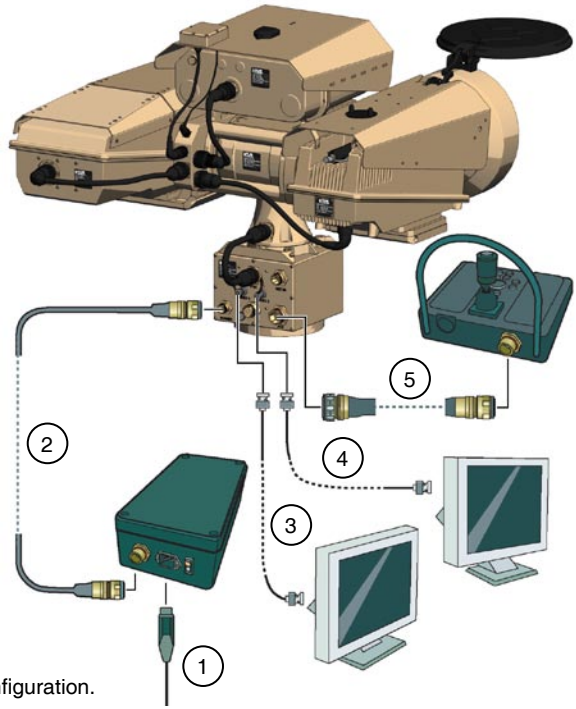


Figure 9.6 JPC2 configuration.

JPC2 configuration

Callout	Denomination	Part number	Connections
1	AC Mains cable	-	From AC mains supply to Power Supply.
2	Power cable	194 628	From POWER connector (J2) on JPC2 to Power Supply unit.
3	Video cable	908 929	From VIDEO 1 connector (J3) on JPC2 to monitor.
	NOTE: If only one monitor is used, it shall be connected to the J3 connector.		
4	Video cable	908 929	From VIDEO 2 connector (J11) on JPC2 to monitor.
5	JCU cable	194 612	From JCU connector (J1) on JPC2 to J10 connector on JCU.

9.2.2.2 Junction Box configuration

With this configuration, the Junction Box is used for connections of the JCU, Power Supply unit and monitors. The system is controlled and powered via the System Cable, connected to the JPC2 unit.

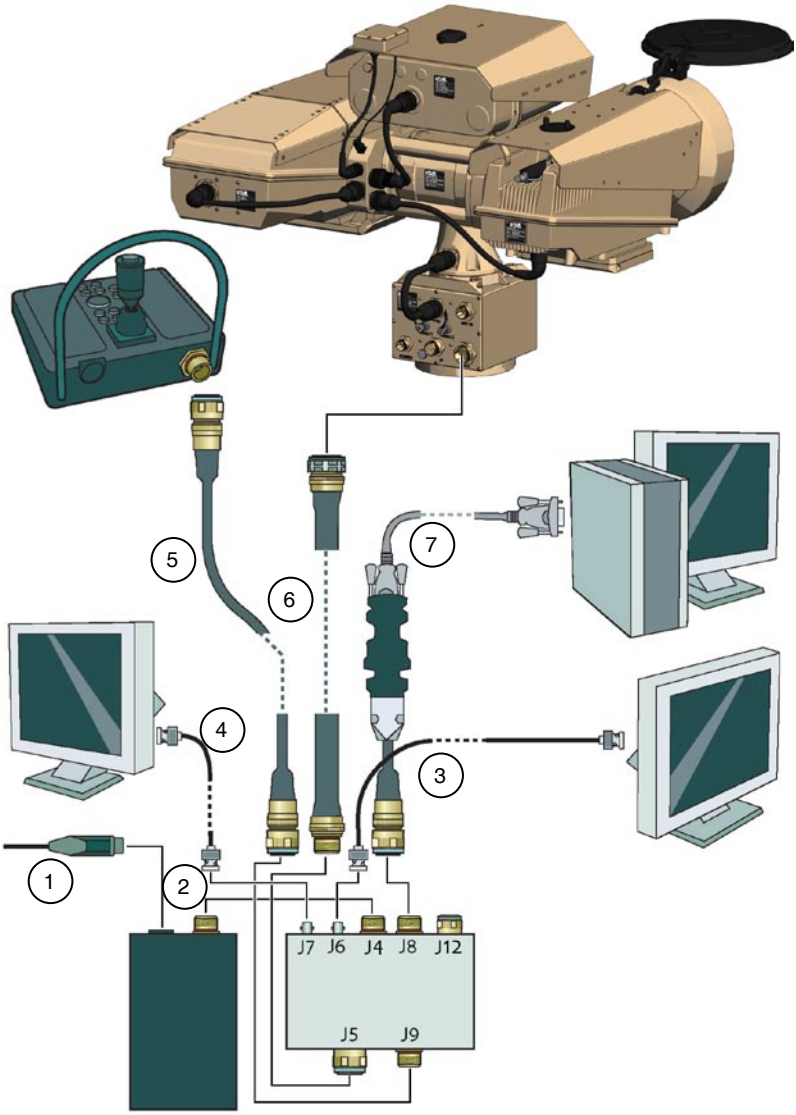


Figure 9.7 Junction Box configuration.

Junction Box configuration			
Callout	Denomination	Part number	Connections
1	AC Mains cable	-	From AC mains supply to Power Supply.
2	Power cable	194 628	From J4 connector on Junction Box to Power Supply.
3	Video cable	908 929	From J6 connector on Junction Box to monitor.
		NOTE: If only one monitor is used, it shall be connected to the J6 connector.	
4	Video cable	908 929	From J7 connector on Junction Box to monitor.
5	JCU cable	194 612	From J9 connector on Junction Box to J10 connector on JCU.
6	System cable	1 196 215 614 006 015	From J5 connector on Junction Box to JCU connector (J1) on JPC2.
7	Host cable	614 005 140 194 638	From J8 connector on Junction Box to external computer.

9.2.2.3 Power Box configuration

With this configuration, the Power Box is used for connections of the JCU and monitors. The system is controlled and powered via the single System Cable, connected to the JPC2 unit. The Power Box has integrated power supply functionality.

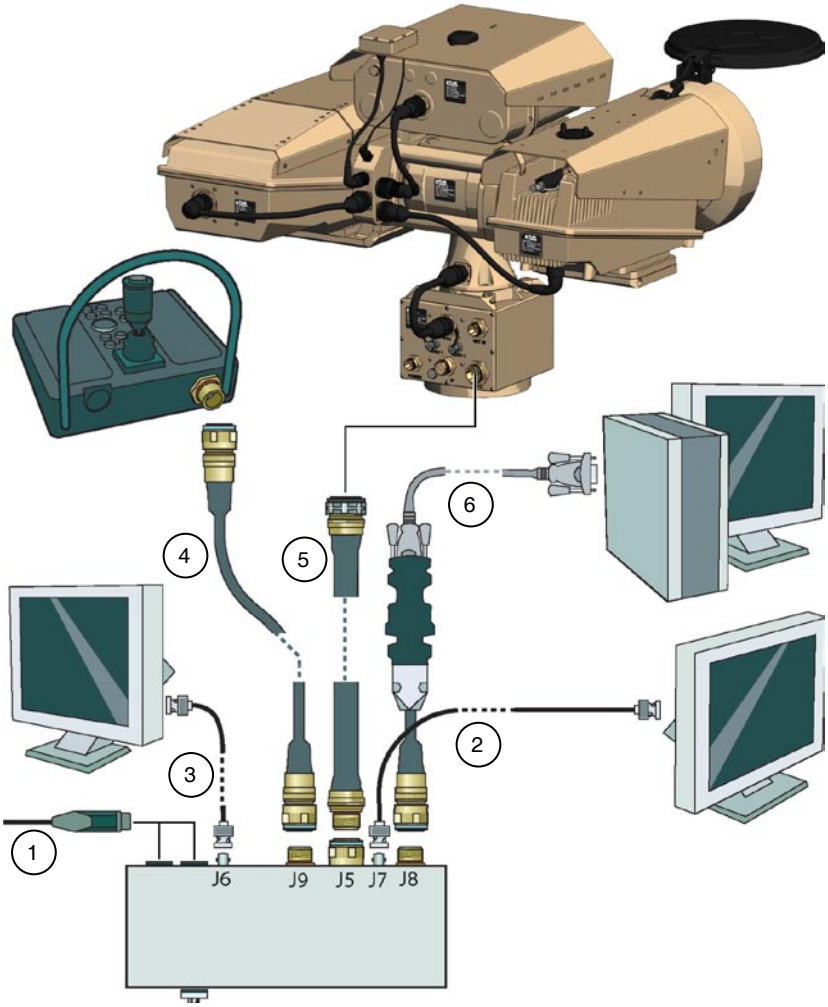


Figure 9.8 Power Box configuration.

Power Box configuration

Callout	Denomination	Part number	Connections
1	AC Mains cable	-	From AC mains supply to power inlet on Power Box.
2	Video cable	908 929	From J7 connector on Power Box to monitor.
		NOTE: If only one monitor is used, it shall be connected to the J7 connector.	
3	Video cable	908 929	From J6 connector on Power Box to monitor.
4	JCU cable	194 612	From J9 connector on Power Box to J10 connector on JCU.
5	System cable	1 196 215 614 006 015	From J5 connector on Power Box to JCU connector (J1) on JPC2.
6	Host cable	614 005 140 194 638	From J8 connector on Power Box to external computer.

9.3 Alignment

Alignment of the Ranger HRC MS system is performed by FLIR before delivery of the system. There is no need to change the alignment during normal operation or after normal disassembling and remounting of the system.

However, after service or replacement of the IR Camera, TV camera and/or LRF unit, a new alignment may be needed:

- If a camera has been replaced, its alignment with the rest of the system must be verified and adjusted if needed.
- If the LRF unit has been replaced, both the IR and TV cameras' alignment with the LRF unit must be verified and adjusted if needed.

9.3.1 Alignment method

The alignment method depends on the equipment that has been replaced:

- If one camera is replaced, the other camera is used as reference.
- If both cameras are replaced and the system is not equipped with an LRF unit, one of the cameras is used as reference.
- If both cameras are replaced, the LRF unit is used as reference.
- If the LRF unit is replaced, the LRF unit is used as reference.

If one of the cameras is used as reference, the reference camera is first directed towards a distant alignment object. The position of other camera is then adjusted, so that it aims at the same alignment object. See section 9.3.2.

If the LRF unit is used as reference, range measurements are made closer and closer to a distant alignment object to determine where the LRF unit is aiming, see Figure 9.9. The camera is aligned to aim in the same way. See section 9.3.3.

9.3.2 Alignment with camera as reference

If the TV camera has been replaced, the IR camera is used as reference and vice versa. If both cameras have been replaced and the system is not equipped with an LRF unit, either the IR camera or the TV camera is used as reference.

A distant and well defined alignment object is required.

NOTE: Ensure that the crosshair reticle is visible in both cameras. If not, see section 7.6.1.2.

Alignment with camera as reference

Step	Action
1	Press the **TV/IR** button to select the reference camera.
2	Use the joystick to direct the system towards the alignment object.
3	Use the optical zoom and zoom in maximally, see section 11.2. (Do not use the digital zoom.)
4	Use the joystick and move the system until the center of the crosshair reticle is at a well defined point on the alignment object. **NOTE**: Once the reference camera is aiming at the alignment object, do not move the system.
5	Press the **TV/IR** button to select the other camera.
6	Verify the alignment; if the crosshair reticle is at the same well defined point on the alignment object, do not change anything.
7	If the alignment is not correct, adjust the position of the camera according to the camera adjustment procedures in section 9.3.4. Start with the azimuth adjustment. When the elevation adjustment is completed, the azimuth alignment must be verified again and adjusted if needed. **NOTE**: Do not adjust the position of the reference camera.

9.3.3 Alignment with LRF unit as reference

If the LRF unit or both cameras have been replaced, the LRF unit is used as reference.

A distant alignment object with sharp horizontal and vertical edges is required. Typical objects are buildings, chimneys and lampposts. The distance to the object must be at least 800 m or more, depending on visibility.

In order to determine where the LRF unit is aiming, distant measurements are made closer and closer to the alignment object until the object is hit, as illustrated in Figure 9.9. The laser pulse can be regarded as a circular lobe. As soon as a part of the lobe is on the alignment object, the LRF unit will detect the object.

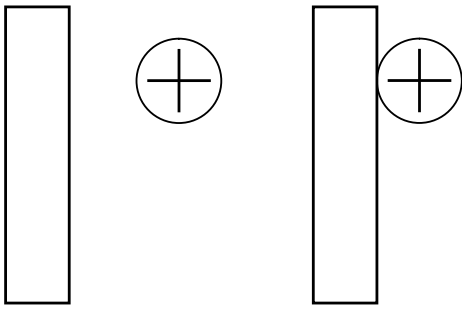


Figure 9.9 Laser lobe approaching from right, with crosshair reticle centered.

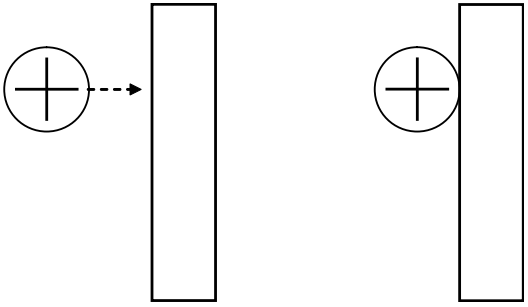


Figure 9.10 Laser lobe approaching from left, with crosshair reticle centered.

NOTE: Ensure that the crosshair reticle is visible in both cameras. If not, see section 7.6.1.2.

Alignment with LRF unit as reference

Step	Action
1	Press the **TV/IR** button to select the camera that has the best visibility for the present conditions.
2	Use the joystick to direct the system towards the alignment object.
3	Use the optical zoom and zoom in maximally, see section 11.2. (Do not use the digital zoom.)
4	Use the joystick to direct the system outside the alignment object.
5	Use the LRF unit to measure the distance to the object, see section 11.5.
6	By estimating the distance to the object and comparing with the LRF result, it should be possible to determine if it was a hit or a miss.
7 a	If it was a hit, move the system a little bit more away from the object. Return to step 5.
7 b	If it was a miss, move the system a little bit towards the vertical edge of the object and measure the distance again. Repeat until a hit is registered.
8	The edge of the laser lobe should now be at the vertical edge of the alignment object and in best case the crosshair reticle is in the middle of the laser lobe, as shown in the right part of Figure 9.9.
9	Use the joystick to direct the system to the other side of the alignment object, see figure 9.10.
10	Measure the distance again and move the system a little bit towards the vertical edge of the object until a hit is registered.
11	In best case, the crosshair reticle is now at the same distance from the vertical edge of the distant object as in step 8. In that case, the azimuth alignment of the camera is correct and no azimuth adjustments shall be made.
12	If the azimuth alignment is not correct, as in Figure 9.11, adjust the position of the camera according to the azimuth adjustment procedure in section 9.3.4.1. Repeated distance measurements and azimuth adjustments may be needed before the azimuth alignment is correct.
13	Use the joystick to direct the system above the alignment object.
14	Measure the distance again and move the system a little bit towards the horizontal edge of the object until a hit is registered.
15	In best case, the crosshair reticle is now at the same distance from the horizontal edge as it was from the vertical edge. In that case, the elevation alignment of the camera is correct and no elevation adjustments shall be made.

Alignment with LRF unit as reference	
Step	**Action**
16	If the elevation alignment is not correct, as in Figure 9.12, adjust the position of the camera according to the elevation adjustment procedure in section 9.3.4.2. Repeated distance measurements and elevation adjustments may be needed before the elevation alignment is correct.
17	Verify that the azimuth alignment is still correct. If not, repeat the distance measurements from the sides and azimuth adjustment procedures followed by distance measurements from above and elevation adjustments until the both the azimuth and elevation alignment is correct.
18	The camera that has now been aligned is used as reference when aligning the other camera, according to section 9.3.2.

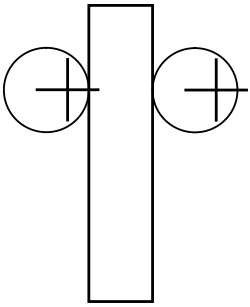


Figure 9.11 Azimuth alignment not correct

Figure 9.12 Elevation alignment not correct

9.3.4 Camera adjustments

9.3.4.1 Azimuth adjustment

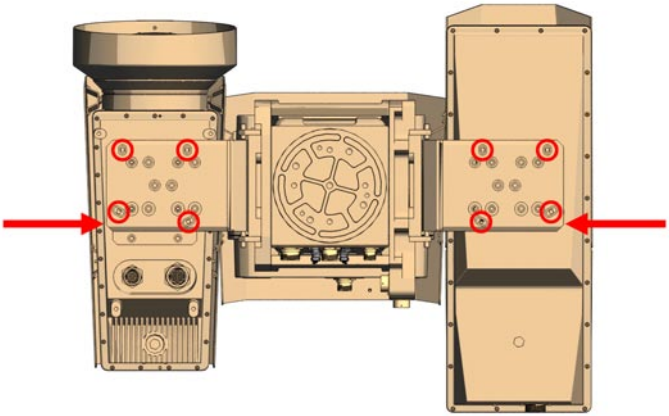


Figure 9.13 Azimuth adjustment screws

Azimuth adjustment	
Step	**Action**
1	Loosen the four screws that are marked with rings in Figure 9.13 a bit.
2	Adjust the camera position with the azimuth adjustment screw, which is marked with an arrow in Figure 9.13. Loosen the screw to turn the camera towards the center of the system, and tighten the screw to turn the camera away from the center.
3	When the position of the camera is correct, cross-tighten the four screws that are marked with rings in Figure 9.13. (Do not tighten the azimuth adjustment screw.)

9.3.4.2 Elevation adjustment

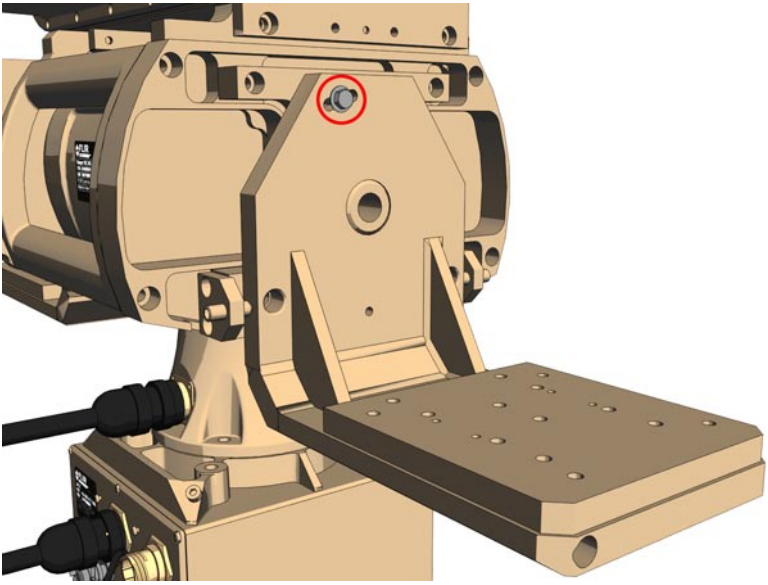


Figure 9.14 Hexagon head bolt

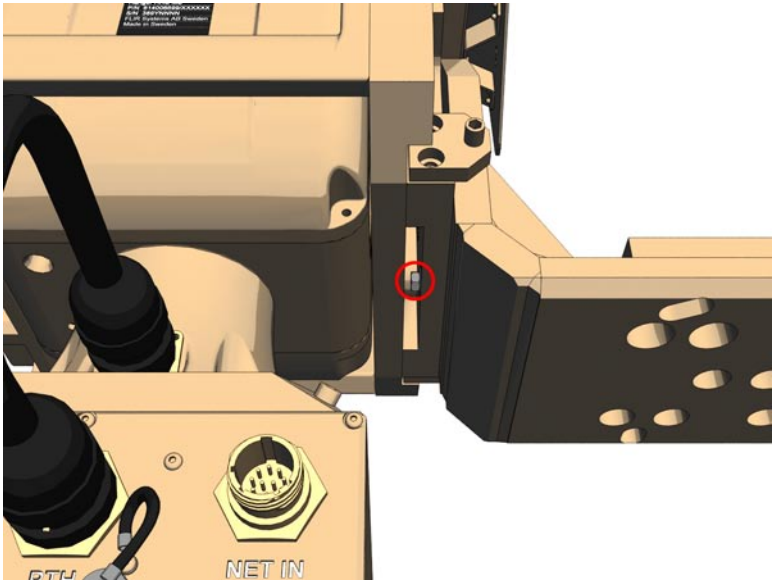


Figure 9.15 Hexagon head bolt

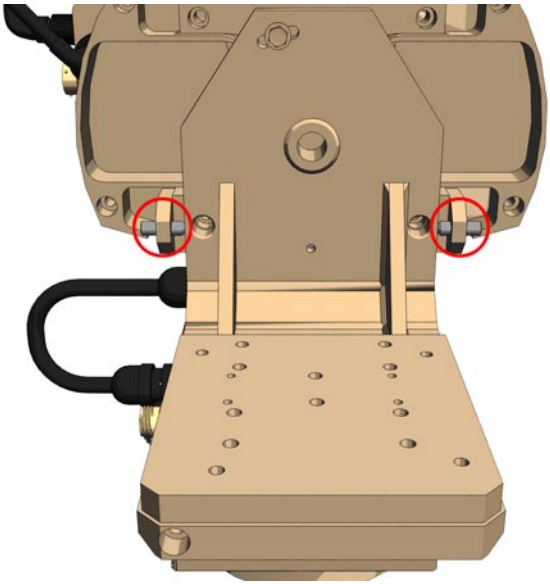


Figure 9.16 Elevation adjustment screws

Elevation adjustment	
Step	**Action**
1	Loosen the two hexagon head bolts a bit, see Figure 9.14 and Figure 9.15.
2 a	*Raise the IR Camer*a by loosening the rear elevation adjustment screw and tighten the front screw, see Figure 9.16. *Lower the IR Camera* by loosening the front elevation adjustment screw and tighten the rear elevation adjustment screw.
2 b	*Raise the TV Camera* by loosening the front elevation adjustment screw and tighten the rear screw, see Figure 9.16. *Lower the TV Camera* by loosening the rear elevation adjustment screw and tighten the front elevation adjustment screw.
3	When the position of the camera is correct, tighten the two hexagon head bolts, see Figure 9.14 and Figure 9.15.
4	Tighten the two elevation adjustment screws, see Figure 9.16.

10 Basic settings

This chapter provides instructions for basic settings in the System Software.

For detailed information about all system settings, see chapter 7.

10.1 Video signal setting

The *IR/TV video swap* feature is used to control the video signal. The recommended *IR/TV video swap* setting depends on the number of connected video monitors.

10.1.1 One monitor

When one video monitor is connected, the VIDEO 1 connector on JPC2 unit (J3), Junction Box (J6) or Power Box (J7) shall be used, see section 9.2.2.

When one monitor is used, the recommended *IR/TV video swap* setting is YES. With this setting, the currently active video channel (IR or TV) is always displayed on the video monitor. In this case, the **TV/IR** button is used to toggle between TV and IR imaging on the monitor. The *Active channel* indicator is always shown.

10.1.2 Two monitors

When two video monitors are connected, both video connectors on the JPC2 unit, Junction Box or Power Box shall be used.

When two monitors are used, the recommended *IR/TV video swap* setting is NO. With this setting, each video channel (IR and TV) is always displayed on its dedicated video monitor. In this case, the **TV/IR** button is used to toggle control between the TV and IR monitors. The *Active channel* indicator is shown on the active monitor.

10.1.3 IR/TV video swap setting

IR/TV video swap setting

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Maintenance** …from the **Setup** menu and press the ENTER button. The *Setup – Maintenance* dialog box is displayed.
3	Select **IR/TV video swap**.
4 a	If one video monitor is connected, use the LEFT/RIGHT navigation buttons to select **Yes**.
4 b	If two video monitors are connected, use the LEFT/RIGHT navigation buttons to select **No**.
5	Press the ENTER button to confirm and to exit MENU mode.

10.2 Joystick Control Unit settings

The functionality of the Joystick Control Unit (JCU) depends to some extent on settings in the System Software.

10.2.1 Original or Alternative setting

The JCU operates with two different settings – Original and Alternative – with somewhat different functions for the joystick and the keypad buttons.

For details on the functionality of the JCU with Original and Alternative setting, see section 6.2.1.

Original/Alternative setting

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Maintenance** …from the **Setup** menu and press the ENTER button. The *Setup – Maintenance* dialog box is displayed.
3	Select **MMI Control mode**.
4	Use the LEFT/RIGHT navigation buttons to select the desired setting of the JCU – **Original** or **Alternative**.
5	Press the ENTER button to confirm and to exit MENU mode.

10.2.2 NUC button

The **NUC** button has two operational modes:

- NUC/AF (this is the default setting):
  Press button NUC < 1 second to perform an Internal NUC.
  Press button NUC > 1 second to perform a one-shot auto focus adjustment.
  and
  Press buttons FCN + NUC < 1 second to perform an External NUC against the lens cover.
  Press buttons FCN + NUC > 1 second to go to the fix focus position.
  and
  Press the C + NUC buttons < 1 second to perform an External NUC against the scene.
  Press the C + NUC buttons > 1 second to perform a one-shot auto focus adjustment.
- AF/NUC:
  Press button NUC < 1 second to perform a one-shot auto focus adjustment.
  Press button NUC > 1 second to perform an Internal NUC.
  and
  Press buttons FCN + NUC < 1 second to go to the fix focus position.
  Press buttons FCN + NUC > 1 second to perform an External NUC against the lens cover.
  and
  Press the C + NUC buttons < 1 second to perform a one-shot auto focus adjustment.
  Press the C + NUC buttons > 1 second to perform an External NUC against the scene.

The *Nuc button* feature is used to select the operational mode of the NUC button.

NUC button setting

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Image** …from the **Setup** menu and press the ENTER button. The *Setup – Image* dialog box is displayed.

NUC button setting	
Step	**Action**
3	Select **Nuc button**.
4	Use the LEFT/RIGHT navigation buttons to select the desired NUC button setting; **NUC/AF** or **AF/NUC**.
5	Press the ENTER button to confirm and to exit MENU mode.

10.2.3 Joystick polarity

The joystick has two operational modes:

- Normal: When the operator moves the joystick towards himself, the Pan/Tilt unit will move downwards.
- Pilot: When the operator moves the joystick away from himself, the Pan/Tilt unit will move downwards.

The *Joystick polarity* feature is used to select the operational mode of the joystick.

Joystick setting	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **Pan-Tilt …**from the **Setup** menu and press the ENTER button. The *Setup – Pan/Tilt* dialog box is displayed.
3	Select **Joystick polarity**.
4	Use the LEFT/RIGHT navigation buttons to select the desired NUC button setting; **Normal** or **Pilot.**
5	Press the ENTER button to confirm and to exit MENU mode.

10.2.4 Autoscan point selection

The *Left/Right scanpoint selection* feature is used to control the function of the ◀ and ▶ buttons:

- On: The ◀ and ▶ buttons are used to move the system to the previous/next autoscan point. This is the default setting.
- Off: The ◀ and ▶ buttons can not be used to move the system to the previous/next autoscan point.

Autoscan point selection setting

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Pan-Tilt …**from the **Setup** menu and press the ENTER button. The *Setup – Pan/Tilt* dialog box is displayed.
3	Select **Left-Right scanpoint selection**.
4	Use the LEFT/RIGHT navigation buttons to select the desired NUC button setting; **On** or **Off.**
5	Press the ENTER button to confirm and to exit MENU mode.

10.3 Home position

There are two positions to park the system at, the home position and the mechanical home position.

The home position is defined by a DMC calibration or by manual setting. The DMC calibration is used to set the home position to true north. Manual setting is used to set the home position to a specific target, for example a gateway or an entrance door. When the PRK button is pressed < 1 second, the system moves directly to the home position.

When the system is in the mechanical home position, the cameras and sensors are directed straight forwards. The system is sent to the mechanical home position when the PRK button is pressed > 1 second. This position is recommended before the system is turned off.

10.3.1 DMC calibration

The DMC calibration is used to set the home position to true north.

The DMC unit establishes the direction to magnetic north. In order to find true north, the local magnetic declination between magnetic north and true north must be entered into the system before the DMC calibration is started. A negative number corrects toward west and a positive number towards east.

In order to find magnetic north, the Digital Magnetic Compass (DMC) unit measures the geomagnetic field. It is important that the system is placed away from any sources of magnetic interference, which may interfere with the measurement and spoil the result. Devices like transformers, motors, radars, power lines etc. emit powerful fields which can have severe impact on the reliability of the readings. Also larger masses of certain materials such as iron will have an impact. For instance, a steel vehicle like a tank close to the system may create large deviations.

For information about the operation of the DMC unit, see section 3.1.5.

NOTE: The IR Camera shall be turned off during the DMC calibration, to avoid magnetic interference.

NOTE: The Azimuth value in the *Setup – Pan/Tilt* dialog box will automatically be adjusted to correspond with the magnetic north reading of the DMC unit. Hence, a DMC calibration will replace any previous true north or manual setting of the home position.

Preparations

Step	Action
1	Ensure that the system is placed away from any magnetic interference, to ensure correct readings from the DMC unit.
2	Ensure that IR is selected. If not, press the **TV/IR** button to select IR. Press the ENTER button to enter MENU mode. Select **Power off …** from the **Image** menu and press the ENTER button to turn off the IR Camera.

Setting home position to true north

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Calibrate …** from the **DMC** menu and press the ENTER button. The *DMC Calibration mode* dialog box is displayed.
3	Select **True north correction** and use the LEFT/RIGHT buttons to enter the magnetic declination value. A negative number corrects toward west and a positive number towards east.
	NOTE: Hold down the LEFT/RIGHT button for a while to decrease/increase the Azimuth value with larger increments.
4	Press the ENTER button to start the calibration. A search pattern is performed in order to find the magnetic north. The readings of the DMC unit are displayed during the process. When the search is finished, the text “Calibrated” is displayed and the calibration score is presented.
5	Evaluate the calibration score. A poor score is an indication of magnetic interference. • Horizontal: Shall ideally be 9, on a scale from 0 to 9. • Vertical: Shall ideally be 9, on a scale from 0 to 9. • Mag. of local field: Shall be low, on a scale from 0 to 100. • The calibration result can either be confirmed, by pressing the ENTER button, or rejected, by pressing the CANCEL button.
6	Press the ENTER button to confirm the calibration result. Press the CANCEL button to reject the calibration result.
	NOTE: Repeated consecutive accepted calibrations may yield a better result.
7	Select **Power on** from the **Image** menu and press the ENTER button to turn on the IR camera.

If the calibration is repeatedly unsuccessful, it may be necessary to find a new geographical position of the system. If the geographical location cannot be changed and/or the source of deviation is not possible to locate or minimize, a manual calibration method may have to be used. With the manual setting procedure, see section 10.3.2, it is possible to manually set the home position to true north, if the direction towards true north can be established by external means.

10.3.2 Manual setting

Manual setting is used to set the home position to a specific target, for example a gateway or an entrance door. Manual setting can also be used to manually set the home position to true north, if the DMC calibration does not succeed. In that case, the true north direction must be established by other means than with the DMC unit.

Manual setting of home position

Step	Action
1	Press the ENTER button to enter MENU mode.
	Select **Pan-tilt…**from the **Setup** menu and press the ENTER button. The *Setup – Pan/tilt* dialog box is displayed.
2	Use the joystick to move the system to the desired home position; a specific target or true north.
3	Select **Azimuth** and use the LEFT/RIGHT buttons to set the value to **0**°. **NOTE:** Hold down the LEFT/RIGHT button for a while to decrease/increase the Azimuth value with larger increments.
4	Press the ENTER button to confirm and to exit MENU mode.

10.4 Miscellaneous settings

10.4.1 Preset focus distance

The preset focus distance is the position to which the system is set when the *Focus to fixed position* feature is performed, see section 11.2.

Setting Preset focus distance

Step	Description
1	Press the ENTER button to enter MENU mode.
2	Select **Image…** from the **Setup** menu and press the ENTER button.
3	Select **Preset focus distance**.
4	Use the LEFT/RIGHT navigation buttons to select the desired fixed focus distance.
5	Press the ENTER button to confirm and to exit the MENU mode.

10.4.2 Slave mode

The *Slave mode* feature is used to activate/deactivate *Slave mode*. When *Slave mode* is active, changes in field-of-view will apply to both the IR and TV camera.

Setting Slave mode On/Off

Step	Description
1	Press the joystick button > 1 second toggle between Slave mode on/off. The status text *Slave mode on/off* is temporarily displayed.

As an alternative to using the JCU as described above, the System Software menu system can be used to control the Slave mode setting.

NOTE: For features with on/off alternatives, the displayed feature is the action that will be performed if the feature is selected – not the current status. That is, *Slave mode off* means that the *Slave mode* is currently ON and that it will be turned OFF if the feature is selected.

Setting Slave mode On/Off	
Step	**Description**
1	Press the ENTER button to enter MENU mode.
2 a	Select **Slave mode On** from the **Image** menu and press the ENTER button to activate *Slave mode*.
2 b	Select **Slave mode Off** from the **Image** menu and press the ENTER button to deactivate *Slave mode*.

10.5 Save settings

When a setting is changed, it will apply as soon as the ENTER button is pressed to confirm the change. To save the current settings for the next time the system is started up, the **PRK** button has to be pressed.

Save settings	
Step	**Action**
1	Press the **PRK** button > 1 second to save the system settings. The system will be sent to the mechanical home position.
	NOTE: Do not turn off the system while “Saving” is displayed on the monitor.

10.6 Default settings

The *Default setting* feature is used to reset system settings to default values.

NOTE: Settings such as autoscan points and autoscan lists, Baudrate and Protocol are not changed.

Setting default values	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **Maintenance …**from the **Setup** menu and press the ENTER button. The *Setup – Maintenance* dialog box is displayed.
3	Select **Default settings**.
4	Use the LEFT/RIGHT navigation buttons to select **Yes**.
5	Press the ENTER button to confirm and to exit MENU mode.

11 System operation

This chapter describes the procedures for normal system operation.

There are two different settings for the JCU – Original and Alternative – with somewhat different functions for the joystick and the keypad buttons. The setting is made in the *Setup – Maintenance* dialog box, see section 7.6.1.6. The functions for both the Original and the Alternative settings are described in the tables below.

11.1 System on/off

11.1.1 Starting up the system

Starting up the system

Step	Action
1	Verify that all cables are connected and fastened properly.
2	Verify that nobody is close to the system. Turn on the system with the ON/OFF switch on the Power Box or Power Supply unit.
3	The red status indicator on the JCU flashes while the connection is being established. A steady light indicates that the connection is OK.
4	The TV camera is ready to use after about 30 seconds. The IR camera is ready to use after cool down, which typically takes several minutes. A test pattern is displayed until the IR image appears; Figure 11.1. Meanwhile, adjust the monitor until all 16 levels of the test pattern are visible (use the brightness and contrast controls on the monitor).
5	Verify that the lens cover of the IR camera is open. If not, press the **C** + ▲ buttons to open the lens cover or open it manually with the handle on top of the camera.
6	Press and hold down the **PRK** button for 3 seconds to activate the Pan/Tilt unit.

NOTE: For start up in cold weather, see section 11.6.

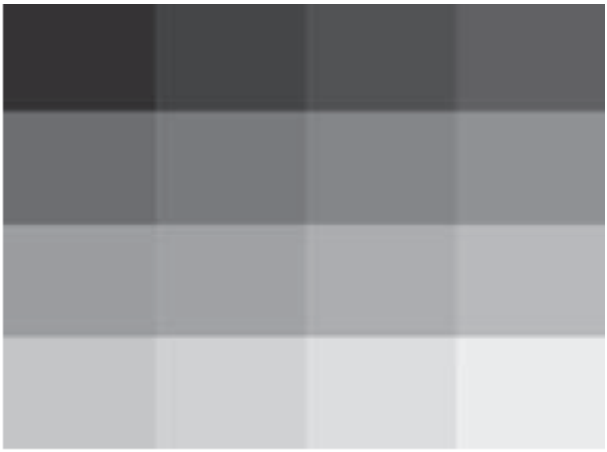


Figure 11.1 Test pattern.

11.1.2 Turning off the system

Turning off the system

Step	Action
1	Press the **PRK** button > 1 second to send the system to the mechanical home position. The system settings will automatically be saved.
	NOTE: Do not turn off the system while “Saving” is displayed on the monitor.
2	Verify that the lens cover is closed. If not, close it manually with the handle on top of the camera.
3	Turn off the system with the ON/OFF switch on the Power Box or Power Supply unit.

11.1.3 Remote power control

The JCU can be used to remotely control the power. If the system is equipped with a Remote Power Controller unit, the entire system will be turned on/off. Otherwise, the IR and TV cameras and the LRF, DMC and GPS units will be turned on/off.

NOTE: The Power Box or Power Supply unit has to be turned on; otherwise it is not possible to use the remote power control function.

Remotely turning power on

Step	Action
1	Press and hold down the **FCN** button.
2	While the **FCN** button is held down, press and hold down the ENTER button for more than 3 seconds to turn on the power.

Remotely turning power off

Step	Action
1	Press and hold down the **FCN** button.
2	While the **FCN** button is held down, press and hold down the **FRZ** button for more than 3 seconds to initiate the power off command. **NOTE**: The system will be parked before the power off command is executed, which typically means that the power is turned off after 10 seconds.

11.2 Basic features

Basic features can be executed with the JCU or via the System Software menu system.

Basic features		
Feature	**ORIGINAL setting**	**ALTERNATIVE setting**
TV/IR	Press the **TV/IR** button to toggle between TV imaging and IR imaging.	
FOV (alt. 1)	Press the joystick button < 1 second to go to the next preset field-of-view.	-
FOV (alt. 2)	Press the ENTER button to enter MENU mode.	
	Select **FOV…** from the **Image** menu and press the ENTER button to go to the next preset field-of-view.	
Zoom	Use the joystick to direct the camera towards the target scene.	
	Press the ▲ button to zoom in. Press the ▼ button to zoom out.	Turn the joystick collar to the left to zoom out. Turn the joystick collar to the right to zoom in.
Auto focus	Verify that the target is in the center of the image.	
	Keep the camera steady when auto focusing.	
	Press the **NUC** button > 1second to perform a one-shot auto focus adjustment.	Press the joystick button < 1 second to perform a one-shot auto focus adjustment.
	NOTE: If the default setting for the **NUC** button has been changed (*Setup- Image* dialog box, see section 7.6.1.1), the **NUC** button shall be pressed < 1 second to auto focus.	The **NUC** button can also be used to auto focus, as for the Original setting.
Auto focus (TV only)	Ensure that TV is selected. If not, press the **TV/IR** button to select TV.	
	Press the ENTER button to enter MENU mode.	
	Select **Auto focus** from the **Image** menu and press the ENTER button.	
	NOTE: The *Auto focus* feature is not supported by all TV cameras. If not supported, the *Auto focus* feature is disabled in the **Image** menu.	

Basic features

Feature	ORIGINAL setting	ALTERNATIVE setting
Focus to fixed position	Press the **FCN** + **NUC** buttons > 1 second to go to the fixed focus position.	
	NOTE: If the default setting for the **FCN** + **NUC** buttons has been changed (*Setup- Image* dialog box, see section 7.6.1.1), the **FCN** + **NUC** buttons shall be pressed < 1 second to go to the fixed focus position.	
	NOTE: The fixed focus position is set in the *Setup – Image* dialog box, see section 7.6.1.1.	
Manual focus	Turn the joystick collar to the left/right to focus near/far.	Press the **FCN** button and turn the joystick collar to the left/right to focus near/far.
Freeze (alt. 1)	Press the **FRZ** button to toggle between live and frozen image.	
Freeze (alt. 2)	Press the ENTER button to enter MENU mode.	
	Select **Freeze/Live** from the **Image** menu and press the ENTER button to change the monitor from live to frozen image or vice versa.	
Declutter	Select **Declutter** from the **Image** menu and press the ENTER button to temporarily remove the system information from the monitor.	
	Press the ENTER button to display the system information again	
Park	Press the **PRK** button < 1 second to send the system to the home position. If the **PRK** button is pressed < 1 second again when the system is in home position, the lens cover will be closed and PARK mode will be entered. Press the **PRK** button > 1 second to send the system to the mechanical home position, close the lens cover and enter PARK mode.	
	NOTE: The procedure for defining the home position is described in section 10.3.	

11.3 IR image

Frequently used features for control of the IR image can be executed with the Joystick Control Unit (JCU) or via the System Software menu system, as described in the sections below.

Detailed instructions for optimization of the IR image are provided in chapter 12.

11.3.1 NUC

NUC (Non-Uniformity Correction) is a function that performs an internal calibration of the IR Camera.

NUC can be performed in three different ways. With Internal NUC, the image is calibrated against a shutter inside the camera. With External NUC, either the lens cover or the scene is used as thermal reference.

The normal procedure is to start with an Internal NUC. If an acceptable image quality is not achieved, an External NUC against the lens cover or against the scene may improve the image.

NOTE: When the camera is started, a NUC is needed every 5 minutes. After about 30 minutes, a NUC is only needed when the quality of the image is degenerated.

Internal NUC	
Step	**Action**
1	Press the **NUC** button < 1 second to perform an Internal NUC.
	NOTE: If the default setting for the **NUC** button has been changed (*Setup- Image* dialog box, see section 7.6.1.1), the **NUC** button shall be pressed > 1 second to perform an Internal NUC.

External NUC against lens cover

Step	Action
1	Press the FCN + NUC buttons < 1 second to perform an External NUC against the lens cover.
	NOTE: If the default setting for the NUC button has been changed (*Setup- Image* dialog box, see section 7.6.1.1), the FCN + NUC buttons shall be pressed > 1 second to perform an External NUC against the lens cover.

External NUC against scene

Step	Action
1	Direct the camera towards a surface with an even temperature. The temperature of the reference surface shall preferably be the same as the temperature of the target. A clear sky can, even if it is cold, be used as an acceptable reference surface. Press the **C** + **NUC** buttons < 1 second to perform an External NUC against the scene.
	NOTE: If the default setting for the **NUC** button has been changed (Setup- Image dialog box, see section 7.6.1.1), the **C** + **NUC** buttons shall be pressed > 1 second to perform an Internal NUC.

11.3.2 Adjustment mode

There are five combinations of Adjustment mode and Color Distribution mode selectable via the System Software menu system.

- Manual: Manual adjustment of level and span.
- Auto (linear): Automatic adjustment of level and span, with color distribution in Linear mode.
- Auto (full): Automatic adjustment of level and span, with color distribution in Histogram mode.
- DDE (linear): Automatic adjustment of level and span, with color distribution in Linear mode and with digital enhancement of details in the scene.
- DDE (full): Automatic adjustment of level and span, with color distribution in Histogram mode and with digital enhancement of details in the scene.

With color distribution in Linear mode, the colors are distributed linearly from the darkest to the brightest pixel in the image. With Color Distribution in Histogram mode the colors are distributed based on the contents of the image.

NOTE: The Auto (full) mode normally gives a good image quality.

Selecting Adjustment mode and Color Distribution mode

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Image…** from the **Setup** menu and press the ENTER button.
3	Select **Level/Span**.
4	Use the LEFT/RIGHT navigation buttons to select adjustment mode.
5	Press the ENTER button to confirm and exit the MENU mode.

11.3.3 Manual adjustment

When the Manual adjustment mode is selected, see section 11.3.2, the level and span values have to be adjusted manually.

Adjusting level and span

Step	Action
1	Press and hold down the **FCN** + ▲ buttons to increase the level value. Press and hold down the **FCN** + ▼ buttons to decrease the level value.
2	Press and hold down the **FCN** + ◀ buttons to decrease the span value. Press and hold down the **FCN** + ▶ buttons to increase the span value.

As an alternative to using the JCU as described above, the System Software menu system can be used:

Adjusting level and span

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **Man. level/span** from the **Image** menu and press the ENTER button. The *Man. level/span* dialog box is displayed.
3	Select **Level** and use the UP/DOWN navigation buttons to move the center of the span.
4	Select **Span** and use the UP/DOWN navigation buttons to decrease/increase the width of the span.
5	Press the ENTER button to confirm and exit the MENU mode.

11.3.4 DDE adjustment

DDE (Digital Detail Enhancement) is an adjustment mode that enhances the visibility of details in the scene. The DDE Control value is used to tune the DDE filter, which gives a continuous shift from less to more detail enhancement.

The DDE Control setting under normal conditions is a matter of personal taste. Test values in the range of 40–65 to find the setting that suits you best.

Adjusting DDE Control value

Step	ORIGINAL setting	ALTERNATIVE setting
1	-	Press and hold down the ▲ button to increase the DDE value. Press and hold down the ▼ button to decrease the DDE value.

As an alternative to using the JCU as described above, the System Software menu system can be used:

Manual adjustment	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **Image…** from the **Setup** menu and press the ENTER button.
3	Select **Adjust DDE**.
4	Use the LEFT/RIGHT navigation buttons to select **Yes**. The *DDE* dialog box is displayed.
5	Use the UP/DOWN navigation buttons to increase/decrease the DDE Control value.
6	Press the ENTER button to confirm and to exit MENU mode.

11.3.5 IR palette

There are four different IR palettes:

- Rainbow
- Rainbow HC
- Gray
- Iron

The default IR palette is Gray. Changing the palette from Gray to Rainbow may improve the perception of details in low contrast scenes, see section 12.3.

All IR palettes are possible to invert. With the Gray palette for example, white or black can be set to represent hot (whitehot is default). Inverting the palette may have an effect on how the image is perceived.

Selecting palette	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **Image…** from the **Setup** menu and press the ENTER button.
3	Select **Color scale**.
4	Use the LEFT/RIGHT buttons to select IR palette, normal or inverted.

Inverting palette	
Step	**Action**
1	Press the **INV** button to toggle between White hot and Black hot IR palette.

11.4 Auto scanning

Auto scanning is used to automatically move the system from point to point in a preset autoscan list.

The time that the system stays on the target, the speed with which the system moves to next autoscan point, the focus and the field-of-view for each autoscan point are fully programmable. It is possible to define up to 32 autoscan points, in up to five lists (the currently active autoscan list + four stored lists).

11.4.1 AUTOSCAN mode

Auto scanning is performed when the system is in AUTOSCAN mode, provided that autoscan points have been defined.

AUTOSCAN mode	
Step	**Action**
1	Press the **SCN** button to enter AUTOSCAN mode.
2	The system moves automatically between the preset autoscan points.
3	Move the joystick in any direction or press the **C** button to exit AUTOSCAN mode.

The functions of the Joystick Control Unit (JCU) in AUTOSCAN mode are described in section 6.2.2.

11.4.2 Autoscan lists

Autoscan lists can be created, saved, reloaded and deleted. Autoscan points can be edited and moved.

The procedures for managing autoscan lists apply to the currently active autoscan list. To be able to manage a stored autoscan list, the stored list must first be recalled. Please refer to section 11.4.2.7.

11.4.2.1 Preparations

The features for programming of autoscan points and management of autoscan lists are available in the System Software menu system when IR is selected (not when TV is selected).

Selecting IR Camera	
1	Ensure that IR is selected. If not, press the **TV/IR** button to select IR.

For full functionality of the Joystick Control Unit (JCU) when programming autoscan points and managing autoscan lists, the Original setting of the JCU must be selected.

Original setting	
1	Press the ENTER button to enter MENU mode.
2	Select **Maintenance…** from the **Setup** menu and press the ENTER button. The *Setup – Maintenance* dialog box is displayed.
3	Select **MMI control mode**.
4	Use the LEFT/RIGHT buttons to select **Original**. Press the ENTER button to confirm and to exit MENU mode.

11.4.2.2 Adjustments of FOV and focus

When defining autoscan points, the JCU is used to make adjustments of field-of-view and focus, as described in the sections below.

Adjusting FOV and focus	
1 a	Press the joystick button < 1 second to go to the next preset field-of-view. Repeat until the system is at the desired field-of-view.
1 b	Use the ▲ and ▼ buttons to zoom in/out to the desired field-of-view.
2	Turn the joystick collar to the left/right to focus near/far.

11.4.2.3 Speed and Dwell settings

The Speed and Dwell settings of the autoscan points are made in the *New pos #* and *Edit pos #* dialog boxes, as described in the sections below.

The Speed setting defines how fast the system shall move to next autoscan point. The preset speed rates are defined in the *Setup – Pan/tilt* dialog box, see section 7.6.1.3.

The Dwell setting defines how long the system shall stay on this autoscan point before moving on to the next point.

Setting Speed and Dwell	
1	In the *New pos #* or *Edit pos #* dialog box, use the UP/DOWN buttons to select **Speed**.
2	Use the LEFT/RIGHT buttons to select the speed setting.
	NOTE: Hold down the LEFT/RIGHT button for a while to decrease/increase the speed with larger increments.
3	Use the UP/DOWN buttons to select **Dwell**.
4	Use the LEFT/RIGHT buttons to select the dwell time setting.
	NOTE: Hold down the LEFT/RIGHT button for a while to decrease/increase the time with larger increments.
5	Press the ENTER button to confirm.

11.4.2.4 Creating autoscan lists and Appending autoscan points

This section describes how autoscan lists are created and how new autoscan points are appended to the currently active autoscan list.

To be able to append autoscan points to a stored list, the stored list must first be recalled, see section 11.4.2.7.

NOTE: When an autoscan list is recalled, the currently active autoscan list is overwritten. If the operator wants to store the currently active autoscan list, it must be done before recalling another list.

Creating autoscan lists and Appending autoscan points

Step	Action
1	Do the necessary settings according to section 11.4.2.1.
2	Press the ENTER button to enter MENU mode.
3	Select **Positions…** from the **Pan/Tilt** menu and press the ENTER button. The *Current positions list* dialog box is displayed. The system is now in PROG POSITION mode.
4 a	To create a new autoscan list, use the LEFT/RIGHT buttons to select **New** and press the ENTER button.
	NOTE: The currently active autoscan list will be deleted when New is selected.
4 b	To append an autoscan point to the currently active autoscan list, use the LEFT/RIGHT buttons to select **Append** and press the ENTER button.
5	Use the joystick to move the system to the desired position for the new autoscan point.
6	Use the JCU to make the desired adjustments of field-of-view and focus; see section 11.4.2.2.
7	Press the ENTER button to register and save the position of the system and the field-of-view, focus and zoom settings. The next available position number is assigned to the autoscan point. The *New pos #* dialog box is displayed.
8	Select the Speed and Dwell settings of the autoscan point, see section 11.4.2.3.
9	Repeat step 5-8 until all autoscan points have been defined.
10	Press the CANCEL button to exit the PROG POSITION mode. The *Quit programming* dialog box will appear. Select **Yes** to exit.
11	To save the new autoscan list, see section 11.4.2.7 and section 11.4.2.8.

11.4.2.5 Editing autoscan points settings and Moving autoscan points

This section describes how the speed and dwell settings of the autoscan points are edited and how the position of an autoscan point is moved.

Editing settings and Moving autoscan points

Step	Action
1	Do the necessary settings according to section 11.4.2.1.
2	Press the **SCN** button to enter AUTOSCAN mode.
3	Press the **FCN** button to enter PROG POSITION mode.
4	Use the ◀ and ▶ buttons to go to the desired autoscan point.
5 a	To edit the autoscan point, press the **FCN** button to open the *Edit pos #* dialog box.
5 b	To move the autoscan point, press and hold down the **FCN** button and use the joystick to move the system to the new desired position.
	Use the JCU to make the desired adjustments of field-of-view and focus; see section 11.4.2.2.
	Press the **FCN** button to register and save the position and the field-of-view, focus and zoom settings. The *Edit pos #* dialog box is displayed.
6	Select the Speed and Dwell settings of the autoscan point, see section 11.4.2.3.
7	Repeat step 4-6 to edit next autoscan point or move next autoscan point.
8	Press the CANCEL button to exit the PROG POSITION mode. The *Quit programming* dialog box will appear. Select **Yes** to exit.
9	To save the new autoscan list, see section 11.4.2.7 and section 11.4.2.8.

11.4.2.6 Route sequence

This section describes how the route sequence is managed.

The route sequence defines the order in which the autoscan points shall be scanned.

The order of the autoscan points in the currently active autoscan list can be changed and autoscan points can be inactivated. Inactivated autoscan points are still available and can be activated again if needed.

Managing the route sequence	
Step	**Action**
1	Ensure that IR is selected. If not, press the **TV/IR** button to select IR.
2	Press the ENTER button to enter MENU mode.
3	Select **Route sequence…** from the **Pan/Tilt** menu and press the ENTER button. The *Route sequence* dialog box is displayed.
4	Use the LEFT/RIGHT and UP/DOWN navigation buttons to select the autoscan point to be affected. **NOTE:** The system will move to the position of the selected autoscan point.
5	Press the **FCN** button to allow changes of the selected autoscan point.
6 a	Use the LEFT/RIGHT navigation buttons to move the point within the autoscan list.
6 b	Use the UP/DOWN navigation buttons to move the point from active to inactive status, or vice versa.
7 a	Press the **FCN** button to accept the changes. A new autoscan point can now be selected. Repeat from step 4.
7 b	Press the ENTER button to accept the changes and to exit MENU mode.

11.4.2.7 Storing/recalling/deleting autoscan lists

This section describes how autoscan lists are stored, recalled and deleted.

It is possible to store up to four different lists (A, B, C and D). It is also possible to save the currently active autoscan list, see section 11.4.2.8.

NOTE: When an autoscan list is recalled, the currently active autoscan list is overwritten. If the operator wants to store the currently active autoscan list, it must be done before recalling another list.

Storing/recalling/deleting autoscan lists	
Step	**Action**
1	Ensure that IR is selected. If not, press the **TV/IR** button to select IR.
2	Press the ENTER button to enter MENU mode.
3	Select **Store/recall…** from the **Pan/Tilt** menu and press the ENTER button. The *Store/recall position list* dialog box is displayed.
4	Select the **List no** item.
5	Use the LEFT/RIGHT button to select the desired list name.
6	Select the **Action** item.
7	Use the LEFT/RIGHT button to select the desired action.
8	Press the ENTER button to execute the **Store**, **Recall** or **Delete** action. When storing: If the list name is already used, the *Overwrite list* dialog box will be displayed. Select **Yes** to overwrite the list and to exit MENU mode. Select **No** to return to the *Store/recall position list* dialog box. When recalling: The *Overwrite active list* dialog box will be displayed. Select **Yes** to overwrite the currently active autoscan list and to exit MENU mode. Select **No** to return to the *Store/recall position list* dialog box. When deleting: The *Delete list* dialog box will be displayed and to exit MENU mode. Select **Yes** to delete the selected list. Select **No** to to the *Store/recall position list* dialog box.

11.4.2.8 Saving current autoscan list

This section describes how the currently active autoscan list is saved. The saved list will be available the next time the system is started up.

Saving current autoscan list	
Step	**Action**
1	Press the **PRK** button to save the currently active autoscan list.

11.5 Distance measurements

The LRF (Laser Range Finder) unit is used to measure the distance to a target. The LRF unit determines the distance by measuring the time it takes for a laser pulse to go the target and back again.

The LRF unit is charged after every laser pulse shot. The status text “Laser charging (N)” (N = a number between 1 and 6) is displayed during the charging. When the unit is ready for next shot, “Laser ready (N)” is displayed.

Generally, an interval of 6 seconds is recommended between the shots, to ensure an adequate operating temperature of the LRF unit. The operator may exceed this recommendation momentarily, but if the rate is too high the system will block the LRF unit for a short recovery time.

The status text “Laser charging (6)” is displayed when the LRF unit is activated. The number (N) is decremented after each shot and incremented when about 6 seconds has elapsed since the last shot. If a shot is fired when “Laser ready (1)” is displayed, the LRF unit will temporarily be blocked for recovery. “Laser not ready (N)” will be displayed, where the number (N) is a count down in seconds until a new shot is possible. Normally this time is 35 seconds, but in extremely hot environments the count down starts at 70.

When the system is used with a remote computer, the results from the LRF unit can be reported to the remote computer. Depending on the setting of the *Auto Forward Targets* feature, see section 7.8, the operator may have to approve the results that shall be reported.

NOTE: Before using the LRF unit, please read the safety instructions in chapter 2.

11.5.1 Activate

Activating LRF unit	
Step	**Action**
1	Press the **FCN** + **INV** buttons to activate the LRF unit and enter LRF mode. “Laser ready (6)” is displayed on the monitor.

As an alternative to using the JCU as described above, the System Software menu system can be used:

Activating LRF unit	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **Activate laser** from the **LRF** menu and press the ENTER button to activate the LRF unit and enter LRF mode. “Laser ready (6)” is displayed on the monitor.

11.5.2 Measure

To be able to measure the distance, the target must be within line of sight from the LRF unit; that is, with no other object in between.

The LRF unit operates in a wave length that is closer to the visible spectrum than the infrared. This means that even if an object is possible to see on the IR image, it may not be possible to measure the distance to it. Generally, it is possible to measure the distance to an object that is within eyesight or at a maximum distance of 20 km, if the target is large enough (e.g. a bridge or a ship).

If the target reflection is low or if the target is angled from the laser beam, there may be no signal back and the distance cannot be measured.

NOTE: Do not aim the laser at close or highly reflective objects or surfaces, as that may damage the laser detector.

NOTE: The sun represents a hazard to the LRF unit and may cause damage. Never aim the LRF unit at the sun, as that may cause damage.

Measuring the distance	
Step	Action
1	Use the joystick to direct the system towards the target.
2	Press the **FCN** + **SCN** buttons to fire a single shot. **NOTE:** It is not possible to fire a shot if the image is frozen or if the IR and/or TV camera is turned off.
3	The distance to the target is displayed on the monitor. If multiple targets are found, both the shortest and the longest distance will be displayed. If no target is found, “No target detected” will be displayed.
4	When “Laser ready (N)” is displayed, a new shot can be fired. Repeat from step 1.

NOTE: If a remote computer is used and the system is set to forward accepted results only (see the *Auto Forward Targets* feature, section 7.8), the ENTER button shall be pressed to approve the result.

11.5.3 Deactivate

Deactivating LRF unit	
Step	**Action**
1	Press the **C** button to deactivate the LRF unit and to exit LRF mode.

11.6 Cold weather conditions

The Ranger HRC MS system is designed and manufactured to comply with demanding requirements. The system can be used under the most challenging weather conditions. In addition to protections such as sealing, bearings and encapsulation, there are also built-in heaters that protect the electronics and defrost the lens in low temperatures.

11.6.1 Heating

If the ambient temperature is below freezing point, built-in heaters will automatically be started before the system is turned on. The heating of the system takes several minutes – up to 30 minutes if the ambient temperature is very low. It is recommended to let the whole heating procedure take its time, but if necessary the heating can be interrupted by pressing the **PRK** button.

When the heaters are on, the heater indicator on the JCU is lit.

11.6.1.1 Defrosting

If the front lens of the IR camera needs more heating, at this time or later, the defroster can be activated manually.

Defrosting the IR camera lens

Step	Action
1	Press the **TV/IR** button to display the IR image.
2	Press the ENTER button to enter MENU mode.
3	Select **Defrost** from the **Image** menu and press the ENTER button.
4	The defroster is automatically turned off after 10 minutes or when the joystick is moved.

NOTE: The *Defrost* feature is only enabled at freezing ambient temperature.

11.6.2 Pan/tilt wake-up

If the ambient temperature is below freezing point, an automatic wake-up movement sequence is started when the Pan/Tilt unit is activated at system start up. The wake-up procedure takes a couple of minutes. It is recommended to let the whole wake-up procedure take its time, but if it is necessary the procedure can be interrupted by pressing the **PRK** button.

11.6.2.1 Manual Pan/tilt wake-up

If the Pan/Tilt unit has been inactive for a long period of time in extreme cold weather, manual wake-up movements shall be performed.

NOTE: In cold weather, it is strongly recommended to let the Pan/Unit unit move continuously, for example by making a defrosting autoscan list. This list can be saved and loaded whenever needed.

Manual Pan/Tilt wake-up

Step	Action
1	Use the joystick to move the Pan/Tilt unit up and down, back and forth.

12 Optimizing the IR Image

The quality of the IR image depends on many factors, such as target temperature, ambient temperature, distance to target, etc. The IR Camera has a number of functions – automatic and manual – that are used to control the image quality.

This chapter describes basic and advanced procedures for how to achieve an image of high quality. Inexperienced users are recommended to follow the instructions in section 12.1. Advanced users are recommended to follow the instructions in section 12.2.

The optimizing functions are controlled via the IR Camera menu system and via the Joystick Control Unit (JCU). Frequently used functions can also be executed via the System Software menu system, as described in section 11.3.

There are two different settings for the JCU – Original and Alternative – with somewhat different functions for the joystick and the keypad buttons. The setting is made in the *Setup – Maintenance* dialog box, see section 7.6.1.6. The functions for both the Original and the Alternative settings are described in the tables below.

12.1 Basic procedures

The IR Camera has a number of functions that automatically optimize the image quality. However, to achieve an even better image, there are some basic manual actions and adjustments that have to be carried out.

This section provides the basic procedures for optimization of the image quality. Instructions for advanced users are provided in section 12.2.

For detailed information about the optimizing functions, please refer to section 5.2.

12.1.1 Starting point

The image optimizing procedure starts from a defined starting point.

When the system is started, it is normally automatically set to the starting point. When the camera has been running for some time and various ad-

justments have been made, the system may need to be set to the starting point manually before the optimizing procedure starts.

12.1.1.1 Display indicators

The top line status indicators and the temperature range indicator for the IR Camera provide a quick overview of the current settings. These indicators are not displayed by default, but are made visible via the IR Camera menu system.

Figure 12.1 IR Camera top line status indicator.

Figure 12.2 Temperature range indicator.

NOTE: When the IR Camera menu system is not opened, the temperature range indicator is hidden behind the system information.

Displaying IR Camera indicators	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Setup** and press the ENTER button.
4	Select **GUI**… and press the ENTER button. The GUI Setup dialog box is displayed.
5	Select **Upper status**.
6	Use the LEFT/RIGHT navigation buttons to select **On**.
7	Select **Temp range**.
8	Use the LEFT/RIGHT navigation buttons to select **On**.
9	Press the ENTER button to confirm.
10	Press the CANCEL button to exit the IR Camera menu system.

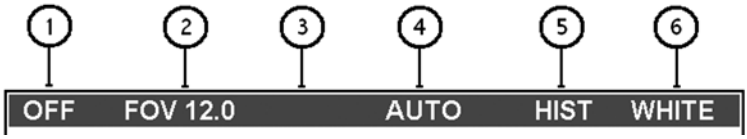


Figure 12.3 IR Camera top line status indicator.

At the starting point, the top line status indicator 1 (Filter type) shall be OFF and indicator 3 (Digital zoom factor) shall be blank.

12.1.1.2 Filter Off

Filter is a function that reduces the noise visible in the image in low contrast scenes. The Filter shall normally be set to OFF. For low contrast scenes, see section 12.3.

When the Filter is OFF, the top line status indicator number 1 displays OFF.

Setting Filter OFF

Step	Action
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Setup** and press the ENTER button.
4	Select **Image**… and press the ENTER button. The Image Setup dialog box is displayed.
5	Select **Filter**.
6	Use the LEFT/RIGHT navigation buttons to select **Off**.
7	Press the ENTER button to confirm.
8	Press the CANCEL button to exit the IR Camera menu system.

12.1.1.3 No digital zoom

The digital zoom has no effect on the image adjustments. However, the digital zoom factor shall be 1x when the image is optimized

When the digital zoom factor is 1x, the top line status indicator 3 is blank.

Setting Digital zoom	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Image**… and press the ENTER button
4	Select **Zoom**… and press the ENTER button. *The Digital Zoom* dialog box is displayed.
5	Select **Digital Zoom** and press the ENTER button. *The Digital Zoom* dialog box is displayed.
6	Select **Factor**.
7	Use the LEFT/RIGHT buttons to select x1.
8	Press the ENTER button to confirm.
9	Press the CANCEL button to exit the IR Camera menu system.

12.1.1.4 Adjustment area

The IR Camera automatically adjusts the image based on the scene contents. By selecting different adjustment areas, it is possible to control which part of the scene that shall be used when adjusting the image.

For basic optimization of the image, the camera shall be set to use the largest adjustment area; Area 3.

Figure 12.4 Adjust Area 3.

Selecting adjustment area	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Setup** and press the ENTER button.
4	Select **Image**… and press the ENTER button. The Image Setup dialog box is displayed.
5	Select **Adjust area**.
6	Use the LEFT/RIGHT navigation buttons to select **Area 3**.
7	Press the ENTER button to confirm.
8	Press the CANCEL button to exit the IR Camera menu system.

12.1.2 Select scene

The camera uses the scene as viewed on the monitor as basis for image adjustments. The target scene, including zooming and focusing, shall be selected before adjustments are made to optimize the image.

12.1.2.1 Optical zoom

Optical zooming		
Step	**ORIGINAL setting**	**ALTERNATIVE setting**
1	Use the joystick to direct the camera towards the target scene.	
2	Press button ▲ to zoom in. Press button ▼ to zoom out.	Turn the joystick collar to the left to zoom out. Turn the joystick collar to the right to zoom in.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Optical zooming	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Image** and press the ENTER button.
4	Select **Zoom**… and press the ENTER button. The *Zoom* dialog box is displayed.
5	Select **Zoom**.
6	Use the LEFT/RIGHT navigation buttons to zoom continuously in/out.
7	Press the ENTER button to confirm.
8	Press the CANCEL button to exit the IR Camera menu system.

12.1.2.2 Auto focus

Auto focus is a feature that is frequently used whenever the scene is changed.

The camera uses an area in the center of the image when auto focusing, as shown in Figure 12.5.

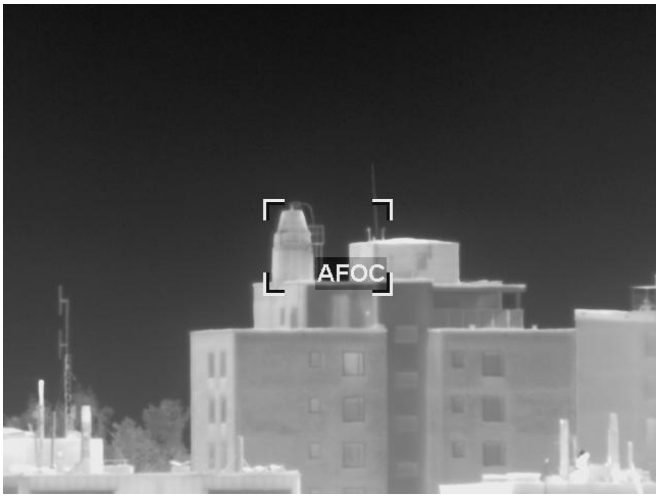


Figure 12.5 Auto focus area.

NOTE: When the image has low contrasts between different areas, the IR Camera will have difficulties to auto focus.

Auto focusing		
Step	**ORIGINAL setting**	**ALTERNATIVE setting**
1	Verify that the target is in the center of the image.	
2	Keep the camera steady when auto focusing.	
	Press button **NUC** > 1 second to perform a one-shot auto focus adjustment.	Press the joystick button < 1 second to perform a one-shot auto focus adjustment.
	NOTE: If the default setting for the NUC button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **NUC** button shall be pressed < 1 second to auto focus.	The **NUC** button can also be used to auto focus, as for the Original setting.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Auto focusing	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Image** and press the ENTER button.
4	Select **Focus**… and press the ENTER button. The *Focus* dialog box is displayed.
5	Select **Auto**.
6	Press the LEFT or RIGHT navigation button to perform a one-shot auto focus adjustment.
7	Press the ENTER button to exit the dialog box.
8	Press the CANCEL button to exit the IR Camera menu system.

12.1.3 Range selection

When the IR Camera is turned on, the temperature range is automatically selected, but may have to be adjusted. When the environmental conditions change, the range selection may also need to be changed.

NOTE: The range selection shall reflect the temperature of the scene (not the place where the camera is positioned).

Selecting temperature range	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Image** and press the ENTER button.
4	Select **Range**… and press the ENTER button. The *Range* dialog box is displayed.
5	Use the LEFT/RIGHT navigation buttons to select the correct temperature range.
6	Press the ENTER button to confirm.
7	Press the CANCEL button to exit the IR Camera menu system.

12.1.4 NUC

The NUC (Non-Uniformity Correction) function performs an internal calibration of the camera.

NUC can be performed in three different ways. With Internal NUC, the image is calibrated against a shutter inside the camera. With External NUC, either the lens cover or the scene is used as thermal reference.

An Internal NUC normally gives a good image quality.

NOTE: When the camera is started, a NUC is needed every 5 minutes. After about 30 minutes, a NUC is only needed when the quality of the image is degenerated.

Internal NUC	
Step	**Action**
1	Press button **NUC** < 1 second to perform an Internal NUC.
	NOTE: If the default setting for the **NUC** button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **NUC** button shall be pressed > 1 second to perform an Internal NUC.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Internal NUC	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Image** and press the ENTER button.
4	Select **NUC** and press the ENTER button to perform a NUC.
5	Press the CANCEL button to exit the IR Camera menu system.

12.1.5 Adjustment mode

Auto Level-Span is an adjustment mode that automatically adjusts the level and span values.

Auto Level-Span normally gives a good image quality.

NOTE: In scenes with low or high contrast, another adjustment mode and manual tuning may be needed to achieve a good image. Please refer to section 12.3.

Selecting Adjustment mode	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.

Selecting Adjustment mode	
Step	**Action**
3	Select **Setup** and press the ENTER button.
4	Select **Image**… and press the ENTER button. The *Image Setup* dialog box is displayed.
5	Select **Adjust mode**.
6	Use the LEFT/RIGHT navigation buttons to select **Level-Span**.
7	Press the ENTER button to confirm.
8	Press the CANCEL button to exit the IR Camera menu system.

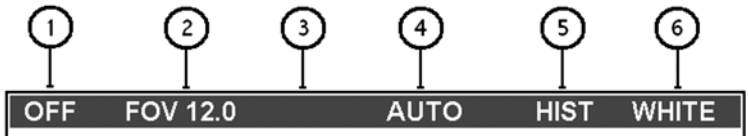


Figure 12.6 Top line status indicator.

Top line status indicator 4 indicates the selected adjustment mode (AUTO).

12.1.7 Color Distribution

There are two Color Distribution modes; Linear and Histogram.

- In Linear mode, the colors are distributed linearly from the darkest to the brightest pixel in the image.
- In Histogram mode, the colors are distributed based on the contents of the image.

The Histogram mode normally gives the best image, but for small details the Linear mode may be better. The Linear mode also gives a more intuitive perception of the temperature contents.

NOTE: The most suitable color distribution setting depends on many factors. Toggle between Histogram and Linear to see which mode suits the current situation best.

Selecting Color Distribution mode	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Setup** and press the ENTER button.
4	Select **Image**… and press the ENTER button. The *Image Setup* dialog box is displayed.
5	Select **Color distribution**.
6	Use the LEFT/RIGHT navigation buttons to select **Histogram** or **Linear**.
7	Press the ENTER button to confirm.
8	Press the CANCEL button to exit the IR Camera menu system.

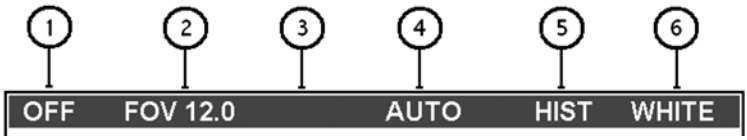


Figure 12.7 Top line status indicator.

Top line status indicator 5 indicates the selected color distribution mode (LIN or HIST).

12.1.7 Save settings

The *Save settings* feature saves the current IR Camera settings, for example Adjustment mode and Color distribution. The saved settings will be loaded when the system is switched on next time.

NOTE: The IR Camera settings are not saved when the PRK button is pressed.

Saving settings	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **IR menu** from the **Setup** menu and press the ENTER button. The menu system of the IR Camera is opened.
3	Select **Setup** and press the ENTER button.
4	Select **Save settings** and press the ENTER button. The *Save settings* dialog box is displayed.
5	Select **OK** and press the ENTER button to confirm.
6	Press the CANCEL button to exit the IR Camera menu system.

12.2 Advanced procedures

This section describes how the advanced user can make use of automatic and manual features and settings to optimize the image quality.

To avoid cross references, some of the descriptions and instructions in this section are duplications of corresponding parts in the basic procedures section.

For detailed information about the optimizing functions, please refer to section 5.2.

For typical settings in low and high contrast scenes, please refer to section 12.3.

12.2.1 Select scene

The camera uses the scene as viewed on the monitor as basis for image adjustments. The target scene, including zooming and focusing, shall be selected before adjustments are made to optimize the image.

12.2.1.1 Digital zoom

The digital zoom has no effect on the image adjustments. However, the digital zoom factor shall be 1x when the image is optimized.

Digital zooming	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Zoom…/Digital Zoom/Factor.**
3	Use the LEFT/RIGHT buttons to select **x1**.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.1.2 Optical zoom

Optical zooming		
Step	**ORIGINAL setting**	**ALTERNATIVE setting**
1	Use the joystick to direct the camera towards the target scene.	
2	Press button ▲ to zoom in. Press button ▼ to zoom out.	Turn the joystick collar to the left to zoom out. Turn the joystick collar to the right to zoom in.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Optical zooming	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Zoom…/Zoom**.
3	Use the LEFT/RIGHT navigation buttons to zoom continuously in/out.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.2 Focus

Focus is a feature that is frequently used whenever the scene is changed. Auto focusing and focusing to a fixed position can be performed, followed by manual adjustments if needed.

12.2.2.1 Focus area

The camera normally uses a vertically and horizontally centered 80x60 pixel box when auto focusing. It is possible to change the size of the box, by selecting one of three preset focus areas.

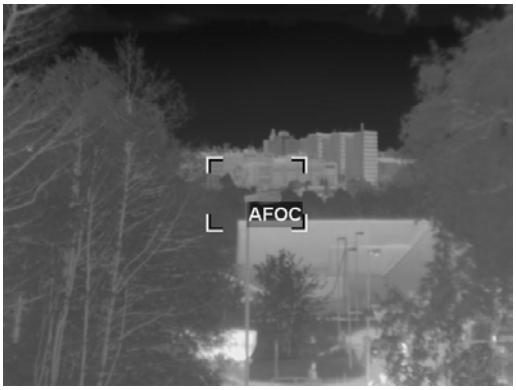


Figure 12.8 Default auto focus area.

Selecting focus area	
Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image/Focus area**.
3	Use the LEFT/RIGHT buttons to select area.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.2.2 Auto focus

The system performs a one-shot auto focus adjustment, which can be tuned manually.

NOTE: When the image has low contrasts between different areas, the IR Camera will have difficulties to auto focus.

Auto focusing and manual adjustments

Step	ORIGINAL setting	ALTERNATIVE setting
1	Verify that the target is in the center of the image.	
2	Keep the camera steady when auto focusing.	
	Press button **NUC** > 1 second to perform a one-shot auto focus adjustment.	Press the joystick button < 1 second to perform a one-shot auto focus adjustment.
	NOTE: If the default setting for the NUC button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **NUC** button shall be pressed < 1 second to auto focus.	The **NUC** button can also be used to auto focus, as for the Original setting.
3	Turn the joystick collar to the left/right to manually adjust the focus near/far.	Press button FCN and turn the joystick collar left/right to manually adjust the focus near/far.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Auto focusing and manual adjustments

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/ Focus…**.
3	Select **Auto** and press the LEFT or RIGHT navigation button to perform a one-shot auto focus adjustment.
	Select <> and use the LEFT/RIGHT buttons to manually adjust the focus.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.2.3 Fixed focus

Focusing to a fixed position is used when there are low contrasts between different areas in the image, which makes it difficult for the camera to auto focus. The Fix function may also be used when the object of interest is outside the focus area, or to focus on a scene containing an object of interest at a known distance.

NOTE: The fixed focus position is set in the *Setup–Image* dialog box, see section 7.6.1.1.

Focusing to fixed position and manual adjustments

Step	ORIGINAL setting	ALTERNATIVE setting
1	Press buttons **FCN** + **NUC** > 1 second to go to the fixed focus position. **NOTE**: If the default setting for the **FCN** + **NUC** buttons has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **FCN** + **NUC** buttons shall be pressed < 1 second to go to the fixed focus position.	
2	Turn the joystick collar to the left/right to manually adjust the focus near/far.	Press button **FCN** and turn the joystick collar left/right to manually adjust the focus near/far.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Focusing to fixed position and manual adjustments

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/ Focus…**.
3	Select **Fix** and press the LEFT or RIGHT navigation button to set the camera to the fixed focus position.
4	Select <> and use the LEFT/RIGHT buttons to manually adjust the focus.
5	Press the ENTER button to confirm.
6	Press the CANCEL button to exit the IR Camera menu system.

12.2.3 Range selection

When the camera is turned on, the temperature range is automatically selected, but may have to be adjusted. When the environmental conditions change, the range selection may also need to be changed.

NOTE: The range selection shall reflect the temperature of the scene (not the place where the camera is positioned).

Selecting temperature range

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/ Range**….
3	Use the LEFT/RIGHT navigation buttons to select the correct temperature range.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.4 NUC

The NUC (Non-Uniformity Correction) function performs an internal calibration of the camera.

NUC can be performed in three different ways. With Internal NUC, the image is calibrated against a shutter inside the camera (Internal shutter). With External NUC, either the lens cover (External shutter) or the scene (Shutter off) is used as thermal reference.

The normal procedure is to start with an Internal NUC. If an acceptable image quality is not achieved, an External NUC against the lens cover or against the scene may improve the image.

NOTE: When the camera is started, a NUC is needed every 5 minutes. After about 30 minutes, a NUC is only needed when the quality of the image is degenerated.

12.2.4.1 Internal NUC

Internal NUC

Step	Action
1	Press button **NUC** < 1 second to perform an Internal NUC.
	NOTE: If the default setting for the **NUC** button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **NUC** button shall be pressed > 1 second to perform an Internal NUC.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Internal NUC

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Shutter**.
3	Use the LEFT/RIGHT navigation buttons to select **Internal**.
4	Press the ENTER button to confirm.
5	Press the ENTER button to re-open the IR Camera menu system.
6	Select **Image…/NUC**.
7	Press the LEFT or RIGHT navigation button or ENTER to perform a NUC.
8	Press the CANCEL button to exit the IR Camera menu system.

12.2.4.2 External NUC against lens cover

External NUC against lens cover

Step	Action
1	Press buttons **FCN** + **NUC** < 1 second to perform an External NUC against the lens cover.
	NOTE: If the default setting for the **FCN** + **NUC** button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **FCN** + **NUC** buttons shall be pressed > 1 second to perform an External NUC.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

External NUC against lens cover	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Shutter**.
3	Use the LEFT/RIGHT navigation buttons to select **External**.
4	Press the ENTER button to confirm.
5	Press the ENTER button to re-open the IR Camera menu system.
6	Select **Image…/NUC**.
7	Press the LEFT or RIGHT navigation button or ENTER to perform a NUC.
8	Press the CANCEL button to exit the IR Camera menu system.

12.2.4.3 External NUC against scene

When an External NUC against the scene is performed, the camera shall be directed towards a surface with an even temperature. The temperature of the reference surface shall preferably be the same as the temperature of the target. A clear sky can, even if it is cold, be used as an acceptable reference surface.

External NUC against scene	
Step	**Action**
1	Press buttons **C** + **NUC** < 1 second to perform an External NUC against the scene.
	NOTE: If the default setting for the **NUC** button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the **C** + **NUC** buttons shall be pressed > 1 second to perform an Internal NUC.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

External NUC against scene

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Shutter**.
3	Use the LEFT/RIGHT navigation buttons to select **Off**.
4	Press the ENTER button to confirm.
5	Press the ENTER button to re-open the IR Camera menu system.
6	Select **Image…/NUC**.
7	Press the LEFT or RIGHT navigation button or ENTER to perform a NUC.
8	Press the CANCEL button to exit the IR Camera menu system.

12.2.5 Adjustment area

The IR Camera automatically adjusts the image based on the scene contents. By selecting different adjustment areas, it is possible to control which part of the scene that shall be used when adjusting the image.

The selected area has an impact on the adjustments of level (brightness), span (contrast) and color distribution, as described in section 5.2.2.

NOTE: When the digital zoom is used, the adjustment area may be outside the part of the image that is visible on the monitor. In that case, the adjustment area setting may have to be changed.

Selecting adjustment area

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Adjust area**.
3	Use the LEFT/RIGHT navigation buttons to select area.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.6 Adjustment mode

There are four adjustment modes selectable via the IR Camera menu system; Auto Level, Auto Level-Span, DDE and Manual.

- In Auto Level mode, level is automatically adjusted.
- In Auto Level-Span mode, both level and span are automatically adjusted.
- DDE (Digital Detail Enhancement) is an automatic adjustment mode for level and span, which also enhances the visibility of details in the scene.
- In Manual mode, level and span adjustments are made manually.

The most suitable mode depends on many factors. Auto mode normally gives a good image quality, but in scenes with low or high contrast DDE and/or Manual mode may be better.

NOTE: For typical settings in low and high contrast scenes, please refer to section 12.3.

12.2.6.1 Selecting mode

Toggle between Auto, DDE and Manual to see which of the modes suits the current situation best.

NOTE: If DDE mode is selected when manual adjustments have been made in Auto mode, the manual adjustments will still apply. This is indicated with the symbol * in the top line status bar: DDE*. It is recommended to set the brightness and contrast values to 0, see section 12.2.7.1.

NOTE: In Manual mode, frequent manual adjustments (see section 12.2.7.3) are needed to achieve a good image.

Selecting Adjustment mode	
Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Adjust mode**.
3	Use the LEFT/RIGHT navigation buttons to select adjustment mode.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

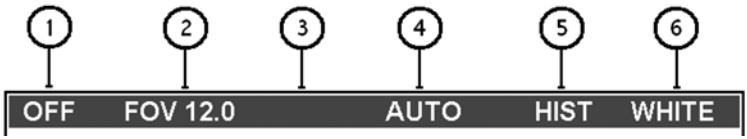


Figure 12.9 Top line status indicator

Top line status indicator 4 indicates the selected mode (AUTO L, AUTO, MANUAL or DDE).

12.2.7 Adjust image

Adjust image is a feature that allows manual adjustments of the image with regards to level and span, or the corresponding brightness and contrast.

The appearance of the dialog box depends on the selected adjustment mode.

In Auto and DDE mode, the symbol * appears in the top line status bar, indicating that manual adjustments have been made: AUTO* and DDE*.

NOTE: The manual settings are a matter of personal taste, and may vary from scene to scene. Test different settings and see how the quality of the image changes.

12.2.7.1 Adjustments in Auto Level-Span and DDE mode

In Auto Level-Span and DDE mode, level and span are automatically adjusted. The *Adjust image* feature makes it possible to tune the automatic values, by adjusting brightness and contrast with a percentage offset.

Adjusting image in Auto Level-Span & DDE mode

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Adjust Image…**.
3	Select **Brightness** and use the LEFT/RIGHT navigation buttons to select an offset percentage.
4	Select **Contrast** and use the LEFT/RIGHT navigation buttons to a select an offset percentage
5	Press the ENTER button to confirm.
6	Press the CANCEL button to exit the IR Camera menu system.

12.2.7.2 Adjustments in Auto Level mode

In Auto Level mode, level is automatically adjusted. The *Adjust image* feature is used to manually adjust the span value. The *Adjust image* feature also makes it possible to tune the automatic level value, by adjusting brightness with a percentage offset.

Adjusting image in Auto Level mode

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Adjust Image…**.
	Select **Auto** and press the LEFT or RIGHT navigation button to do an auto adjustment of the image, which is a good starting point.
3	Select **Span** and use the LEFT/RIGHT navigation buttons to decrease/increase the width of the span.
4	Select **Brightness** and use the LEFT/RIGHT navigation buttons to a select an offset percentage
5	Press the ENTER button to confirm.
6	Press the CANCEL button to exit the IR Camera menu system.

12.2.7.3 Adjustment in Manual mode

In Manual mode, both level and span are adjusted manually. Frequent adjustments and fine-tuning are needed to achieve a good image quality.

Adjusting image in Manual mode

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Adjust Image**…. Select **Auto** and press the LEFT or RIGHT navigation button to do an auto adjustment of the image, which is a good starting point.
3	Select **Level** and use the LEFT/RIGHT navigation buttons to move the center of the span.
4	Select **Span** and use the LEFT/RIGHT navigation buttons to decrease/increase the width of the span.
5	Press the ENTER button to confirm.
6	Press the CANCEL button to exit the IR Camera menu system.

12.2.8 Color Distribution

There are two Color Distribution modes; Linear and Histogram.

- In Linear mode, the colors are distributed linearly from the darkest to the brightest pixel in the image.
- In Histogram mode, the colors are distributed based on the contents of the image.

The Histogram mode normally gives the best image, but for small details the Linear mode may be better. The Linear mode also gives a more intuitive perception of the temperature contents.

NOTE: The most suitable color distribution setting depends on many factors. Toggle between Histogram and Linear to see which mode suits the current situation best.

Selecting Color distribution	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Color distribution**.
3	Use the LEFT/RIGHT navigation buttons to select **Histogram** or **Linear**.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

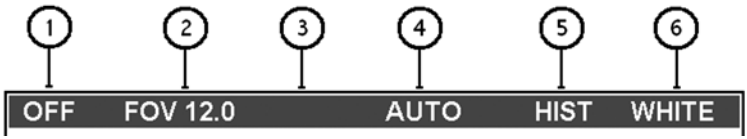


Figure 12.10 Top line status indicator

Top line status indicator 5 indicates the selected color distribution mode (LIN or HIST).

12.2.9 DDE Control

DDE (Digital Detail Enhancement) is an adjustment mode that enhances the visibility of details in the scene. *DDE Control* is a feature that allows tuning of the DDE filter, which gives a continuous shift from less to more detail enhancement.

The DDE Control setting under normal conditions is a matter of personal taste. Test values in the range of 40-65 to find the setting that suits you best.

NOTE: For typical settings in low and high contrast scenes, please refer to section 12.3.

NOTE: To use the JCU for adjustments of the DDE Control value, as described below, the Alternative setting of the JCU must be selected. This is done in the Setup – Maintenance dialog box, see section 7.6.1.6.

Adjusting the DDE Control value	
Step	**Action**
1	Press and hold down button ▲ to increase the DDE value. Press and hold down button ▼ to decrease the DDE value.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Adjusting the DDE Control value	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/DDE Control**.
3	Use the LEFT/RIGHT navigation buttons to select value.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.10 Filter

Filter is a function that reduces the noise visible in the image in low contrast scenes. Low and high filtering is available

Normally the Filter shall be set to Off. In low contrast scenes, the Filter shall be set to Low or High to improve the image. Please refer to section 12.3.

Filtering is normally not suitable for moving targets, as it may cause smearing in the image presentation.

Selecting Filter type	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Filter**.
3	Use the LEFT/RIGHT navigation buttons to select **Low**, **High** or **Off**.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.11 Palette

There are four different IR palettes:

- Rainbow
- Rainbow HC
- Gray
- Iron

12.2.11.1 Select palette

The default IR palette is Gray. Changing the palette from Gray to Rainbow may improve the perception of details in low contrast scenes. Please refer to section 12.3.

Selecting Palette	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Palette…**.
3	Use the LEFT/RIGHT navigation buttons to select **Rainbow**, **Rainbow HC**, **Gray** or **Iron**.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.2.11.2 Invert Palette

All IR palettes are possible to invert. With the Gray palette for example, white or black can be set to represent hot (whitehot is default). Inverting the palette may have an effect on how the image is perceived.

Inverting Palette	
Step	**Action**
1	Press button **INV** to toggle between White hot and Black hot IR palette.

As an alternative to using the JCU as described above, the IR Camera menu system can be used:

Inverting Palette

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Invert palette**.
3	Press the ENTER button to invert the palette.
4	Press the CANCEL button to exit the IR Camera menu system.

12.2.12 Zoom interpolation

Zoom interpolation is a function that has effect when the digital zoom is used, see section 5.2.10.

The default setting of Zoom interpolation is On.

Selecting Zoom interpolation On/Off

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Zoom…/Digital Zoom/Factor**.
3	Use the LEFT/RIGHT buttons to zoom to the desired position.
4	Press the ENTER button to confirm.
5	Press the ENTER button to re-open the IR Camera menu system.
6	Select **Setup/Image…/Zoom interpolation**.
7	Use the LEFT/RIGHT navigation buttons to select On or Off.
8	Press the ENTER button to confirm.
9	Press the CANCEL button to exit the IR Camera menu system.

12.2.13 Save settings

The *Save settings* feature saves the current IR Camera settings, for example Adjustment mode, Color distribution, Shutter and Adjustment area. The saved settings will be loaded when the system is switched on next time.

NOTE: The IR Camera settings are not saved when the PRK button is pressed.

Saving settings

Step	Action
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Save settings**.
3	Select OK and press the ENTER button to confirm.
4	Press the CANCEL button to exit the IR Camera menu system.

12.3 Typical settings for Low/Normal/High Contrast scenes

The optimal settings of the parameters that are used to control the image quality depend on many different factors. The thermal contrast in the scene is a factor that to a large extent has an impact on the choice of settings.

This section provides typical settings for scenes with low, normal and high thermal contrast.

NOTE: The typical settings shall be used as a starting point for further fine-tuning to achieve an optimal image quality.

12.3.1 Summary

Typical conditions for low thermal contrast are rainy and foggy weather. The low contrasts make it difficult for the camera to successfully apply the automatic features. Hence, manual adjustments are required to achieve an image of high quality.

A typical situation with high thermal contrast is a sunny day in the desert. The DDE (Digital Detail Enhancement) function, tuned to a high value, makes it possible to for example read texts on signs or view details such as people even against strong sunlight.

The table below summarizes the typical settings in low, normal and high contrast scenes.

	Low contrast	Normal contrast	High contrast
Adjustment mode	Manual or DDE 0-20	Auto or DDE 40-65	DDE 60-100
Filter	Low or High	Off	Off
Focus	Manual focus	Auto focus	Auto focus
Palette	1. Gray 2. Rainbow	Gray	Gray

12.3.2 Adjustment mode

12.3.2.1 Adjustment mode

Typical settings:

- Low contrast Manual or DDE
- Normal contrast Auto or DDE
- High contrast DDE

Selecting Adjustment mode	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Adjust mode**.
3	Use the LEFT/RIGHT navigation buttons to select adjustment mode.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.3.2.2 DDE Control value

DDE Control is a feature that controls the level of detail enhancement and noise reduction. Please refer to section 12.2.9.

Typical settings:

- Low contrast 0-20 (noise reduction)
- Normal contrast 40-65 (normal detail enhancement)
- High contrast 60-100 (extreme detail enhancement)

NOTE: To use the JCU for adjustments of the DDE Control value, as described below, the Alternative setting of the JCU must be selected. This is done in the Setup – Maintenance dialog box, see section 7.6.1.6.

Adjusting the DDE Control value

Step	Action
1	Press and hold down button ▲ to increase the DDE value. Press and hold down button ▼ to decrease the DDE value.

12.3.3 Filter

Filter is a function that reduces the noise visible in the image in low contrast scenes. Please refer to section 12.2.10.

12.3.3.1 Filter type

Typical settings:

- Low contrast Low or High
- Normal contrast Off
- High contrast Off

Selecting Filter type	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Setup/Image…/Filter**.
3	Use the LEFT/RIGHT navigation buttons to select **Low**, **High** or **Off**.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

12.3.2 Focus

Typical settings:

- Low contrast Manual focus
- Normal contrast Auto focus
- High contrast Auto focus

12.3.2.1 Manual focus

Manual focusing		
Step	**ORIGINAL setting**	**ALTERNATIVE setting**
1	Turn the joystick collar to the left/right to focus near/far.	Press button **FCN** and turn the joystick collar to the left/right to focus near/far.

12.3.2.2 Auto focus

Auto focusing		
Step	**ORIGINAL setting**	**ALTERNATIVE setting**
1	Verify that the target is in the center of the image.	
2	Keep the camera steady when auto focusing.	
	Press button **NUC** > 1 second to perform a one-shot auto focus adjustment.	Press the joystick button < 1 second to perform a one-shot auto focus adjustment.
	NOTE: If the default setting for the NUC button has been changed (*Setup-Image* dialog box, see section 7.6.1.1), the NUC button shall be pressed < 1 second to auto focus.	The **NUC** button can also be used to auto focus, as for the Original setting.

12.3.3 Palette

The default IR palette is Gray. Changing the palette from Gray to Rainbow may improve the perception of details in low contrast scenes. Please refer to section 12.2.11.

Typical settings:

- Low contrast 1. Gray, 2. Rainbow
- Normal contrast Gray
- High contrast Gray

Selecting Palette	
Step	**Action**
1	Select **Setup/IR menu** to open the IR Camera menu system.
2	Select **Image/Palette…**.
3	Use the LEFT/RIGHT navigation buttons to select **Rainbow**, **Rainbow HC**, **Gray** or **Iron**.
4	Press the ENTER button to confirm.
5	Press the CANCEL button to exit the IR Camera menu system.

Inverting the palette may also have an effect on how the image is perceived.

Inverting Palette	
Step	**Action**
1	Press button **INV** to toggle between White hot and Black hot IR palette.

13 Maintenance and cleaning

13.1 Camera body, cables & accessories

The camera body, cables and accessories may be cleaned by wiping with a soft cloth. To remove stains, wipe with a soft cloth moistened with a mild detergent solution and wrung dry, then wipe with a dry soft cloth.

NOTE: Do not use benzene, thinner, or any other chemical product on the camera, the cables or the accessories, as this may cause deterioration.

13.2 Lenses

In order to make the system withstand severe field conditions, all lenses are coated with a hard carbon thin film coating.

To clean the lenses, any consumer-grade glass cleaner can be used.

13.3 Storage

The system shall be stored in a temperature intervall of -40° – +70°C and within a immidity intervall of < 55% RH.

13.4 Preventive Maintenance

System must be turned on every 12 month for at least one hour.

14 Technical support

For technical support, service inquiries, or comments & questions about the documentation, please contact FLIR Systems using one of the following two email addresses:

- imagingboston.support@flir.com (US / North American customers only)
- imagingsweden.support@flir.se

For telephone numbers to FLIR Systems offices, see the back cover of this manual.

15 Technical appendices

15.1 Technical specifications

15.1.1 Thermal imager specifications

Ranger HRC	Ranger HRC-S			Ranger HRC-U	
	614005703/1	614005703/2	614005703/3	614005704/2	614005704/3
Spectral range	3.6 - 4.9 µm				
Optical zoom	Continuosly variable 12.5 x between NFoV and WFoV				
Wide field of view, WFoV	18.75° x 14°	14.1° x 10.5°	14.1° x 10.5°	9.4° x 7.0°	9.4° x 7.0°
Narrow field of view, NFoV	1.5° x 1.1°	1.1° x 0.8°	1.1° x 0.8°	0.75° x 0.55°	0.75° x 0.55°
F-number (F#)	4				
Min. focus distance	10–50 m			40–200 m	
Selectable pre-set inter-midiate FoVs for optical zoom	Multiple				
Electrical zoom	2x and 4x bi-linearly interpolated				
Automated features	Auto Focus, Image Auto Adjust (AGC), Tunable Digital Detail Enhancement (DDE)				
Image frequency	50/60 Hz				

15.1.2 Detector specifications

Ranger HRC	Ranger HRC-S			Ranger HRC-U	
	614005703/1	614005703/2	614005703/3	614005704/2	614005704/3
Detector type	640 x 480 InSb focal plane array				
Pitch	20 µm	15 µm	15 µm	15 µm	15 µm
Cooling	Integrated sterling cooling				
Start-up time	< 10 min				

15.1.3 Image specifications

Ranger HRC	Ranger HRC-S			Ranger HRC-U	
	614005703/1	614005703/2	614005703/3	614005704/2	614005704/3
Video output	composite video PAL or NTSC				
Palette	Rainbow, Rainbow HC (High Contrast), Iron, Gray (White hot). All palettes can be inverted				

15.1.4 Optics specifications

Ranger HRC	Ranger HRC-S			Ranger HRC-U	
	614005703/1	614005703/2	614005703/3	614005704/2	614005704/3
Optical zoom time between NFoV and WFoV	< 5 second				
Focusing	Auto or manual				
Athermalization	Automatic temp. compensation keeps focus during the whole operation temperature range. Focus retention post FoV change.				
Front lens defrosting	Electrical heater element				

15.1.5 TV options

TV-Option	SR-TV	UR-TV	LR-TV
Image Sensor	1/4” Color CCD	1/2” Color CCD	1/3” Color CCD
Picture Elements	NTSC 768(H) x 474(V) PAL 752(H) x 582(V)	752(H) x 582(V)	NTSC 768(H) x 494(V) PAL 752(H) x 582(V)
Optical Zoom	26x	25x	60x
Field of View	1.6º - 42º	0.5º - 12.3º	PAL 0.49º - 28.7º NTSC 0.37º - 21.7.3º
FoV match	On/Off slave mode		
F-number	1.6 to 3.8	1.4 to 6	3.8 to 7.1
Electronic Zoom	12x		10x
Min sensitivity	2.0 lux (F/1.6), 0.7lux with IR filter disengaged	0.006 lux	Color mode: 0.7 lux B&W mode 0.08 lux

TV-Option	SR-TV	UR-TV	LR-TV
Horizontal resolution	NTSC>470 TVL PAL>460 TVL	480 TVL	540 TVL
S/N (signal to noise) ratio	>50 dB	>50 dB	>50 dB
Contrast/Brightness	Auto	Auto/Manual	Auto/Manual
Auto adjust	Automatic (iris, gain and shutter)	Automatic	Automatic
Palettes	Color/Black and white	Color/Black and white	Color/Black and white
Close focus, Wide	0.32m	2.5m	5.0m
Close focus, Narrow	0.15m	2.5m	5.0m
Focus	One shot AF/Manual	One shot AF/Manual	Manual
IR cut off filter	On/Off	-	-
Back light compensation	On/Off	On/Off	On/Off
White balance	Auto	Auto/Manual	Auto

15.1.6 Laser Range Finder

Eye safe	Yes
Wavelength	Approx. 1540nm or 1570nm
Output energy	≤8 mj
Measurement range	80 m - 20500 m
Measurement resolution	<5 m
Range accuracy	+-10 m or better

15.1.7 Global Positioning System

Accuracy	3 m
Number of Channels	16

15.1.8 Pan/Tilt

Pan angle	360° continuous
Pan Speed	0.03°/sec to 65°/sec
Max pan acceleration	1 rad/sec^2
Tilt angle	-35° to +35°
Tilt speed	0.03°/sec to 30°/sec
Max tilt acceleration	0.5 rad/sec^2
Accuracy	±0.5 mrad
Repeteatability	±0.1 mrad

15.2 Parts list

Denomination	**P/N**	**Description**
JCU cable 3 m (10 ft.)	194 612	J9–J10. 23S + 23S connectors
System cable 15 m (50 ft.)	1 196 215	J1–J5. 23S + 23P connectors, dual video
System cable 61 m (200 ft.)	614 006 524	J1–J5. 23S + 23P connectors, dual video, on reel
System cable WSTI 61 m (200 ft.)	614 006 015	J1–J5. 23S + 23P connectors, dual video
Power cable 3 m	194 628	J2/J4 from Power supply
System cable Multi sensor 23 m	614 005 292/01	PTH-JPC
Video cable 3 m (10 ft.)	908 929	75 Ω coax with BNC connectors
Host Cable	614 005 140	Host Cable, complete with converter RS-485 → RS-232
Host Cable	194 638	Used with screw terminal devices (i.e. fiber transceivers)
Short Cable	614 005 888	PTH-JPC
System cable Multi sensor 10 m	614 005 292/02	PTH-JPC
System cable Multi sensor 15 m	614 005 292/03	PTH-JPC
System cable Multi sensor 30 m	614 005 292/04	PTH-JPC
System cable Multi sensor 12,5 m	614 005 292/05	PTH-JPC
Adapter cable Sentry	614 005 493	JCU to PC

Denomination	P/N	Description
Cable PTH to HRC	G007 678	X3 to IR camera
Cable PTH/B10 to LR-TV	G008 096	X2 to LR-TV
Cable PTH to UR-TV	614 007 038	X2 to UR-TV
Cable PTH to SR-TV	614 006 302	X2 to SR-TV
Cable PTH to LRF	G007 887	X6 to LRF housing
Cable PTH to DMC	G007 706	X5 to DMC
MSO-2 Pan/Tilt	614 005 724/5xx	Side mounted
ThermoVision™ Sentry JB	194 782	Junction box
JPC2	614 005 412	System controller
Power Box	614 006 013	19 inch IP30 C-Temp
ThermoVision™ Sentry JCU	194 783	Joystick Control Unit
Power supply DC THV Sentry	194 684	Separate power supply
Ethernet cable straight	G007451/xxx	J14 to switch
Ethernet cable crossover	G007452/xxx	J14 to PC

** Available length 05, 15, 30 and 60 meters.*

15.3 Document list

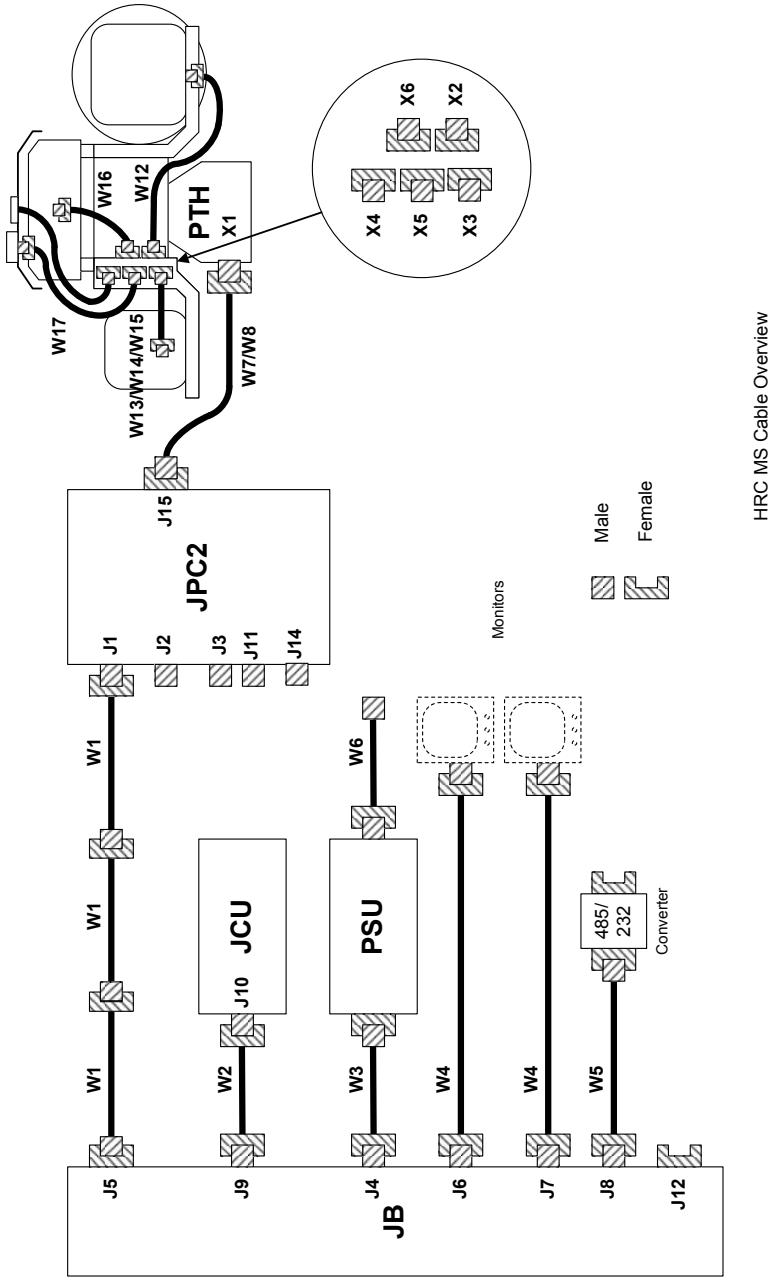
Name	Document number
Ranger HRC MS Acceptance Test Record	Doc. No. PP 614006699
Ranger HRC MS Acceptance Test Procedure	Doc. No. PE 614006699
HRC MS ICD	Doc. No PM503232
HRC MS Operator's Manual	Doc. No. TM 614006699
HRC MS Integrator's Manual	Doc. No. G008082
Technical Specification HRC-S	Doc. No. RS 614005703
Technical Specification HRC-U	Doc. No. RS 614005704
TASS Commands in JPC2	Doc. No. SW IDD-614006390
Pelco "D" Protocol Integrator's manual	Doc. No. 1 558 151

15.4 Connector overview

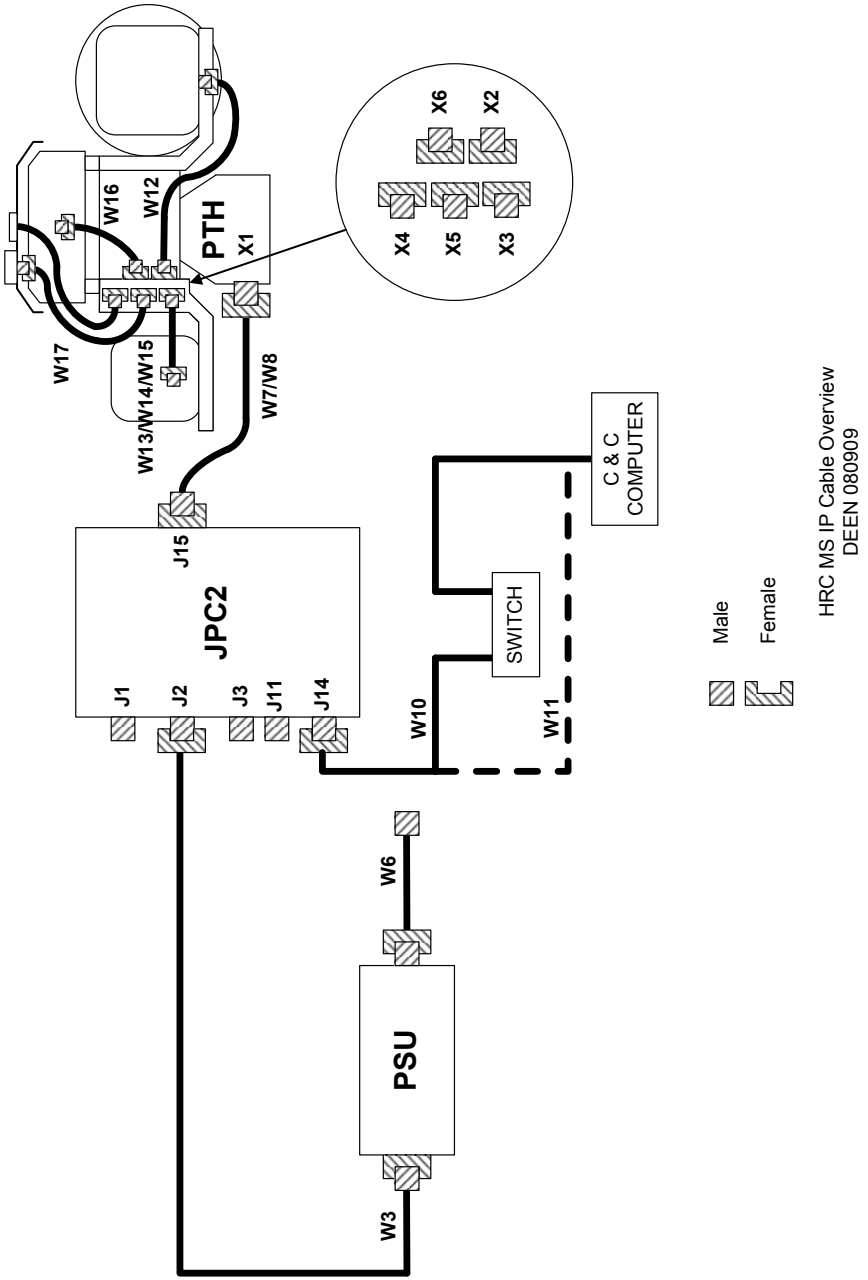
15.4.1 Connectors

Name	Type	Function	Location	Mating connector
J1	D38999/24WB98PN, 23-pin	System	JPC2	D38999/26WE99SN, 23-pin
J2	D38999/24WB98PN, 6-pin	Local power in	JPC2	D38999/26WB98SN, 6-pin
J3	BNC, standard config	Video 1	JPC2	BNC, standard config.
J4	D38999/24WB98PN, 6-pin	Power in	Junction Box	D38999/26WB98SN, 6-pin
J5	D38999/26WE99SN, 23-pin	System	▪ Junction Box ▪ Power Supply	D38999/24WE99PN, 23-pin
J6	BNC, standard config	Video 1	▪ Junction Box ▪ Power Supply	BNC, standard config.
J7	BNC, standard config	Video 2	▪ Junction Box ▪ Power Supply	BNC, standard config.
J8	D38999/24WC98PN, 10-pin	Network in	▪ Junction Box ▪ Power Supply	D38999/26WC98SN, 10-pin
J9	D38999/24WE99PN, 23-pin	System	▪ Junction Box ▪ Power Supply	D38999/26WE99SN, 23-pin
J10	D38999/24WE99PN, 23-pin	System	Joystick Control Unit	D38999/26WE99SN, 23-pin
J11	BNC, standard config	Video 2.	JPC2	BNC, standard config.
J12	D38999/26WC98SN, 10-pin	Network out	Junction Box	D38999/24WC98PN, 10-pin
J14	D38999/24WC98SN, 10 pin	Ethernet	JPC2	D38999/24WC98PN, 10 pin
J15	MS3474W16 26S	System	JPC2	MS3474W16 26P
J16	D38999/26WC98SN, 10-pin	Network in	JPC2	
No des	IEC320	Power in	Power Supply	IEC320
No des	D38999/24WB98SN, 6-pin	Power out	Power Supply	D38999/26WB98PN, 6-pin

15.4.2 Connector placement General



15.4.3 Connector placement IP network option



15.5 Pin configurations

15.5.1 Pin configuration – JPC2

15.5.1.1 J1 – 23-pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	Reserved	
B	Reserved	
C	TV Video negative	Coax 75 Ω
D	TV Video positive	Coax 75 Ω
E	Reserved	
F	RS485CONSRX_A	AWG 26 twisted pair
G	RS485CONSRX_B	AWG 26 twisted pair
H	RS485CONSTX_A	AWG 26 twisted pair
J	RS485CONSTX_B	AWG 26 twisted pair
K	Reserved	
L	Reserved	
M	Reserved	
N	Reserved	
P	RS485TX_EN_A	AWG 26 twisted pair
R	RS485TX_EN_B	AWG 26 twisted pair
S	Video positive	Coax 75 Ω
T	Signal GND	AWG 26
U	Remote present	AWG 26
V	Heater on	AWG 26
W	28 VDC return	AWG 20
X	Video negative	Coax 75 Ω
Y	Video GND	AWG 26
Z	28 VDC	AWG 20

15.5.1.2 J2 – 6-pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	28 VDC return	AWG 20
B	28 VDC return	AWG 20
C	28 VDC	AWG 20
D	28 VDC	AWG 20
E	RXD test	AWG 24
F	TXD test	AWG 24

15.5.1.3 J3 – BNC connector

Standard configuration.

15.5.1.4 J11 – BNC connector

Standard configuration.

15.5.1.5 J14 – 10 pin connector

PIN	Conductor Type	Signal Name	Wire type
A	AWG 26 twisted pair	Tx+	CAT5E
B	AWG 26 twisted pair	Tx-	CAT5E
C	AWG 26 twisted pair	Rx+	CAT5E
D		RESERVED	
E		RESERVED	
F	AWG 26 twisted pair	Rx-	CAT5E
G		RESERVED	
H		RESERVED	
J		NC	
K		NC	

15.5.1.6 J15 – 26 pin connector

NOTE: Pin designations are printed on connector.

Pin	**Signal name**	**Wire type**
A	TPIN	AWG 26 twisted pair
B	TPON	AWG 26 twisted pair
C	TPOP	AWG 26 twisted pair
D	Reserved	
E	24V	AWG 20
F	GND	AWG 20
G	VIDEO1 OUT	Coax 75 Ω
H	VIDEO1 GND	Coax 75 Ω
J	VIDEO2 OUT	Coax 75 Ω
K	VIDEO2 GND	Coax 75 Ω
L	Reserved	

Pin	Signal name	Wire type
M	Reserved	
N	REZ1	AWG 24
P	REZ2	AWG 24
R	REZ3	AWG 24
S	REZ4	AWG 24
T	TPIP	AWG 26 twisted pair
U	24V	AWG 20
V	GND	AWG 20
W	GND	AWG 20
X	Reserved	
Y	Reserved	
Z	Reserved	
a	Reserved	
b	24V	AWG 20
c	Reserved	

15.5.1.7 J16 – 10 pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	Reserved	
B	Reserved	
C	Reserved	
D	Reserved	
E	Reserved	
F	RXPOS_HOSTUP	AWG 26 twisted pair
G	RXNEG_HOSTUP	AWG 26 twisted pair

Pin	Signal name	Wire type
H	TXPOS_HOSTUP	AWG 26 twisted pair
J	TXNEG_HOSTUP	AWG 26 twisted pair
K	Signal GND	AWG 26 twisted pair

15.5.2 Pin configuration – Joystick Control Unit (JCU)

15.5.2.1 J10 – 23-pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	Reserved	
B	Reserved	
C	TV Video negative	Coax 75 Ω
D	TV Video positive	Coax 75 Ω
E	Terminator disable	AWG 26
F	RS485CONSRX_A	AWG 26 twisted pair
G	RS485CONSRX_B	AWG 26 twisted pair
H	RS485CONSTX_A	AWG 26 twisted pair
J	RS485CONSTX_B	AWG 26 twisted pair
K	RS485HOSTRX_A	AWG 26 twisted pair
L	RS485HOSTRX_B	AWG 26 twisted pair
M	RS485HOSTTX_A	AWG 26 twisted pair
N	RS485HOSTTX_B	AWG 26 twisted pair
P	RS485TX_EN_A	AWG 26 twisted pair
R	RS485TX_EN_B	AWG 26 twisted pair
S	Video positive	Coax 75 Ω
T	Signal GND	AWG 26
U	Remote present	AWG 26

Pin	Signal name	Wire type
V	Heater on	AWG 26
W	28 VDC return	AWG 20
X	TV Video negative	Coax 75 Ω
Y	Video GND	AWG 26
Z	28 VDC	AWG 20

15.5.3 Pin configuration – JB

15.5.3.1 J4 – 6-pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	28 VDC return	AWG 20
B	28 VDC return	AWG 20
C	28 VDC	AWG 20
D	28 VDC	AWG 20
E	N/C	
F	N/C	

15.5.3.2 J5 – 23-pin connector

Pin	Signal name	Wire type
A	Reserved	
B	Reserved	
C	TV Video negative	Coax 75 Ω
D	TV Video positive	Coax 75 Ω
E	Terminator disable	AWG 26
F	RS485CONSRX_A	AWG 26 twisted pair
G	RS485CONSRX_B	AWG 26 twisted pair

Pin	Signal name	Wire type
H	RS485CONSTX_A	AWG 26 twisted pair
J	RS485CONSTX_B	AWG 26 twisted pair
K	Reserved	
L	Reserved	
M	Reserved	
N	Reserved	
P	RS485TX_EN_A	AWG 26 twisted pair
R	RS485TX_EN_B	AWG 26 twisted pair
S	Video positive	Coax 75 Ω
T	Signal GND	AWG 26
U	Remote present	AWG 26
V	Heater on	AWG 26
W	28 VDC return	AWG 20
X	Video negative	Coax 75 Ω
Y	Video GND	AWG 26
Z	28 VDC	AWG 20

15.5.3.3 J6 – BNC connector

Standard configuration.

15.5.3.4 J7 – BNC connector

Standard configuration.

15.5.3.5 J8 – 10-pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	5 V pull-up	
B	28 VDC	AWG 20
C	Screen connec	
D	GND	
E	Terminator disable	
F	RXPOS_HOSTUP	
G	RXNEG_HOSTUP	
H	TXPOS_HOSTUP	
J	TXNEG_HOSTUP	
K	Signal GND	

15.5.3.6 J9 – 23-pin connector

NOTE: Pin designations are printed on copnnector.

Pin	Signal name	Wire type
A	Reserved	
B	Reserved	
C	TV Video negative	Coax 75 Ω
D	TV Video positive	Coax 75 Ω
E	Terminator disable	AWG 26
F	RS485CONSRX_A	AWG 26 twisted pair
G	RS485CONSRX_B	AWG 26 twisted pair
H	RS485CONSTX_A	AWG 26 twisted pair
J	RS485CONSTX_B	AWG 26 twisted pair
K	RS485HOSTRX_A	AWG 26 twisted pair

Pin	Signal name	Wire type
L	RS485HOSTRX_B	AWG 26 twisted pair
M	RS485HOSTTX_A	AWG 26 twisted pair
N	RS485HOSTTX_B	AWG 26 twisted pair
P	RS485TX_EN_A	AWG 26 twisted pair
R	RS485TX_EN_B	AWG 26 twisted pair
S	Video positive	Coax 75 Ω
T	Signal GND	AWG 26
U	Remote present	AWG 26
V	Heater on	AWG 26
W	28 VDC return	AWG 20
X	Video negative	Coax 75 Ω
Y	Video GND	AWG 26
Z	28 VDC	AWG 20

15.5.3.7 J12 – 10-pin connector

NOTE: Pin designations are printed on connector.

Pin	Signal name	Wire type
A	MULTIDROP	
B	28 V	AWG 20
C	Reserved	
D	MULTIDROP RTN	
E	Reserved	
F	TXPOS_HOSTDOWN	
G	TXNEG_HOSTDOWN	
H	RXPOS_HOSTDOWN	
J	RXPOS_HOSTDOWN	
K	Signal GND	

15.6 Basic dimensions

15.6.1 Basic dimensions – Pan/tilt head

15.6.1.1

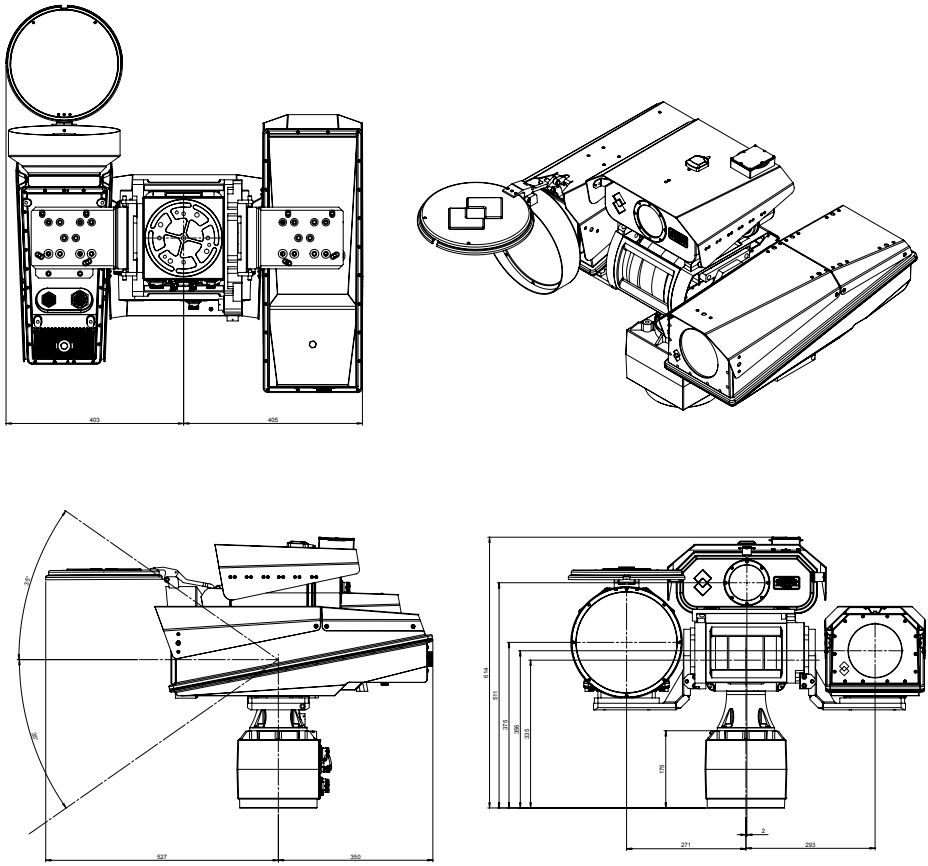


Figure 15.2 HRC-U, LR-TV and Pan/tilt (Basic dimensions in mm).

15.6.1.2

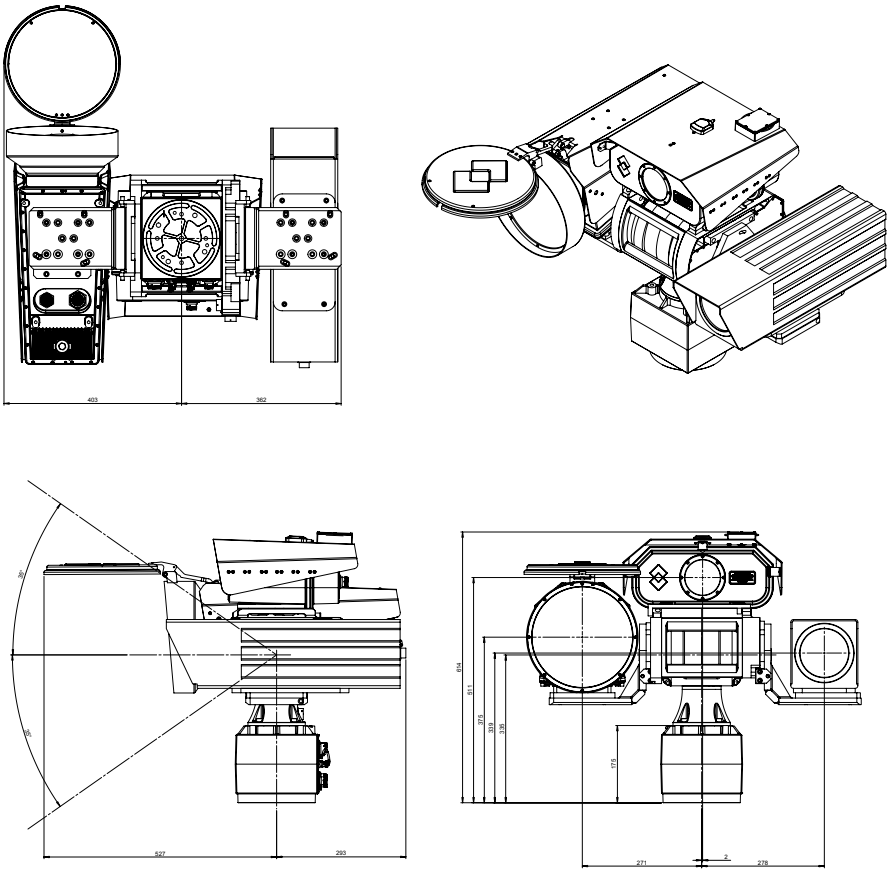


Figure 15.3 HRC-U, UR-TV and Pan/tilt (Basic dimensions in mm).

15.6.1.3

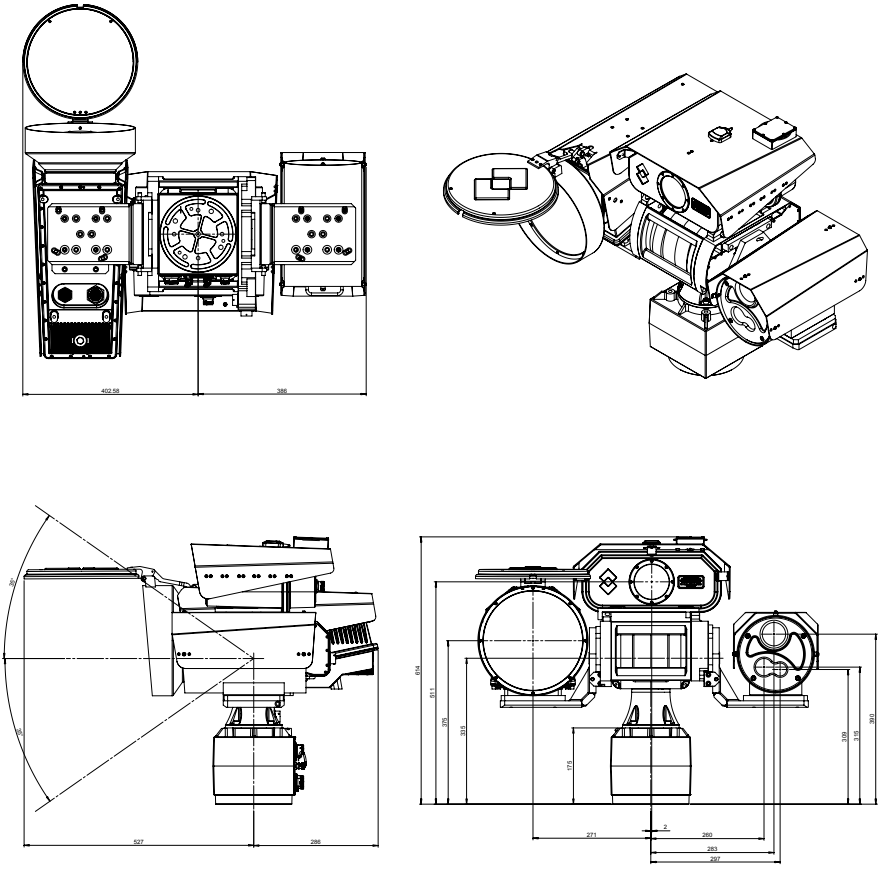


Figure 15.4 HRC-U, SR-TV and Pan/tilt (Basic dimensions in mm).

15.6.1.4

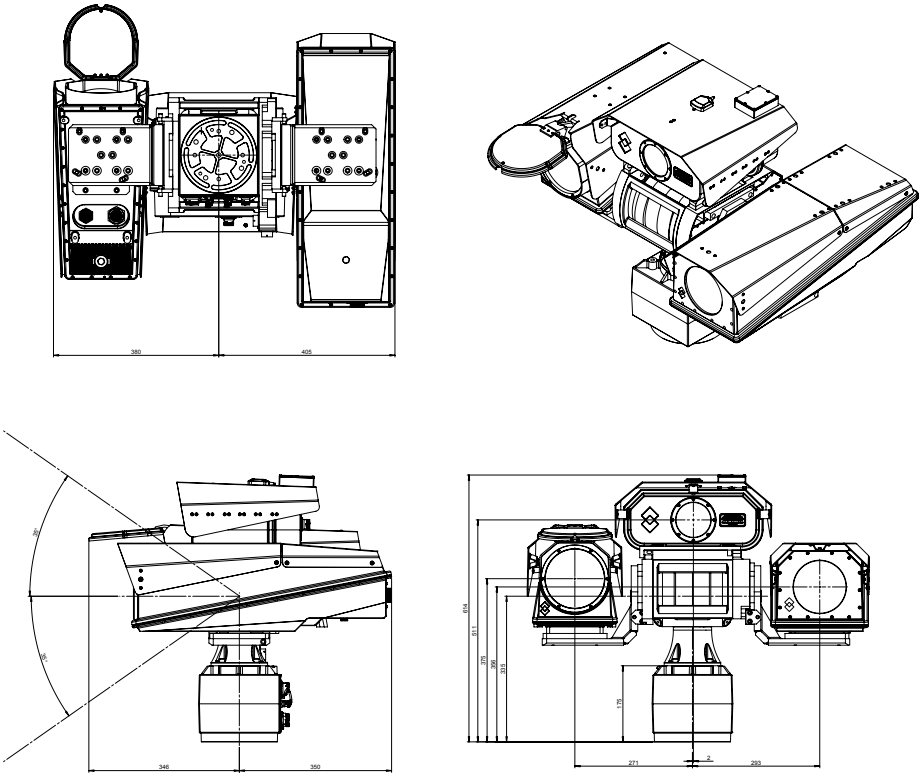


Figure 15.5 HRC-S, LR-TV and Pan/tilt (Basic dimensions in mm).

15.6.1.5

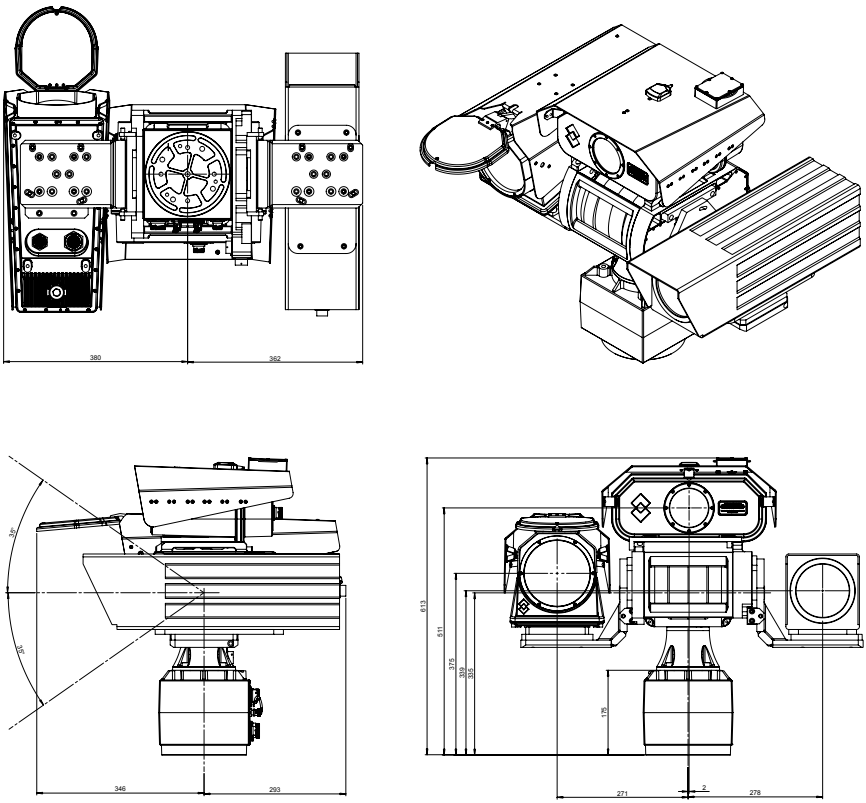


Figure 15.6 HRC-S, UR-TV and Pan/tilt (Basic dimensions in mm).

15.6.1.6

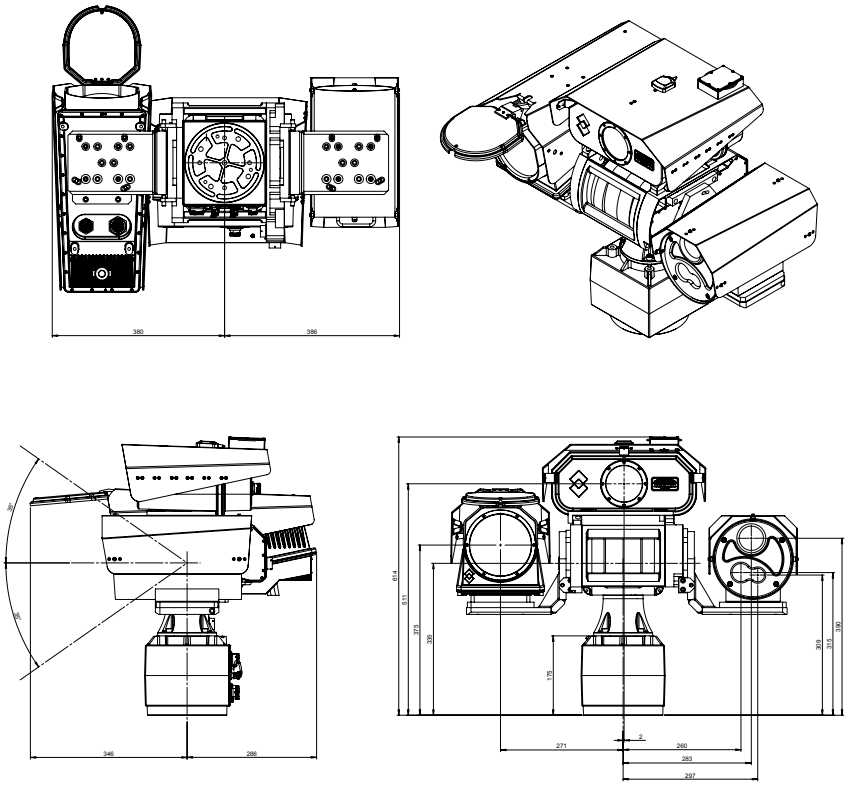


Figure 15.7 HRC-S, SR-TV and Pan/tilt (Basic dimensions in mm).

15.6.2 Basic dimensions – Joystick Control Unit (JCU)

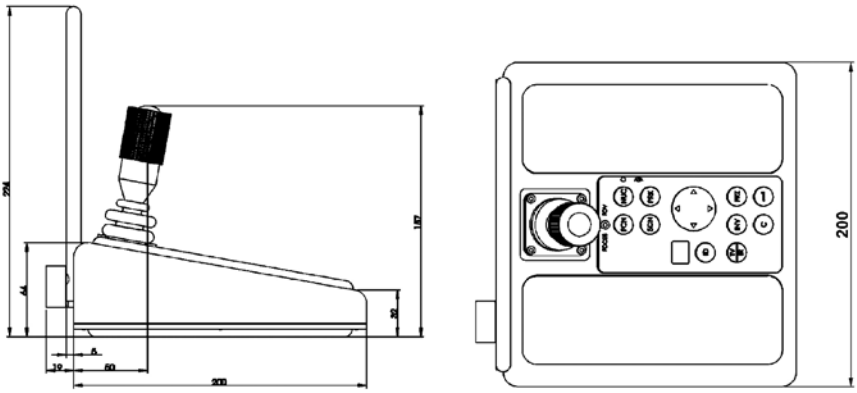


Figure 15.8 Basic dimensions – Joystick Control Unit (JCU) (Basic dimensions in mm).

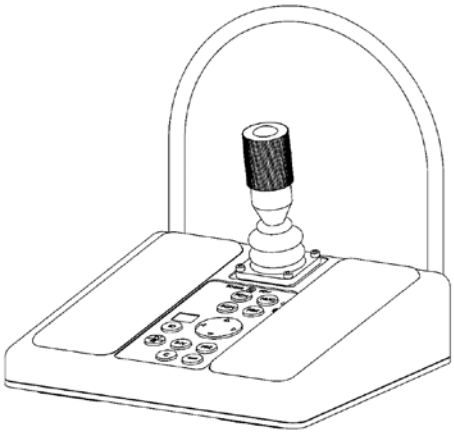


Figure 15.9 Basic dimensions – Joystick Control Unit (JCU) (Basic dimensions in mm).

15.6.3 Basic dimensions – Junction box (JB)

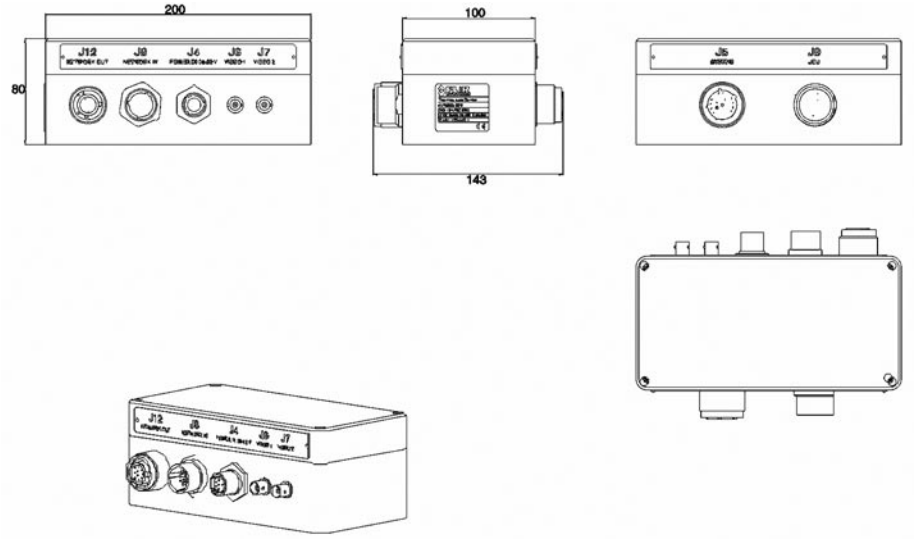


Figure 15.10 Basic dimensions – Junction box (JB) (Basic dimensions in mm).

15.6.4 Basic dimensions – Power supply (PS)

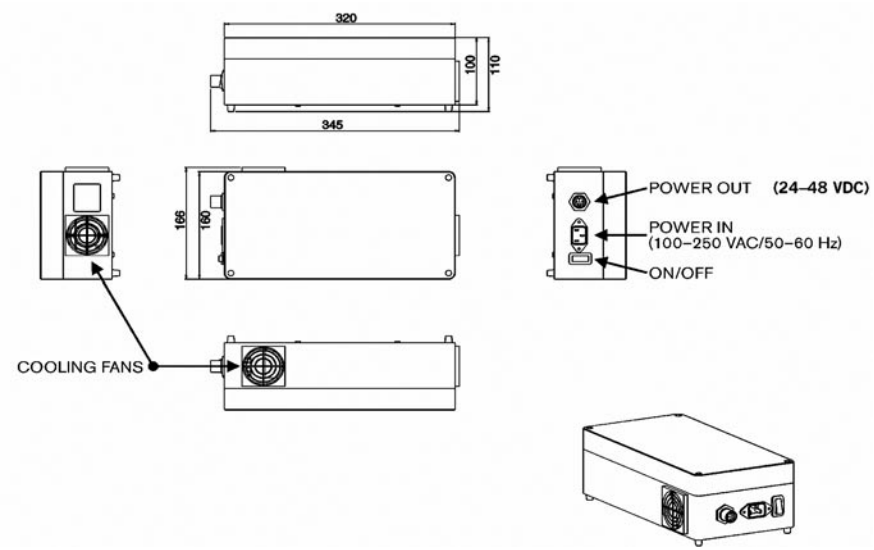


Figure 15.11 Basic dimensions – Power supply (PS) (Basic dimensions in mm).

15.6.5 Basic dimensions – Power box

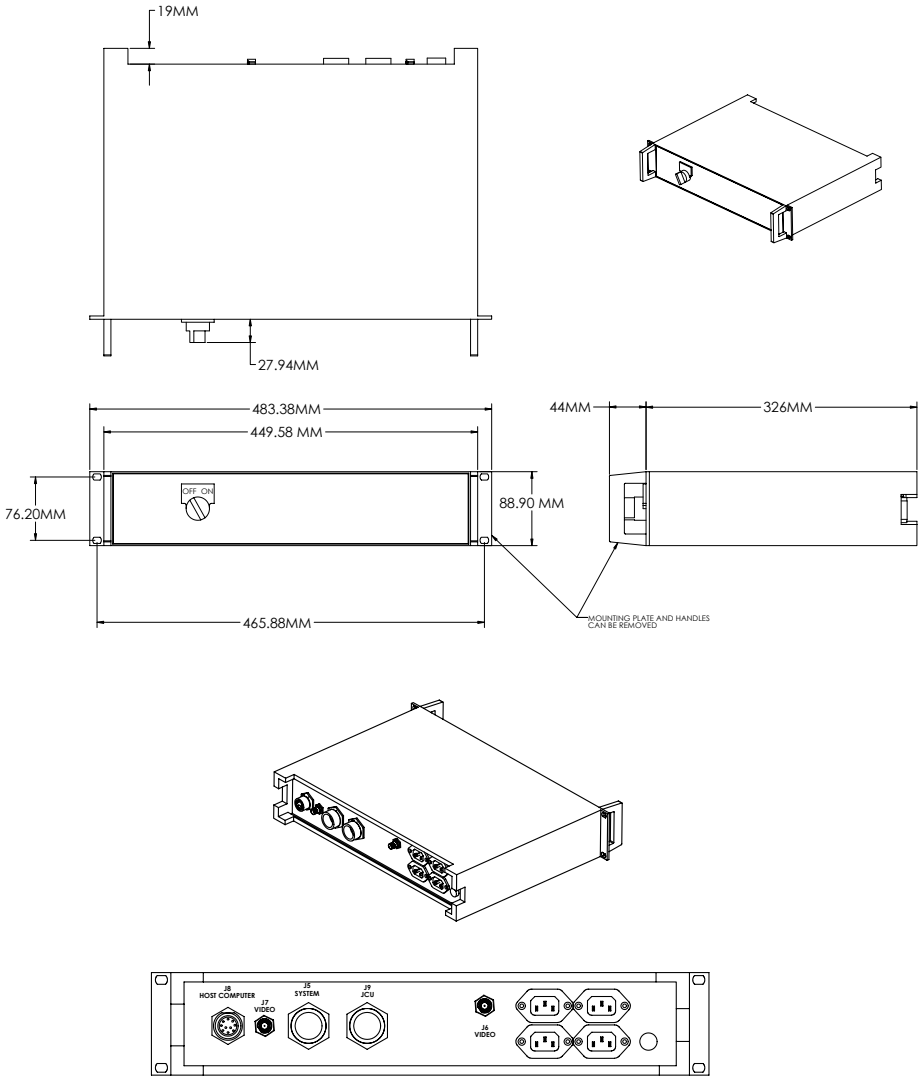


Figure 15.12 Basic dimensions – Power box (Basic dimensions in mm).

15.6.6 Basic dimensions – JPC2

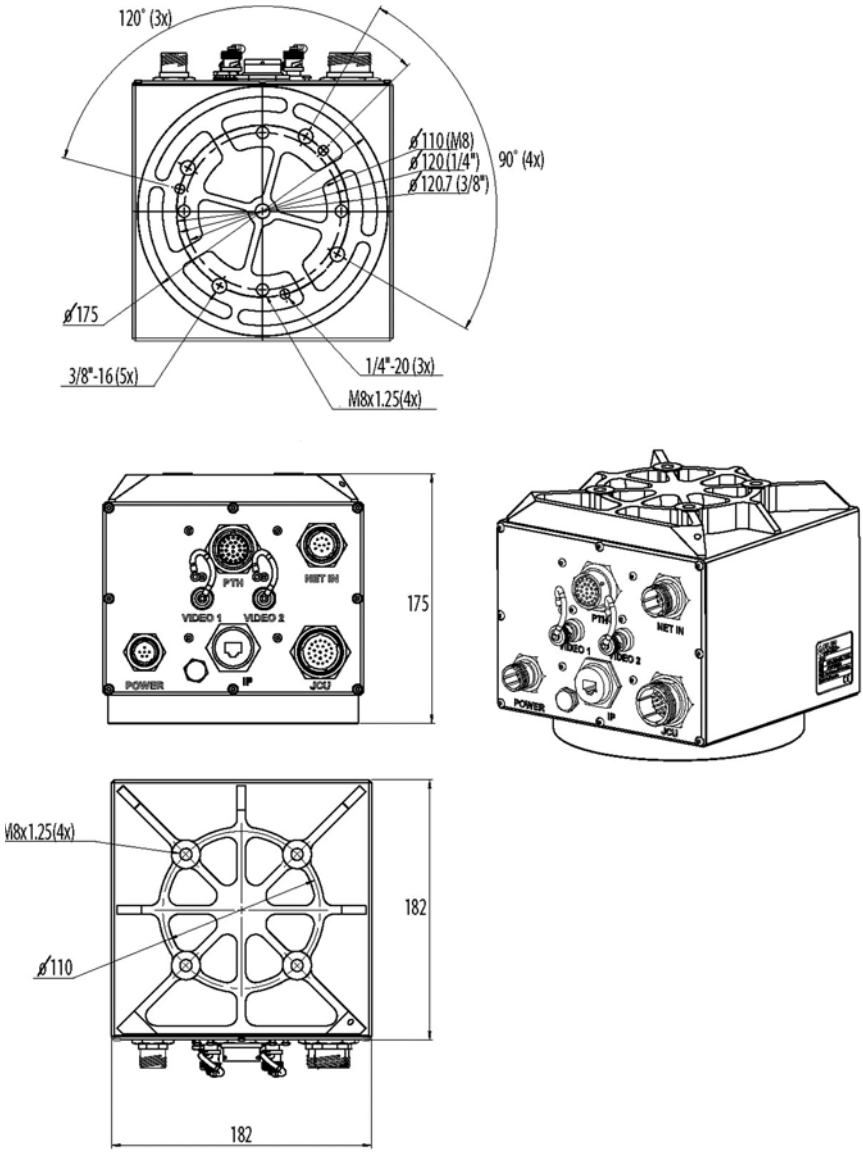


Figure 15.13 Basic dimensions – JPC2 (Basic dimensions in mm).

15.6.7 Basic dimensions – Mount plate

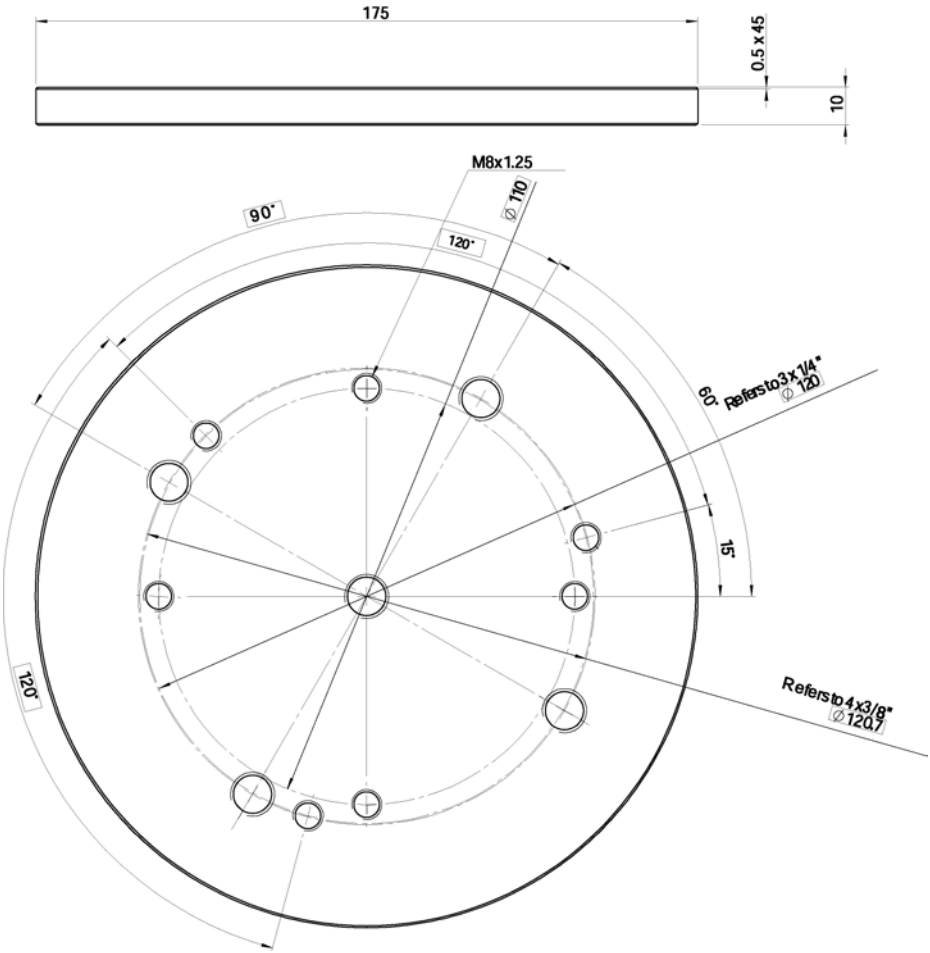


Figure 15.14 Mount plate (Basic dimensions in mm).

15.7 Diagnostic tools

The Ranger HRC MS system has an integrated series of diagnostic tests.

The *Setup – Diag tool* dialog box is used to run the Focus, FOV, Pan/Tilt, GPS, LRF and DMC diagnostic tests.

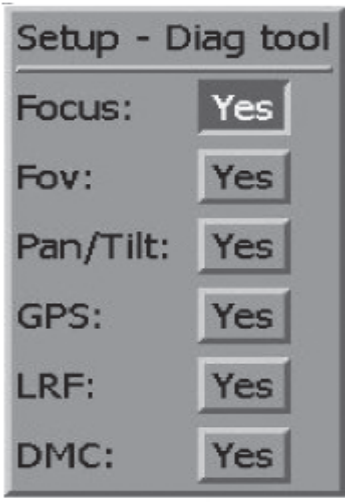


Figure 15.15 Setup – Diag tool dialog box.

Running diagnostic test	
Step	**Action**
1	Press the ENTER button to enter MENU mode.
2	Select **Maintenance…** from the **Setup** menu and press the ENTER button. The *Setup – Maintenance* dialog box is displayed.
3	Select **Run diag tool**.
4	Use the LEFT/RIGHT buttons to select **Yes**. The *Setup – Diag tool* dialog box is displayed.
5	Select each function/unit and use the LEFT/RIGHT buttons to select **Yes**/**No** to include/exclude the function/unit from the diagnostic test. **NOTE:** It is only possible to run a test of a unit if it is powered on.
6	Press the ENTER button to initiate the diagnostic tests. Press the CANCEL button to exit.

Running diagnostic test	
Step	**Action**
7	The results of the diagnostic tests are displayed, see example below.
8	Press the ENTER or CANCEL button to exit MENU mode.

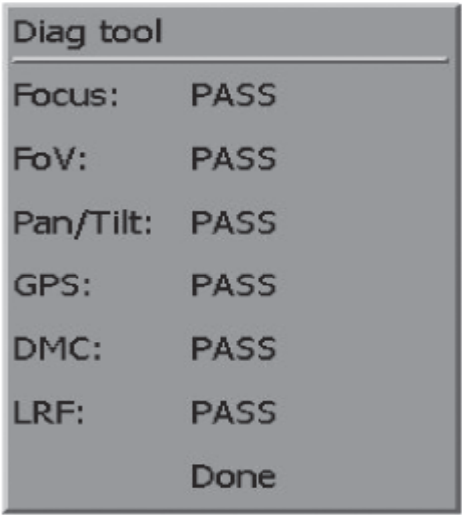


Figure 15.16 Example of diagnostic tests results.

15.8 Trouble shooting

The table below is a guide for actions to take to correct simple operational faults that may occur during normal use of the Ranger HRC MS system.

Trouble shooting guide

Symptom	Action
No image appears on the monitor at power on, or the picture is distorted or continually scrolling.	• Verify that the video cable is correctly connected to the system and to the monitor. • Verify that the monitor is set to the correct TV system (PAL/NTSC). • Check the status indicator LED on the JCU. The LED should give a flashing light during start up and a steady light when the system is operational. If not, check the power cable and the mains cable to the power supply.
The system does not start in cold environment.	Depending on the ambient temperature, it will take up to 30 minutes for the heaters to warm the system up in extreme cold. When the heaters are on, the system heater indicator on the JCU is lit.
The system starts normally and the system information is displayed, but no IR image appears.	The image could be totally out of focus. Perform an auto focus adjustment.
The system starts up properly and gives an acceptable image, but the system does not react on commands from the JCU.	Check the cable that connecs the system to the JCU.
No system information is displayed.	• The *Declutter* feature may be active. Press the ENTER button to display the system information. • Verify the settings in the *Setup – Symbology* dialog box.
The IR image is totally black or white.	Change the adjustment mode setting.
The IR image is of bad quality.	Perform a NUC.
The autoscan points can not be changed.	Ensure that IR is selected; the features for programming of autoscan points are only available when IR is selected.
Expected features are not displayed.	The displayed menu options and features are somewhat different, depending on if IR or TV is selected. Ensure that correct channel (IR or TV) is selected.

Trouble shooting guide

Symptom	Action
The video image is displayed, but the Pan/Tilt unit does not operate after power on.	Press and hold down the **PRK** button for 3 seconds to activate the Pan/Tilt unit.
Pressing the buttons on the JCU does not give the expected effect.	Check the JCU settings in the System Software; for example, the *MMI Control mode*, *Nuc button* and *Left/Right scanpoint selection* features.
The TV image looks strange.	Check the TV settings in the System Software; the *Back light comp*, *Image effect* and *Near IR sensitive* features.

15.9 IP network solution

Ranger HRC MS with an IP network configuration is an extra option.

With the IP network configuration, a standard PC running a security and surveillance application – such as the FLIR Nexus application – is used to control multiple Ranger HRC MS systems.

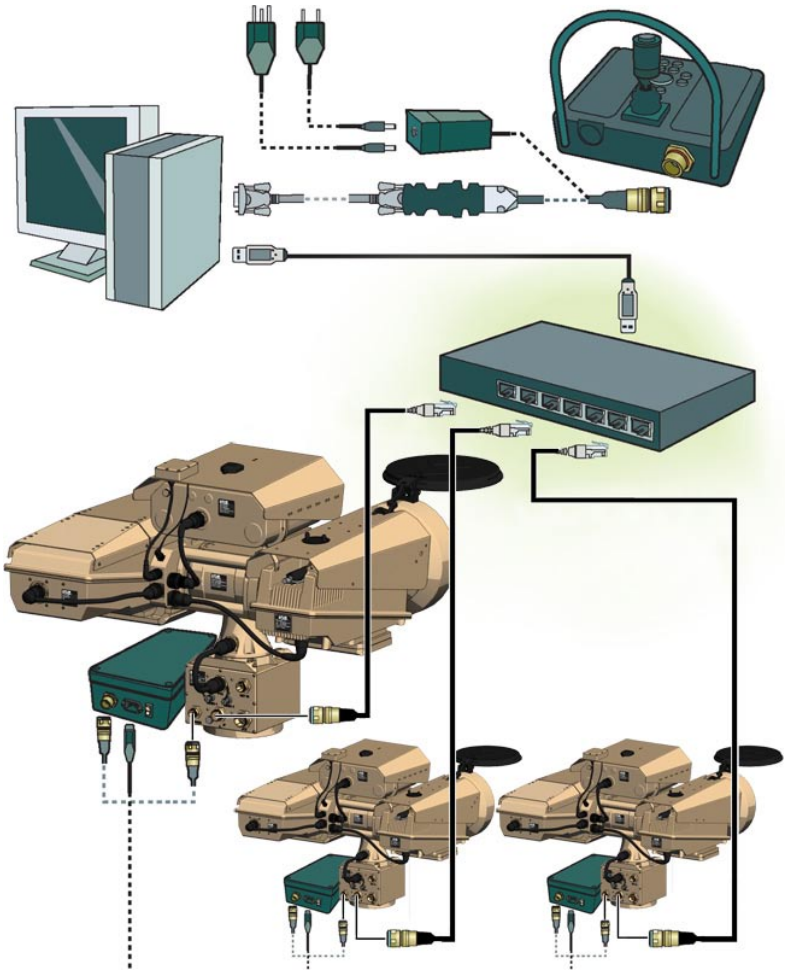


Figure 15.17 IP network configuration.

The Ranger HRC MS systems are connected to a LAN switch via the JPC2 units. Each system is powered from its own Power Supply unit. The JCU can be connected to the PC with an adapter cable, which also includes an AC converter.

15.9.1 Equipment

The following equipment is needed for the IP network option:

- One or several Ranger HRC MS systems, with JPC2 units configured for the IP option.
- One Power Supply unit per system.
- One non-crossover FTP/STP cable per system for connection to the LAN switch.
- A crossover FTP/STP cable for connection of a standard PC directly to the JPC2 units for change of network settings etc.
- A COTS LAN switch (10/100 Mb or 10/100/1000 Mb).
- A standard PC running a suitable security and surveillance application, for example the FLIR Nexus application.
- Optionally a Joystick Control Unit (JCU).
- Optionally an adapter cable for connection of the Joystick Control Unit to the PC.

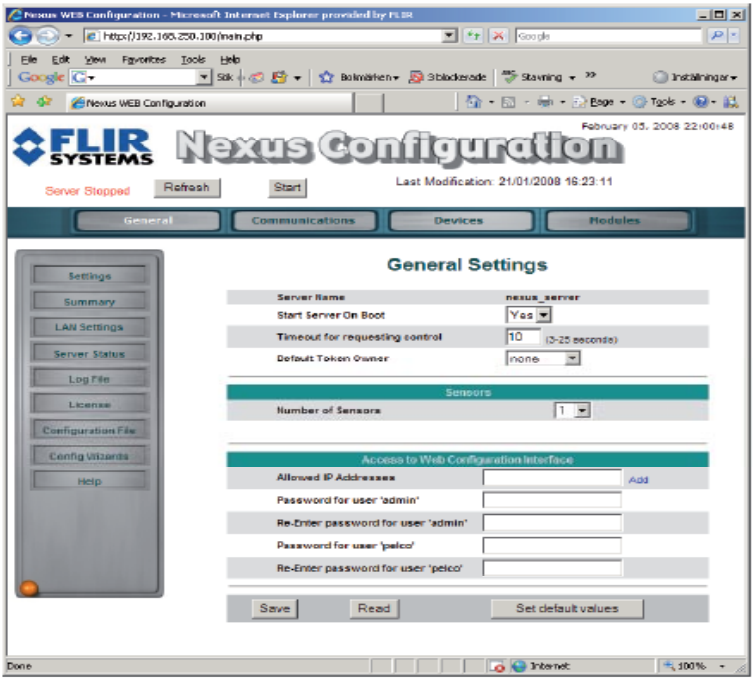
15.9.2 FLIR Nexus application

The FLIR Nexus application can be used to control the Ranger HRC MS systems in an IP network.

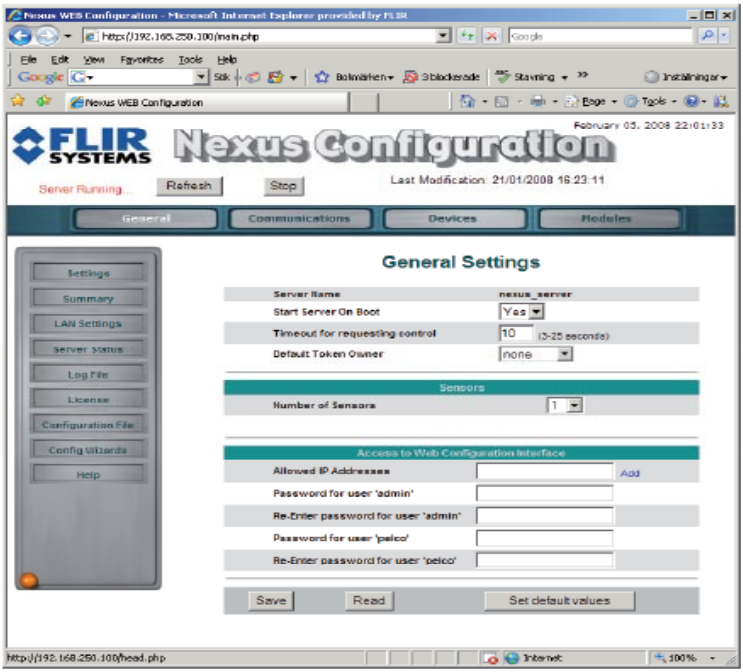
For more information about the FLIR Nexus application, please refer to the Nexus manual.

Starting the video server

Step	Action
1	To start the video server, use any web browser to connect to the server's web configurator and click the Start button at the top of the page.



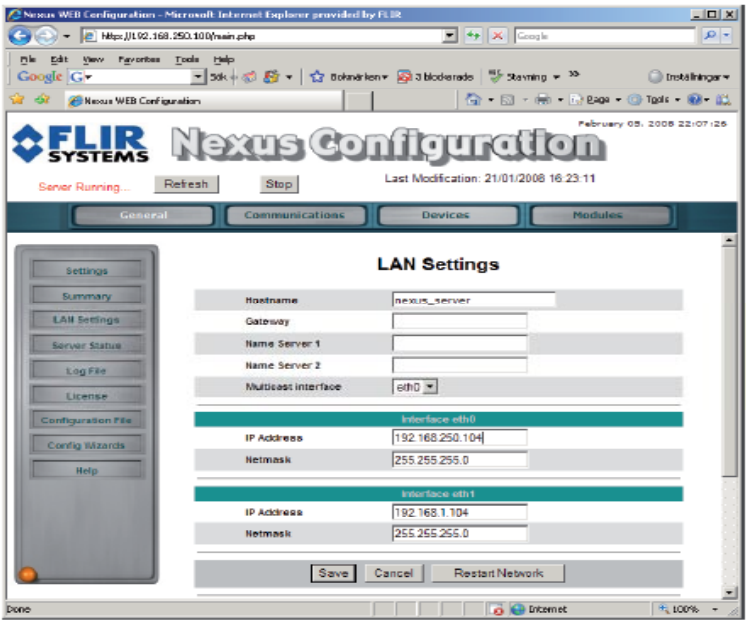
Changing the video server startup options

Step	Action
1	To change the video server start-up options, do one of the following: • To make the server start automatically when the Ranger HRC MS system starts, select **Yes** in the *Start Server On Boot* list box and then click **Save** in the bottom of the page. • To make the server <u>not</u> start automatically when the Ranger HRC MS system starts, select **No** in the *Start Server On Boot* list box and then click **Save** in the bottom of the page. 

Changing the IP address

Step	Action
1	Connect a standard PC to the Ranger HRC MS system, using one of the following methods: • Directly to the JPC2 unit, using a crossover FTP/STP cable. • Via the LAN network, using a non-crossover FTP/STP cable.
2	Start your web browser of choice and enter the following address in the address field: http://192.168.250.100/main.php 
3	Click on LAN settings in the left pane. 

Changing the IP address

Step	Action
4	Enter a new **IP address** in the IP Address text box. You can also change **Host name** and **Net mask**. Host name can be set freely, but Net mask may need to be set to 255.255.255.0. When all changes are made, click **Save** in the bottom of the page and start using the new IP number. 

16 History of Infrared technology

Less than 200 years ago the existence of the infrared portion of the electromagnetic spectrum wasn't even suspected. The original significance of the infrared spectrum, or simply 'the infrared' as it is often called, as a form of heat radiation is perhaps less obvious today than it was at the time of its discovery by Herschel in 1800.

Figure 16.1 Sir William Herschel (1738–1822).

The discovery was made accidentally during the search for a new optical material. Sir William Herschel – Royal Astronomer to King George III of England, and already famous for his discovery of the planet Uranus – was searching for an optical filter material to reduce the brightness of the sun's image in telescopes during solar observations. While testing different samples of colored glass which gave similar reductions in brightness he was intrigued to find that some of the samples passed very little of the sun's heat, while others passed so much heat that he risked eye damage after only a few seconds' observation.

Herschel was soon convinced of the necessity of setting up a systematic experiment, with the objective of finding a single material that would give the desired reduction in brightness as well as the maximum reduction in heat. He began the experiment by actually repeating Newton's prism experiment, but looking for the heating effect rather than the visual distribution of intensity in the spectrum. He first blackened the bulb of a sensitive mercury-in-glass thermometer with ink, and with this as his radiation detector he proceeded to test the heating effect of the various colors of the spectrum formed on the top of a table by passing sunlight through a glass prism. Other thermometers, placed outside the sun's rays, served as controls.

As the blackened thermometer was moved slowly along the colors of the spectrum, the temperature readings showed a steady increase from the

violet end to the red end. This was not entirely unexpected, since the Italian researcher, Landriani, in a similar experiment in 1777 had observed much the same effect. It was Herschel, however, who was the first to recognize that there must be a point where the heating effect reaches a maximum, and that measurements confined to the visible portion of the spectrum failed to locate this point.

Figure 16.2 Marsilio Landriani (1746–1815).

Moving the thermometer into the dark region beyond the red end of the spectrum, Herschel confirmed that the heating continued to increase. The maximum point, when he found it, lay well beyond the red end – in what is known today as the 'infrared wavelengths'.

When Herschel revealed his discovery, he referred to this new portion of the electromagnetic spectrum as the 'thermometrical spectrum'. The radiation itself he sometimes referred to as 'dark heat', or simply 'the invisible rays'. Ironically, and contrary to popular opinion, it wasn't Herschel who originated the term 'infrared'. The word only began to appear in print around 75 years later, and it is still unclear who should receive credit as the originator.

Herschel's use of glass in the prism of his original experiment led to some early controversies with his contemporaries about the actual existence of the infrared wavelengths. Different investigators, in attempting to confirm his work, used various types of glass indiscriminately, having different transparencies in the infrared. Through his later experiments, Herschel was aware of the limited transparency of glass to the newly-discovered thermal radiation, and he was forced to conclude that optics for the infrared would probably be doomed to the use of reflective elements exclusively (i.e. plane and curved mirrors). Fortunately, this proved to be true only until 1830, when the Italian investigator, Melloni, made his great discovery that naturally occurring rock salt (NaCl) – which was available

in large enough natural crystals to be made into lenses and prisms – is remarkably transparent to the infrared. The result was that rock salt became the principal infrared optical material, and remained so for the next hundred years, until the art of synthetic crystal growing was mastered in the 1930's.

Figure 16.3 Macedonio Melloni (1798–1854).

Thermometers, as radiation detectors, remained unchallenged until 1829, the year Nobili invented the thermocouple. (Herschel's own thermometer could be read to 0.2 °C (0.036 °F), and later models were able to be read to 0.05 °C (0.09 °F)). Then a breakthrough occurred; Melloni connected a number of thermocouples in series to form the first thermopile. The new device was at least 40 times as sensitive as the best thermometer of the day for detecting heat radiation – capable of detecting the heat from a person standing three meters away.

The first so-called 'heat-picture' became possible in 1840, the result of work by Sir John Herschel, son of the discoverer of the infrared and a famous astronomer in his own right. Based upon the differential evaporation of a thin film of oil when exposed to a heat pattern focused upon it, the thermal image could be seen by reflected light where the interference effects of the oil film made the image visible to the eye. Sir John also managed to obtain a primitive record of the thermal image on paper, which he called a 'thermograph'.

Figure 16.4 Samuel P. Langley (1834–1906).

The improvement of infrared-detector sensitivity progressed slowly. Another major breakthrough, made by Langley in 1880, was the invention of the bolometer. This consisted of a thin blackened strip of platinum connected in one arm of a Wheatstone bridge circuit upon which the infrared radiation was focused and to which a sensitive galvanometer responded. This instrument is said to have been able to detect the heat from a cow at a distance of 400 meters.

An English scientist, Sir James Dewar, first introduced the use of liquefied gases as cooling agents (such as liquid nitrogen with a temperature of -196 °C (-320.8 °F)) in low temperature research. In 1892 he invented a unique vacuum insulating container in which it is possible to store liquefied gases for entire days. The common 'thermos bottle', used for storing hot and cold drinks, is based upon his invention.

Between the years 1900 and 1920, the inventors of the world 'discovered' the infrared. Many patents were issued for devices to detect personnel, artillery, aircraft, ships – and even icebergs. The first operating systems, in the modern sense, began to be developed during the 1914–18 war, when both sides had research programs devoted to the military exploitation of the infrared. These programs included experimental systems for enemy intrusion/detection, remote temperature sensing, secure communications, and 'flying torpedo' guidance. An infrared search system tested during this period was able to detect an approaching airplane at a distance of 1.5 km (0.94 miles), or a person more than 300 meters (984 ft.) away.

The most sensitive systems up to this time were all based upon variations of the bolometer idea, but the period between the two wars saw the development of two revolutionary new infrared detectors: the image converter and the photon detector. At first, the image converter received the

greatest attention by the military, because it enabled an observer for the first time in history to literally 'see in the dark'. However, the sensitivity of the image converter was limited to the near infrared wavelengths, and the most interesting military targets (i.e. enemy soldiers) had to be illuminated by infrared search beams. Since this involved the risk of giving away the observer's position to a similarly-equipped enemy observer, it is understandable that military interest in the image converter eventually faded.

The tactical military disadvantages of so-called 'active' (i.e. search beam-equipped) thermal imaging systems provided impetus following the 1939–45 war for extensive secret military infrared-research programs into the possibilities of developing 'passive' (no search beam) systems around the extremely sensitive photon detector. During this period, military secrecy regulations completely prevented disclosure of the status of infrared-imaging technology. This secrecy only began to be lifted in the middle of the 1950's, and from that time adequate thermal-imaging devices finally began to be available to civilian science and industry.

17 Theory of thermal imaging

17.1 Introduction

The subjects of infrared radiation is still new to many who will use an infrared camera. In this section the theory behind thermal imaging will be given.

17.2 The electromagnetic spectrum

The electromagnetic spectrum is divided arbitrarily into a number of wavelength regions, called bands, distinguished by the methods used to produce and detect the radiation. There is no fundamental difference between radiation in the different bands of the electromagnetic spectrum. They are all governed by the same laws and the only differences are those due to differences in wavelength.

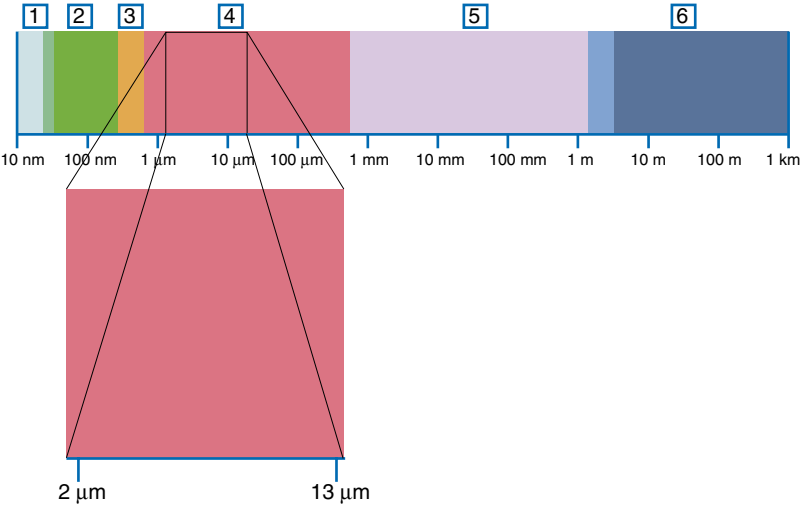


Figure 17.1 The electromagnetic spectrum 1: X-ray; 2: UV; 3: Visible; 4: IR; 5: Microwaves; 6: Radiowaves.

Thermal imaging makes use of the infrared spectral band. At the short-wavelength end the boundary lies at the limit of visual perception, in the deep red. At the long wavelength end it merges with the microwave radio wavelengths, in the millimeter range.

The infrared band is often further subdivided into four smaller bands, the boundaries of which are also arbitrarily chosen. They include: the *near infrared* (0.75–3 μm), the *middle infrared* (3–6 μm), the *far infrared* (6–15 μm) and the *extreme infrared* (15–100 μm). Although the wavelengths are given in μm (micrometers), other units are often still used to measure wavelength in this spectral region, e.g. nanometer (nm) and Ångström (Å).

17.3 Blackbody radiation

A blackbody is defined as an object which absorbs all radiation that impinges on it at any wavelength. The apparent misnomer black relating to an object emitting radiation is explained by Kirchhoff's Law (after *Gustav Robert Kirchhoff*, 1824–1887), which states that a body capable of absorbing all radiation at any wavelength is equally capable in the emission of radiation.

Figure 17.2 Gustav Robert Kirchhoff (1824–1887).

The construction of a blackbody source is, in principle, very simple. The radiation characteristics of an aperture in an isotherm cavity made of an opaque absorbing material represents almost exactly the properties of a blackbody. A practical application of the principle to the construction of a perfect absorber of radiation consists of a box that is light tight except for an aperture in one of the sides. Any radiation which then enters the hole is scattered and absorbed by repeated reflections so only an infinitesimal fraction can possibly escape. The blackness which is obtained at the aperture is nearly equal to a blackbody and almost perfect for all wavelengths.

By providing such an isothermal cavity with a suitable heater it becomes what is termed a *cavity radiator*. An isothermal cavity heated to a uniform temperature generates blackbody radiation, the characteristics of which are determined solely by the temperature of the cavity.

If the temperature of blackbody radiation increases to more than 525 °C (977 °F), the source begins to be visible so that it appears to the eye no longer black. This is the incipient red heat temperature of the radiator, which then becomes orange or yellow as the temperature increases further. In fact, the definition of the so-called color temperature of an object is the temperature to which a blackbody would have to be heated to have the same appearance.

Now consider three expressions that describe the radiation emitted from a blackbody.

17.3.1 Planck's law

Figure 17.3 Max Planck (1858–1947).

Max Planck (1858–1947) was able to describe the spectral distribution of the radiation from a blackbody by means of the following formula:

where:

$M_{e,\lambda}$	Blackbody spectral radiance (radiant exitance)
c	Velocity of light = 3×10^8 m/s
h	Planck's constant = 6.6×10^{-34} Joule sec
k	Boltzmann's constant = 1.4×10^{-23} Joule/K
T	Absolute temperature (K) of a blackbody
λ	Wavelength (m)

Planck's formula, when plotted graphically for various temperatures, produces a family of curves. Following any particular Planck curve, the spectral exitance is zero at $\lambda = 0$, then increases rapidly to a maximum at a wavelength λ_{max} and after passing, it approaches zero again at very long wavelengths. The higher the temperature, the shorter the wavelength at which maximum occurs.

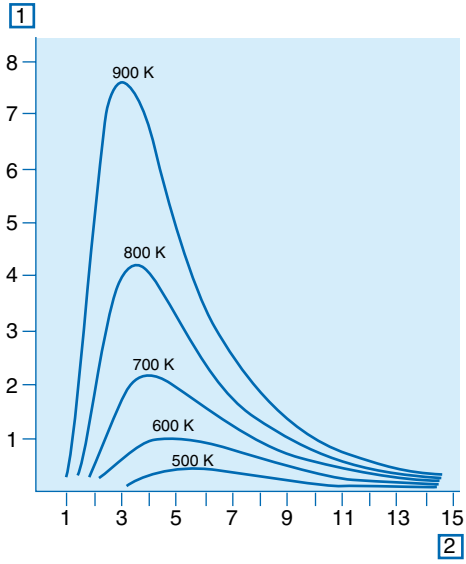


Figure 17.4 Blackbody spectral radiant exitance according to Planck's law, plotted for various absolute temperatures. 1: Spectral radiant exitance; 2: Wavelength (µm).

17.3.2 Wien's displacement law

By differentiating Planck's formula with respect to λ, and finding the maximum, we have:

$$\lambda_{max} = \frac{2898}{T}[\mu m]$$

This is Wien's displacements law (after *Wilhelm Wien*, 1864–1928), which expresses mathematically the common observation that colors vary from red to orange or yellow as the temperature of a thermal radiator increases. The wavelength of the color is the same as the wavelength calculated for λ_{max}. A good approximation of the value of λ_{max} for a given blackbody temperature is obtained by applying the rule-of-thumb 3000/T μm. Thus, a very hot star such as Sirius (11.000 K), emitting bluish-white light, radiates with the peak of spectral radiant exitance occurring within the invisible ultraviolet spectrum, at wavelength 0.27 μm.

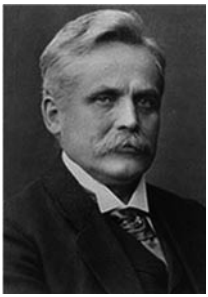


Figure 17.5 Wilhelm Wien (1864–1928).

The sun (approx. 6.000 K) emits yellow light, peaking at about 0.5 μm in the middle of the visible light spectrum.

At room temperature (300 K) the peak of radiant exitance lies at 9.7 μm, in the far infrared, while at the temperature of liquid nitrogen (77 K) the maximum of the almost insignificant amount of radiant exitance occurs at 38 μm, in the extreme infrared wavelengths.

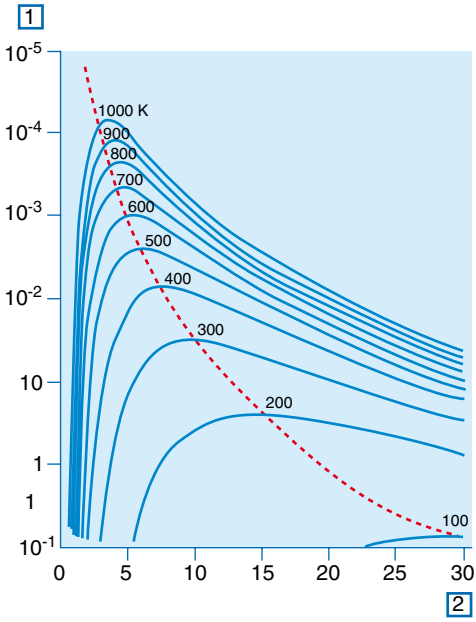


Figure 17.6 Planckian curves plotted on semi-log scales from 100 K to 1.000 K. The dotted line represents the locus of maximum radiant exitance at each temperature as described by Wien's displacement law. 1: Spectral radiant exitance (W/cm2 (µm)); 2: Wavelength (µm).

17.3.3 Stefan-Boltzmann's law

By integrating Planck's formula from $\lambda = 0$ to $\lambda = \infty$, we obtain the total radiant exitance (M_e) of a blackbody:

$$M_e = \sigma T^4 \left[W / m^2 \right] \quad \text{where} \quad \sigma = 5.67 \cdot 10^{-8} \left[W / m^2 K^4 \right]$$

This is the Stefan-Boltzmann formula (after *Josef Stefan*, 1835–1893, and *Ludwig Boltzmann*, 1844–1906), which states that the total emissive power of a blackbody is proportional to the fourth power of its absolute temperature. Graphically, M_e represents the area below the Planck curve for a particular temperature. It can be shown that the radiant exitance in the interval $\lambda = 0$ to λ_{max} is only 25 % of the total, which represents about the amount of the sun's radiation which lies inside the visible light spectrum.

Figure 17.7 Josef Stefan (1835–1893) and Ludwig Boltzmann (1844–1906).

Using the Stefan-Boltzmann formula to calculate the power radiated by the human body, at a temperature of 300 K and an external surface area of approx. 2 m^2, we obtain 1 kW. This power loss could not be sustained if it were not for the compensating absorption of radiation from surrounding surfaces, at room temperatures which do not vary too drastically from the temperature of the body – or, of course, the addition of clothing.

17.3.4 Non-blackbody emitters

So far, only blackbody radiators and blackbody radiation have been discussed. However, real objects almost never comply with these laws over an extended wavelength region – although they may approach the blackbody behavior in certain spectral intervals. For example, a certain type of white paint may appear perfectly *white* in the visible light spectrum, but becomes distinctly *gray* at about 2 µm, and beyond 3 µm it is almost *black*.

There are three processes which can occur that prevent a real object from acting like a blackbody: a fraction of the incident radiation α may be absorbed, a fraction ρ may be reflected, and a fraction τ may be transmitted. Since all of these factors are more or less wavelength dependent, the subscript λ is used to imply the spectral dependence of their definitions. Thus:

- The spectral absorptance α_λ = the ratio of the spectral radiant power absorbed by an object to that incident upon it.
- The spectral reflectance ρ_λ = the ratio of the spectral radiant power reflected by an object to that incident upon it.
- The spectral transmittance τ_λ = the ratio of the spectral radiant power transmitted through an object to that incident upon it.

The sum of these three factors must always add up to the whole at any wavelength, so we have the relation:

$$\alpha_\lambda + \rho_\lambda + \tau_\lambda = 1$$

For opaque materials τ_λ = 0 and the relation simplifies to:

$$\alpha_\lambda + \rho_\lambda = 1$$

Another factor, called the emissivity, is required to describe the fraction ε of the radiant exitance of a blackbody produced by an object at a specific temperature. Thus, we have the definition:

The spectral emissivity ε_λ= the ratio of the spectral radiant power from an object to that from a blackbody at the same temperature and wavelength.

Expressed mathematically, this can be written as the ratio of the spectral exitance of the object to that of a blackbody as follows:

$$\varepsilon_\lambda = \frac{M_{o,\lambda}}{M_{e,\lambda}}$$

Generally speaking, there are three types of radiation source, distinguished by the ways in which the spectral exitance of each varies with wavelength.

- A blackbody, for which $\varepsilon_\lambda = \varepsilon = 1$
- A graybody, for which $\varepsilon_\lambda = \varepsilon$ = constant less than 1
- A selective radiator, for which ε varies with wavelength

According to Kirchhoff's law, for any material the spectral emissivity and spectral absorptance of a body are equal at any specified temperature and wavelength. That is:

$$\varepsilon_\lambda = \alpha_\lambda$$

From this we obtain, for an opaque material (since $\alpha_\lambda + \rho_\lambda = 1$):

$$\varepsilon_\lambda + \rho_\lambda = 1$$

For highly polished materials ε_λ approaches zero, so that for a perfectly reflecting material (i.e. a perfect mirror) we have:

$$\rho_\lambda = 1$$

For a graybody radiator, the Stefan-Boltzmann formula becomes:

$$M = \varepsilon \sigma T^4 \left[W / m^2 \right]$$

This states that the total emissive power of a graybody is the same as a blackbody at the same temperature reduced in proportion to the value of ε from the graybody.

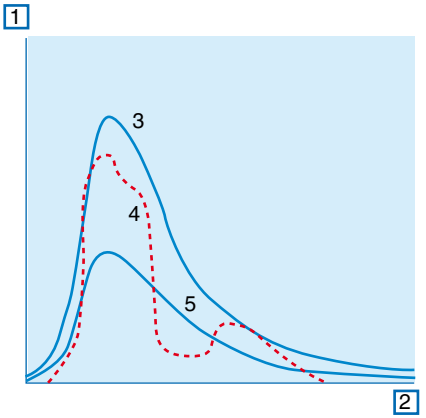


Figure 17.8 Spectral radiant exitance of three types of radiators. 1: Spectral radiant exitance; 2: Wavelength; 3: Blackbody; 4: Selective radiator; 5: Graybody.

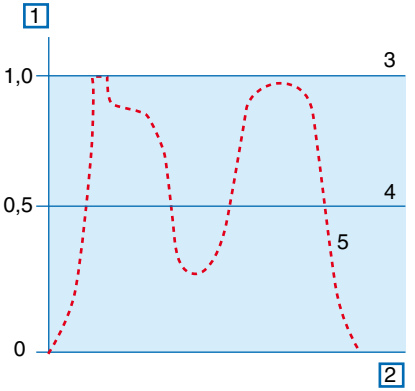


Figure 17.9 Spectral emissivity of three types of radiators. 1: Spectral emissivity; 2: Wavelength; 3: Blackbody; 4: Graybody; 5: Selective radiator.

17.4 Infrared semi-transparent materials

Consider now a non-metallic, semi-transparent body – let us say, in the form of a thick flat plate of plastic material. When the plate is heated, radiation generated within its volume must work its way toward the surfaces through the material in which it is partially absorbed. Moreover, when it arrives at the surface, some of it is reflected back into the interior. The back-reflected radiation is again partially absorbed, but some of it arrives at the other surface, through which most of it escapes; part of it is reflected back again. Although the progressive reflections become weaker and weaker they must all be added up when the total exitance of the plate is sought.

When the resulting geometrical series is summed, the effective emissivity of a semitransparent plate is obtained as:

$$\varepsilon_\lambda = \frac{(1-\rho_\lambda)(1-\tau_\lambda)}{1-\rho_\lambda\tau_\lambda}$$

When the plate becomes opaque this formula is reduced to the single formula:

$$\varepsilon_\lambda = 1-\rho_\lambda$$

This last relation is a particularly convenient one, because it is often easier to measure reflectance than to measure emissivity directly.

18 Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating Current
BIT	Built-in test
DDE	Digital Detail Enhancement
DMC	Digital Magnetic Compass
FFF	FLIR File Format
FOV	Field-of-view
GPS	Global Positioning System
GUI	Graphical User Interface
HI	High
HIST	Histogram
IANA	Internet Assigned Numbers Authority
ICD	Interface Control Document
IP	Internet Protocol
IR	Infrared
JB	Junction Box
JCU	Joystick Control Unit
JPC2	Junction Protocol Converter 2
JPEG	Joint Photographic Experts Group
LIN	Linear
LO	Low
LRF	Laser Range Finder
MMI	Man Machine Interface
NUC	Non-Uniform Correction
PB	Power Box
POST	Power-on self-test
PS	Power Supply
RPC	Remote Power Controller
Ranger HRC MS	Ranger High Resolution Camera Multi-Sensor
RTP	Real Time Protocol

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