PUMATRONIX

ITSCAM 450+

IDEAL FOR SHOTS REQUIRING INTEGRATED LIGHTING

Product

Pumatronix Equipamentos Eletrônicos Ltda.

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Histórico de Alterações

Date	Revision	Content updated
05/22/2024	1.0	Initial Version, regarding firmware version 1.7.1
05/08/2025	1.1	Digital Signature Description; Storage memory update (SAD 816); Classifier inclusion in models

ITSCAM 450 Family Overview

The ITSCAM 450+ by Pumatronix represents a significant advancement in the product portfolio, providing exceptional solutions for various applications, including non-metrological speed enforcement, weighing scale inspection, customs control, toll collection, and electronic security and fencing for cities. Equipped with embedded License Plate Reading (LPR/OCR) features, the image capture architecture of this devicy family stands out for its ability to read vehicle license plate characters. Additionally, it includes crucial characteristics that aid in identification, such as vehicle type, model, and color.

The ITSCAM 450+ device is designed to operate under a wide range of conditions, offering precise vehicle readings and images in both high and low-speed scenarios, during daytime and nighttime, in both highway and urban environments. It can recognize a diverse range of vehicle plates, including reflective, non-reflective, red and non-reflective red plate models, through Multiple Exposures in a single shot, even considering the new Mercosur standard. Furthermore, the image capture system includes the reading of motorcycle license plates.

One characteristic of the ITSCAM 450+ is the capture of images from up to one lane, with an accuracy rate exceeding 95%. This translates into unparalleled efficiency and accuracy.

The software-driven image capture system eliminates the need for installation and maintenance of costly physical ties. In addition, it allows the configuration of regions of interest in the image, which delimit, among others, in which part of the image the reading of plates must be performed, avoiding unnecessary information being processed and optimizing the operation of the device.

Pumatronix offers model with motorized LM lenses, equipped with a CMOS sensor with a Global shutter for drag-free images. In this way, the system can operate the capture of images of vehicles with a speed of up to 150 km/h, providing accurate readings in high-speed scenarios.

Figure 1 - ITSCAM 450+ line

Energy efficiency is a priority and the ITSCAM 450+ is designed for low energy consumption. It communicates via IP protocols and offers optional PoE power, ensuring ease of integration.

With technical support throughout the national territory and the possibility of configuration and installation by a specialized technical team, the ITSCAM 450+ from Pumatronix is the definitive choice for your license plate reading needs in access control systems and highway concessionaires. Consult your salesperson to learn more about how this solution can optimize your operations and improve security in your environment.

Handling Risks

	**This equipment must be supplied with a direct current (DC) source with a voltage between 9 and 28 VdC. Do not connect any of the inputs directly to the mains (AC)!**
	**Oxidation Risk: Electrical and data connections must be protected in a junction box or similar structure to prevent oxidation of the connections and unwanted infiltration of liquids in the cable.**
	**This equipment may be accompanied by lenses, which are sensitive to mechanical impacts such as falls and extreme vibrations.**
	**Installation Location: In cases where it is not possible to meet the installation specifications, it is recommended to consult Pumatronix Technical Support.**
	**Vision Damage: The built-in illuminator emits thermal and light energy (not visible because it is infrared lighting), so it is not recommended to look directly at the LEDs. It is also not recommended to use any optical instrument to look directly at the LEDs. If malfunctions occur, send the product to Pumatronix Technical Assistance.**

Models

Available Models	Resolution	Lens Type	Estimated range (in meters)*
ITSCAM 450+ (S08L6IT1JP)	1280x800 px	Integrated motorized	2,5 a 12 m (2.7-12mm)

* The estimated range is set according to the selected lens and identifies in which distance range the license plate characters remain readable in the OCR reading. When the device is used in conjunction with the illuminator the range may be limited to the applied model. For models with a motorized lens, the lens cannot be modified.

Illuminator Installation: When using an illuminator in conjunction with the ITSCAM 450 device, check in the product specifications the minimum and maximum distance that must be observed about the position of the object to be illuminated.

Image sensors	Lens*	Iluminação Integrada	Cover	Optionals
S08: CMOS 1280x800 px	**L6:** 2.7-12mm	**I**: Infrared	**T0**: Without cover **T1**: Normal back cover **T2**: T back cover, docking connector and 30 cm Ethernet cable (without cable sleeve) **T3**: T cover with 6m ethernet cable **T4:** Rear cover with 6m sleeve and net cable	**A**: Digital Signature **J**: Embedded LPR (Brazil or Chile) **P**: POE power supply**

Digital Signature Functionality: ITSCAM 450+ has high security with Digital Signature and data encryption, guaranteeing the integrity and confidentiality of captured information. More information can be obtained through Technical Support

Summary

1. Getting to Know the Product

The ITSCAM 450+ line of image capture and processing devices was developed for non-metrological inspection, inspection in rotating parking lots, toll evasion, toll collection, parking lots, and applications that require image capture over short distances.

The 1MP image sensor of the ITSCAM 450+ allows the capture and processing of images of up to one range. The sensor is combined with a set of motorized lenses, with circuits detect and control irises from DC models.

The quality and level of detail of the images captured with ambient and artificial lighting of the ITSCAM 450+ comes from additional functionalities to the optical assembly (image sensor with lenses). Multiple Exposures can be captured for each photo request made to the equipment. This feature captures and processes more than one sequential image, with automatic variation of capture parameters.

The ITSCAM 450+ maintains the standardization of the images, even when significant variations occur in the lighting conditions. This is possible by toggling the Image Setup Profiles. Profile changes are made by the equipment, based on the image level and time.

Figure 2 - Examples of daytime images captured with ITSCAM 450+

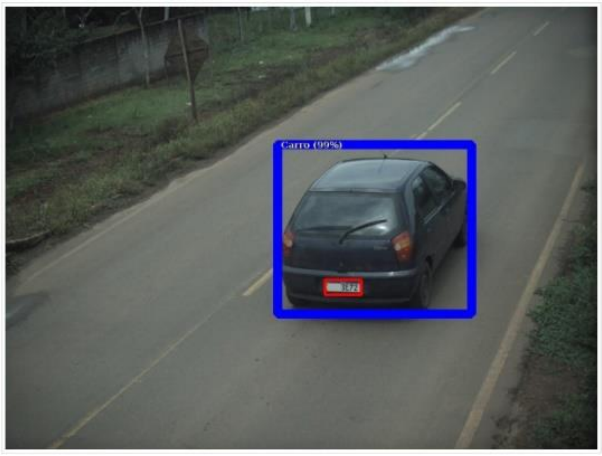
Figure 3 – Example of night images captured with ITSCAM 450+

The ITSCAM 450+ hardware has 2 (two) digital inputs for connecting external sensors, such as loops, doppler sensors and optical barriers, and 2 (two) digital outputs that can be used to control external devices or to trigger infrared lighting devices used in low light situations. However, the ITSCAM 450+ can capture images without the need for external sensors, by enabling software capture (or enable the *Enable object tracking with Classifier* option).

The *Sliding Flap* on the ITSCAM 450+ device housing provides additional protection for the lens in cases where there is a direct incidence of reflections or sunlight, which interfere at the quality of the generated images. The built-in illuminator allows the identification of vehicles during daytime and nighttime period.

In cases where there is insufficient lighting to capture the vehicle license plate legibly, the built-in illuminator is automatically triggered and emits infrared-type light, which is imperceptible to the human eye.

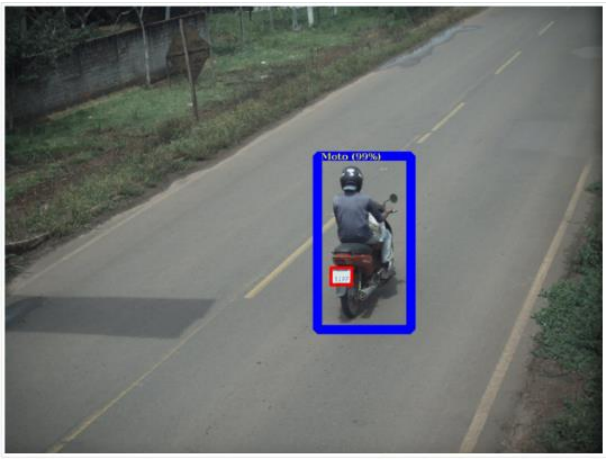
All the images captured by the ITSCAM 450+ pass through the Quad Core ARM processor with neural network processor, which scans them for vehicles and license plates. At the same time as a vehicle is detected, it is classified as a motorcycle, car, truck or bus. This functionality is called *Classifier*, performed with high precision, detecting vehicles even in situations where the license plate is missing or the characters are poorly distinguished. Together with the identification of the vehicle type in the *Classifier*, it is possible to define regions that operate the Virtual Loop in the image (virtual trigger regions). In addition to the characterization of the vehicle in the image, automatic character recognition (OCR) of the license plates in the images is available, considering all Brazilian, Argentinian, Chilean, Colombian, French, Mexican, Dutch, Paraguayan, Peruvian and Uruguayan standards, on plate models with or without reflective film in day and night mode. Contact the Pumatronix Sales Department for the availability of OCR recognition for additional countries.



Classifier identifies a car

Classifier identifies a truck

Classifier identifies a bus



Classifier identifies a motorcycle

The ITSCAM 450+ delivers photos in JPEG format and within these files, the comment field is filled with the data referring to each capture, containing the recognized plates, the type of vehicle identified, and the instantaneous settings of the equipment.

The ITSCAM 450+ line offers 1 100Mbit/s Fast Ethernet port to facilitate connectivity at monitoring points and allow remote and simultaneous access by multiple users. Access can be through the equipment's Web

Interface or applications can connect using the rest API Client, the File Transfer Protocol (FTP), the ITSCAMPRO server or the LINCE server. Equipment access management is done by specifying the network Firewall rules or by specifying the *Routes*. The commands available through the rest API are detailed in the ITSCAM 450+ Integration Manual.

2. Generated Information

The ITSCAM 450+ line captures images of up to one lane in JPEG format and automatically makes available the characters of the license plates of Brazilian, Argentina, Chile, Colombia, France, Mexico, Netherlands, Paraguay, Peru, and Uruguay vehicles. For the release of recognition of additional country plates, please contact Pumatronix Commercial.

The plates read in the images, the data of the type, brand, model, and color* of the captured vehicle, in addition to the information about the configuration of the equipment are stored within the image files, in the JPEG field for the storage of comments. The quality of the generated JPEG files is adjustable and the images can receive the overlay of a caption with configurable content in each Profile. For each photo request, sequential captures can be sent with changes to the capture parameters (*Multiple Exposures*). The data of the vehicle type identified by the Classifier and the plates identified in the OCR *Recognition* are additionally delivered through the interface using the *Snapshot* function, which presents the captured image and all image metadata.

The redirection of the images captured by ITSCAM 450+ can be done via a wired data network, through the Fast Ethernet port. Using the communication interfaces, the ITSCAM 450+ images can be automatically via the device's Web Interface or applications can connect using the REST API Client, the FTP (File Transfer Protocol) protocol, the ITSCAMPRO server, the LINCE server and APIs that allow integration with security agency systems* such as PM-PR, PRF (SPIA), PM-MG (Helios), Detecta-SP and Córtex.

In addition, monitoring of equipment operation and captures can be done in real-time with the Web Interface. The video with the images of the capture is available in MJPEG format with adjustable quality, in addition to the live view available in a floating window, which can be shifted or minimized and optionally displays only the images of the captures taken, with the possibility of zoom and focus adjustment for the current profile.

Information on the device's *Current Status* is available on the home screen, which displays the device's data, such as the Device ID (or Serial Number), the installed versions, the performance status of the CPU, memory and storage and the 2 Digital Inputs and 2 Digital Outputs.

**Functionality depends on an agreement between the customer and the public body responsible.*

3. Additional Documentation

Produto	Link	Descrição
ITSCAM 450+	Integration Manual	Programming and integration manual containing the necessary information for the integration of ITSCAM 450+ with an application
	Installation and Maintenance Guide	Guide containing the information necessary to perform the installation and maintenance of ITSCAM 450+
ITSLUX	Product Manual	ITSLUX illuminator manual

4. Mechanical Specifications

- Material: Polycarbonate;
- IP Protection: IP67;
- Fixing: *Support 450+ for fixing the ITSCAM 450+ to structures, with the help of the equipment fixer to the base*:
    - *450+ Bracket*, using 3 screws 3/16" diameter (not included, as length and type vary according to application):

Figure 4 - Fixing the 450+ Bracket: 1) 450+ device tilt adjustment; 2) 450+ Bracket; 3) Fixing points, using 3/16" screws; 4) Sliding Flap, adjusted in the framing

    - *Fastener, containing the Reinforcement and 2 M4 Allen 3mm screws, fixes the ITSCAM 450+ to the sphere of the Support 450+ and allows the tilt adjustment of the equipment*:

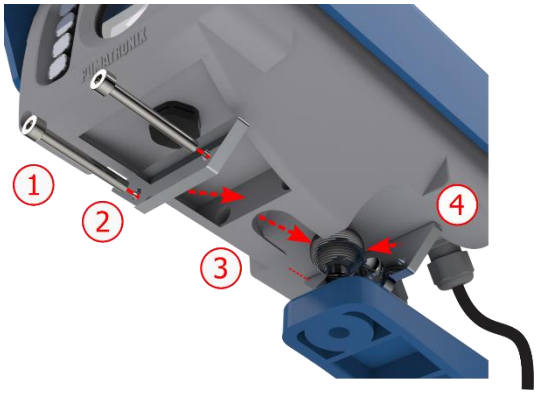


Figure 5 - 450+ Fastener Assembly: 1) M4 Allen 3mm screws (2 units); 2) Support; 3) 450+ cavity; 4) Fastener

- Interfaces: connections are available via cables:

Figure 6 - Connections available for ITSCAM 450+: 1) Ethernet; 2) 12-way sleeve

Opening the rear cover implies instant loss of the ITSCAM 450+ Warranty.

- Operating Ambient Temperature:
  - DC power supply: -10 to 65 °C with relative humidity of 5 to 95% and without condensation (tests carried out in accordance with IEC 60068-2-2);
  - Power via PoE source: -10 a 55 °C.
- Integrated illuminator specifications:

Type of Light	Infrared
Quantity of LEDs	8
Wave Length	850nm
Beam Aperture Lens	22°

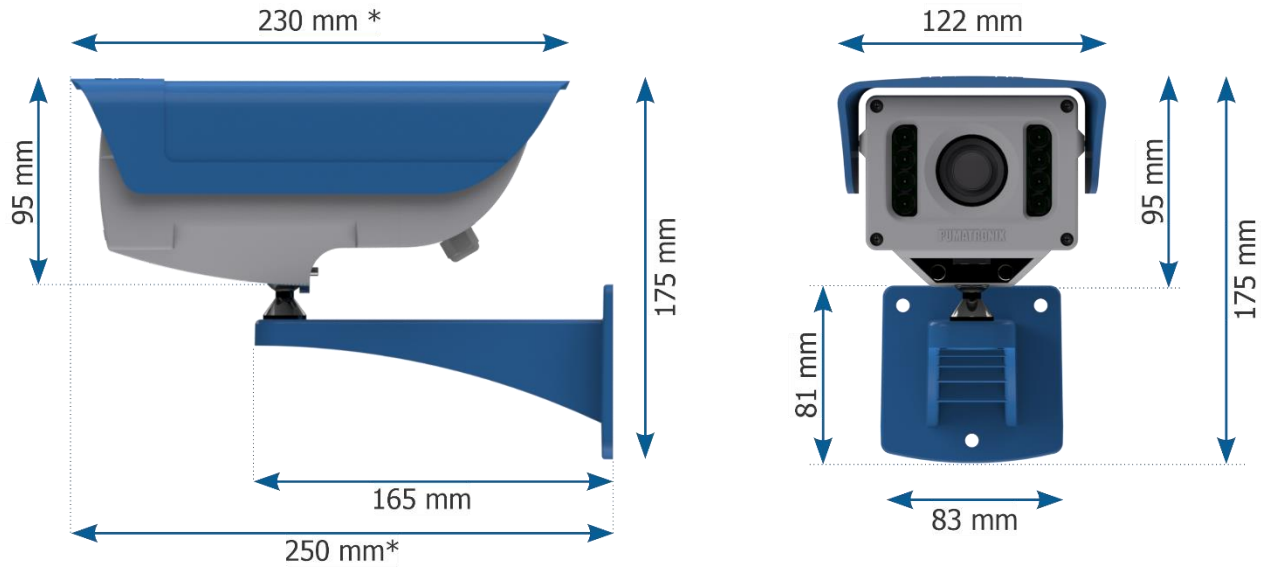
- Weight:

Model	Weight*
ITSCAM 450+ (S08L6IT1JP)	890 g

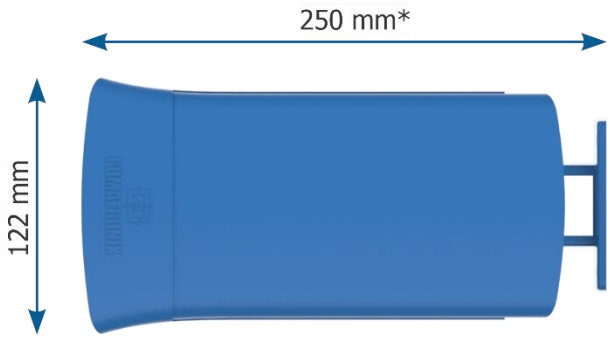
* The indicated weight only considers the capture device without the support. The total weight of the equipment set, considering the attached support, is 1.100 g.

- Dimensions:

Dimensions (millimeters)



* Dimension considering the Sliding Flap in the initial position.



* Dimension considering the sliding flap in the initial position.

4.1. Sensitivity of Sensors to Light

ITSCAM 450+ has a high sensitivity to infrared light. Below are the Sensitivity X Wavelength graphs for the image sensor of the Day/Night versions, representing approximate values for all current sensor models. In the color sensor, 50% of the pixels are green, 25% are red and 25% are blue, according to the Bayer standard. Each color has specific sensitivity, according to the wavelengths. However, in the infrared region, the colors have nearly coincident sensitivity curves.

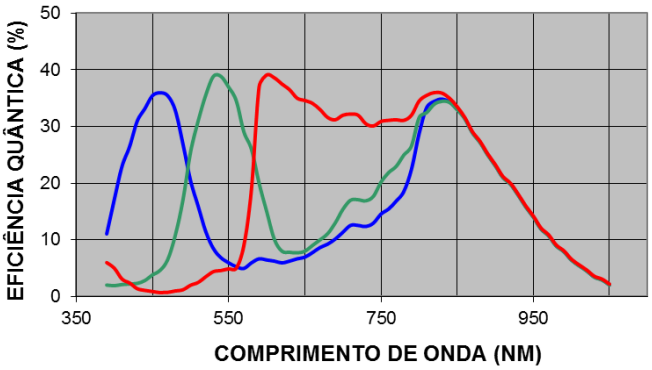


Figure 7 - Sensitivity of red, green and blue colors on the color sensor. The curves are slightly different for each image sensor.

5. Electrical Specifications

- Power: Power over Ethernet - PoE 802.3af (Power 7 W/48 V) or with 9~28 Vdc source (recommended 12 Vdc ±20% or 24 Vdc ±20%);
- Maximum input current: 0,65 A;
- Minimum and Maximum Consumption: 4,5~7 W;
- Minimum power: 4.5 W;
- Maximum power: 7 W;
- Protection against polarity reversal: 28 V;
- Overvoltage protection (máx.): 28 V;
- Overcurrent protection: 0.5 A;
- Inrush current protection: 1.1 A.

ITSCAM 450+ Interfaces	Electrical Specifications
1 Fast Ethernet port	5 kVAC dielectric isolation, ±30 kV electrostatic discharge protection per contact - Level B (IEC 61000-4-2) and ±30 kV by air (IEC 61000-4-2), EFT for peak forward current at 5/50 ns up to 40 A ±5 % (IEC 61000-4-4) and 4 A surge current protection (tP = 8/20 µs) (IEC 61000-4-5)
2 outputs	User-Programmable Bidirectional Isolated 3.75 kV Digital Interfaces (maximum current 50 mA, maximum voltage 28 Vdc, and impedance of 10 kΩ)
2 Serial RS-232 EIA/TIA ports	2 ports with a maximum transmission rate of 115,200 kbps and electrostatic discharge protection of ±8 kV per contact (IEC 61000-4-2) and ±15 kV by air (IEC 61000-4-2)

Interface	Connectivity Specifications
1 Fast Ethernet port	100 bit/s

Component	Image Processing Specifications
CPU	Quad core ARM
RAM memory	LPDDR4 8Gbit x 32bit speed 2667Mbps

Image sensors	Global Shutter de 1 MP (1280x800 px) Day/Night mode (generates color images by day and monochrome images by night) Physical size of the sensor: 1/2.4” Internal frame rate: 30 fps Shutter minimum of 48 µs and maximum of 30000 µs (or 30 ms)
Minimum and maximum shutter	Shutter minimum 48 µs and maximum 30000 µs (or 30 milliseconds)
Internal storage	Total of 6 GB free for the user, without possibility of expansion
NPU	2.0Tops
Watchdog	in hardware with a period of 50 seconds

Oxidation Risk: Electrical and data connections must be protected in a junction box or similar structure to prevent oxidation of the connections and unwanted infiltration of liquids in the cable.

5.1. Electrical Connections

The equipment has two cables in its structure, used for the connections:

- 12-way sleeve cable AWG 26 (without shield and without shielding) with 1.50m long, 6.3mm gauge, which allows connecting the external power supply and accessing the I/O;
- Ethernet cable for external use with an RJ-45 connector, ultraviolet protection, according to the EIA/TIA-568A standard.

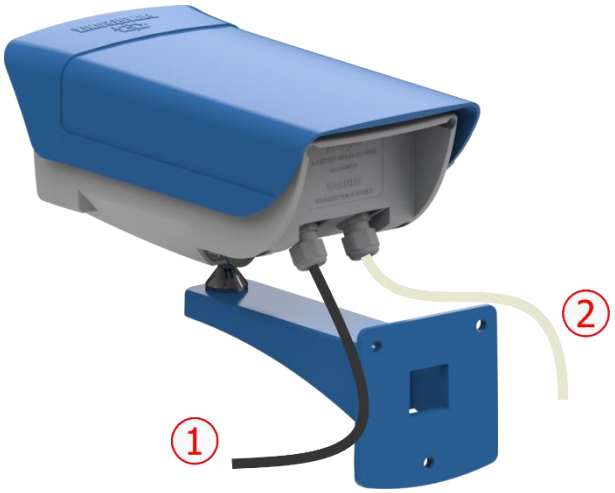


Figure 8 – Cables of the ITSCAM 450+ device housing: 1) Ethernet cable; 2) Multi-way cable

Terminal/Color	Description
Red	12Vdc or 24Vdc power supply
Brown	Negative (GND)
Green	Input 1 + (IN 1+)
Blue	Input 1 - (IN 1-)
Purple	TX RS232 2
White	RX RS232 2
Blue + White	Do not connect

Terminal/Color	Description
Red + White	Do not connect
Gray	Input 2 + (IN 2+)
Black	Input 2 - (IN 2-)
Orange	Output 1+ (OUT 1+)
Yellow	Output 1 - (OUT 1-)

Unused wires must be left floating.

The use of a terminal box to protect electrical and data connections is mandatory.

The input and output signals are optically isolated, and the circuits are laid out in the figure:

Input

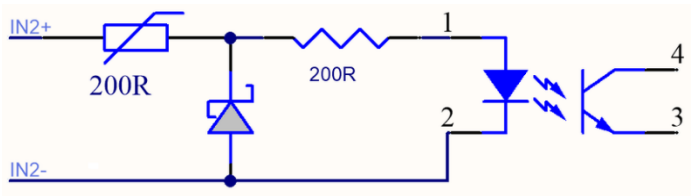


Figure 9 - ITSCAM 450+ isolated input signal circuit

Recommended current: 10mA

Maximum current supported: 20mA

Output

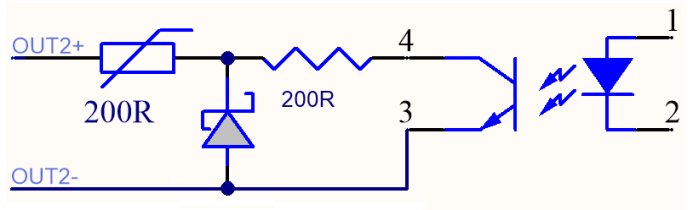


Figure 10 - ITSCAM 450+ isolated output signal circuit

Maximum current supported: 30mA

Maximum voltage supported: 28Vdc

The 200-ohm resistors at the input and output are intended to provide basic circuit protection. However, it is up to the user to ensure that the current circulating in both output and input does not exceed **20 mA**. Additional resistors must be inserted to reduce currents above the established limit. The circuit is sized so that the equipment can be connected to 5 Vdc voltage sources without the need for an additional resistor, in the same way for the ITSLUX illuminator trigger signal. Voltages higher than 5 Vdc require additional resistors to limit the current:

Source voltage	Additional resistor indicated
12Vdc	470 ohms
24Vdc	1000 ohms

Risk of Oxidation: The electrical and signal connections made in the ITSCAM 450+ bundle and the data network cable must be protected in a terminal box or similar structure to prevent oxidation of the connections and unwanted infiltration of liquids into the bundle.

5.1.1. Triggering on IOs

The ITSCAM 450+ has 2 outputs that are dedicated to controlling the activation of the illuminator and 2 inputs for the installation of external sensors, such as loops and light barriers, which identify the moment of capture of the images (trigger).

The configuration process is done by software, using the web interface of the device or the communication protocol. Entries in ITSCAM 450+ can be sensitized by: *Rising Edge, Rising Edge, High Level* and *Low Level*.

Specification of IOs: Maximum supported current of 50 mA and maximum supported voltage of 28 Vdc, but it is indicated to activate the circuit with 10 mA.

5.1.2. Flash or Illuminator Shot

When using illuminating devices with ITSCAM 450+, the flash shot output can be synchronized with the sensor exposure for image capture. To maximize the efficiency of these illuminators, this flash shot may occur a few moments before the capture by applying the *Delay* function. This function allows to set a delay in the exposure of the image sensor in relation to the flash shot, to wait until the flash reaches its peak of light emission. As a result, the image is generated with the greatest amount of light provided by the illuminator, as illustrated by the graph of the intensity of the flash over time, after its activation, and the *Delay* in the exposure of the image sensor:

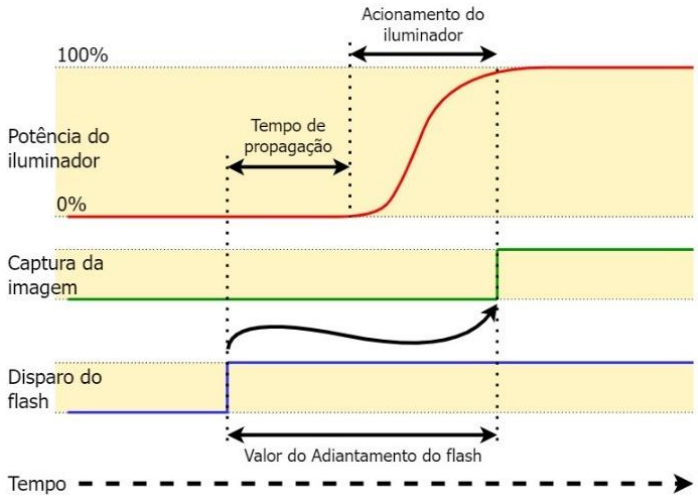


Figure 11 - Moment of Shutter trigger after flash intensification

5.2. Ethernet connection

The ITSCAM 450+ enables communication with other devices using the TCP/IP protocol. For such connection, the equipment provides a Fast Ethernet port (RJ-45 connector). It is indicated to use the EIA/TIA- 568A standard in the connections.

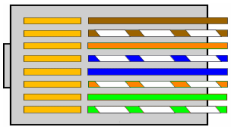


Figure 12 - RJ-45 connector standard EIA/TIA-568A

The Fast Ethernet connection speed is up to 100 Mbit/s with auto negotiation, compatible with the IEEE 802.3af standard.

6. Software Specifications

The ITSCAM 450+ has a web interface for evaluating the generated images and performing configurations. Access to the interface requires that the following be informed username and password, considering the factory default data on *First Access*.

The software features presented are detailed in the Integration Manual, which can be consulted for more information.

6.1. Image Capture Architecture

To meet the applications of Intelligent Transport Systems (ITS), the ITSCAM 450+ has several functionalities associated with image capture. These functionalities make up a general architecture and can be disabled by accessing the Image *Profiles* configured on the equipment. The image acquisition process begins with the image request method (*Trigger*). This request can be made using external sensors, connected to one or more ports of the ITSCAM 450+ (*Inputs*). In the configuration of the doors, it can be informed that the capture trigger will be done by edge (up, down, or both) or level (high and low).

There is an alternative to using external sensors connected to the ITSCAM 450+'s inputs, which is to set up a trigger to capture an image that is triggered by software. In this case, it can be triggered at a Constant time interval or when the device identifies movement in the image (*Motion trigger*), enabling the Motion Detector feature.

After the definition of the image capture flow of ITSCAM 450+, the Multiple Exposures per request functionality can be enabled. This technology allows you to configure two to four sequential images, with variations in capture parameters at each request.

The license plates of the vehicles in the image can be identified by enabling the OCR functionality, which is available for the countries specified in Generated Information. To increase the accuracy of the reading, the *Majority Vote* feature can be enabled. The feature that promotes more complete recognition of vehicles in images is the *Classifier*, which is responsible for identifying the type of vehicle detected in the image.

6.1.1. Motion Detector

The definition of movement between two consecutive ITSCAM 450+ images depends on the configured variation parameter, which considers for the *Motion Detector* a time interval between triggers and a variation *Threshold* required to be activated. In addition, it allows to specify a *Region of Interest*, which delimits the portion of the image in which the movement will be evaluated, corresponding to a polygon with four vertices, drawn over the visualization image.

6.1.2. Classifier

The ITSCAM 450+ is capable of analyzing the captured images in real-time and evaluating the content present in the images. This analysis aims to distinguish motorcycles, cars, trucks, and buses from images that display only the lane. This analysis has a degree of classification certainty, considering samples of images that were used to generate this analysis. It is important to inform the correct type of installation, as the ITSCAM 450+ can be used to capture two or one track simultaneously. In the case of two lanes, the *Panorama* scenario must be chosen.

The *Classifier's Enable object tracking* option allows defining regions that operate the *Virtual Loop* (*Virtual Trigger Regions*), by configuring the direction in which vehicles travel in each lane of the road, with capacity for up to four lanes).

6.1.3. Multiple Exposures

The *Multiple Exposure* functionality of the ITSCAM 450+ generates two to four sequential images per capture request, with different parameter settings. This feature can increase the hit rate in the automatic identification of the plates and identify vehicles that were covered up at the time of capturing the first image. Settings that may vary are:

- The intensity of the *Flash* always corresponds to a percentage of the initial shot. This option is available for the Pumatronix ITSLUX illuminator line;
- The exposure time of the image sensor (*Shutter*), generating images with variation in the amount of light captured;
- Digital post-processing (*Gain*), which allows you to lighten or darken images.

Thus, the different settings in each of the exposures allow, for example, the non-reflective plates to be clearly visualized in the first shot, and the second shot, with the low flash setting, allows the reflective plates to be better visualized by preventing them from being saturated in the image:

Figure 13 - Multiple Exposures during the day

Figure 14 - Multiple Exposures at night

6.1.4. OCR

The ITSCAM 450+ can recognize license plates of Brazilian, Argentina, Chile, Colombia, France, Mexico, Netherlands, Paraguay, Peru, and Uruguay vehicles simultaneously. When enabled, recognition is done on

all captured images. For the release of recognition of additional country plates, please contact Pumatronix Commercial.

Depending on the flow of vehicles and the required processing of ITSCAM 450+, the amount of processing threads can be changed. It is important to set a Processing Timeout, to discard the images in which the plate was not read. The effort spent on plate identification can be set in Processing Mode.

OCR recognition allows you to define an ROI (Region of Interest) on the image to reduce processing in regions of the image where you do not want to find a plate. In the ROI preview image, the size of the characters of the plates can be evaluated by configuring the size of the enabled grid, superimposed on the image preview.

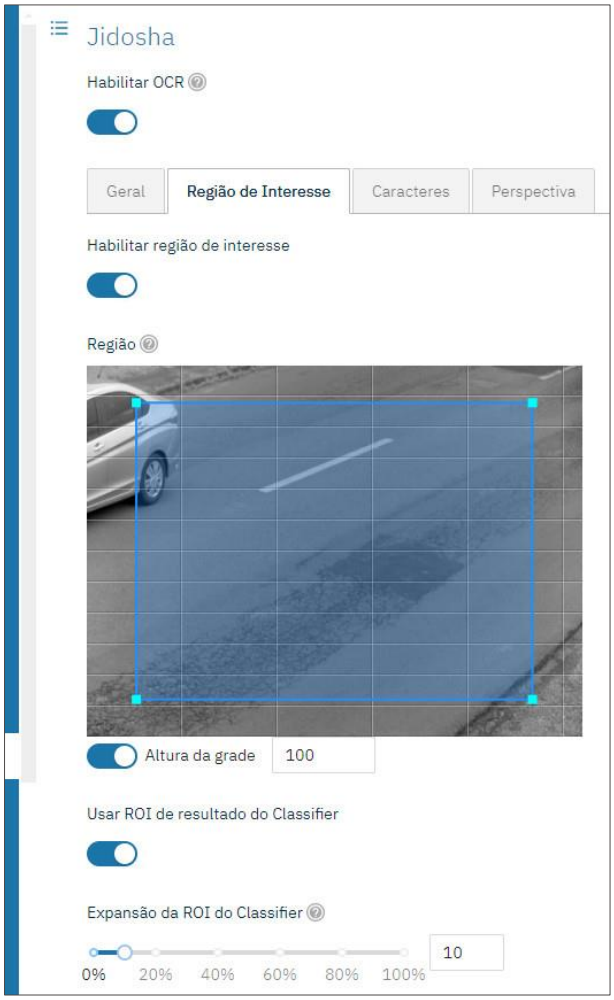


Figure 15 – ITSCAM 450+ web interface for configuring the OCR Region of Interest

6.1.4.1. Majority Vote

The Majority Vote is a feature applied to the results of the automatic character reading step of vehicle license plates (OCR) and/or *Classifier*. This analytic determines which string best describes the vehicle license plate captured in the image. The algorithm compares the identification reliability of each character, based on the image of the character in perfect reading condition. This analysis can be performed only on the set of images of the *Multiple Exposures* or when using sequential images. Just set the parameters of *Maximum different characters* and *Minimum interval between recognitions of identical plates*. During the passage of the vehicle through the region monitored by ITSCAM 450+, several images of the same vehicle

may be captured for processing. However, the option to *Send only the exposure with the best recognition* can be enabled and the other images will be discarded.

6.1.5. Automatic Transition Between Image Profiles

ITSCAM 450+ allows you to register up to four sets of equipment configurations, called Profiles. These settings correspond to image adjustments, framing (zoom and focus) and transition conditions between registered profiles. The change between profiles is automatic, when a time and/or image Level value is reached, which favors obtaining images with the ideal quality in any lighting situation. It is recommended to use one profile for captures with ambient light (daytime) and another for captures with artificial lighting (nighttime).

Refer to the Integration Manual for suggested settings for a profile's Transitions.

6.2. Information Security

Digital Signature and Data Encryption are the information security mechanisms generated by ITSCAM 450 family devices. Digital Signature technology ensures that the information received by the end user can be validated and in the event of an attempt to alter or manipulate the data, it will be promptly identified. Data Encryption ensures that only authorized recipients have access to the images, preventing unauthorized individuals from intercepting or viewing the information.

6.2.1. Digital Signature

ITSCAM 600 and ITSCAM 600 FHD intelligent capture devices are capable of signing all the images captured by the device. The digital signature mechanism uses asymmetric cryptography, using a public key in the PEM or P12 formats.

The public key can be generated internally by the ITSCAM device using a random seed mechanism or it can be generated externally and sent to the capture device via the graphical interface or the M2M API.

When the key is generated by ITSCAM, this process is first done in RAM and only the public key is then sent to the client on the web interface. The private one goes directly into the database.

If the key is generated externally, the storage process follows a similar procedure. The user only sends the public key to the device and this content, after format validation, is stored directly in the database from RAM memory.

The key is stored compressed in a Redis database that resides on the equipment's eMMC. Since the eMMC is a memory welded inside the device, the only way to compromise the key would be to physically remove the chip, find the Redis database file and exploit this file to locate the compressed key.

6.2.2. Encryption

Encryption is the security mechanism that can be configured for accessing the device and sending data to servers via secure protocols such as *https*, FTPS and SFTP, which are responsible for data security when TLS/SSL encryption is applied. This technology ensures that only authorized recipients have access to the images, maintaining the confidentiality of the data generated by the ITSCAM 450 family devices.

6.3. Receiving Images

The ITSCAM 450+ can send the captured images to vehicle storage and monitoring centers in the ways described:

Server	Interaction with ITSCAM 450+
FTP	The FTP server makes it possible to receive the images captured by ITSCAM 450+
ITSCAMPRO	The ITSCAMPRO type server is used to send images and plates read by the on-board OCR. ITSCAMPRO is an application that concentrates images and plates. Various types of reports can be viewed and generated (see Pumatronix for more information about the application)
Cougar	The sending Cougar protocol is of the TCP type (port 60000), proprietary to Pumatronix, which guarantees the highest degree of configuration and flexibility in integration. See the Onboarding Handbook for more information
Lince	The Lince server is Pumatronix's cloud-based SaaS platform, ideal for consolidating large numbers of devices and implementing image-based electronic fencing
REST API Client	The REST API Client allows the device to be integrated with a WEB REST server. Through a template language, the body of the submission and the headers can be customized to meet the needs of the server

7. Licensing

The license of ITSCAM 450+ covers the hardware of the image capture and processing device, with automatic and embedded recognition of the license plates of the vehicles present in the images (OCR) in the Brazilian, Argentina, Chile, Colombia, France, Mexico, Netherlands, Paraguay, Peru and Uruguay standards, in addition to the functionalities presented in this manual. For the release of recognition of additional country plates, please contact Pumatronix Commercial.

New features and bug fixes are made available in the new firmware versions, provided by Pumatronix Technical Support.

8. Initial Setup

8.1. Installation Prerequisites

The conditions at the monitoring site, before installation, are indispensable for the operation of the equipment.

8.1.1. Equipment installation location

To extract the best performance from the ITSCAM 450+, it is recommended that its installation be made parallel to the track and with little horizontal inclination. Concealment of parts of the image by objects such as trees or vehicles from other tracks must be avoided. In situations of reflections such as sunlight, adjust the *Sliding Flap* to the best position that can prevent interference in the quality of the images:

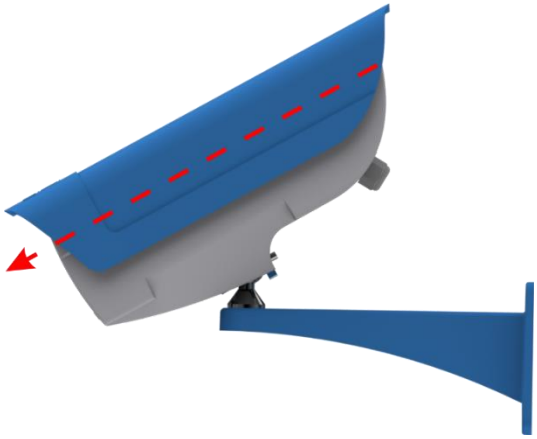


Figure 16 - Illustration of the direction of lens cover extension by the Sliding Flap

The zoom and focus adjustment are intended to produce images where the license plate characters are approximately 20 pixels high. However, the height of the characters can vary from 15 to 30 pixels, and the best recognition rates correspond to the height of 20 pixels.

In traffic inspection applications, ITSCAM 450+ can be installed on poles or gantries with a minimum height of 1.5 meters, which allows OCR reading considering the minimum angles and maximum tilt of the device. The minimum vertical angle of 15° and the maximum of 45° between the center of the lens and a line parallel to the ground must be respected, adjusting zoom and focus for the best visibility of the vehicle plate. Higher angles of vertical inclination generate significant deformations in the images, which implies a reduction in the automatic recognition rate of the license plates detected in the images.

The distance from the ITSCAM 450+ to the vehicle crossing point varies depending on the lens used. On model with an ITSCAM 450+ motorized lens, the distance applied must consider the estimated range for the lens, specified in Models. In nighttime operations, this distance varies according to the model of external lighting device used.

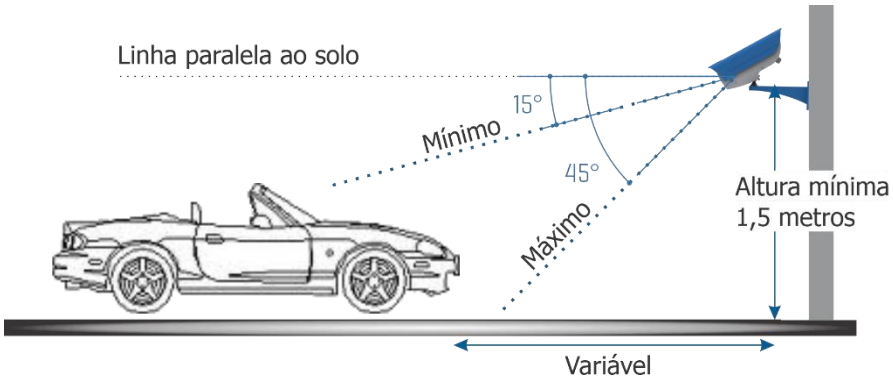


Figure 17 - Side view of the installation

The captured license plate must have a maximum horizontal angle of 30° to the side of the road:

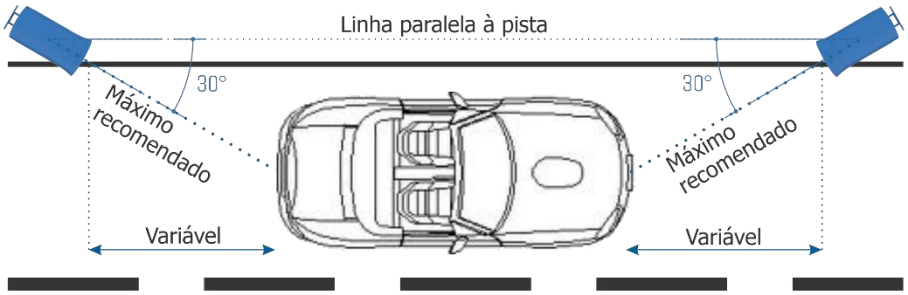


Figure 18 - Top view of the installation

Lighting Installation: When using a Lighting in conjunction with the ITSCAM 450+ device, check the product specifications for the minimum and maximum distance that must be observed in relation to the position of the object to be illuminated.

Installing the ITSCAM 450+ without following the stated distances compromises the quality of the images captured and reduces OCR recognition. If the requirements cannot be met at the installation location, it is recommended to consult Pumatronix Technical Support.

8.1.2. Necessary Infrastructure

At the place of attachment of the equipment, there must be:

- Power supply point in accordance with the Electrical Specifications, Electrical Specifications, close to the equipment installation point;
- Connectivity with the data network near the installation point of the equipment (based on the chosen mode);
- Sheltered place for cable splices, for example, junction box, near the installation point of the equipment;
- Drilling for fixing the 450+ support;
- Suitable screws for fixing the ITSCAM 450+ support the installation site;
- Availability of Auxiliary Configuration Equipment (for framing conference and image adjustments), with the Google Chrome browser (version 85 or higher) installed.

8.2. Necessary Conditions for Installation

To extract the best performance from the ITSCAM 450+, the installation must be carried out with little horizontal inclination and avoid the covering up of parts of the image with objects such as trees or vehicles from other lanes.

Check in the Installation and Maintenance Guide how to make the necessary connections.

Installation Location: In cases where it is not possible to meet the installation specifications, it is recommended to consult Pumatronix Technical Support.

8.2.1. Parameterization of the Network Interface

Ethernet Port Configuration	Default value
IP Address	192.168.0.254
Maintenance IP address	192.168.254.254
Network Mask	255.255.255.0

In situations where the network configuration of ITSCAM 450+ is different from the standard, it is indicated to change the settings prior to the physical installation of the equipment on site. The changed network configuration is saved in flash memory, however it is effectively applied after restarting the equipment. When the change is made by the web interface, the restart is automatic, after confirmation of the change.

The ITSCAM 450+ has a recovery IP address (*192.168.254.254*), for cases where the user changes the IP address mistakenly and loses connection to the device. The use of this IP address for access recovery is only available on a peer-to-peer connection with the equipment, when connected to the Ethernet port.

The maintenance IP address of ITSCAM 450+ (192.168.254.254) is disabled when the primary IP address conflicts with it. Therefore, when manually configuring the network interface (Ethernet) of the equipment, values other than the maintenance IP must be applied, as there will be no way to recover the connection in extraordinary situations of loss of the primary IP.

The most common primary and maintenance IP address conflict situations are:

- ITSCAM 450+ primary IP in range 192.168.254.x and netmask 255.255.255.0
- ITSCAM 450+ primary IP in range 192.168.x.x and netmask 255.255.0.0
- ITSCAM 450+ primary IP in range 192.168.254.x and netmask 255.0.0.0
- Netmask set to 0.0.0.0

8.2.2. Installation Guidelines

1) Fit the ITSCAM 450+ to the 450+ Support with 450+ Fixer;
2) Once the ITSCAM 450+ positioning distances have been respected (as indicated in Equipment Installation Location), attach the device with 450+ Support. By fixing it on the ceiling (upside down) it is possible to configure the equipment to *Rotate the image by 180º* through the web interface;
3) Adjust the position of the ITSCAM 450+ in 450+ Support so that images are captured of the region in which the vehicles travel. If necessary, it is possible to crop the image, selecting only the region of interest (ROI) of the image in which the vehicles are effectively visible for image generation. In this option, the conversion time to JPEG is improved and does not affect *Streams* or live viewing;
4) Connect the the wires corresponding to the power supply, described in Electrical Connections, if DC power or equipment IOs are used:

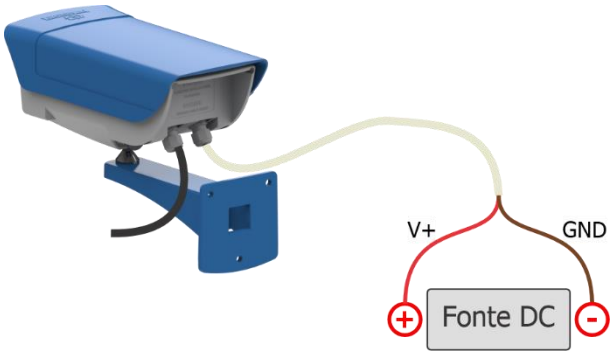


Figure 19 - Power and Signal Connector of ITSCAM 450+

9. First Access

The web interface of the ITSCAM 450+ can be used to quickly check the status of the equipment and the monitoring of the images in real-time. However, the equipment must be energized, following the Electrical Specifications. Availability of *Auxiliary Configuration Equipment* (for framing conference and image adjustments), with the Google Chrome browser (version 85 or higher) installed.

In addition, the *Auxiliary Configuration Equipment* must be on the same data network in ITSCAM 450+ (with a network configuration compatible with that performed in ITSCAM 450+). If a point-to-point connection is used, access to ITSCAM 450+ can be done through the maintenance IP address 192.168.254.254. When entering the IP address of ITSCAM 450+ in the browser address bar of the *Auxiliary Configuration Equipment*, it must be informed:

User	*admin*
Password	*1234*

Figure 20 – Web Interface Access Screen of ITSCAM 450+

10. Care and Maintenance

Some care is needed to ensure the performance of the product and extend its service life.

Product Risks: The use of the product presents risks, which are presented in the Handling Risks section.

10.1. Software Update

Pumatronix periodically provides updates to the ITSCAM 450+ with corrections of defects and inclusions of functionalities, by contacting Technical Support on the Pumatronix website. The device update process requires connecting to an Auxiliary Configuration Equipment that allows access to the ITSCAM 450+ Web Interface, using one of the Web browsers:

- Microsoft Edge 109 or higher;
- Google Chrome versão 85 or higher;
- Firefox versão 21 or higher;
- Opera 25 or higher;
- Safari 8 or higher.

Updating the ITSCAM 450+ firmware requires some security measures during the procedure, to prevent the file from being corrupted and the ITSCAM 450+ device from stopping working:

1) Keep the ITSCAM 450+ device inactive during the update process, ensuring it is not requested by any service or other equipment on the network where it is installed;
2) Keep the ITSCAM 450+ device always on during the execution of the update, taking the necessary measures to prevent it from being restarted or turned off;

Request the firmware file by filling out the form available in the Technical Support menu on the Pumatronix website:

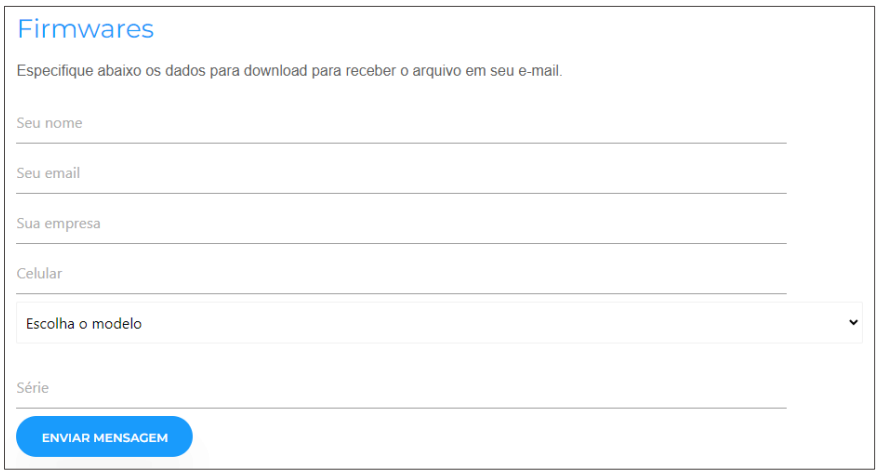


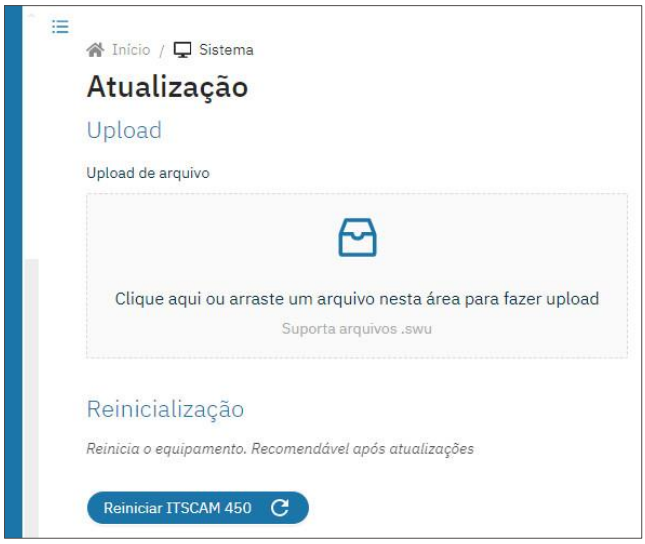
Figure 21 – Firmware Request Form

If you have any questions, please contact Technical Support at suporte@pumatronix.com or WhatsApp +55 (41) 9203-8327.

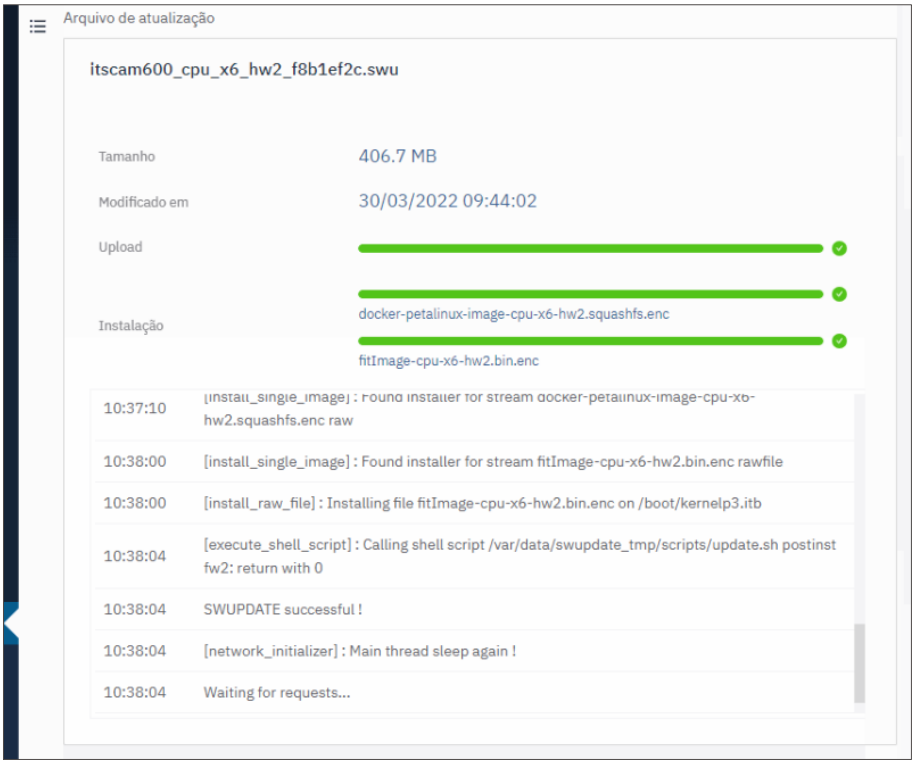
* Pumatronix will provide versions with bug fixes or security improvements for up to 3 years after the product is discontinued and removed from the portfolio.

10.1.1. ITSCAM 450+ Firmware Update via Web Interface

1) Download the firmware file received by email (which starts with the name itscam450 and has the extension .swu) onthe *Auxiliary Configuration Equipment* that will be used to connect to the ITSCAM 450+;
2) Connect the *Auxiliary Configuration Equipment* to the same data network as ITSCAM 450+;
3) Open the *Auxiliary Configuration Equipment* browser;
4) Enter the IP address of ITSCAM 450+ (the default IP address is 192.168.0.254 and point-to-point connections can be made at 192.168.254.254);
5) Enter username and password;
6) Access the menu *System* > *Update* of the web interface of ITSCAM 450+:



7) Select or drag the firmware file (the update starts automatically and occurs in three steps, which are signaled by the progress bar);
8) Follow the *Upload* to reach 100%, and then the Installation, making sure that the device is not restarted or turned off and is not being requested by any service or other equipment on the network during the process. This security is necessary when performing this procedure to prevent the update from corrupting the firmware and causing the equipment to stop functioning;
9) Check the *SWUPDATE* successful message! which indicates the completion of the installation;



10) Click the *Reset ITSCAM 450* button;
11) Wait for the equipment to be restarted for the new firmware changes to be applied;
12) Finish the upgrade procedure by checking the firmware version indicated in the bar on top of the page.

10.2. Updating Analytics Licenses

The licenses of the *Classifier* and OCR image analytics libraries can be updated directly through the web interface. When receiving the *.lic* file provided by Technical Support, go to the *System menu > Licenses* in the interface:

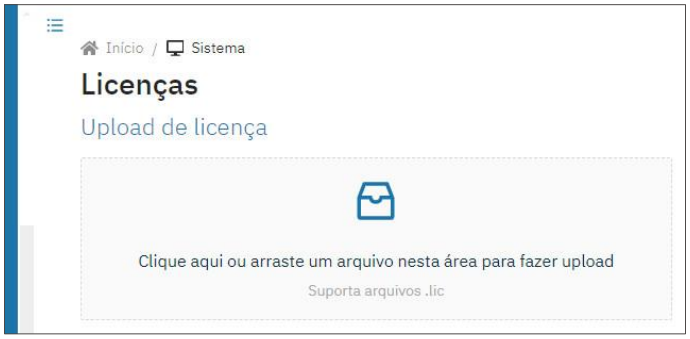


Figure 22 – ITSCAM 450+ web interface for license update

10.3. Preventive Maintenance of ITSCAM 450+ Device

The ITSCAM 450+ image capture and processing device shall provide artifact-free images. However, if the outer surface of the lenses or protective housing has any dirt, the cleaning procedure must be performed:

1) Spray lens cleaning liquid onto the lens surface or water onto the protective housing glass, allowing the removal of excess dirt adhered to the surface;
2) Use a soft, fiber-free cloth to remove dirt by moving the cloth in only one Direction;

3) Wipe a dry cloth after finishing the cleaning and do not use force, as it is possible to damage the surface.

11. General warranty conditions

Pumatronix guarantees the product against any defect in the material or manufacturing process for a period of 1 year from the date of issuance of the invoice, provided that, at the discretion of its authorized technicians, a defect is found under normal conditions of use.

The replacement of defective parts and execution of services arising from this Warranty will only be carried out in the Authorized Technical Assistance of Pumatronix or a third party expressly indicated by it, where the product must be delivered for repair.

This Warranty will only be valid if the product is accompanied by a Maintenance Form duly completed and without erasures and accompanied by an Invoice.

11.1. Situations in which the Product loses its warranty

1) Use of software/hardware not compatible with the specifications of the Manual;
2) Connection of the product to the mains outside the standards established in the product manual and installations that present excessive voltage variation;
3) Infiltration of liquids from the opening/closing of the product;
4) Damage caused by natural agents (electric discharge, flood, sea spray, excessive exposure to climatic variations, among other factors) or excessive exposure to heat (beyond the limits established in the Manual);
5) Use of the product in environments subject to corrosive gases, with excessive moisture and/or dust;
6) Show signs of tampering with security seals;
7) Present opening and modification signals made by the Customer in product locations not authorized by Pumatronix;
8) Damage caused by accidents/falls/vandalism;
9) Display tampered and/or removed serial number;
10) Damage arising from the transport and packaging of the product by the Customer under conditions incompatible with it;
11) Misuse and in disagreement with the Instruction Manual.

12. Privacy Policy

Under the General Data Protection Law (LGPD) - Law No. 13.709, of August 14, 2018, this product has programmable functions for the capture and processing of images that may infringe the LGPD when used, together with other equipment, to capture personal data.

The equipment does not collect, use or store personal information, whether sensitive or not, for its operation.

Pumatronix is not responsible for the purposes, use, and treatment of the images captured, and the control of the information and forms of operation of the product are the sole decision of the user or purchaser of the product.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