



WORKSWELL WIRIS PRO

USER MANUAL

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1 Legal Disclaimer

All products (software, hardware or firmware) manufactured by Workswell s.r.o. are warranted against defective materials and workmanship for a period of twelve (12) months, provided such products have been under normal storage and use in accordance with herein instructions.

The warranty extends only to the original purchaser and is not transferable. It is not applicable to any product which has been subjected to misuse, neglect, accident or abnormal conditions of operation.

In the case of a defect in a product covered by this warranty the product must not be further used in order to prevent additional damage. The purchaser shall promptly report any defect to Workswell s.r.o. or its authorized distributor or this warranty will not apply.

Workswell s.r.o. will, at its option, repair or replace any such defective product free of charge if, upon inspection, it proves to be defective in material or workmanship and provided that it is returned to Workswell within the said twelve-month period.

Nobody but Workswell s.r.o. is allowed to open or modify such product.

Workswell s.r.o. has no other obligation or liability for defects than those set forth above. No other warranty is expressed or implied. Workswell s.r.o. shall not be liable for any direct, indirect, special, incidental or consequential loss or damage, whether based on contract, tort or any other legal theory.

1.1 Copyright

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Names and marks appearing on the products herein are either registered trademarks or trademarks of Workswell s.r.o. All other trademarks, trade names or company names referenced herein are used for identification only and are the property of their respective owners.

2 Warning and Cautions

2.1 Warnings

Before using the product, please read the whole User Manual. Before power-up the camera or drone, please check that there is no visible damage or malfunction, cables are connected properly and verify the polarity is correct.

If there are any visible signs of damage or other defect on the device, or you are not sure with the connection, then on no account should it be installed or put into operation.

Any interference and non-certified service operations into the product leads to an automatic loss of warranty.

2.2 Notifications

Do not use or store the device in conflict with the storage and operating conditions laid down in this manual (only for hardware).

- Do not point the infrared camera (with or without the lens cover) at strong energy sources, for example, devices that cause laser radiation, or the sun. This can have an unwanted effect on the accuracy of the camera. It can also cause damage to the detector in the camera.
- Plug the camera to its own power source. Do not plug the camera into the same power source as drone's motors.
- Use original accessories only.
- Do not plug any power to the GPS/Mavlink power pin.
- Do not use the Workswell WIRIS Pro system in temperatures higher than +50°C (+122°F). High temperatures can cause damage to the camera.
- Do not use the Workswell WIRIS Pro system in temperatures lower than -10°C (+5°F). Low temperatures can cause damage to the camera.
- Do not use the Workswell WIRIS Pro in environmental conditions that make condensation possible (make sure the air is non-condensing)
- Do not apply solvents or equivalent liquids to the cameras, the cables, or other items. Damage to the items can occur. For cleaning refer to chapter 20.
- Be careful when you clean the infrared lens. The lens has an anti-reflective coating which is easily damaged. Do not use too much force to clean the infrared lens. This can cause damage to the anti-reflective coating.
- The encapsulation rating is only applicable when all the openings on the all components of the system are sealed with their correct covers, hatches, or caps.

3 Help and FAQ

3.1 General Instructions

While looking for a solution of any technical problem we recommend following these steps:

- try to find an answer by searching this User Manual
- contact your dealer
- log in and send an email on support.workswell.eu

4 User Information

4.1 Typographic Conventions

Following typographic conventions are used in this User Manual:

- UPPER CASE is used for the names of keys, buttons and menu items
- COURIER is used for filenames and paths
- *Italic* is used for important information and document names
- **bold** is used for the links to other sections, for function names or Internet sites

4.2 Help and Support

For technical questions that were not answered in this User Manual feel free to contact your dealer or visit the product website at www.drone-thermal-camera.com, or log in and send an email on support.workswell.eu.

4.3 Updates

The primary aim of Workswell s.r.o. company is to supply their products in a way that meets the current needs of its users and at the same time to remove all the weaknesses that were found in their use as quickly as possible. For this reason, Workswell s.r.o. regularly releases updates for all their products.

Visit <https://www.workswell-thermal-camera.com/firmware-update/> to download the latest firmware release. The update process itself is described in a later section.

4.4 Firmware

Firmware is the „internal“ control program of the device. From the user’s point of view, only the official firmware released by Workswell s.r.o. company can be used for update of the device.

5 Revision History

0.1.0

- initial draft

0.9.9

- preliminary release version

1.0.0

- TIFF calculation formula repaired.

1.1.0

- Added and adjusted for slight changes in FW v.1.1.0 function interface
- Added deeper insight into the Super-Resolution functionality
- Corrections

1.2.0

- Updated with current interface images.
- Added Geofencing function.

1.2.1

- Added new keyboard control possibilities
- Changed trigger behaviour

1.3.0

- Added a mention about digital outputs.

1.3.1

- Added information forbidding formatting of the SSD via USB OTG.

1.3.2

- Added warning about formatting of the SSD via USB OTG into chapter USB On-The-Go.

201215

- Added new support contact and version numbering.

6 Introduction

Workswell WIRIS Pro is the thermal imaging system for unmanned aerial vehicles (UAVs, drones). It is a lightweight all-in-one system equipped with a thermal imaging camera and a visible spectrum camera. The purpose of the whole system is the simple capture, transfer, storage and processing of radiometric (temperature) data directly from an unmanned aerial vehicle (drone) and display of the data on the screen of the UAV remote controller in real time. The system also offers a variety of measurement functions, colour palettes or alarm (security) modes, which can be combined with a visible spectrum camera.



Figure 6.1: Workswell WIRIS Pro connected to a standard FPV monitor (monitor not included)

Workswell WIRIS Pro is designed in a way which allows control of all of its functions during the flight. The system has digital inputs, which are fully compatible with standard RC receivers that support S.BUS. Two channels serve as navigation buttons in the menu, the rest are shortcuts for the selected functions (image capturing, video recording, palette switching, zoom and others).

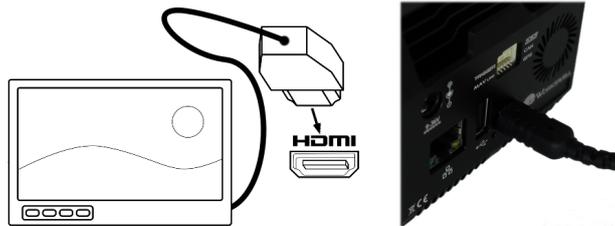
The system offers a digital video output. Both visible and thermal spectrum images can be displayed on the screen at the same time.

7 System Assembly

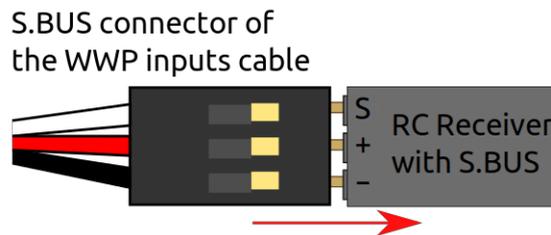
7.1 General Description

Follow these steps to prepare the system:

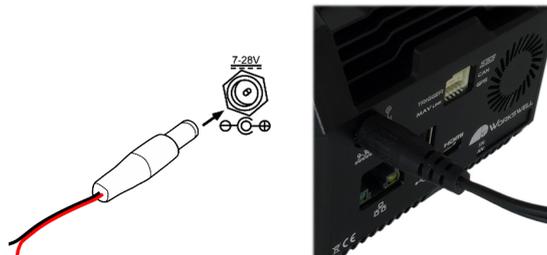
1) Connect the system to a wireless video link or a display using HDMI micro cable (included).



2) Connect the system to a standard RC receiver using S.BUS. Use channels 1 and 2 to control the main functions. System can also be controlled via USB keyboard.



3) Connect the power supply using power supply cable (included). Red wire is +9 to +36 VDC, black wire is GND.



7.2 HDMI Micro Video Output

The Workswell WIRIS system is equipped with a standard HDMI micro video output. It can be connected to any wireless video link or a display with HDMI input that supports WIRIS Pro resolution.

The default WIRIS Pro resolution 1280x720 (also called HD or 720p). It is recommended to use a display with 16:9 aspect ratio.



Figure 7.3: Connex wireless video link and DJI Lightbridge (not included)

The system can be connected to a wireless video link or a display using supplied lightweight HDMI cable.

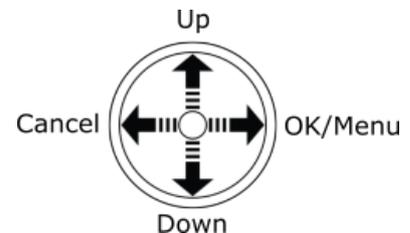
7.3 RC Receiver

For interfacing with standard RC receivers, WIRIS Pro is equipped with a S.BUS input. The S.BUS input, communicating control of multiple servo inputs, allows user to control the system remotely during the flight.

The first two virtual channels on the S.BUS function as primary directional controls within the menus and allow for complete control over the device. The additional channels allow binding of function shortcuts which provide quick, customizable access to various functions; capture trigger, mode change and so forth.

It is recommended to use a joystick for navigation in system menu. If connected as recommended, then the behavior of the joystick is as shown on the following image.

Digital Input	Function
1	Up/Down
2	OK/Cancel
3-4	Optional (shortcuts)



More information about digital inputs can be found in section 8 **Digital IO Ports**.

7.4 USB Keyboard

Besides the digital inputs, the Workswell WIRIS Pro system can be controlled also via standard USB keyboard. Once the keyboard is connected, it can be used for navigation in system menu, for image capturing, video recording, mode switching, zoom or setting numerical values.



Figure 7.4: Connecting a generic USB keyboard.

Warning: Do NOT connect WIRIS Pro to any other powered device (such as PC) through the full size USB port on the rear of WIRIS Pro. As the rear USB port is powered, connection to another powered USB port can lead to permanent damage to either device. Only unpowered devices (USB Keyboards and USB Flash Storage drives) are to be connected into the rear USB A port of WIRIS Pro.

The following table shows the behavior of connected keyboard.

Key	Function
Up	Up
Down	Down
Right	OK/Menu
Left	Cancel
Enter	OK/Menu
Escape	Cancel
F5	Camera switch
F6	Image capture
F7	Video record
+	Zoom in
-	Zoom out

7.5 USB On-The-Go

The Workswell WIRIS Pro's internal SSD memory can be accessed directly using an USB On-The-Go connection between with any system capable of correctly accessing the standard USB mass storage such as a PC with MS Windows or GNU/Linux.

To connect to the internal memory, use a standard USB Micro B connector cable and plug it into the connector in the side of WIRIS Pro.

If communication is successfully established, most modern operating systems will automatically report presence of a mass storage device and allow access to the data.



Figure 7.5: Connecting WIRIS Pro using USB On-The-Go

Warning: Do NOT connect WIRIS Pro to any other powered device (such as PC) through the full size USB port on the rear of WIRIS Pro - only the side Micro USB port can be used for mass storage access. As the rear USB port is powered, connection to another powered USB port can lead to permanent damage to either device.

Warning: Do NOT format the SSD of the camera as a device connected to the PC via USB OTG! Formatting the SSD in this manner will void the warranty and the camera will need to be sent for repair. Use only the firmware GUI of the camera to format the SSD, while the camera is not connected to any other device.

7.6 SD Card

The Workswell WIRIS Pro can be optionally fitted with a MicroSD memory card as a storage medium. Most generic MicroSD cards should be compatible. Video recordings cannot be saved directly to the MicroSD card and have to be recorded only to internal storage (but can be moved over to the MicroSD off-line within the device itself).

To install the MicroSD card simply insert it into the MicroSD slot on left side of the device. Be mindful of the SDCard orientation; contacts should be facing upwards.



Figure 7.6: MicroSD memory card insertion.

The MicroSD card should be recognized by the device even if inserted with the system already running. The MicroSD card should only be removed with the device either unpowered, or after the SD card is manually unmounted in the Memory menu.

7.7 Power Supply

The Workswell WIRIS Pro system can be powered through a +9 to +36 VDC connector on the back panel. The back panel DC connector is compatible with a 5.5 mm/OD (outer diameter) and 2.5 mm/ID (inner diameter) plug, where the inner contact is +9 to +36 VDC and the shell is GND.



Figure 7.7: Inner power pinout, form of the common cable.

The standard package contains appropriate 5.5x2.5mm coaxial connector with a cable (length of 80 cm).

Warning: Failure to follow these instructions could damage the system

7.8 Turning the System OFF

To turn the system off, simply unplug the power supply.

7.9 Focusing the Infrared Camera

The infrared camera has adjustable focus. The focus can be set using the focus tool. Note that the depicted focus tool is not part of standard accessories and is sold separately.

Warning: The WIRIS Pro camera is focused to infinity during manufacturing and in most cases should never need adjustments. Considering the delicate nature of the optics **it is better to not attempt removal of protective glass or adjustment of the focus lens unless absolutely necessary.**



Figure 7.8: Two functions of the new focus tool; first, removing the protective glass, then focusing the lens.



Figure 7.9: Short distance - rotate the lens counter-clockwise. Long distance - rotate the lens clockwise

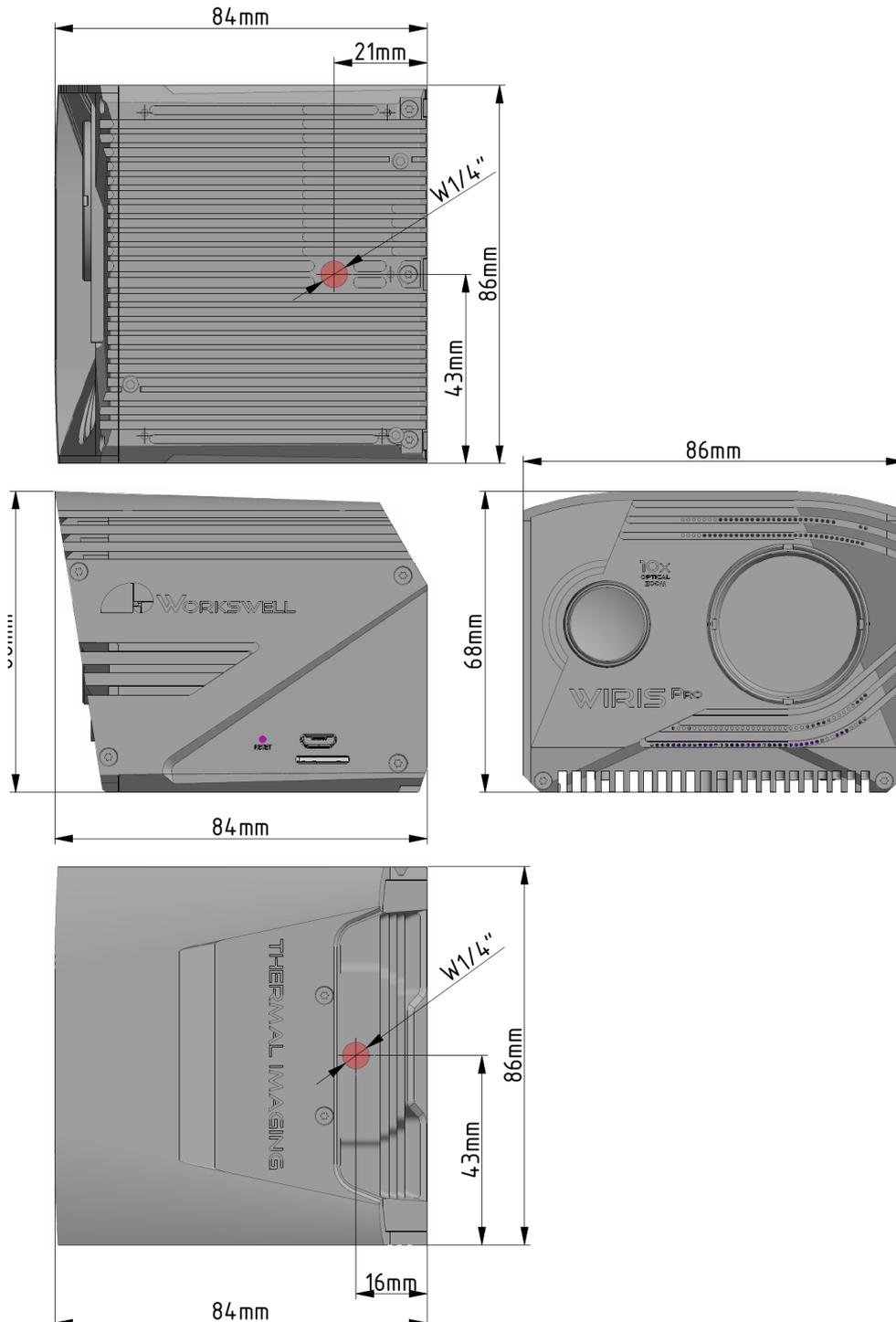
In order to focus for short distance gently rotate the lens counter-clockwise. During this movement, the lens extends from the camera body.

Warning: Trying to rotate the lens too far much may cause the lens to fall out.

In order to focus on long distance (or infinity) gently rotate the lens clockwise. During this movement, the lens retracts to the camera body. Rotating the lens too far in this direction can adjust beyond the intended focus range. Infinity focus is recommended for most of the applications.

7.10 Mounting the System

The Workswell WIRIS Pro system can be mounted to a drone using the 1/4-20 UNC thread (one on bottom or one on back side).



7.11 Input Interfaces

The device’s input ports are all interfaced through one shared connector in the rear, with a cable split to an SBUS, CAN, GPS and Trigger connectors.

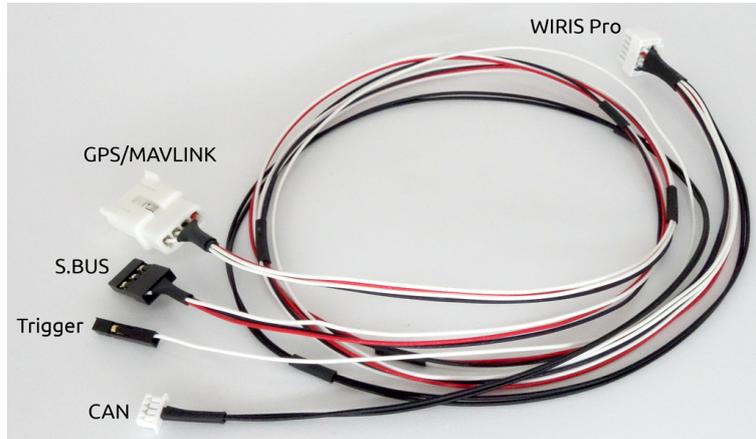
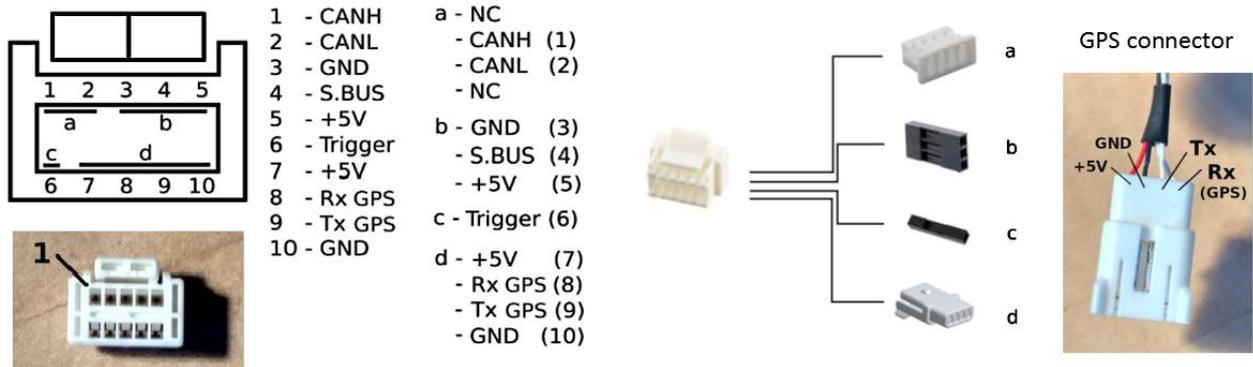


Figure 7.10: The shared input cable.



Connector ZPDR-10V-S (Farnell 2399235, Digi-Key 455-2528-ND)
 Contacts SZPD-002T-P0.3 (Farnell 2399439, Digi-Key 455-2539-1-ND)

Figure 7.11: The input cable pinout description.

8 Digital Inputs

8.1 S.BUS Input

The S.BUS input port can be used. It is a standard used for Futaba RC controllers. Only the first version of S.BUS is supported.

Mechanically, a common servo-wire like 3 pin jumper cable connector is used for S.BUS.

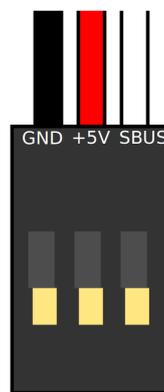


Figure 8.1: S.BUS pinout - 3 pin servo cable.

Pin	Description
1	GND
2	VCC 5V out
3	S.BUS in

Warning: The +5V wire on the S.BUS input is intended for powering otherwise unpowered transceivers and converters from WIRIS Pro. If your transceiver or convertor is powered otherwise, do **NOT** connect the +5V wires and leave them unconnected instead, only connecting the GND and S.BUS pins. If the +5V wires are connected, damage of either device might occur.

S.BUS allows transmission of many servo-like channel PWM signals through a simple three pin connection. The device is compatible with S.BUS enabled receivers and converters such as the Futaba SBE-1 PWM-S.BUS converter.

Note: The simplest way of ensuring reliable receiver functionality is to use a receiver with plain PWM servo outputs and using an OEM PWM-S.BUS, offered for purchase as an accessory.

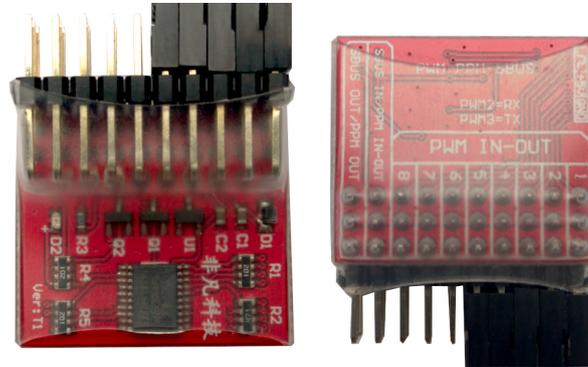


Figure 8.2: OEM PWM converter

In theory, any S.BUS compatible receiver might be compatible, but due to slight variations in the implementation, not every one reliably is.

Tested S.BUS functional receivers are:

- FUTABA SBE-1
- HITEC OPTIMA D
- FUTABA R2008SB
- FUTABA R7014SB



Figure 8.3: FUTABA SBE-1

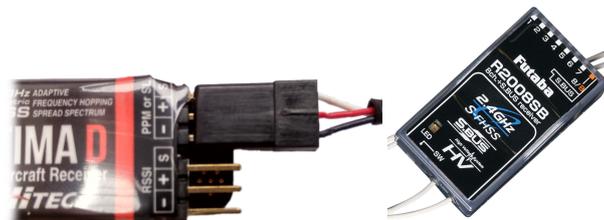


Figure 8.4: Example of connecting SBUS to OPTIMA D receiver.

The device's S.BUS connector plugs directly into the S.BUS output of these devices, although additional care and resources might be required in case of male-male connection.

A setting important to the S.BUS port is the **S.BUS Offset**. Since S.BUS has up to 16 channels, the S.BUS Offset can be set between 0 to 9. For more details, see Table 8.1.

S.BUS Offset	S.BUS Channel	WIRIS IO
0	1	1
0	7	7
1	1	-
1	2	1
1	7	6
9	10	1
9	16	7

Table 8.1: S.BUS Offset example - which S.BUS Channel corresponds to WIRIS IO

8.1.1 S.BUS through Amimon Connex

S.BUS signal from RC transceiver can be sent through Amimon Connex, so there is no need for the receiver. For this, you need the Amimon Connex and RC transceiver with TRAINER support.

1. Connect the RC transceiver TRAINER port to Amimon Connex receiver.
2. Connect the Amimon Connex transceiver S.BUS port to WIRIS S.BUS input.
3. Set up the TRAINER channels in RC transceiver.

This setting was tested with Futaba T148G RC controller (TRAINER setting to 8 CH. mode).



Figure 8.5: Amimon Connex TRAINER cable (left) and S.BUS cable (right).

8.1.2 S.BUS through DJI Lightbridge 1

S.BUS signal from RC transceiver can be sent through DJI Lightbridge 1, so there is no need for the receiver. For this, you need the DJI Lightbridge 1 and RC transceiver with TRAINER support.

1. Connect the RC transceiver TRAINER port to DJI Lightbridge 1 receiver (mono jack to TRAINER port and stereo jack to DJI Lightbridge 1).
2. Connect the DJI Lightbridge 1 transceiver S.BUS port to WIRIS S.BUS input.
3. Set up the TRAINER channels in RC transceiver.

This setting was tested with Futaba T148G RC controller (TRAINER setting to 12 CH. mode).



Figure 8.6: DJI Lightbridge 1 TRAINER cable (left) and S.BUS cable (right).

8.2 Trigger Signal

Aside from the more sophisticated S.BUS control solution, WIRIS SECURITY retains a single basic digital input that can be used for manual capture triggering.

The capture trigger is intended as an optional, user-implemented fallback. To signal on the trigger input signal, user is expected to connect and then disconnect the Trigger wire from the +5V wire on any of the S.BUS or GPS or CAN connectors.

The trigger signal is triggered with zero or ground on falling edge, the signal should be at least 100 ms long.

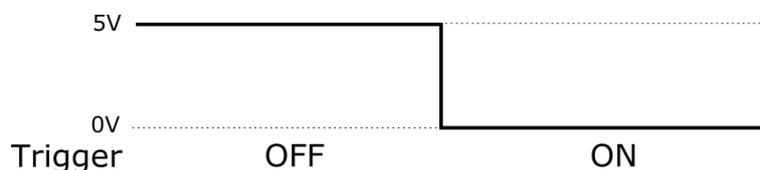


Figure 8.7: Trigger signal

9 GPS and MAVLink

There are three different ways to provide GPS coordinates to the Workswell WIRIS Pro:

1. GPS NMEA protocol
2. MAVLink protocol
3. DJI CAN

In this chapter, the GPS and MAVLink interfaces are explained. They share the same physical interface, but they differ in communication protocol.

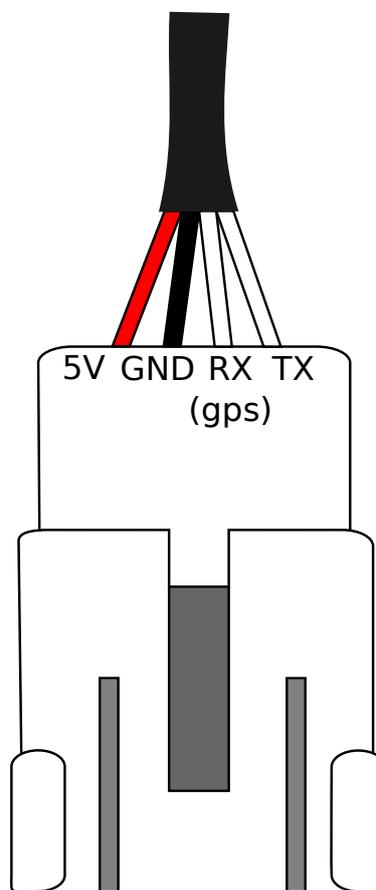


Figure 9.1: GPS or MAVLink pinout - 4 pin molex 36877-0004.

Warning: The +5V wire on the GPS input is intended for powering otherwise unpowered GPS modules from WIRIS Pro. If your GPS source is powered otherwise, do **NOT** connect the +5V wires and leave them unconnected instead, only connecting the GND, TXD and RXD pins. If the +5V wires are connected, damage of either device might occur.

9.1 GPS

The Workswell WIRIS Pro system is equipped with GPS interface through the unified interface cable with a 4 pin connector. As for the physical layer, the Workswell WIRIS system is designed for UART with operating voltage of 5 V, although it is tolerant to 3.3 V.

- UART at **baud rate 115200 bps**
- operating voltage of 5 V, although it is tolerant to 3.3 V
- supports standard **NMEA protocol**
- GPS connected to the GPS connector is indicated by the GPS icon in the Status bar



Figure 9.2: GPS icon in the Status bar.

To connect a custom GPS to WIRIS Pro, please do the following:

1. Check if the GPS supports NMEA protocol
2. Set the GPS baud rate to 115200 bps
3. Crimp the GPS cables and insert them into the empty Molex connector
4. Connect the GPS to WIRIS Pro

Listing 9.1: NMEA string example

```
$GNGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47
```

Where:

```
GGA          Global Positioning System Fix Data
123519      Fix taken at 12:35:19 UTC
4807.038,N  Latitude 48 deg 07.038' N
01131.000,E Longitude 11 deg 31.000' E
1           Fix quality: 0 = invalid
1 = GPS fix (SPS)
2 = DGPS fix
3 = PPS fix
4 = Real Time Kinematic
5 = Float RTK
6 = estimated (dead reckoning) (2.3 feature)
7 = Manual input mode
8 = Simulation mode
08          Number of satellites being tracked
0.9         Horizontal dilution of position
545.4,M     Altitude, Meters, above mean sea level
46.9,M     Height of geoid (mean sea level) above WGS84
ellipsoid
(empty field) time in seconds since last DGPS update
(empty field) DGPS station ID number
*47         the checksum data, always begins with *
```

9.2 MAVLink

MAVLink or Micro Air Vehicle Link is a protocol for communicating with small unmanned vehicles. It is used by UAV autopilots like Pixhawk.

Autopilots or any device supporting MAVLink messages can be connected to WIRIS Pro unified interface cable with a 4 pin connector. As for the physical layer, the Workswell WIRIS system is designed for UART with operating voltage of 5 V, although it is tolerant to 3.3 V.

- UART at **baud rate 57600 bps**
- supports GPS and camera commands to save frames or record video
- operating voltage of 5 V, although it is tolerant to 3.3 V
- GPS connected to the GPS connector is indicated by the GPS icon in the Status bar

WIRIS Pro supports the following MAVLink messages:

- MAVLINK_MSG_ID_GLOBAL_POSITION_INT
- MAVLINK_MSG_ID_GPS_STATUS

- MAVLINK_MSG_ID_COMMAND_LONG

WIRIS Pro supports the following MAVLink commands:

- MAV_CMD_REQUEST_CAMERA_INFORMATION
- MAV_CMD_REQUEST_CAMERA_CAPTURE_STATUS
- MAV_CMD_IMAGE_START_CAPTURE
- MAV_CMD_IMAGE_STOP_CAPTURE
- MAV_CMD_VIDEO_START_CAPTURE
- MAV_CMD_VIDEO_STOP_CAPTURE

To connect an autopilot to WIRIS Pro, please do the following:

1. Set your autopilot to send messages and commands with UART at 57600 bps
2. Crimp the autopilot cables and insert them into the empty Molex connector
3. Connect the autopilot to WIRIS Pro

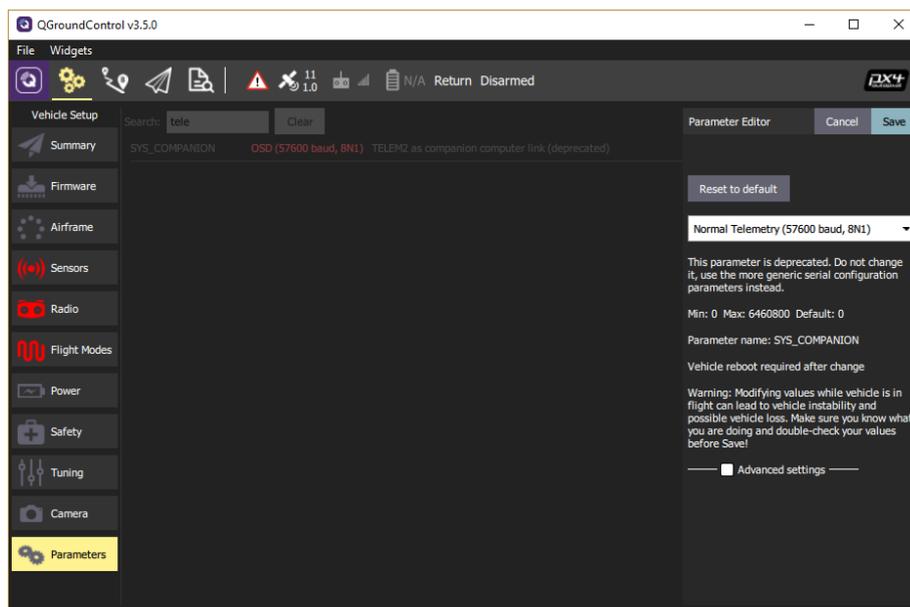


Figure 9.3: QGroundControl settings for Pixhawk autopilot.

For example, using the Pixhawk 4 autopilot, set the TELEM2 interface as Companion Link or Normal Telemetry.

10 DJI Drones and CAN Bus

WORKSWELL WIRIS Pro comes with a cable for connecting the system to DJI CAN Bus on M600 drone with Ronin gimball.

WIRIS Pro can read the DJI GPS coordinates from the CAN bus, so there is no need for external GPS. It can also be controlled with DJI Lightbridge 2 controller.

Currently WIRIS Pro supports the A2 and A3 controllers.

10.1 System Connection

1. Connect the 10 wire standard cable to the WIRIS Pro and the CAN plug on the cable to the CAN1 port on the DJI Ronin.
2. Connect the power cable to your DJI Ronin DTAP connector.
3. Connect the power cable barrel side to the WIRIS.
4. Power up your DJI Ronin. WIRIS Pro should power on automatically.



Figure 10.1: WIRIS Pro - DJI Ronin connection.

10.2 System Control

You can control the WIRIS with your remote controller and use several of its functions directly. You can see description of these functions in the Table 10.1. Some of the buttons have more functions assigned. They behave

differently if your WIRIS is in the Main screen, in the menu or if you are holding the button for certain amount of time.



Figure 10.2: DJI Lightbridge 2 controller.

Button	System State	Function
1	-	Capture
1	Hold 2sec	Correction (NUC)
2	Main Screen	Change Mode
2	In the Menu	Escape
3	-	Record
4 - Wheel	Main Screen	Zoom
4 - Wheel	In the Menu	Move Up or Down
4 - Button	-	Enter or Open Menu

Table 10.1: WIRIS Pro functions assigned to the RC controller.

11 Digital Output

WORKSWELL WIRIS Pro has optional digital output feature. This is a replacement for CAN interface and it must be specified during the order, since it needs different hardware.

The digital output uses the CANH and CANL wire. The CANH wire is changed to signal and CANL is changed to GND.

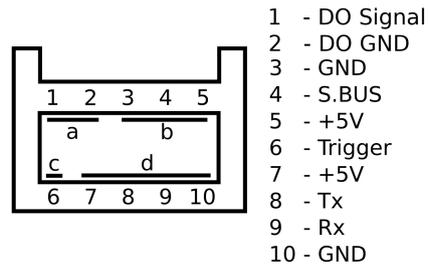


Figure 11.1: Connector pinout with Digital Outputs configuration.

The default level is GND or logical low. It emits 100 milliseconds long 5V logical high pulse when image is finished saving.

12 System Appearance

The Workswell WIRIS Pro system will automatically start within seconds of the power supply being provided. Once the system loads the following screen appears, by default set in the Inspection layout.

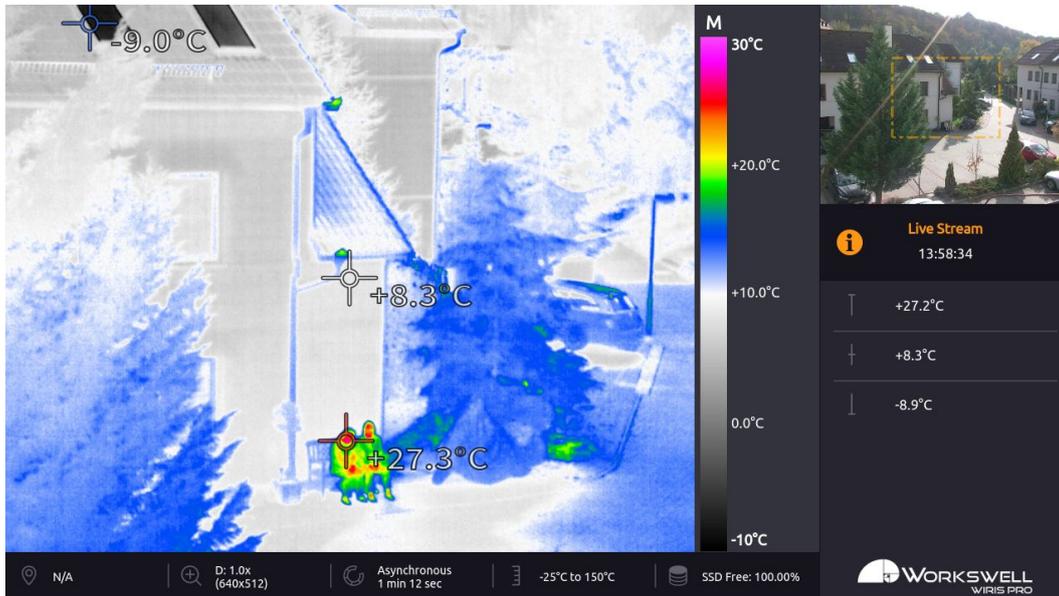


Figure 12.1: Main screen.

This screen consists of the following parts

- PRIMARY CAMERA SCREEN - live stream from the camera currently selected as primary
- SECONDARY CAMERA SCREEN - live stream from the other camera
- INSPECTION PANEL - customizable display of select datapoints
- STATUS BAR - displays some summary information about state of the device (only present in Inspection mode)

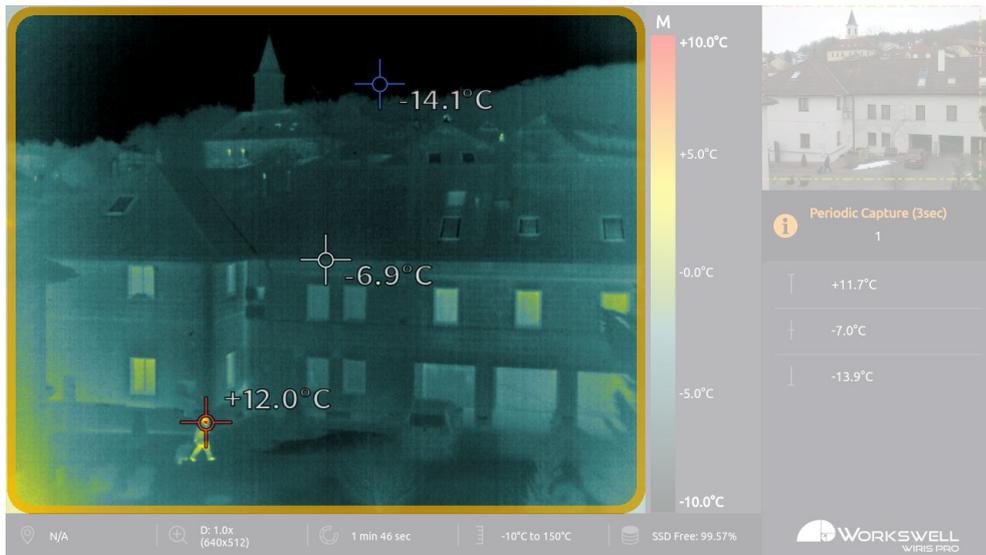


Figure 12.2: Primary camera screen.

PRIMARY CAMERA SCREEN shows live stream from the selected camera (infrared or visible spectrum). In case of infrared camera, the image from the camera is complemented with information about the palette and the temperature range. It is possible to switch between infrared and visible spectrum camera during the flight.

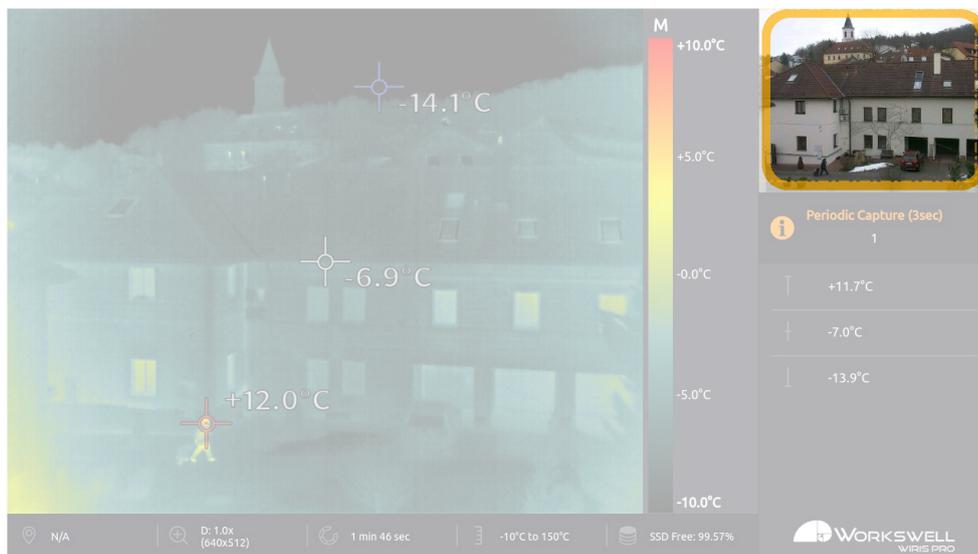


Figure 12.3: Secondary camera screen.

SECONDARY CAMERA SCREEN is an additional live stream camera screen. It shows live stream from the camera that is not set as the primary (shown in PRIMARY CAMERA SCREEN). In this case, the infrared camera screen isn't provided with a temperature scale (legend). The min/max and center crosses are not shown in SECONDARY CAMERA SCREEN either.

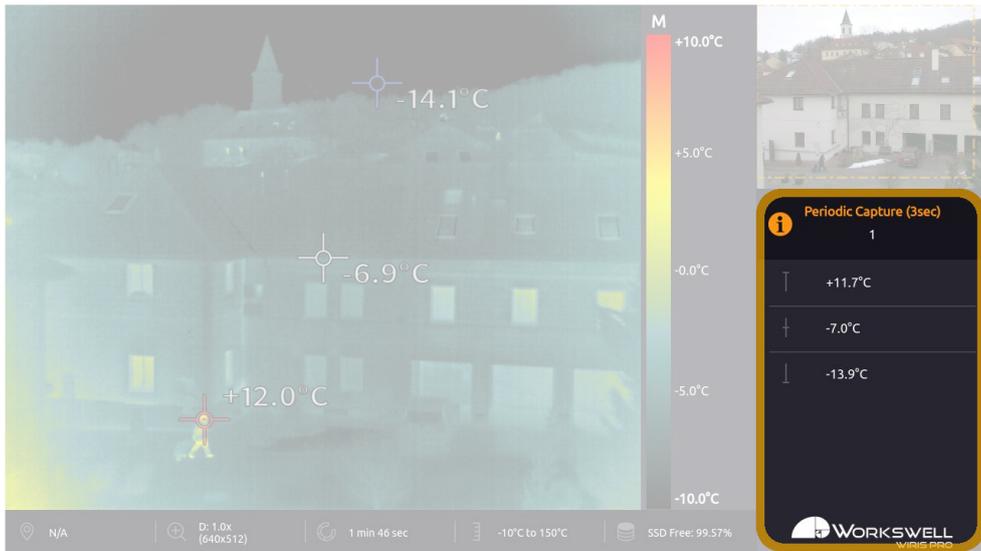


Figure 12.4: Inspection panel.

INSPECTION PANEL shows the most important information during operation. Depending on how it's set up, it can display temperature extremes, status of the camera and so on.



Figure 12.5: Status bar.

STATUS BAR contains some of the important system information such as zoom factor (and the corresponding image resolution), time from last shutter calibration (NUC), GPS information (in the case GPS is connected), temperature range and remaining free memory space.

Note that the STATUS BAR is only visible in the Inspection layout mode.

12.1 Layouts

WIRIS Pro implements several different Layouts - different arrangement of elements on screen. Each layout is best suited for a particular situation or a use case. Selection of the layout is up to preference of the user. The underlying functionality of the camera remains mostly the same in all layouts.

12.1.1 Inspection

The INSPECTION layout is the Wiris Pro's default. It is designed for inspection and measurement uses in mind. The surface area of screens from cameras is the smallest and the saved space is used for presentation of system status and measured data.

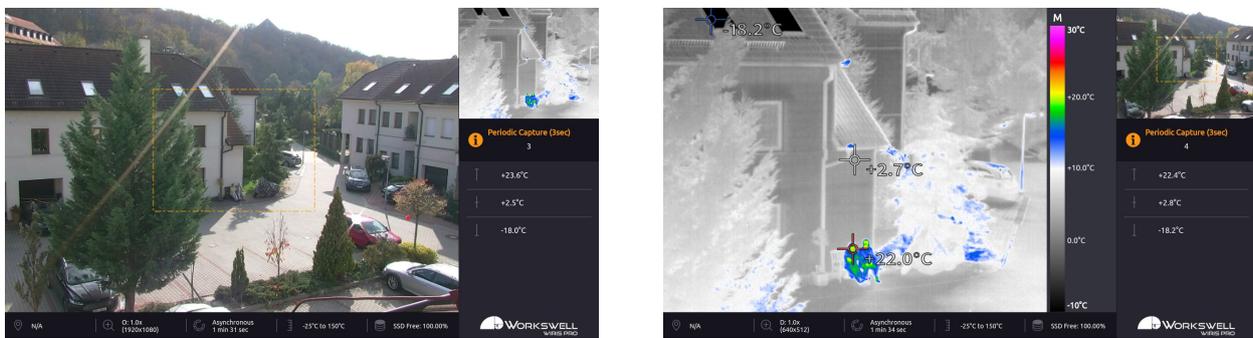


Figure 12.6: Inspection layout.

12.1.2 Security

The SECURITY layout aims to make camera screens as large as possible, simultaneously. It's primarily intended for purposes like security, where the image itself is more important than data.

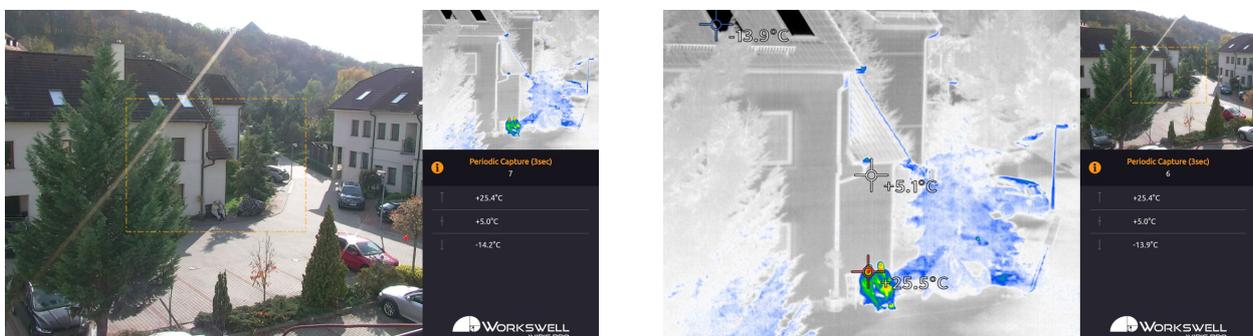


Figure 12.7: Security layout.

12.1.3 Fullscreen

The FULLSCREEN layout shows only one of the camera streams at a time (user can however choose which one is displayed) over the entire screen. The information panels are showed as transparent overlays in case of a full width ratio camera (visible camera) or within the screen's margin in case of a more narrow aspect camera (thermal camera). The fullscreen layout offers the best visual performance possible from either of the cameras which is ideal for situations where one of the images isn't important.

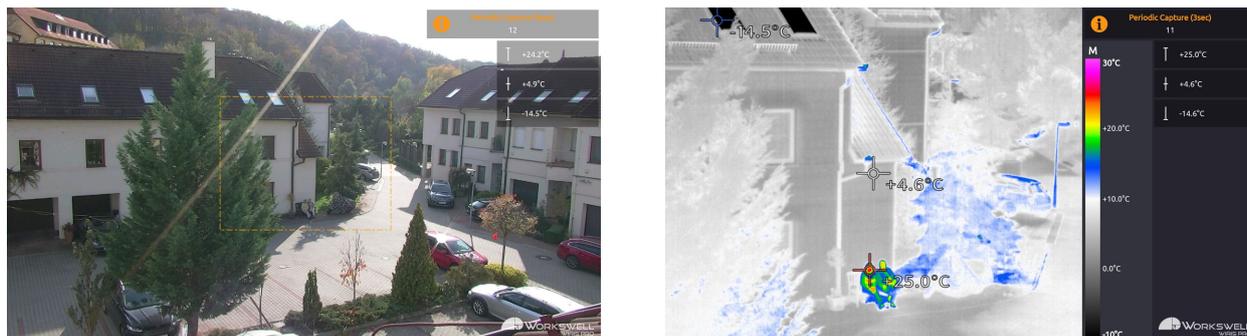


Figure 12.8: Fullscreen layout.

12.1.4 PiP Fusion

The Picture in Picture Fusion layout (PIP FUSION) is the most advanced layout, presenting a superimposed view which displays image from both cameras simultaneously across the entire screen. The PiP Fusion mode however comes with some limitations stemming from physical constraints of the device and optics. Information panels are shown as transparent overlays on the outer section of the screen.

Note: Due to the inherent parallax effect of horizontally offset camera apertures and due to the optical distortion caused by radically different lenses, the PiP Fusion overlay only matches well for objects within a certain distance envelope. The image match is best with objects at distance of approximately 30m and it is most accurate at the center of the screen, with the accuracy degrading towards the edges of the overlay.

Note: The PiP Fusion layout always locks the zoom level of the thermal camera at levels based on relative FOV ratios; individual zoom levels cannot be adjusted separately and the screen size ratios may vary.

Note: The PiP Fusion layout relies on correct selection of Thermal lens installed on the camera as well as present calibration data appropriate for the given lens.



Figure 12.9: PiP Fusion Layout.

13 Main Menu (Settings)

13.1 General Description

The Workswell WIRIS Pro system offers many customization options. All the configuration can be done using the MAIN MENU. It can be opened by moving the joystick to the right side (if connected to an RC transmitter as recommended) or by pressing ENTER button (if standard USB keyboard is connected). The MAIN MENU will appear on the left side of PRIMARY CAMERA SCREEN.

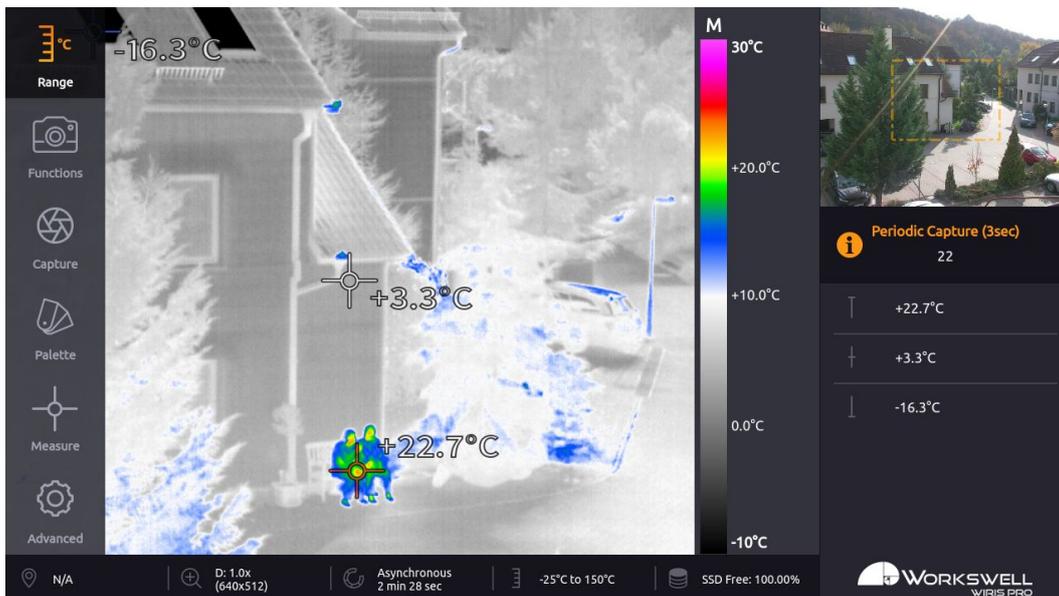


Figure 13.1: Main menu.

The MAIN MENU is divided into 6 categories:

- RANGE - Automatic or manual temperature range, temperature limits.
- FUNCTIONS - Zoom, Primary camera screen selection, Layout selection.
- CAPTURE - Option to manually trigger immediate capture or recording, Image Correction (NUC) and to toggle capture between periodic and one-off. Newly added the Geofencing options.
- PALETTE - Choice from 19 different color palette options.
- MEASURE - Option to toggle the temperature extreme marking crosses on and off and to activate the temperature threshold based alarm display.
- ADVANCED - Measurement, Display, Save Images, Isotherms, Communication Interface, Memory, System and Info

13.2 Range

RANGE submenu allows user to choose between AUTOMATIC range mode, the MANUAL mode, and the SPAN mode. In case of manual temperature range, user manually sets the upper and lower limit. The SPAN mode is analogous to MANUAL mode in function, but instead of requiring minimal and maximal value, user sets the centerpoint temperature and temperature span, with the minimal and maximal values calculated automatically.

Additionally, the ENVIRONMENT option allows the user to toggle between the two internal temperature ranges of the thermal camera itself.

RANGE menu consists of the following items:

- MODE - AUTOMATIC, SPAN and MANUAL
- MAX - Manual temperature range maximum. Available only when MANUAL range selected.
- MIN - Manual temperature range minimum. Available only when MANUAL range selected.
- WINDOW - The temperature range around the centerpoint determining position of the minimum and maximum. Available only with SPAN mode selected.
- CENTER - The centerpoint value which the SPAN mode will determine the position of minimum and maximum around. Available only with SPAN mode selected.
- ENVIRONMENT - Switches thermal camera between the available ranges (for example -25°C to $+150^{\circ}\text{C}$ and -40°C to $+550^{\circ}\text{C}$).

AUTOMATIC temperature range sets the color palette with regards to minimum and maximum temperature measured in the scene. Automatic range is indicated by the A letter shown above the temperature legend.

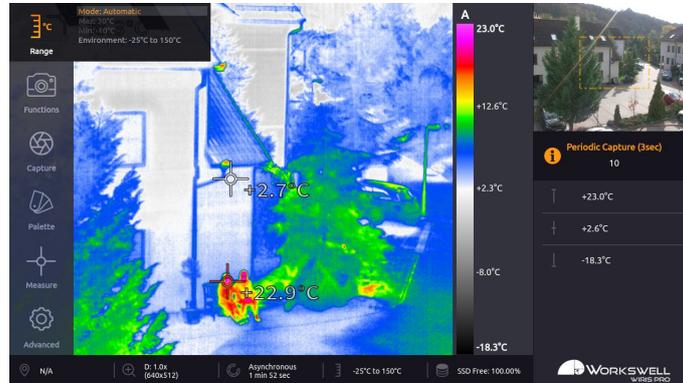


Figure 13.2: Range settings – AUTOMATIC.

MANUAL temperature range distributes the colors of the selected color palette linearly between minimum (MIN) and maximum (MAX) limits that were set by user. Manual range is indicated by the M letter shown above the temperature legend.



Figure 13.3: Range settings – MANUAL.

Changes are previewed in real time and can be confirmed to be kept or canceled, in which case the last value set is maintained.

SPAN range is analogous to MANUAL range in function, but the limits of the range are automatically determined from the CENTER and WINDOW parameters. Span range is indicated by the S letter shown above the temperature legend.

13.3 Functions

FUNCTIONS submenu allows you to manually set the zoom level of the primary camera, switch which camera is the primary and to switch between the available screen layout options.

- ZOOM - set the zoom value on the main camera (physical zoom on the visible spectrum camera, digital zoom on the thermal camera).
- MAIN CAMERA - toggle which camera (thermal or visible light) is displayed as the primary (main) screen and which is in the secondary (preview) screen.
- ZOOM SIMULTANEOUSLY - Zoom both cameras simultaneously
- LAYOUT - cycles between the available layout modes; (INSPECTION, SECURITY, FULLSCREEN and PiP Fusion).
- THERMAL OPACITY - Opacity of thermal camera image in PiP Fusion mode

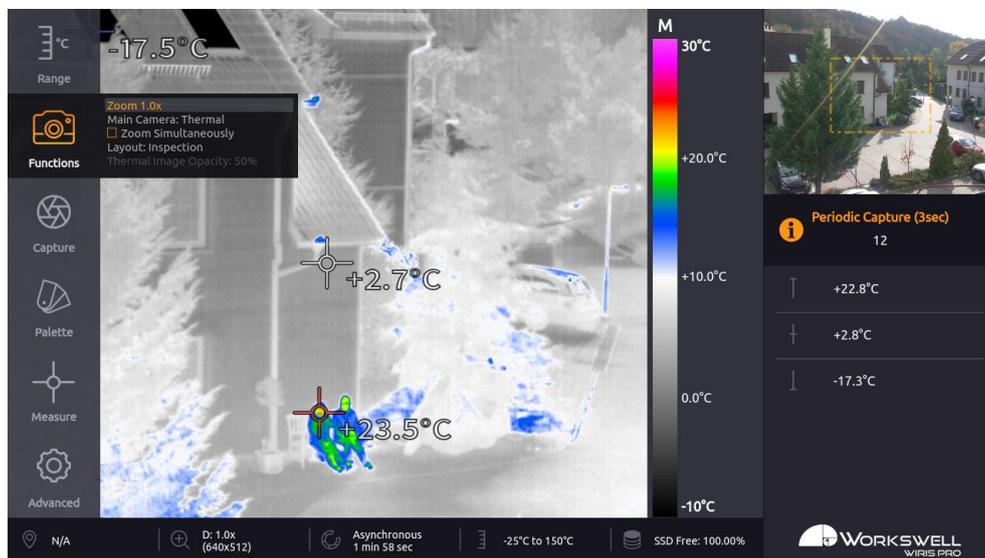


Figure 13.4: Functions settings

The SECURITY layout removes the status bar at bottom of the primary view as well as the temperature legend on right side of the thermal camera. The FULLSCREEN layout further removes the secondary screen, showing only one camera type.

Note: Zoom level set for the camera in primary screen will be maintained for the same camera type once it's toggled into the secondary screen.

13.4 Capture

CAPTURE submenu allows user to manually capture images, record video, manually trigger the thermal shutter calibration (NUC) and to set periodic series capture.

CAPTURE menu consists of the following items:

- CAPTURE - Captures an image or a series, depending on the PERIODIC IMAGE CAPTURE setting
- RECORD - Starts and stops recording of radiometric video
- IMAGE CORRECTION (NUC) - manually triggers the shutter correction of the thermal camera
- PERIODIC IMAGE CAPTURE - either sets the period for automatic image capture or turns it off altogether.
- GEOFENCING TRIGGER - Set the Geofencig ON or OFF.
- CAPTURE START FLIGHT LEVEL - Set the altitude above ground to start automatic image capture.
- CAPTURE STOP FLIGHT LEVEL - Set the altitude above ground to stop automatic image capture. This means that the UAV must be between START and STOP to capture.
- CAPTURE SPEED BELOW - Set maximum speed for capture.
- GPS - Current GPS speed and altitude.

Geofencig

Geofencing is a special mode of automatic image capture used for UAV autopilot sessions. The camera will automatically trigger capturing images when conditions are met.

User can define in which altitude the camera should capture images with START and STOP FLIGHT LEVEL. The image will be captured each time the UAV slows down below the setting SPEED BELOW.

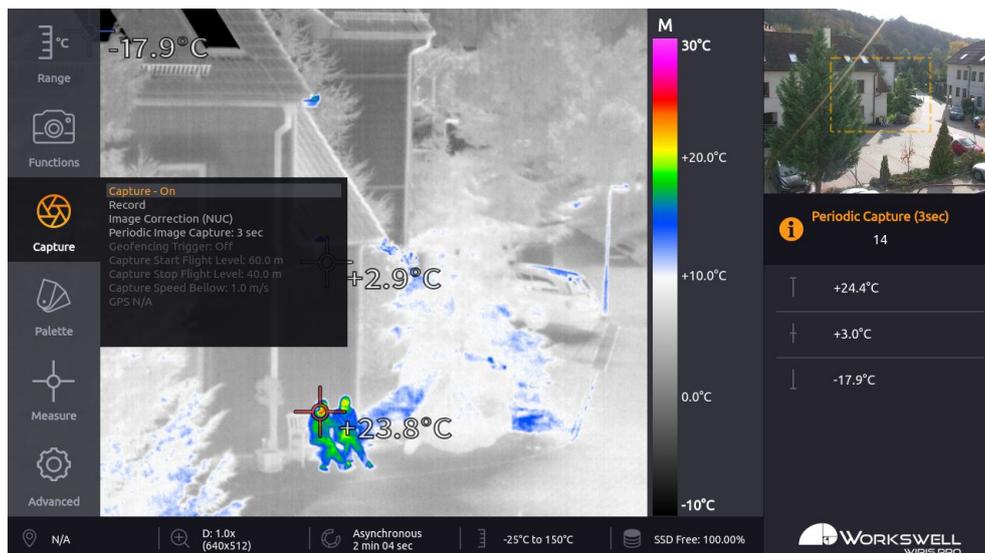


Figure 13.5: Capture options.

13.5 Palette

PALETTE category includes set of nineteen color palettes that can be applied on the infrared image.

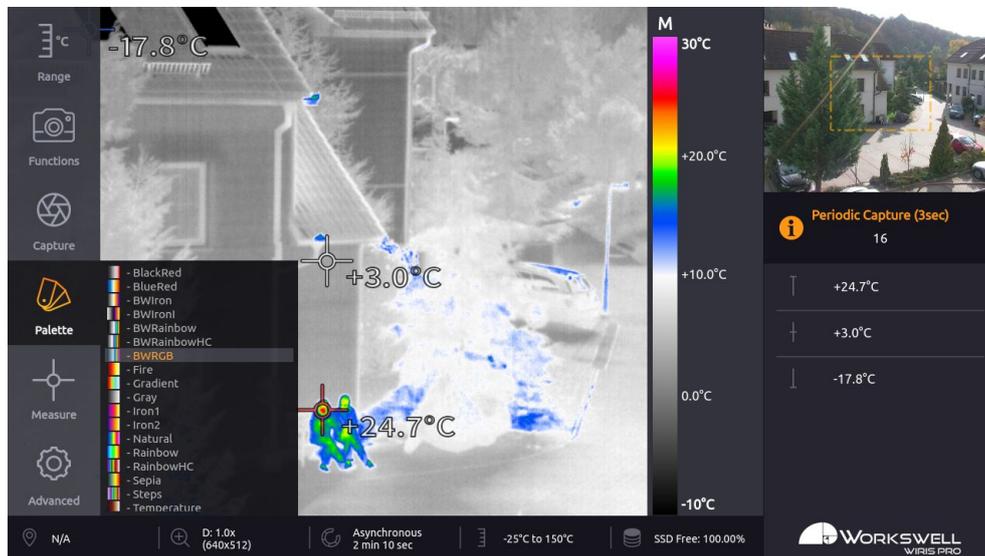


Figure 13.6: Palette settings.

13.6 Measure

MEASURE submenu allows user to toggle the display of three marking highlighting crosses (CENTER, MIN and MAX) as well as toggle if they should display the temperature measured in the given area. Additionally, the MEASURE submenu allows setup of ALARM visualization overlay as an alternative to linear palettes in four different modes (ABOVE, BELOW, BETWEEN or ABOVE&BELOW) and the thresholds of the visualization.

MEASURE menu consists of the following items:

- SHOW CROSS MAX - toggles appearance of the highlight cross which always positions itself on the maximal temperature measured within the view
- SHOW CROSS MIN - toggles appearance of the highlight cross which always positions itself on the minimal temperature measured within the view
- SHOW CROSS CENTER - toggles appearance of the highlight cross always positioned at the center of the screen
- SHOW TEMPERATURES - toggles display of measured temperature values at each of the three highlighting crosses
- ALARM - cycles between the available ALARM overlay modes and the option to leave ALARM off altogether.
- LIMIT ABOVE - sets the upper temperature threshold considered in the ALARM visualization (only accessible when relevant in current ALARM setting)
- LIMIT BELOW - sets the lower temperature threshold considered in the ALARM visualization (only accessible when relevant in current ALARM setting)

ABOVE & BELOW mode marks all the areas that have higher temperature than ABOVE LIMIT or lower temperature than BELOW LIMIT.



Figure 13.7: Alarm display – ABOVE & BELOW.

Modes ABOVE, BELOW and BETWEEN work analogously, but only mark the image area appropriate for the respective mode; ABOVE mode marks only areas with temperature above the upper threshold, BELOW marks only areas with temperatures below the threshold and BETWEEN marks the area with temperature beneath the upper but above the lower threshold.

Note: The colors of marked areas can be set in Advanced menu. Default colors are red for Above mode, blue for Below mode, green for Between mode and red and blue color for Above & Below mode.

Note: The currently set isotherm limit is shown in the temperature legend.

Note: Whenever user activates any of the Alarm modes, the palette is set to simple Grayscale to make the visualization clearer. This can be overridden by setting the desired palette manually again, from the Palette menu. Additionally, this behavior can be completely disabled in the Advanced menu.

13.7 Advanced

ADVANCED category allows user to set advanced behavior of the device. It is divided into nine more categories – THERMAL CAMERA, VISIBLE CAMERA, LAYOUT, IMAGES & VIDEO, ALARMS, COMMUNICATION INTERFACE, MEMORY, SYSTEM and INFO.

Note: The Advanced menu cannot be accessed while Video or Image Series capture is underway. The user will be notified of this and prompted to stop the capture or recording before accessing the Advanced menu.

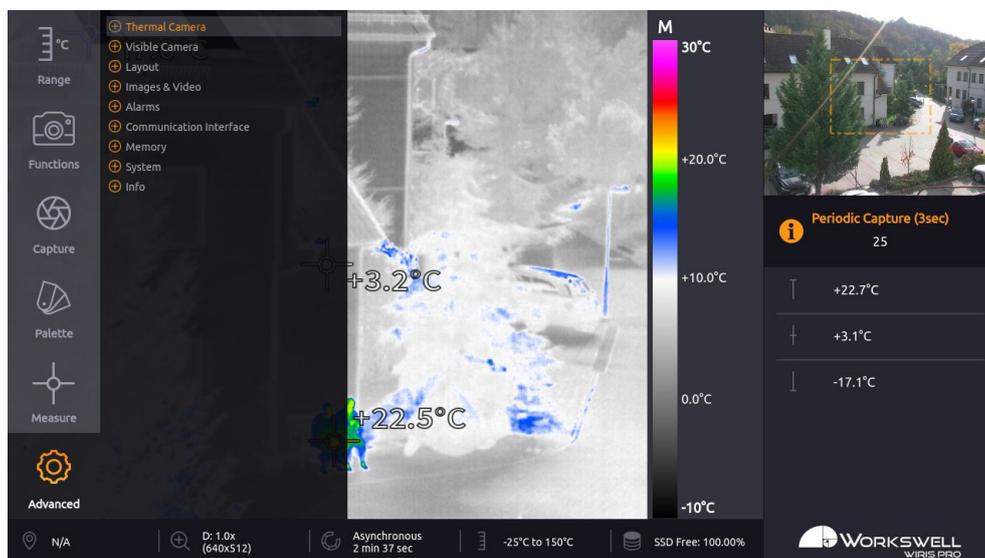


Figure 13.8: Advanced settings.

ADVANCED MENU consists of the following categories:

- THERMAL CAMERA - Emissivity, Atmospheric temperature, Shutter correction (NUC) period and reset to Default settings
- VISIBLE CAMERA - Gamma, White Balance, Vibration Compensation, Backlight Compensation, Wide Dynamic Range Mode, Defog, Noise Reduction (2D), Noise Reduction (3D), Color Gain, Exposure Mode, Shutter, Iris, Gain, Exposure Compensation and reset to Default settings
- LAYOUT - Layout mode toggle, Toggle of which datapoints should be displayed in the INSPECTION PANEL (Maximum, Center, Minimum, Range Mode, Zoom (Visible), Zoom (Thermal), Captured Images, Recorded Video), Thermal Frame toggle, GPS Info cycling
- IMAGES & VIDEO - Toggles for capture file types, Image Save to, Video Radiometric, Video Visible
- ALARMS - Alarm Palette, Alarm Above, Alarm Below, Alarm Between, Alarm Opacity
- COMMUNICATION INTERFACE - IO Channel function bindings, S.Bus Offset, Trigger binding
- MEMORY - Set SSD, Set SD Card, Set Flash Drive, Update, Copy Logs

- SYSTEM - Current Time, Current Date, Units, Language, Reboot System, Set Default Settings
- INFO - Product name, Firmware version, Serial Number, Article Number, Workswell address, CPU and IR Core Temperatures

Note: The Advanced menu cannot be accessed while Video or Image Series capture is underway. The user will be notified of this and prompted to stop the capture or recording before accessing the Advanced menu.

13.7.1 Thermal Camera

THERMAL CAMERA submenu contains settings of measurement parameters; material emissivity, the reflected and ambient atmospheric temperatures, allows you to set the time period for automatic shutter calibration and also allows you to revert these parameters to their default values.

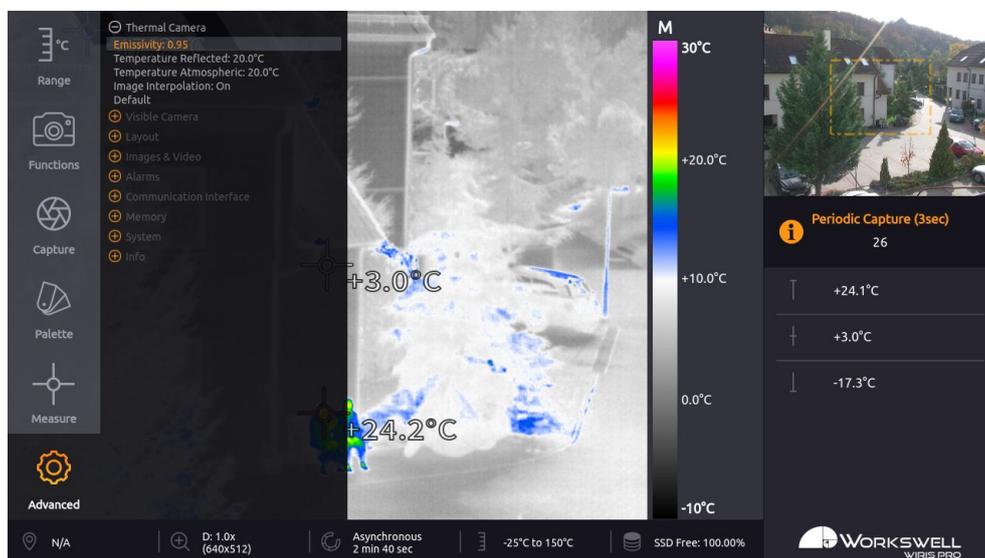


Figure 13.9: Thermal Camera menu.

THERMAL CAMERA submenu consists of the following items:

- EMISSIVITY - Emissivity of the observed measured surface in the scene.
- TEMPERATURE REFLECTED - Temperature of radiation reflected by reflective surfaces in the scene.
- TEMPERATURE ATMOSPHERIC - Temperature of the ambient air between the device and the observed scenery.
- SYNCHRONOUS CORRECTION (NUC) - Perform the NUC in fixed time periods or asynchronously with changing camera temperature
- CORRECTION (NUC) PERIOD - Time period after which the shutter based calibration automatically triggers.
- LENS - A switch for setting the currently installed thermal camera lens. Correct selection is necessary for appropriate calibration to be loaded.

- IMAGE INTERPOLATION - Option to toggle digital smoothing in thermal camera image.
- DEFAULT - Option to reset all the items above to their default values.

Note: The Lens option only appears in the menu in case the WIRIS Pro camera has been calibrated for use with multiple exchangeable thermal lenses.

13.7.2 Visible Camera

Visible Camera submenu allows user to set the parameters common to many regular digital video cameras. It also allows these parameters to be reset to their default values.

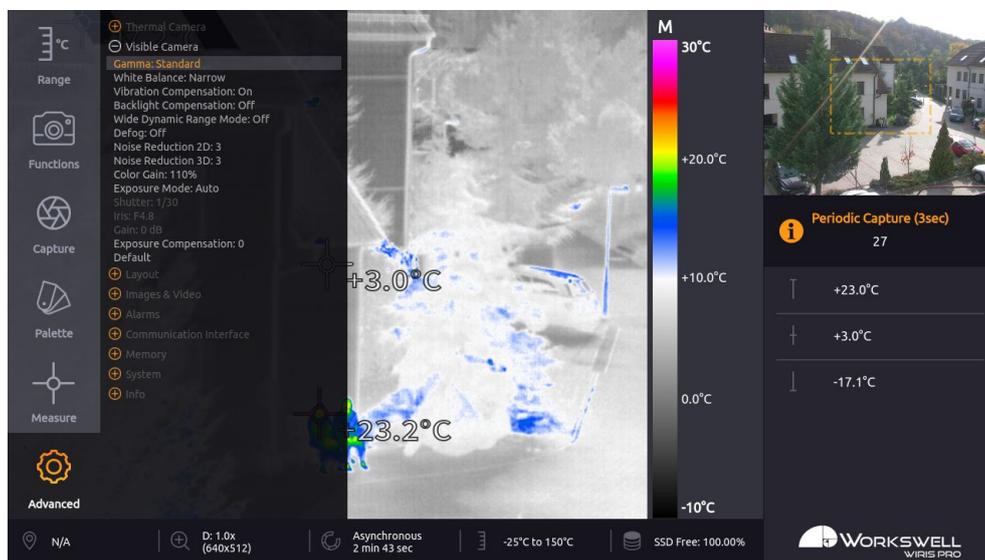


Figure 13.10: Visible Camera submenu.

VISIBLE CAMERA submenu consists of the following items:

- GAMMA - cycles between STANDARD, STRAIGHT, NARROW and WIDE. This changes the gamma curve used for mapping and compression of the values observed by the camera.
- WHITE BALANCE - cycles between WIDE, NARROW, INDOOR, OUTDOOR. WIDE and NARROW are automatic modes which cover color temperature range from about 10000K to 2200K and about 7000K to 2500K respectively. INDOOR and OUTDOOR are fixed color temperature balance modes for about 3200K and 5800K respectively.
- VIBRATION COMPENSATION - toggles ON and OFF. Optical vibration compensation is implemented mechanically and attempts to decrease blurring and shaking effects. It's mostly effective against vibrations within the frequency range of 2-17Hz.
- BACKLIGHT COMPENSATION - toggles ON and OFF. Backlight compensation attempts to ignore small, very bright areas of the scene when determining the correct exposure settings which may allow intensely backlit objects still remain well visible in the resulting image. This is at the cost of potentially losing detail in very

bright areas of the image.

- WIDE DYNAMIC RANGE MODE - toggles ON and OFF. Wide dynamic range cleverly maps the observed brightness levels through the image to bring more contrast out of areas that're in shadow or uneven light, providing a clearer, more informative image in high contrast scenes.
- DEFOG - toggles ON and OFF. Defog attempts to bring out more detail in foggy or misty scenes.
- NOISE REDUCTION 2D - sets one of 5 available levels of spatial noise reduction or turns it off. Spatial noise reduction looks at each frame individually and attempts to decrease noise by comparing values of neighboring pixels. Higher 2D noise reduction settings might lead to loss of detail in the image.
- NOISE REDUCTION 3D - sets one of 5 available levels of temporal noise reduction or turns it off. Temporal noise reduction looks at series of frames and attempts to decrease noise by comparing current pixel value with the past ones. Higher 3D noise reduction settings might introduce afterimage or "ghosting" phenomena in the image.
- COLOR GAIN - sets the level of color gain from 60% to 200%. Color gain can decrease or increase the level of color saturation of the image.
- EXPOSURE MODE - cycles between the modes AUTO, SHUTTER PRIORITY, IRIS PRIORITY, MANUAL. AUTO mode controls all of the parameters of SHUTTER, IRIS and GAIN automatically and attempts to provide the best possible image on basis of heuristics. SHUTTER PRIORITY and IRIS PRIORITY modes allow user to set one of these parameters manually and allow the other two to be determined automatically. MANUAL mode allows the user to set all three parameters manually.
- SHUTTER - sets the shutter duration between 1 second and 1/10000th of a second. High shutter durations increase the amount of available light, helping to decrease the amount of noise, at the cost of blurring objects captured in motion. Set the shutter duration to 1/100 or 1/120 to eliminate flicker from artificial lighting in countries with 50Hz and 60Hz power grid frequencies respectively.
- IRIS - sets the iris (aperture) value between F2.4 and F22. Allows the user to set the physical iris size manually. The iris setting changes the camera's depth of field; small aperture (High F/ value) means higher depth of field - broader envelope within which observed scenery remains relatively sharp. Level of the iris setting also influences the total amount of light available in the camera, which can be detrimental to amount of noise in the image.
- GAIN - sets the gain correction value between 0dB and 34dB. High values of gain can increase brightness of image at the cost of amplifying digital noise.
- EXPOSURE COMPENSATION - sets the brightness adjustment within any of the automatic or semi automatic exposure modes with level from -6 to +6 or turns it off. Exposure compensation allows the user to choose the desired brightness level which the automatic or semiautomatic EXPOSURE MODE settings will adjust the image to.
- DEFAULT - option to reset all the items above to their default values.

These settings items operate similarly to any other common visual spectrum camera and the intricate nuances of their inner functioning is beyond the scope of this manual. Users who do not have the insight into the proper functioning of these parameters will be in most cases best served by leaving them to their default values.

13.7.3 Layout

LAYOUT submenu allows user to toggle information datapoints that appear in the inspection panel on the right side of the screen. It also allows the user to cycle through the possible GPS information displayed.

Each Layout can have different item settings, some settings are exclusive to some Layouts.

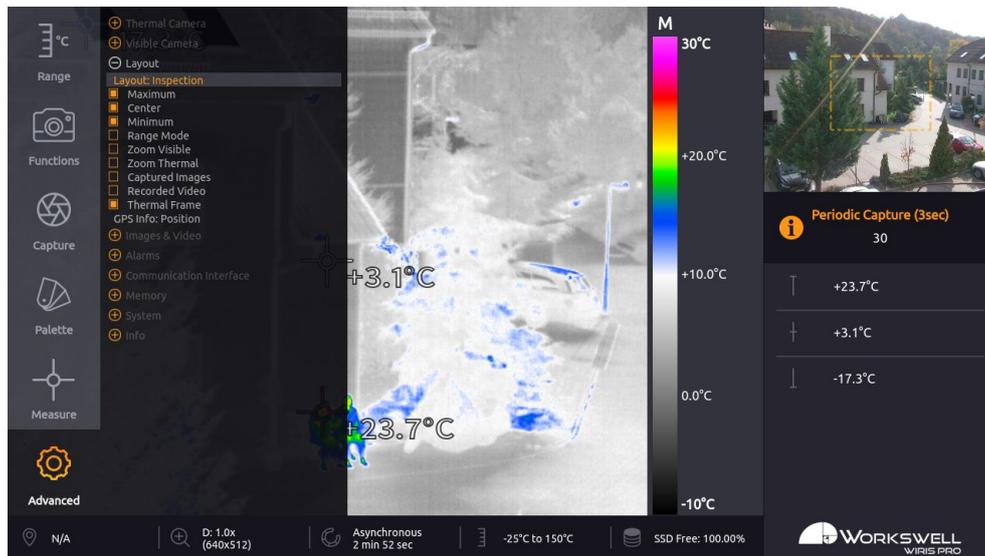


Figure 13.11: Layout submenu and Inspection Panel.

First, you can select Layout:

- Layout - Select between different layouts (Inspection, Security, Fullscreen, PiP Fusion)

LAYOUT menu consists of the following items, toggling the inspection or overlay panel display of the following values:

- MAXIMUM - Maximal temperature measured in the image
- CENTER - Temperature measured at the center point of the image
- MINIMUM - Minimal temperature measured in the image
- RANGE MODE - Currently active range mode and its edge values
- ZOOM VISIBLE - Zoom level and resolution of the visible camera image
- ZOOM THERMAL - Zoom level and resolution of the thermal camera image
- Correction (NUC) - Current NUC status
- GPS - Current GPS status
- ENVIRONMENT - Current thermal camera environment settings
- CAPTURED IMAGES - Number of images currently captured to SSD and to the storage medium currently chosen for image capture saving
- RECORDED VIDEO - Duration of video recordings currently saved to the SSD

- MEMORY - Connected and used memory

Additionally, it contains two more toggles not limited to the inspection panel:

- THERMAL FRAME - Toggles display of a frame overlaid into the visible camera which roughly corresponds with the area within scope of the thermal camera, with the zoom levels of both cameras considered
- GPS INFO - Cycles between the speed, altitude and position GPS values that can be displayed in the status bar at the bottom of the screen.

Note: Due to the physical offset of the two cameras and the resulting parallax effect, the THERMAL FRAME overlay only becomes accurate for sufficiently distant scenery.

13.7.4 Images & Video

IMAGES & VIDEO submenu allows the user to choose which still capture image file types should be saved, and which medium should be used for their storage. It also allows toggling if radiometric and visible video streams should be recorded.

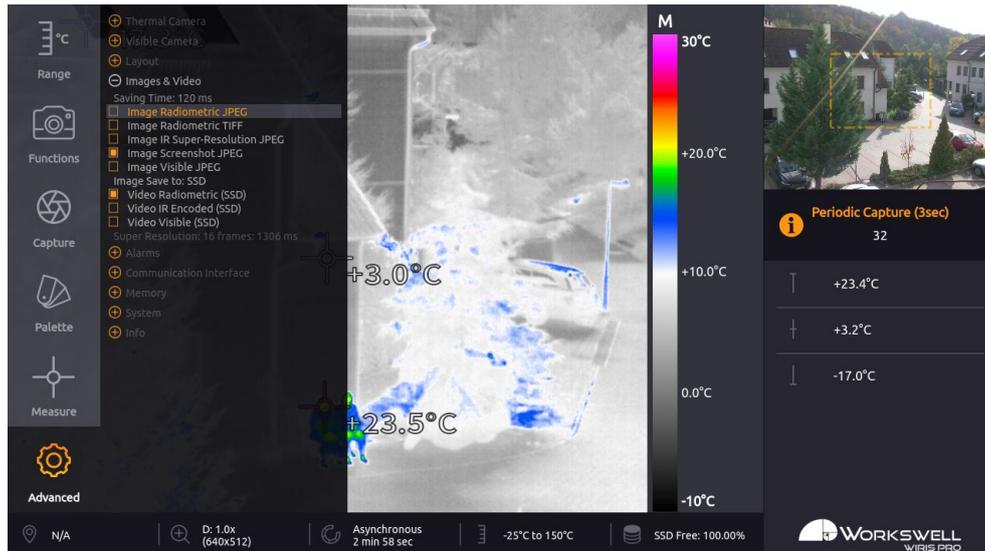


Figure 13.12: Images & Video submenu.

IMAGES & VIDEO submenu consists of the following items:

- SAVING TIME - Displays a rough estimation of the time required to save all the selected capture formats.
- IMAGE RADIOMETRIC JPEG - Toggles saving of radiometric (exact thermal data including) images in the JPEG file format
- IMAGE RADIOMETRIC TIFF - Toggles saving of radiometric (exact thermal data including) images in the TIFF file format
- IMAGE SCREENSHOT JPEG - Toggles saving of simple screen capture images in the JPEG file format
- IMAGE IR SUPER-RESOLUTION JPEG - Toggles saving of special radiometric image containing additional data for super-resolution reconstruction
- IMAGE VISIBLE JPEG - Toggles saving of visible camera image in JPEG file format
- IMAGE SAVE TO - Cycles the storage media (SSD, SD Card, Flash Drive) still image captures will be stored to
- VIDEO THERMAL RADIOMETRIC - Toggles saving of thermal radiometric video sequence capture
- VIDEO THERMAL NONRADIOMETRIC - Toggles saving of thermal video in common compressed format
- VIDEO VISIBLE - Toggles saving of visible video sequence capture

Note: Aside of the storage capacity cost of each file type, requesting simultaneous capture and recording of many concurrent file types will significantly load the device and performance issues might be encountered. It is strongly advised that the user chooses only the capture formats they do need in the given situation even if storage capacity isn't of a concern.

Note: While files of still image capture can be recorded directly to the optional storage media (SD Card, Flash Disk), video sequence files can be only recorded to the internal SSD. User can move the finished video sequence files to the optional storage media later through the MEMORY submenu within the ADVANCED menu.

13.7.5 Alarms

ALARMS submenu allows the user to further specify appearance of the ALARMS display as defined and invoked within the MEASURE menu.

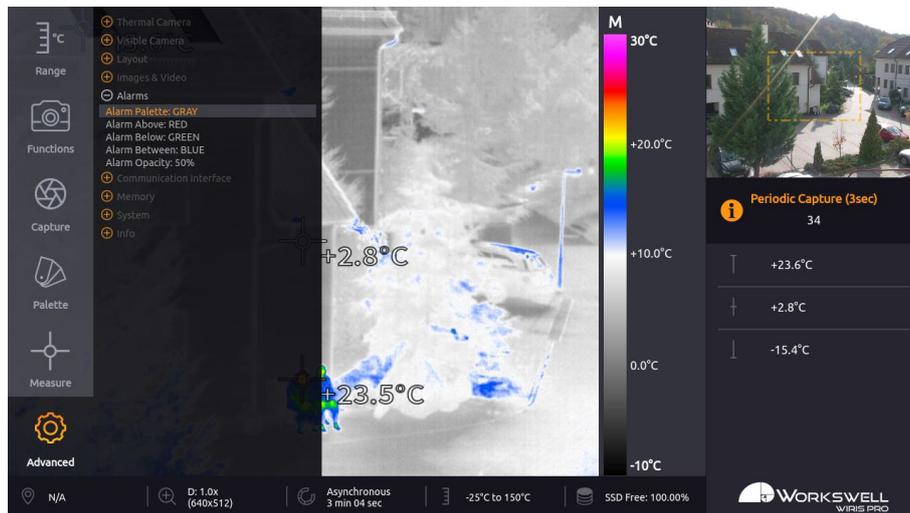


Figure 13.13: Images & Video submenu.

ALARMS submenu consists of the following items:

- ALARM PALETTE - Toggles automatic switch to the GRAY palette when Alarm display activates
- ALARM ABOVE - Cycles through the color options (RED, GREEN, BLUE) which will be used to mark areas with temperature above the upper threshold
- ALARM BELOW - Cycles through the color options (RED, GREEN, BLUE) which will be used to mark areas with temperature below the lower threshold
- ALARM BETWEEN - Cycles through the color options (RED, GREEN, BLUE) which will be used to mark areas with temperatures below the upper and above the lower threshold
- ALARM OPACITY - Sets the degree of opacity of the ALARM display; lower opacity values will allow for more of the basic palette colors to show

13.7.6 Communication Interface

COMMUNICATION INTERFACE submenu allows user to set behavior of the S.BUS port and the Trigger port. For more information about digital input port connection please see the section 8 **Digital inputs**.

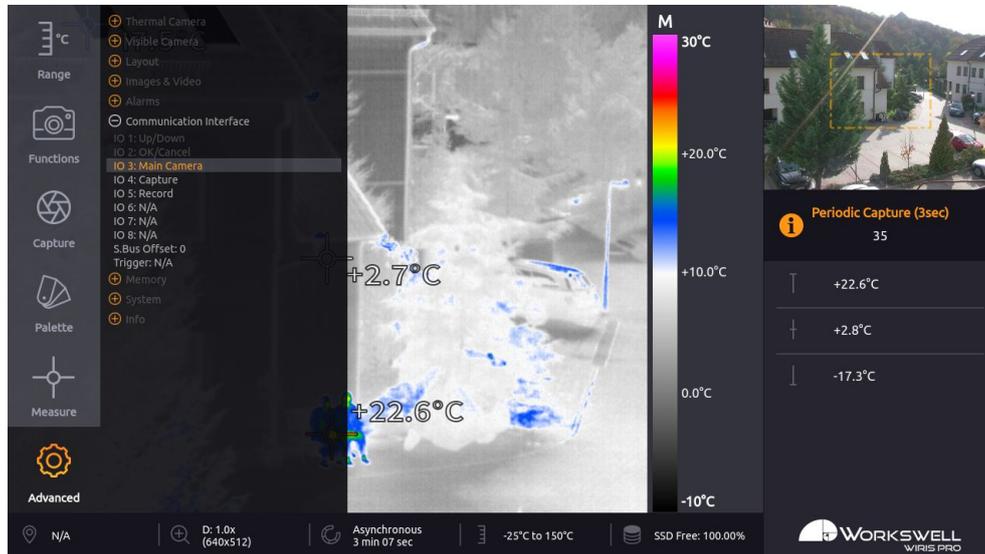


Figure 13.14: Communication Interface menu.

COMMUNICATION INTERFACE menu consists of the following items:

- IO 1, IO 2 - Not available, fixed to menu control
- IO 3 – IO 8 - Behavior binding of each digital additional S.BUS channel
- S.BUS OFFSET - Sets the offset for S.Bus RC control
 - It will shift S.Bus IO inputs by selected number as described in table 8.1
 - For example, S.Bus Offset = 5 will make the S.Bus input IO 6 act as WIRIS IO 1
- TRIGGER - Behavior binding of the digital trigger (Capture Image, toggle Record or trigger shutter correction (NUC))

For each of the digital IO ports 3-8, you can select one of the following functions:

- Main Camera - Toggles which camera is presented on the main screen
- Zoom - Zoom camera currently shown on the primary screen
- Zoom Visible - Zoom visible spectrum camera
- Zoom Thermal - Zoom visible spectrum camera
- Palette - Cycle through the available color palettes
- Alarm ON/OFF - Toggle the alarm overlay display
- Range mode - Toggle the range mode
- Correction (NUC) - Manually trigger the shutter correction (NUC) once

13.7.7 Memory

MEMORY submenu allows user to format storage devices and to move stored files between them or erase them altogether. It also allows the user to trigger a search for an update file and to copy system logs to external storage devices.

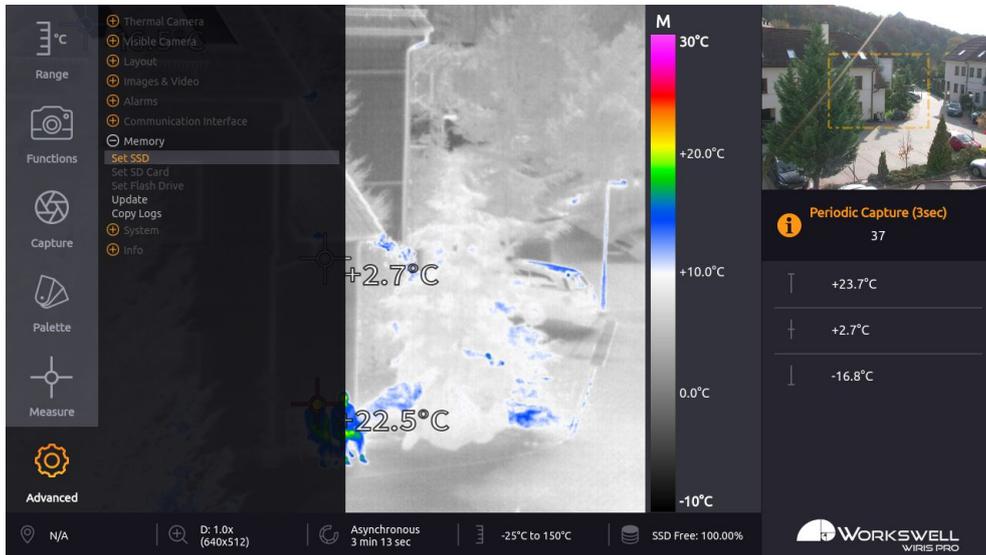


Figure 13.15: Memory menu.

MEMORY menu consists of the following items:

- SET SSD - Access further options for work with the internal SSD storage.
- SET SD CARD - Access further options for work with the SD Card storage.
- SET FLASH DRIVE - Access further options for work with Flash Drive storage.
- UPDATE - Initiate a search for an update file on all of the device storage devices.
- COPY LOGS - Copies internal system logs to all the storage devices, making the files accessible to the user.

Note: The SET SD CARD and SET FLASH DRIVE options are only accessible if the respective storage device is present and recognized by the system.

More about transferring data in chapter 15.

13.7.8 System

SYSTEM category allows user to set the current time and date, set the temperature unit, set the system language, set ethernet network interface settings, reboot the system and to revert default settings.

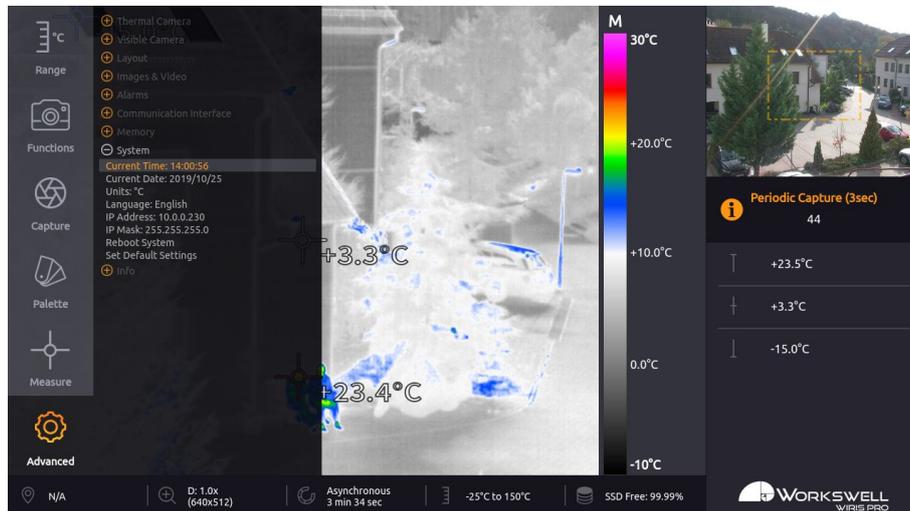


Figure 13.16: System menu.

SYSTEM menu consists of the following items:

- CURRENT TIME - Current system time
- CURRENT DATE - Current system date
- UNITS - Cycles through the available temperature units (degrees Celsius, Fahrenheit or Kelvin)
- LANGUAGE - Cycles through the available system language options
- IP Address - IPv4 network address of the WWP camera
- IP Mask - IPv4 netmask of the WWP camera
- REBOOT SYSTEM - Restarts the device
- SET DEFAULT SETTINGS - Sets the system to factory default settings

Warning: The WWP camera can connect on ethernet for advanced functionality. It is only intended to be operated within secure, local networks and its security cannot be guaranteed on open public networks. In case transmission over public networks is necessary, it's recommended to route the traffic through a secure virtual private network.

Note: Correctly set system time and date are important for correct tagging of date and time in the captured images and recorded videos.

Note: Rebooting the system may help refresh the device.

13.7.9 Info

INFO category displays information about system such as firmware version, serial number (needed for communication with Workswell), article number, device temperature and information about the Workswell s.r.o. company.

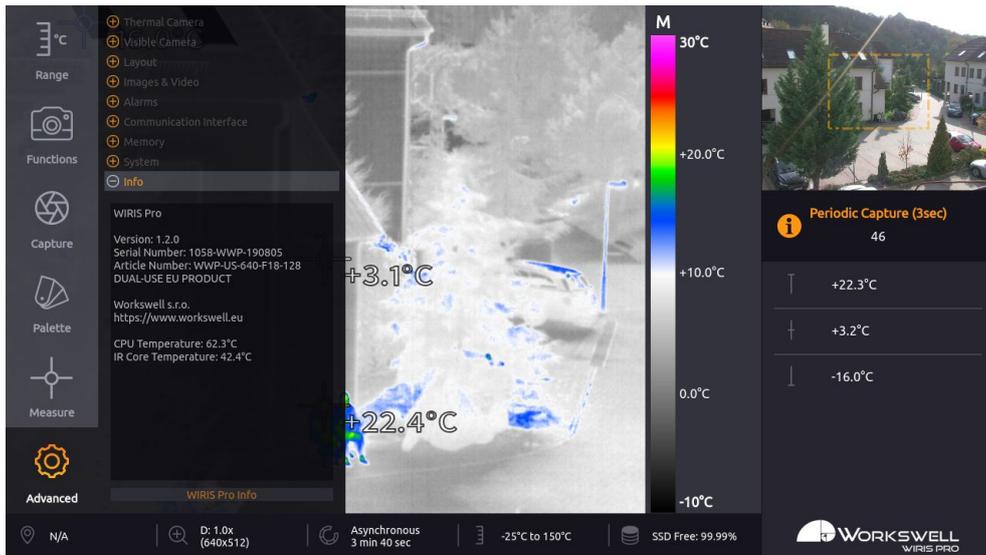


Figure 13.17: Info menu.

14 Images and Video

WORKSWELL WIRIS Pro allows the user to capture and record several image and video formats. The user is advised to save only the desired formats, since each image or video format have performance and memory requirements that add up.

Each image is tagged with Exif metadata including source, date, time and GPS coordinates (if available).

Following formats are supported:

- Images
 - Radiometric JPEG
 - Radiometric TIFF
 - Screenshot JPEG
 - IR Super-Resolution JPEG
 - Visible JPEG
- video
 - Radiometric
 - Visible

Images can be saved directly to connected memory (Flash Drive or SD Card). Video can be recorded only to the internal SSD memory due to high memory speed requirements.

14.1 Images

All the images can be opened in standard image viewers. Images named as radiometric contain additional temperature information and can be further edited in CorePlayer or Thermolab software.

14.1.1 Radiometric JPEG

Plain JPEG image from thermal camera without any overlays, containing additional temperature informations.

14.1.2 Radiometric TIFF

TIFF image in 16bit gray-scale, where each pixel represents measured temperature. It can be opened in standard image viewer, but the contrast is not adjusted.

TIFF image is meant as opened format for user developed applications. It can be also used with third party software Pix4D.

The temperature value in degrees Celsius can be calculated with the following formula:

$$T_{pixel} = \frac{pixel}{40} - 100$$

14.1.3 Screenshot JPEG

Screenshot of current display in JPEG format. User can save the current display state, including overlays and menu with the exception of ADVANCED MENU (since capturing and recording while in ADVANCED MENU is not supported).

14.1.4 IR Super-Resolution JPEG

Plain JPEG image from thermal camera without any overlays, containing additional temperature information for super-resolution image reconstruction.

Super-Resolution image capture leverages advanced algorithms that allow for a higher spatial resolution to be calculated, with high quality detail maintained and superior to typical single-frame re-scaling tools.

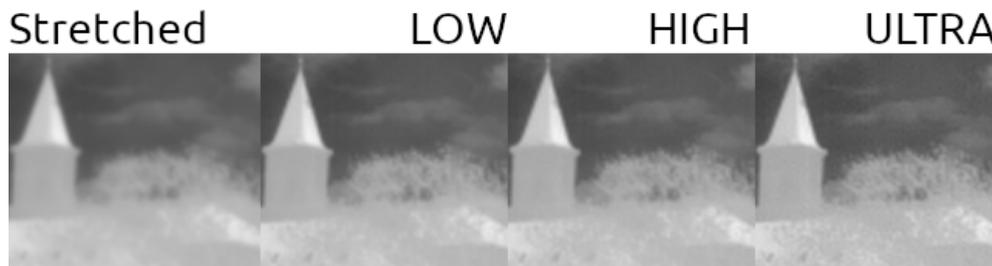


Figure 14.1: Example of the results attainable with Super-Resolution shots. The leftmost sample is the same image simply stretched using typical bicubic algorithm, the later three samples are reconstructed through the superresolution algorithm with varying number of samples (maximally 16) and processing time. The example shows a slice of a larger picture.

Super-Resolution functions by capturing a rapid succession of frames as if in a radiometric sequence, however they're then processed to produce a single higher resolution (typically approximately double in both dimensions) frame.

The function comes with certain caveats. The calculation to produce the final result is quite resource intensive and cannot be performed on the WWP camera itself; instead, the data is captured in a special format and have to be processed on an external computer afterwards, using the CorePlayer or Thermolab software.

Another caveat is that while the algorithm can provide higher detail, it tends to be at cost of introducing or amplifying additional noise or visual artifacts. In most situations though, the resulting images should be universally of higher quality and also retain radiometric, thermal measurement enabling quality.

Even the capture of the Super-Resolution data is quite demanding, with capture duration depending on the IR camera's frame rate. It is recommended that Super-Resolution images are taken alone with no other formats captured simultaneously, and it is recommended the number of Super-Resolution frames is kept low; even 16 frames typically produces very good results. User can decide the number of frames to be captured for a single Super-Resolution image before capturing. Frames can be optionally discarded during processing, but it's impossible to increase their number in processing beyond the count that has been set before capture.

While the Super-Resolution algorithm does attempt to account and compensate for motion in the scene, it is recommended these shots are taken from as stable and static position as possible and work the best when

observing static objects or slow phenomena. Motion of the camera or the objects in the scene will lead to artifacts in the resulting image. If motion cannot be avoided it's better to shoot lower counts of frames with lower capture time.

14.1.5 Visible JPEG

Plain JPEG from visible camera in full HD (1920x1080) resolution.

14.2 Video

14.2.1 Thermal Radiometric Sequence

Temperature data from thermal camera. CorePlayer or Thermolab software is needed for playing and editing this format but lossless capture of radiometric data in full resolution and framerate is ensured. The editing software allows user to measure temperatures in areas of interest or to recolour it using a new colour palette.

14.2.2 Thermal Nonradiometric Video

A common MP4 based video format with encoded, compressed image of the thermal stream, permanently coloured with the selected palette, without exact radiometric values. The main advantage of this format is that it can be immediately displayed by almost any modern universal personal computer, smartphone, tablet etc, with no additional processing required as long as the common codecs are available. It also takes up considerably less storage space than the Radiometric Sequence. The main disadvantage is inability to measure exact temperature values from it, even in specialised software, although rough values can be inferred from known palette and set range. There's also slight loss of visual detail caused by lossful compression.

Note: Only one type of thermal video can be recorded at any given time.

14.2.3 Visible

Compressed video stream from visible camera in HD (1280x720) resolution. Can be played with any video player supporting *H.264* video in *MP4* container.

15 Data Transfer and Memory Manipulation

Workswell WIRIS Pro system is equipped with internal SSD storage for captured images and recorded video. This storage can be further extended and copied from using an optional SD Card and a Flash Drive.

There's two ways of extracting recorded data from the device. Either through a direct connection to another device acting as an USB Host is made, which makes the internal SSD accessible as a generic Mass Storage device, or by using the removable SD Card or Flash Drive to transfer the files. Files can be either captured directly to these removable media, or moved to them manually from the internal SSD storage.

15.1 Application Menu

Note: Only still image capture can be done directly to the SD Card and Flash Drive external devices, sequence recordings are always saved to the internal SSD storage and have to be either recovered via USB transfer or copied to the external storage media manually.

All of the three storage media (SSD, SD Card, Flash Disk) can be managed within the menu through the options **ADVANCED > MEMORY > SET [SSD/SD Card/Flash Drive]**.

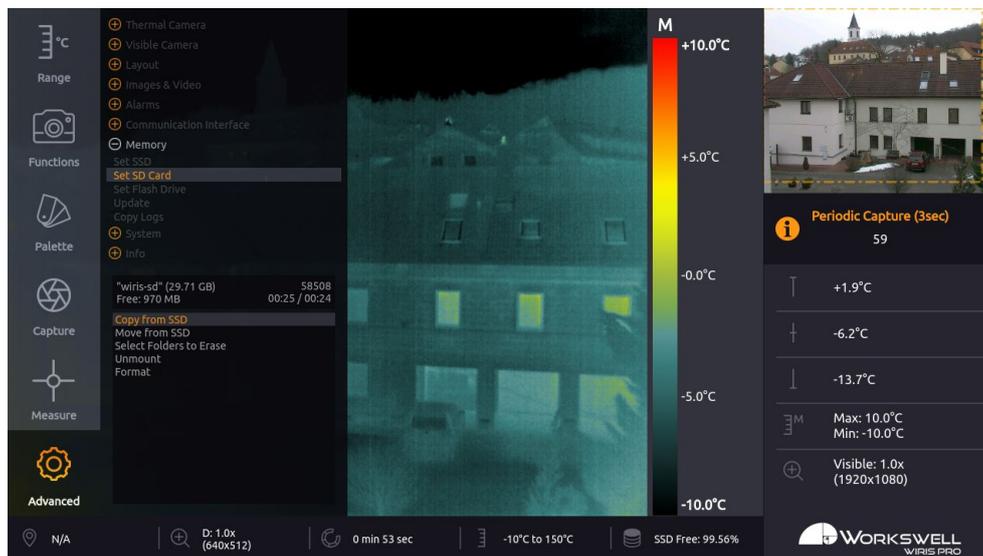


Figure 15.1: Storage manipulation submenu.

The memory management menu for the SD CARD and FLASH DRIVE have the following options:

- **COPY FROM SSD** - After scanning the SSD storage for available data, allows selective copy of folders containing the captured images and sequences to the chosen external medium. Copied files are NOT removed from the internal SSD storage.
- **MOVE FROM SSD** - After scanning the SSD storage for available data, allows selective move of folders

containing the captured images and sequences to the chosen external medium. Copied files ARE removed from the internal SSD storage.

- **SELECT FOLDERS TO ERASE** - After scanning the selected storage medium for available data, allows selective deletion of folders containing the captured images and sequences. If these files haven't been copied previously, they will be lost.
- **UNMOUNT** - Safely unmounts the chosen external medium so it can be physically removed without risk of data loss. External media are automatically mounted again, after being reinserted into the device.
- **FORMAT** - Performs a format of the storage device. **Beware**, this will delete all the data stored on the given storage medium, including data unrelated to operation of the device.

Note: The memory management menu for the internal SSD storage has only the **SELECT FOLDERS TO ERASE** and **FORMAT** options, which function as outlined above. Data cannot be copied or moved from external storage media to the SSD. The SSD cannot be unmounted.

Note: The respective media menu options only become accessible if the given storage medium (SD Card, Flash Disk) is physically connected to the device and successfully mounted

Once the **COPY**, **MOVE** or **TO ERASE** option is selected, memory of the medium is scanned for data (this may take a while). User is prompted to choose which folders should be copied, moved, or erased. New data folders are always created automatically based on the current date and time.

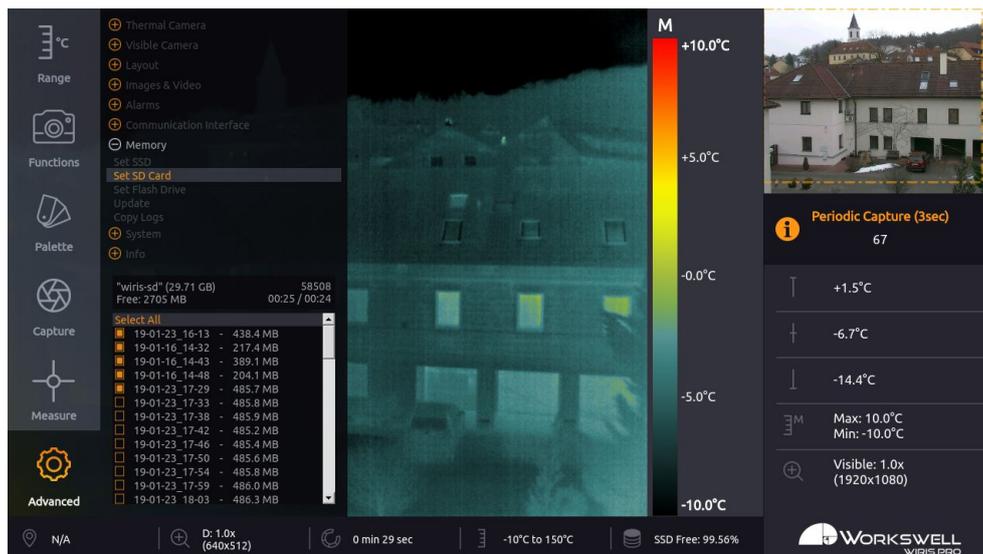


Figure 15.2: Selection of folders to be acted upon.

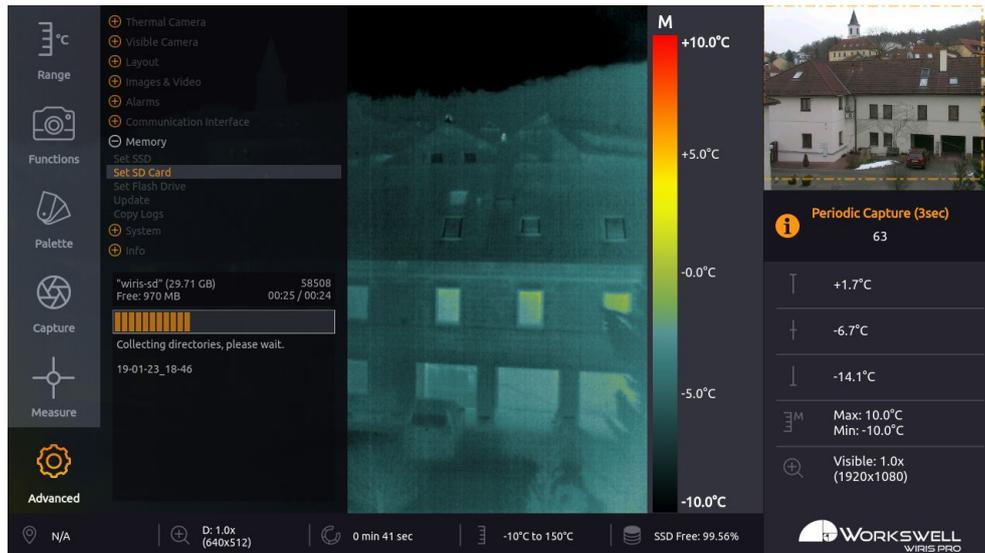


Figure 15.3: Longer actions display a progress bar.

The copy/move process starts when the user chooses COPY/MOVE SELECTED.

Warning: Do not unplug power supply or USB flash drive during copy/move process. Data loss may occur.

Warning: Either always manually unmount external storage media before physically removing it from the device, or only remove it while the device is powered off altogether. Data loss may occur, otherwise.

15.1.1 Formatting Memory

We highly recommend using the supplied USB flash drive and SD Card that is already formatted. It might be necessary to format any new Flash Drive or SD Card.

This can be done directly from the ADVANCED > MEMORY > SET FLASH DRIVE menu. The formatted file system is FAT32 with one partition.

Warning: Do not use other file system formats than default FAT32. Do not make more than one partition in the memory.

Warning: Never format SSD of the camera as a device connected to the PC via USB OTG cable! Format the SSD of the camera only through the firmware GUI.

15.2 Mass Storage (USB OTG)

WIRIS Pro can be connected directly to PC or Mac with Micro USB cable and act as a Mass Storage. Thus the data from connected memory can be accessed, copied, moved or deleted.

The WIRIS must be started and running the whole time. When connected, the warning window on the WIRIS display informing about the connection should appear.

After disconnecting the WIRIS Pro will reboot itself.

Warning: Never format SSD of the camera as a device connected to the PC via USB OTG cable! Format the SSD of the camera only through the firmware GUI.

Warning: Only connect external host devices (PC/Mac) to USB Type Micro B slot on side of the device; the rear USB Type A slot is only intended to be used with peripheral devices like the keyboard and Flash Drives. Connecting powered devices to the rear slot could lead to damage.

16 Firmware Update

Workswell WIRIS Pro system is supplied with the latest firmware. As time goes on, newer firmware could appear in order to bring the user new functions, improve the old ones or fix bugs. For this purpose, the system allows the user to update the firmware.

To update WIRIS Pro, follow these steps:

1. Download the update file from <https://www.workswell-thermal-camera.com/firmware-update/>.
2. Copy the update file `update-wiris-pro.tar` to USB flash drive, SD Card or internal SSD (make sure the filename is correct).
3. Connect the memory with update to WIRIS Pro.
4. Select **ADVANCED > MEMORY > UPDATE**.
5. Confirm the update installation.

16.1 Firmware Update Process

After the **ADVANCED > MEMORY > UPDATE** choice is selected, the device will search all three storage devices for valid update files. If an update file is found, the user will be prompted one last time to confirm or cancel the update. Once the update is initiated, it may take several minutes.

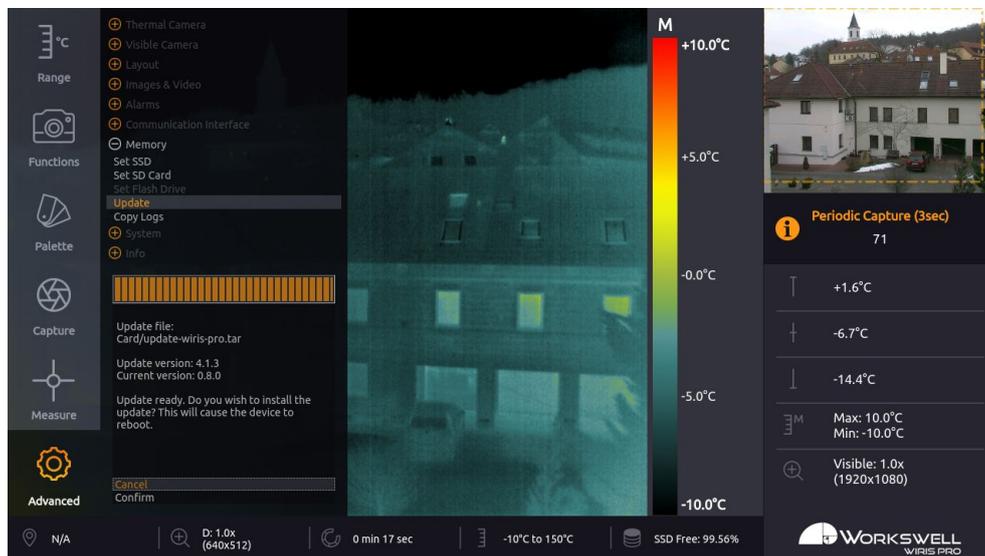


Figure 16.1: Update menu – firmware update available.

Warning: Do not turn off the system and do not unplug the power supply during the firmware update process. Otherwise, damage to the system may occur.

17 Workswell CorePlayer

17.1 General Description

The Workswell WIRIS Pro system can capture radiometric images and record radiometric video compatible with Workswell CorePlayer (supplied with Workswell WIRIS Pro system). Workswell CorePlayer offers the user many functions for editing and processing radiometric images and videos.

Workswell CorePlayer is available at <http://www.workswell.eu/CorePlayer>

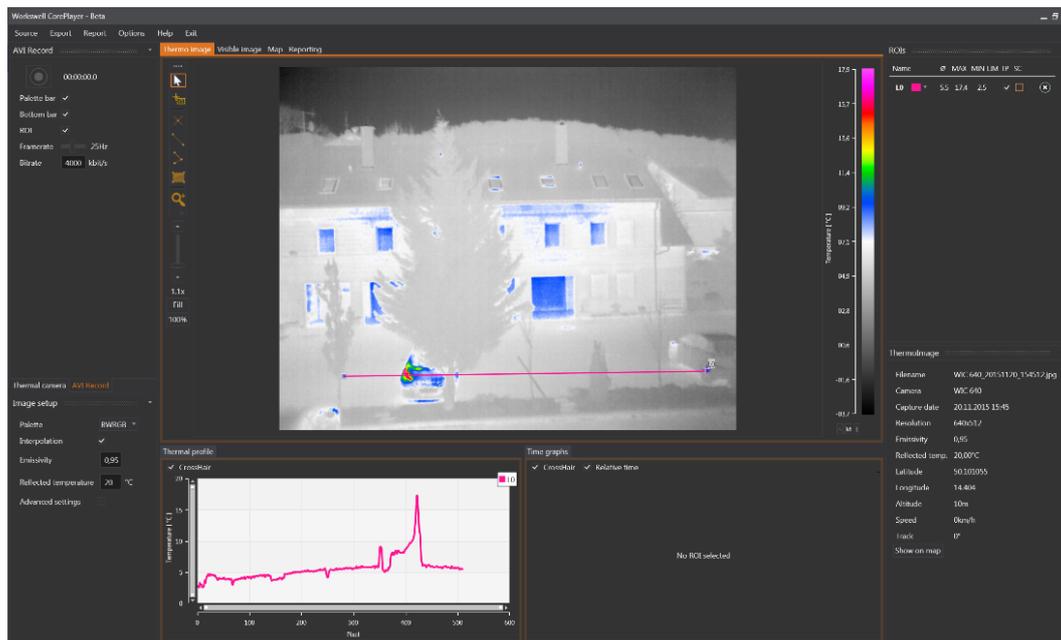


Figure 17.1: Workswell CorePlayer.

Workswell CorePlayer allows the user to

- Change measurement parameters (emissivity, ...)
- Change temperature range, colour palette
- Use multiple isotherms
- Use measurement functions in multiple ROIs (region of interest)
- Export images
- Export .avi video
- Generate PDF reports
- And much more...

To learn more, please refer to CorePlayer manual.



18 Environmental Conditions

18.1 Environmental Conditions

You should follow these storage and operating conditions for proper function of the Workswell WIRIS Pro system:

Operation temperature range	from -10°C to +50°C
Storage temperature range	from -30°C to +60°C
Humidity	5-95%, noncondensing
Maximum irradiance	100W/cm ²

Storage or use of the device outside of these specified values can lead to permanent damage.

19 Infrared Camera Behavior

19.1 Infrared Camera Warm-Up

Modern infrared cameras based on a microbolometer array need to internally warm up to their working temperature before the measured values stabilize. The sensor begins to automatically warm up after the user turns the camera on. The infrared camera is usually up to ideal internal temperature in about 15 minutes.

During the warm-up process the accuracy of the measured temperature data is lower and various defects can appear in the thermal image. Therefore, we recommend to let the infrared camera warm up before capturing critical data.

19.2 Non-Uniformity Correction (NUC)

Infrared cameras need to be periodically calibrated in order to get reasonable measurement accuracy. This process is called Non-uniformity correction (NUC) or shutter calibration. WIRIS Pro is equipped with an internal, automated shutter which can be triggered manually but also engages automatically in a set interval.

Note: Time until the next automatic calibration is shown in STATUS BAR. The downside of NUC is that the stream of thermal camera image gets briefly interrupted while the NUC is performed, so while more frequent NUC means higher quality data, user has to be aware of the frames that will be lost with each NUC.

Note: Whenever the device detects too rapid shifts in internal temperature, the NUC timer indicator (present in Inspection layout Status Bar and optionally in Inspection Panel in other layouts) will turn red. This means the accuracy of thermal data may be lower but no functionality is impaired.

Note: Even after NUC is performed, temperature non-uniformity can, depending on the environmental circumstances, still reach up to 4°C

19.3 Camera Calibration

The WIRIS Pro undergoes external calibration as a final step of the manufacturing process and the user doesn't need to perform additional calibration other than the automatic NUC.

The stated accuracy of a calibrated camera is $\pm 2\%$ of measured value or $\pm 2^{\circ}\text{C}$ ($\pm 3.6^{\circ}\text{F}$) absolute (whichever is higher) on the measurement range of 0 to 500°C (32°F to 932°F) and with camera already warmed up with ambient temperature in the range from 0°C to 40°C (32°F to 104°F).

Note: For maximal accuracy to be maintained, it's recommended for the device to be sent to the manufacturer for a calibration once a year, otherwise the stated accuracy cannot be guaranteed.

Warning: as with all measurement devices, the volatility of the device's storage environment in terms of temperature swings, light radiation, electromagnetic interference and vibrations can have detrimental effects on quality of the device's calibration and its longevity. Attempt to store the device with as few disturbances of any sort as possible for maintaining maximal accuracy.

20 Maintenance

20.1 Cleaning the WIRIS Head and Cables

Liquids: Use one of these liquids:

- Warm water optionally with a weak detergent solution

Equipment:

- A soft cloth

Procedure:

1. Soak the cloth in the liquid.
2. Twist the cloth to remove excess liquid.
3. Clean the part with the cloth.

Warning: Do NOT use any common cleaning detergent on the infrared lens, they tend to react with the antireflective coating and will irreparably destroy it!

20.2 Cleaning the Infrared Lens

Liquids: Use one of these liquids:

- A commercial lens cleaning liquid with more than 30% isopropyl alcohol or 96% ethyl alcohol (C₂H₅OH)

Equipment:

- Cotton wool

Procedure:

1. Soak the cotton wool in the liquid.
2. Twist the cotton wool to remove excess liquid.
3. Clean the lens one time only and discard the cotton wool.

Warning: Make sure that you read all applicable MSDS (Material Safety Data Sheets) and warning labels on containers before you use a liquid: the liquids can be dangerous.

Caution:

- Be careful when you clean the infrared lens. The lens has a delicate anti-reflective coating.
- Do not clean the infrared lens too vigorously. This can damage anti-reflective coating. Re-applying anti-reflective coating is not possible and is required to change the lens.

21 Troubleshooting

21.1 Turning ON

When the power cable is plugged in, the LED should begin flashing. If nothing happens, please check you power supply. A stable power supply is essential for correct functioning of the device.

21.2 Reset button

On side of the WWP device, a reset button is present. This button has two functions.

- If the reset button is held down during device startup, the device should go directly into Safe Mode as described in the next section.
- Holding the reset button for 15 seconds while the camera is already running (but even if no image is produced) should reset the device to factory default state.

To actuate the reset button, use a fine pointed object such as a toothpick or an unfolded paperclip.



Figure 21.1: Reset button.

21.3 Safe Mode

In case the device detects issues with the main firmware even after repeated reboot attempts, it will launch the Safemode application instead.

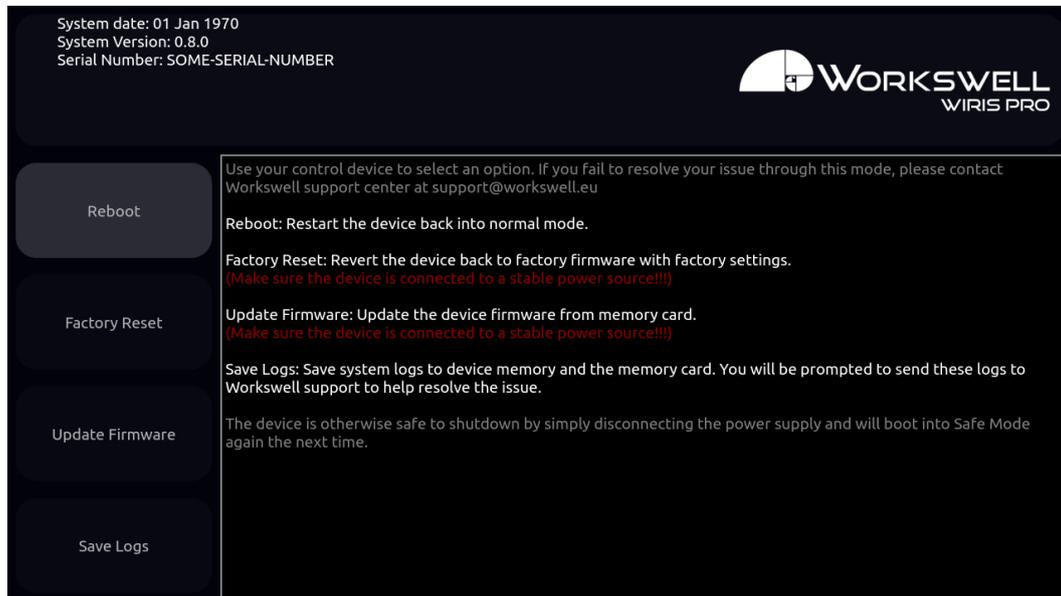


Figure 21.2: Safe mode.

The Safemode application offers the following options:

- REBOOT and continue with standard application
 - Choose this option when first observing the safe mode.
- FACTORY RESET
 - Choose this option to restore the system to its Factory defaults. All of the applied updates will be removed.
 - A stable power supply has to be maintained during the Factory Default!
- UPDATE FIRMWARE
 - This allows you to manually update firmware on the device when the main firmware application doesn't function.
- SAVE LOGS to connected external devices
 - Choose this option to copy log files for faster solving of the issue.
 - Log files will be copied to all of the externally accessible SSD, the SD Card and the Flash Drive, if they are present
 - Please, send these log files to Workswell support center with information about the issue.

In the case none of the first three options help resolve the issue, please contact the Workswell support center support.workswell.eu and report the problem, supplying the system logs saved through the fourth option.

21.4 Reset to Factory Default

You can reset the WIRIS Pro to its factory default state with the pin button. Press the pin button for more than 5 seconds. The LED should start blinking rapidly. Do not unplug the WIRIS Pro from power source during this process!

Factory default can help in some situations. Typically if some settings or update caused the WIRIS Pro to stop displaying the image or other minor things like going back to previous working firmware version.

Factory default will not work if the LED is not emitting light.

21.5 Remote Control

When selecting the TRIGGER mode for a digital input, make sure that the selected input is not connected to your remote controller with PWM output. Otherwise, the TRIGGER input will not behave as expected.

21.6 System Update

Make sure that your WIRIS Pro version is up to date. You can find information about the current version on <https://www.workswell-thermal-camera.com/firmware-update/>



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