FLUKE
Process Instruments

ThermoView® Series

Thermal Imager Camera

Users Manual

PN 59802
May 2018, Rev. 1.0, 05/2018

Warranty

The manufacturer warrants this instrument to be free from defects in material and workmanship under normal use and service for the period of two years from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, batteries, or any product which has been subject to misuse, neglect, accident, or abnormal conditions of operation.

In the event of failure of a product covered by this warranty, the manufacturer will repair the instrument when it is returned by the purchaser, freight prepaid, to an authorized Service Facility within the applicable warranty period, provided manufacturer's examination discloses to its satisfaction that the product was defective. The manufacturer may, at its option, replace the product in lieu of repair. With regard to any covered product returned within the applicable warranty period, repairs or replacement will be made without charge and with return freight paid by the manufacturer, unless the failure was caused by misuse, neglect, accident, or abnormal conditions of operation or storage, in which case repairs will be billed at a reasonable cost. In such a case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. THE MANUFACTURER SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

Software Warranty

The manufacturer does not warrant that the software described herein will function properly in every hardware and software environment. This software may not work in combination with modified or emulated versions of Windows operating environments, memory-resident software, or on computers with inadequate memory. The manufacturer warrants that the program disk is free from defects in material and workmanship, assuming normal use, for a period of one year. Except for this warranty, the manufacturer makes no warranty or representation, either expressed or implied, with respect to this software or documentation, including its quality, performance, merchantability, or fitness for a particular purpose. As a result, this software and documentation are licensed "as is," and the licensee (i.e., the User) assumes the entire risk as to its quality and performance. The liability of the manufacturer under this warranty shall be limited to the amount paid by the User. In no event shall the manufacturer be liable for any costs including but not limited to those incurred as a result of lost profits or revenue, loss of use of the computer software, loss of data, the cost of substitute software, claims by third parties, or for other similar costs. The manufacturer's software and documentation are copyrighted with all rights reserved. It is illegal to make copies for another person.

Disclaimer for Export Control Classification

These products are controlled under ECCN 6A003.B.4.B and an export license is needed for certain destinations. Please see RS1 controls for licensing requirements.

Specifications subject to change without notice.

COMPLIANCE STATEMENT

The device complies with the requirements of the European Directives.
EC – Directive 2014/30/EU -- EMC
EC – Directive 2011/65/EU -- RoHS II

EN 61326-1: 2013	Electrical measurement, control and laboratory devices - Electromagnetic susceptibility (EMC)
EN 50581: 2012	Technical documentation for the evaluation of electrical products with respect to restriction of hazardous substances (RoHS)

Electromagnetic Compatibility Applies to use in Korea only. Class A Equipment (Industrial Broadcasting & Communication Equipment)
This product meets requirements for industrial (Class A) electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and is not to be used in homes.

Contacts

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1. Safety Instructions

This document contains important information, which should be kept at all times with the instrument during its operational life. Other users of this instrument should be given these instructions with the instrument. Eventual updates to this information must be added to the original document. The instrument can only be operated by trained personnel in accordance with these instructions and local safety regulations.

Acceptable Operation
This instrument is intended only for the measurement of temperature. The instrument is appropriate for continuous use. The instrument operates reliably in demanding conditions, such as in high environmental temperatures, as long as the documented technical specifications for all instrument components are adhered to. Compliance with the operating instructions is necessary to ensure the expected results.

Unacceptable Operation
The instrument should not be used for medical diagnosis.

Replacement Parts and Accessories
Use only original parts and accessories approved by the manufacturer. The use of other products can compromise the operation safety and functionality of the instrument.

Instrument Disposal

Disposal of old instruments should be handled according to professional and environmental regulations as electronic waste.

Operating Instructions
The following symbols are used to highlight essential safety information in the operation instructions:

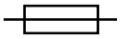
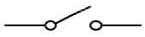
Helpful information regarding the optimal use of the instrument.

Warnings concerning operation to avoid instrument damage and personal injury.

Pay attention to the following safety instructions:

Use in 115/230 V~ electrical systems can result in electrical hazards and personal injury, if not properly protected. All instrument parts supplied by electricity must be covered to prevent physical contact and other hazards always.

Table 1: General Symbols

Symbol	Definition
	AC (Alternating Current)
	DC (Direct Current)
	Risk of danger. Important information. See manual.
	Hazardous voltage. Risk of electrical shock.
	Helpful information regarding the optimal use of the instrument.
	Earth ground
	Protective ground
	Fuse
	Normally-open (NO) relay
	Normally-closed (NC) relay
	Switch or relay contact
	DC power supply
	Conforms to European Union directive.
	Disposal of old instruments should be handled according to professional and environmental regulations as electronic waste.

2. Product Description

The ThermoView® Series infrared cameras are rugged thermal imaging infrared cameras, designed for industrial process control applications, to withstand an IP67 rating in demanding industrial environments. An IP67 rating is just valid, if the chosen ThermoView® camera operates with it's standard lens and has no external add-on lens attached. External add-on lenses are not water tight and have a degraded IP54 rating. All ThermoView® Series infrared cameras are noncontact, highly sensitive infrared thermal imaging cameras with motorized and software controlled variable focus capability. In addition, a fixed focus (640 by 480 pixel, 15 fps) Visible Light Camera (VLCM), positioned in the lower left corner of the front, is integrated to support the sighting functionality.
The infrared radiation, emitted from measured objects, is detected and converted into an electrical signal by a two-dimensional uncooled focal plane array detector. After this, the amplified analog temperature signal is converted into a digital signal, which can be displayed and analysed as a thermal image in color or black & white on a PC-software application. The ThermoView® Series infrared cameras are equipped with a GigE Vision network interface, which supports the PoE standard IEEE 802.3at (Power over Ethernet, max. 25.4 W, 1 Gbit data). Such a high-speed interface allows an easy networking and power supply over long distances. Via the GigE Vision interface, the camera control and the infrared image data transmission for 9 and 60 Hz (frames per second) ThermoView® Series cameras in 640 x 480 pixel infrared resolution is possible. For long Ethernet cable runs beyond 90 m (295 ft), additional fiber optic Ethernet accessories are available.

Table 2: Available Models

Model	Temperature Range	Resolution (pixels / IFOV)	Lens Type	Field of View Horizontal x Vertical	Focus
TV43	-10 to 1200°C (14 to 2192°F)	320 x 240 ..... 1.86 mrad with standard lens	Standard Lens	34° x 25.5°	Software controlled
			0.75 x Wide	45° x 34°	Software controlled
			2 x Tele	17° x 12.7°	Software controlled
			4 x Tele	8.5° x 6.3°	Software controlled
			Macro-Lens	7.8 x 4.1 mm (0.31 x 0.16 in)	fixed at 11 mm (0.42 in)
TV46	-10 to 1200°C (14 to 2192°F)	640 x 480 ..... 0.93 mrad with standard lens	Standard Lens	34° x 25.5°	Software controlled
			0.75 x Wide	45° x 34°	Software controlled
			2 x Tele	17° x 12.7°	Software controlled
			4 x Tele	8.5° x 6.3°	Software controlled
			Macro-Lens	11 x 8.2 mm (0.43 x 0.32 in)	fixed at 11 mm (0.42 in)

Figure 1: Front and rear view of ThermoView® Series infrared cameras

2.1. System Architecture

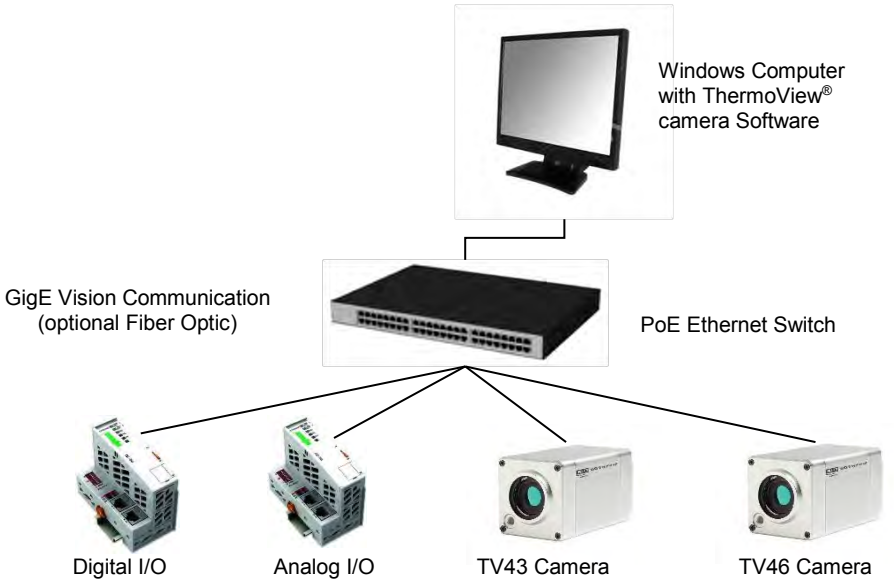


Figure 2: Typical System Architecture for Multi ThermoView® Camera Usage

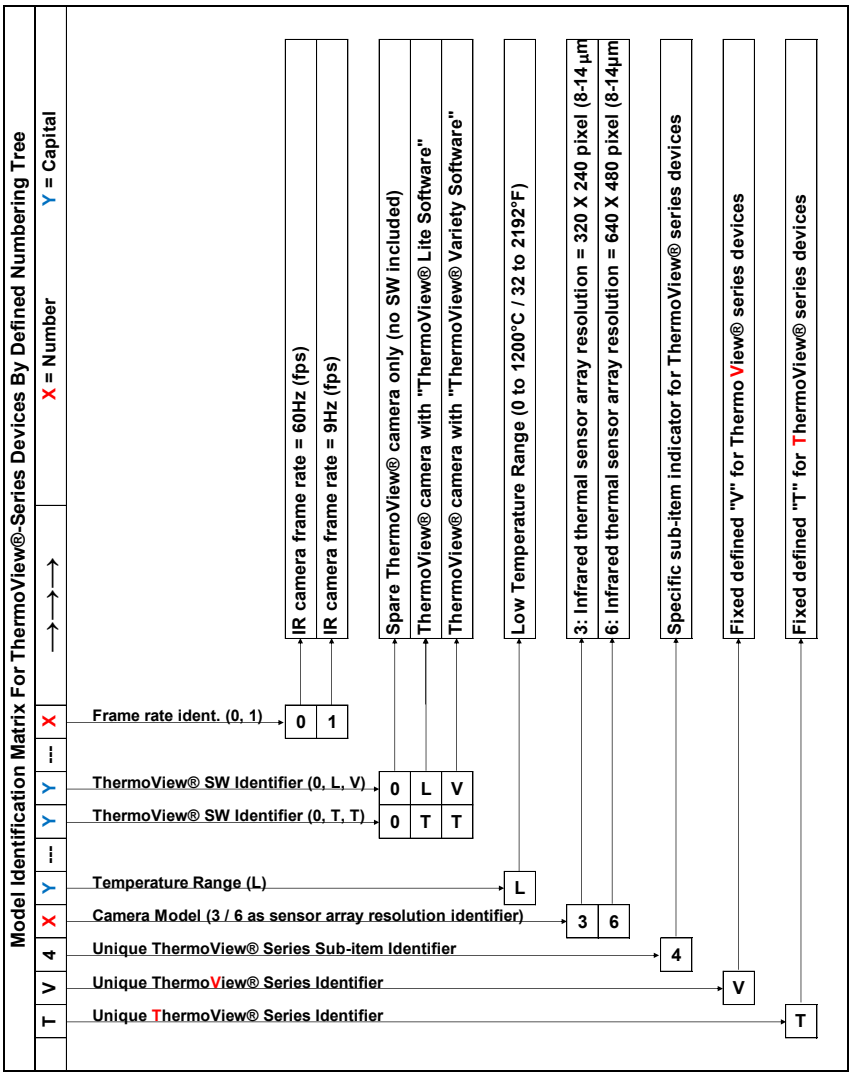


Figure 3: Identification matrix for ThermoView® infrared cameras

3. Technical Data

3.1. General Specifications

General Specifications	
Device / **Model** / **Parameter**	**TV43 & TV46**
Environmental rating/protection	IP67 (IEC 60529)
Ambient OperatingTemperature	-10°C to 50°C (14°F to 122°F)
Storage Temperature	-20°C to 70°C (-4°F to 158°F)
Relative Humidity	10% to 95%, non-condensing
Mechanical Shock Resistance	IEC60068-2-27: 50 G, 6 msec, 3 axis
Mechanical Vibration Resistance	IEC60068-2-26: 3 G, 11-200 Hz, 3 axis
Warm-up Time	max. 5 min.
Weight	approx. 1 kg (2.2 lb)
Housing Material	Aluminum, bright dipped, anodized, clear coated
Dimensions	83 mm (3.27 in) x 83 mm (3.27 in) x 154 mm (6.0 in) (Width x Height x Length)
Sighting Frame rate (9 fps or 60 fps) for thermal camera needs to be specified at time of order	TV43 (Thermal): 320 x 240, 9 fps / 60 fps TV46 (Thermal): 640 x 480, 9 fps / 60 fps Visible light camera: 640 x 480, 15 fps

3.2. Electrical Specifications

Electrical Specifications	
Device Model / **Parameter**	**TV43 & TV46**
Power Supply	12VDC - 26VDC, ± 5% Power over Ethernet (IEEE 802.3at)
Power Consumption	16 W (Max)
LED Indicator	Indicates power on and system error codes
Digital Communication Interface	GigE Vision - Full duplex, 1000 Mbit - PoE IEEE 802.3at, Mixed DC & data - TCP/IP, UDP, http, Web-Server

3.3. Measurement and Optical Specifications

Measurement Specifications		
Parameter \ **Device Model**	**TV43 & TV46**	
Measuring range	Standard: -10°C to 1200°C (14°F to 2192°F)	
Accuracy	± 2°C or ± 2% of reading (whichever is greater)	
Infrared resolution (number of pixels)	TV43: 320 x 240 (76800) TV46: 640 x 480 (307200)	
Spectral range	8 – 14 µm	
Emissivity correction	0.10 to 1.00	
Field of View (aperture angle)	TV43 (horiz. x vert.)	TV46 (horiz. x vert.)
• **Integrated Standard Lens only**	34° x 25.5°	34° x 25.5°
• **Add-On Lens (Wide Angle)**	45° x 34°	45° x 34°
• **Add-On Lens (2 x Telephoto)**	17° x 12.7°	17° x 12.7°
• **Add-On Lens (4 x Telephoto)**	8.5° x 6.3°	8.5° x 6.3°
• **Add-On Lens (Macro)**	7.8 x 4.1 mm (0.31 x 0.16 in)	11 x 8.2 mm (0.43 x 0.32 in)
Focus range IR camera		
• **Integrated Standard Lens only**	152 mm (5.9 in) to ∞ (motorized remote focus)	
• **Add-On Lens (0.75X Wide Angle)**	152 mm (5.9 in) to ∞ (motorized remote focus)	
• **Add-On Lens (2X Tele)**	406 mm (16 in) to ∞ (motorized remote focus)	
• **Add-On Lens (4X Tele)**	2540 mm (100 in) to ∞ (motorized remote focus)	
• **Add-On Lens (1.43X Macro)**	11 mm (0.42 in) (fixed fokus)	
Focus range Visible Light camera	600 mm (23.6 in) - ∞ (fixed focus)	

3.4. Dimensions

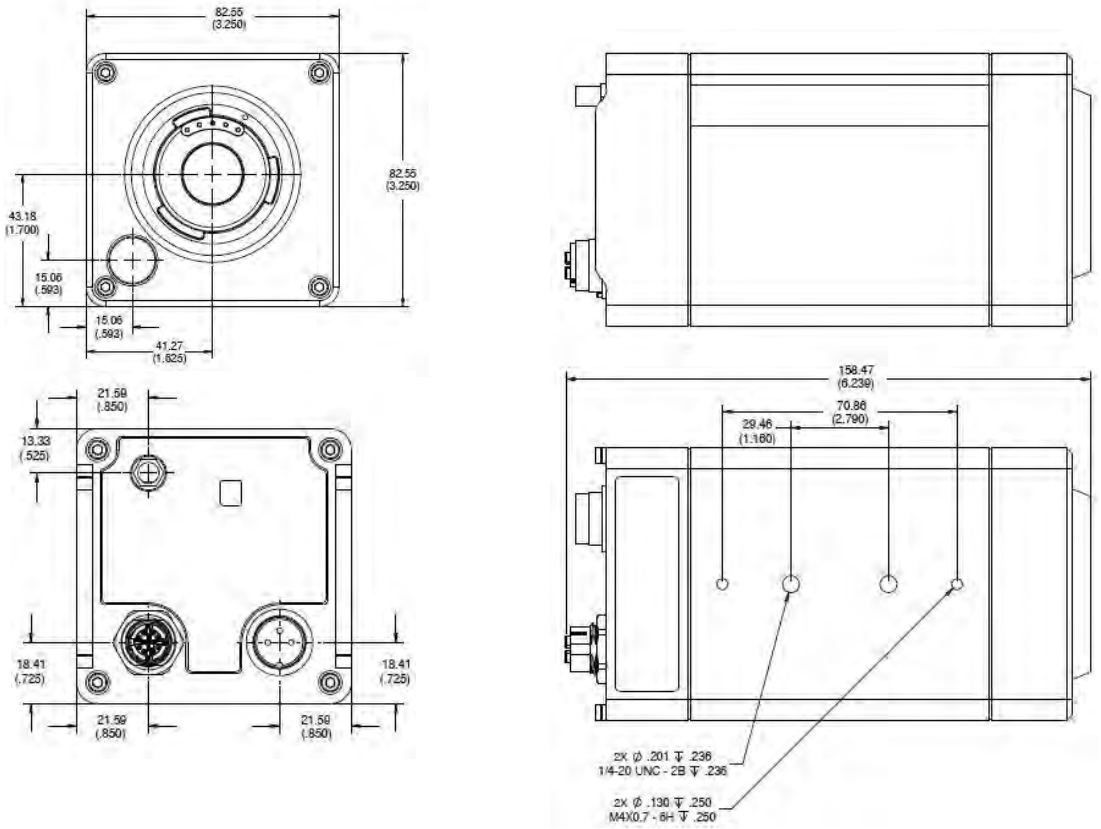


Figure 4: Front, Rear and Side View Dimensions of Standard ThermoView® Imager

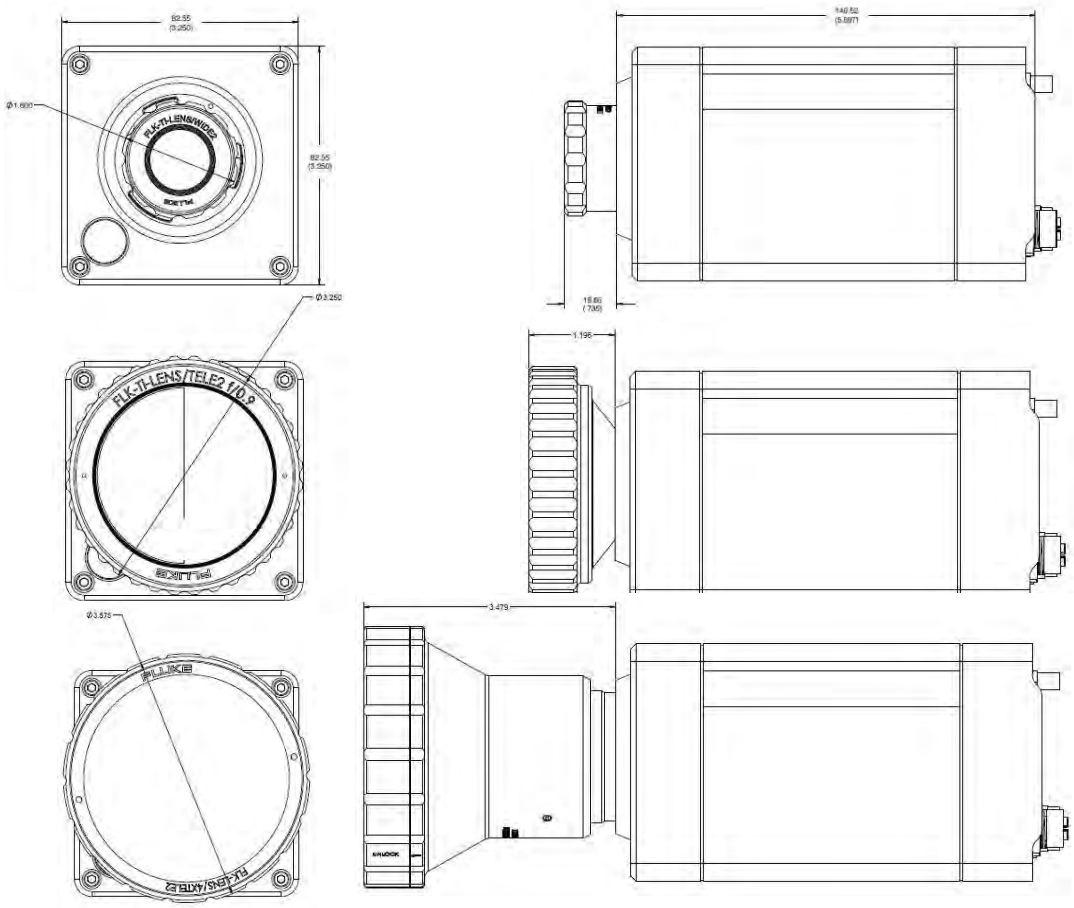


Figure 5: Dimensions of ThermoView® Imager with Add-On lenses

It must be considered, that there is no obstruction or coverage of the left below integrated visible light camera, if just the integrated Standard lens is used. An attached Wide-Angle lens will have a partial obstruction of the visible light camera, but is still operational. If a 2x-Tele, a 4x-Tele or a Macro lens is attached, the visible light camera window is nearly fully covered and can't be used for sighting support.

3.5. Scope of Delivery

The ThermoView® standard device delivery includes the following:

- ThermoView®-Series IR Camera
- User Manual and Quickstart are stored in the camera memory
- Metal sealing connector caps for GigE connector and power connector
- Printed version of Safety Data Sheet & Quickstart are in camera box

4. Basics to keep in mind

4.1. ThermoView® TV40 Imager Location

The ThermoView® imager location and configuration depends on the application. Before deciding on a location, you need to be aware of the ambient temperature, the atmospheric quality and the possible electromagnetic interference at the location. If you plan to use air purging, you need to have an air connection available. Also, wiring and conduit runs must be considered, including computer wiring and connections, if used. The following subsections cover topics to consider before you install the ThermoView® camera.

4.2. Measurement of Infrared Temperatures

Every object emits an amount of infrared radiation (IR) according to its surface temperature. The intensity of the infrared radiation changes with the temperature of the object. Depending on the material and surface properties, the emitted radiation lies in a wavelength spectrum of approximately 1 to 20 µm. The intensity of the infrared radiation (heat radiation) is dependent on the material. For many substances, this material-dependent constant is known. It is referred to as **emissivity value**. See appendix 9.1 Typical Emissivity Values on page 39.
Infrared cameras are optical-electronic sensors. These sensors can detect radiation sources of heat. Infrared cameras consist of a lens, spectral filter, sensor array, and an electronic signal processing unit. The task of the spectral filter is to select the wavelength spectrum of interest. The sensor converts the infrared radiation into an electrical signal. The connected electronics processes this signal for further analysis. The intensity of the emitted infrared radiation is thereby used to determine the temperature of the target. Since the intensity of the infrared radiation is dependent on the material, the appropriate emissivity can be selected on the sensor. The biggest advantage of the infrared camera is its capability for the contactless determination of target surface temperatures. Consequently, surface temperatures of moving or hard to reach objects can be easily measured.

4.3. Emissivity of Target Object

For accurate surface temperature readings, the IR camera must be set to the appropriate emissivity value for the target material. Determine the emissivity of the target object, as described in the appendix. When measuring materials with low emissivity, the results could be effected by interfering infrared radiation from background objects (such as heating systems, flames, fireclay bricks, etc. near to or behind the target object). This type of problem can occur when measuring reflective surfaces and very thin materials, such as plastic films and glass. This error can be reduced to a minimum if care is taken during installation, and the camera is shielded from reflected infrared radiation.

5. Installation

5.1. Ambient Temperatures

Without water cooling, the ThermoView® camera is designed for ambient operating temperatures between -15 to 50°C (5 to 122°F). With water cooling equipment, it can be used in environments at higher temperatures.

5.2. Environment

The pure ThermoView® infrared camera without any attached external lens complies with the international protection standard IP67.
Please note, that the international protection class of IP67 must be downgraded to IP54, if an external add-on lens is attached. Such lenses are not watertight or splash-proof and don't resist harsh environment conditions.
Note that effectiveness against splashing under IP67 is possible only, if terminal caps are in place and all external connectors are connected and comply to IP67 too. To retain the given IP67 protection class, please inspect periodically all seals of the waterproof connectors and end caps.

5.3. Electrical Interference

To minimize electrical or electromagnetic interference, follow these precautions:

- Mount the unit as far away as possible from possible sources of interference such as motorized equipment producing large step load changes!
- Ensure a fully insulated installation of the unit (avoid ground loops!).
- Make sure the shield wire in the unit cable is earth grounded at one location!

When installing the ThermoView® infrared camera, check for any high-intensity discharge lamps or heaters that may be in the field of view (either background or reflected on a shiny target)! Reflected heat sources can cause a sensor to give erroneous readings.

5.4. Geometry

The camera provides different lens models to accommodate a wide range of applications. Each individual lens provides different thermal images (Field of View) and minimum detectable pixel sizes (Instantaneous Field of View). The optical diagram below shows the principal graphical representation for measuring distance over the field of view.

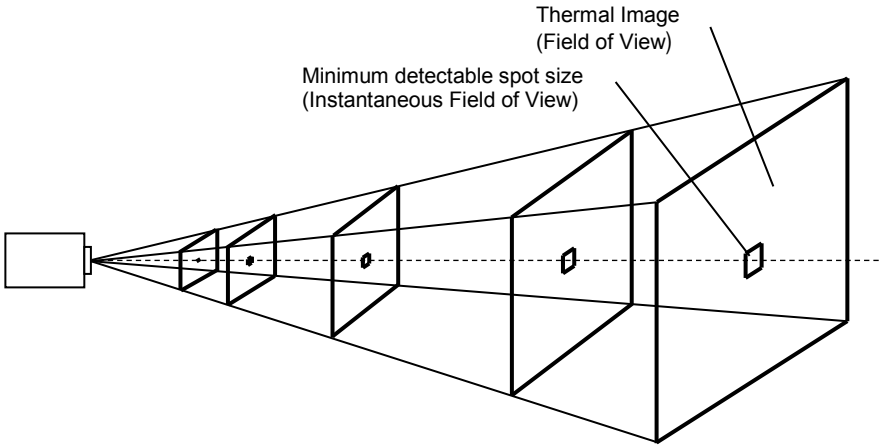


Figure 6: Field of View for the Camera

5.4.1. Spot size (IFOV) calculation of aperture angle for different lens types

It is important that the ThermoView® camera is mounted at a distance from the target, sufficient to be able to “see” the entire area of interest. For this reason, the manufacturer provides a web-based software tool, which allows the pixel size or Instantaneous Field of View (IFOV) calculation for a given lens, based on a specific camera mounting distance. The web-based spot size calculator also covers several other infrared temperature measurement devices and will be found in the product specific section under the following web-link address:

Figure 7: Picture extract of the ThermoView® Field of View Calculator

5.5. Focusing

After the camera has been mounted, it is important to make sure that the optimum focus has been established for the given mounting distance. It is important to focus the camera correctly to obtain the sharpest image of the target you wish to view. The motorized focus of the ThermoView® imager camera can be set via the PC software over the GigE Vision interface.

Figure 8: Focusing the ThermoView® camera via PC Software (no manual focus)

It should be noted, that if the focus changes or the camera is moved from its installed location, the user must make sure that a new focus setting has been achieved.

5.6. Mounting

The camera installation requires the most planning effort. The camera needs to be accurately mounted in relationship to the product (target). Adjustments to align the camera with the target may have to be designed into the camera mounting to provide the required alignment accuracy. Avoiding or removing physical mounting limitations and obstructions in the camera's optical path, may also be required.

5.7. Cable Connections

Before connecting and disconnecting any connector, make sure that the device is unpowered!

5.7.1. Connecting the GigE Vision Ethernet Communication Cable

The standard GigE Vision Ethernet cable comes with an IP67 rated M12 connector assembled to one end of the camera, and an IP20 rated RJ45 connector at the other end. The standard low temperature (LT) cable is about 5 mm (0.2 in) in outer diameter and 7.5 m (25 ft) long. Other cable lengths are available as an accessory. The cable withstands ambient temperatures up to 80°C (176°F).

To connect the GigE Vision Ethernet cable follows the steps below:

1. Remove the rear metal sealed connector cap for the GigE M12 connector
2. Attach the male GigE M12 cable plug straight into the female GigE terminal at the rear side of the ThermoView® camera body by turning the outer mounting thread in clockwise direction
3. Attach the corresponding GigE RJ45 connector to the related device, like Ethernet switch, computer, fiber optic converter or PLC.

5.7.2. Connecting the Power Supply Cable

The power supply cable comes with a three-socket female M16 connector, assigned to the cameras rear three pin male M16 connector. The corresponding end of the power supply cable is carried out as a pig tail, to connect to an external power supply device. The standard cable is about 5 mm (0.2 in) in outer diameter and is 7.5 m (25 ft) long. The cable withstands ambient temperatures up to 80°C (176°F).

To connect the power to the ThermoView® camera, follow the steps below:

1. Connect the power connector to the camera
2. Tighten the outer nut of the female connector
3. Supply the open pig tail ends with power (12VDC - 26VDC). Take care about the right polarity and connect the **brown** wire to Ground (-) and the **white** wire to +VDC

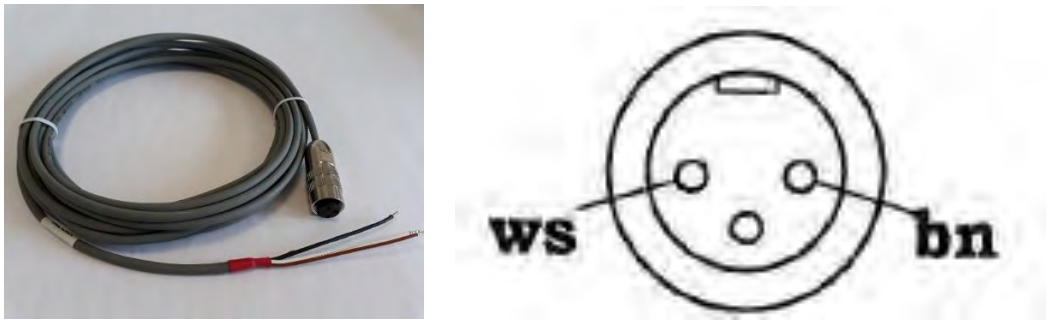


Figure 9: Power Connector

Be very careful in wiring the pig tailed end of the power cable – making sure that the conductor colors on the cable match the correct terminals on the power supply!

The cable shield must be connected to earth ground!

The external power supply must be in the range of 12 VDC to 26 VDC.

An external DIN rail mounted power supply is as an accessory available and allows to power two cameras, I/O modules or fiber optic converters in parallel.
Please refer to section 7.1.9, 24 VDC 1.3 A industrial power supply, DIN rail mount (A-PS-DIN-24V).

5.8. GigE Vision Communication

The GigE Vision communication is based upon the very fast Gigabit Ethernet (GigE) link, which allows data rates of up to 125 MB/s over cable runs up to 100 m (328 ft.). For digital cameras, especially in the professional image processing domain, is GigE the first-class interface. Even complex installations with multiple cameras are easy feasible and allow a wide support for many devices. In general, a GigE compliant camera can be powered over the GigE interface (PoE). An additional power supply isn't needed, if a specific PoE-injector or PoE-switch is used to power the camera via the 8-wire data cable. Besides the clear defined physical GigE interface, the GigE Vision standard enhancement exists, to define specific data protocols, data frames, register sets and communication rules. The clear and logical implementation of the GigE Vision standard eases the integration into all image processing software programs via specified software libraries. Such proceeding allows an easy and cost-effective way to exchange a GigE Vision compatible camera by another GigE Vision compliant one, without changing the software application.

The advantages of the GigE interface are:

- High data rates of up to 125 MB/s
- Reuseability of existing Ethernet structure
- Cable length up to 100 m (328 ft.)
- Easy integration into image processing software by use of libraries
- High degree of standardization by GigE and GigE Vision standards
- PoE-functionality: Power the camera over the 8-wire Ethernet cable

5.9. ThermoView® LED Status Indicator

The ThermoView® imager camera has a built-in multi-color LED in the rear panel, which indicates the current health and alarm status.

Figure 10: Position of the ThermoView® camera status indicator LED

The current LED patterns are:

1. Blinking yellow – in u-boot
2. Solid yellow – Linux kernel loaded and system is booting Linux (loading drivers, etc.)
3. Solid green – no errors, IP address obtained and Ethernet cable connected
4. Blinking red – various errors (can't talk to engine)
5. Blinking green – Flash memory being updated (either SOC or engine)
6. Solid blue – shutter closed
7. Solid red – over temperature

Please note that the camera displays these patterns in a priority order, higher numbered events mask lower numbered events. So, for example, we may be connected to the Ethernet (solid green), but have an over-temperature condition. In that case, we would display solid red until the over-temp condition cleared, then we would display solid green.

6. Internal ThermoView® Web-Server Application

The ThermoView® imager is equipped with an onboard web-server. Several informations are available by call and will be displayed in specific screen domains on an attached computer monitor. Furthermore, several settings can be initiated and transferred to the imager. It is possible to display or set the device IP address, to modify the focus of the infrared camera or to upload a new firmware. Of course, there are two screen domains for displaying the infrared camera image on the upper screen domain and the visible light camera image on the lower screen domain.

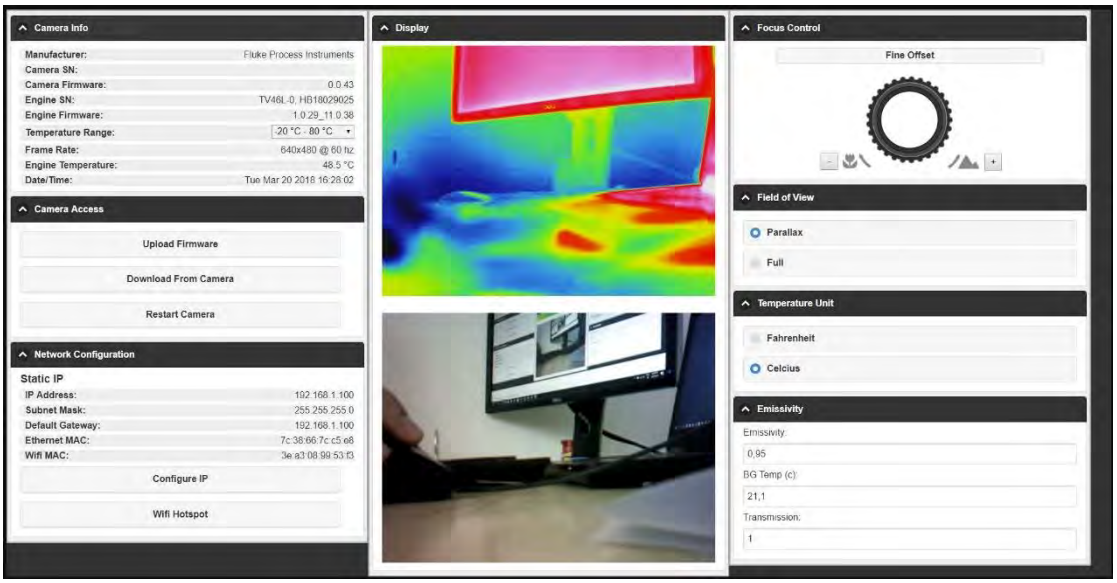


Figure 11: Screenshot of the ThermoView® onboard web-server application

7. Accessories

A full range of accessories for various applications and industrial environments are available. Accessories include items, that may be ordered at any time and added on-site.

7.1. Available electrical accessories for ThermoView® cameras

Code	Description
Electrical Accessories	
A-CB-LT-PS-07	Power supply cable, 80°C (176°F) max., 7.5 m (25 ft.) long
A-CB-LT-PS-25	Power supply cable, 80°C (176°F) max., 25 m (80 ft.) long
A-CB-LT-PS-50	Power supply cable, 80°C (176°F) max., 50 m (160 ft.) long
A-CB-LT-M12-W08-07	Multi-conductor 8 pin cable with M12 connector for ethernet communication, 7.5 m (25 ft.) long
A-CB-LT-M12-W08-25	Multi-conductor 8 pin cable with M12 connector for ethernet communication, 25 m (80 ft.) long
A-CB-LT-M12-W08-50	Multi-conductor 8 pin cable with M12 connector for ethernet communication, 50 m (160 ft.) long
A-TV-POE1	PoE Injector provides power and acts as a single Ethernet hub (115/230 VAC input)
A-TV-POE2	PoE Injector (Industrial) provides power and acts as a single Ethernet hub (115/230 VAC input)
A-PS-DIN-24V	24 VDC 1.2 A industrial power supply, DIN rail mount
A-CB-LT-RJ45-25	Standard Ethernet Cable 25 m (82 ft) with both side RJ45 connectors
A-CON-FO-RJ45	FiberOptic/RJ45 Converter
A-CB-FO-150	Fiber Optic Cable 150 m (492 ft)
A-CB-FO-300	Fiber Optic Cable 300 m (984 ft)
A-CON-SW	4-Port Gigabit Ethernet Switch
A-CB-LT-RJ45-03	Ethernet cable (short) for Junction Box
A-TV-JB	Junction Box
A-CON-16DI	Digital In (16 each) See Note (750-1506)
A-CON-16DO	Digital Out (16 each) See Note (750-1504)
A-CON-2AOC0	Analog Out Current (2 each), 0 - 20 mA See Note (750-563 preset to 0-20 mA)
A-CON-2AOC4	Analog Out Current (2 each), 4 - 20 mA See Note (750-563 preset to 4-20 mA)
A-CON-2R	Relay (2 each) (750-513)
A-CON-2A-ISO	Passive Current Isolator (847-452)
A-CON-BASICKIT	Fieldbus Basic Kit (750-352, 750-602, 750-600)

7.1.1. Power supply cable, 80°C max., 7.5m (25ft.), (A-CB-LT-PS-07)

The power supply cable comes with a three-socket female M16 connector, assigned to the cameras rear three pin male M16 connector. The corresponding end of the power supply cable is carried out as a pig tail, to connect to an external power supply device. The standard cable is about 5 mm (0.2 in) in outer diameter and is 7.5 m (25 ft) long. The cable withstands ambient temperatures up to 80°C (176°F). All three sockets of the M16 connector are wired by a 3-wire supply cable. Just the socket 1 (brown wire = GND) and 3 (white wire = +VDC) of the M16 connector must be supplied by external VDC, if no PoE (Power over Ethernet) is used. Please leave the socket 2 (black wire) at the counter end unwired.

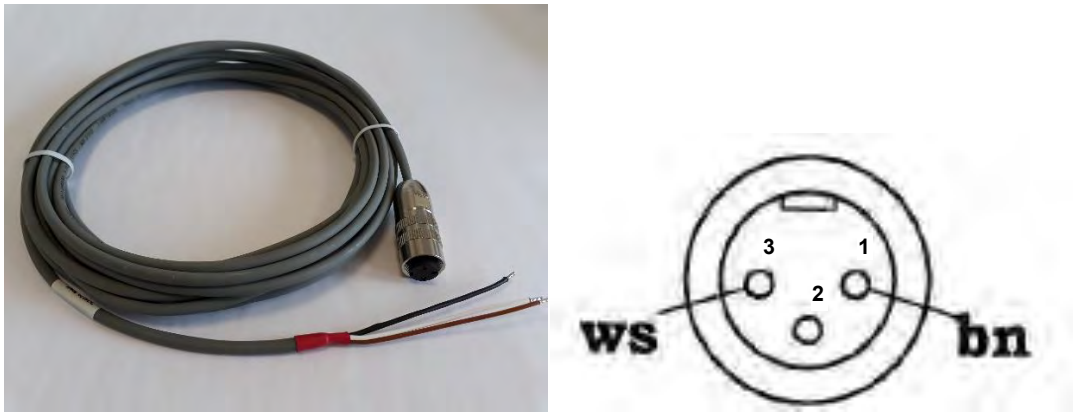


Figure 12: Power supply cable 7.5m (25ft.) with related plug-in contact assignment

7.1.2. Power supply cable, 80°C max., 25m (80ft.), (A-CB-LT-PS-25)

Please see under 7.1.1, Power supply cable, 80°C max., 7.5m (25ft.), (A-CB-LT-PS-07).

Just the supplied cable length differs and is 25m (80ft.) instead of 7.5m (25ft.).

7.1.3. Power supply cable, 80°C max., 50m (160ft.), (A-CB-LT-PS-50)

Please see under 7.1.1, Power supply cable, 80°C max., 7.5m (25ft.), (A-CB-LT-PS-07).

Just the supplied cable length differs and is 50m (160ft.) instead of 7.5m (25ft.).

7.1.4. Ethernet cable, 80°C max., 7.5m (25ft.), (A-CB-LT-M12-W08-07)

The Gigabit Ethernet cable comes with an eight-pin male M12 connector, assigned to the cameras rear eight-socket female M12 connector. The corresponding end of the Gigabit Ethernet cable is equipped with a general RJ45 snap-in connector. The standard cable is about 7 mm (0.3 in) in outer diameter and is 7.5 m (25 ft) long. The cable withstands ambient temperatures up to 80°C (176°F). In case of using PoE (Power over Ethernet) to supply the imager with power, the needed power is injected over the existing 8 data wires.

Figure 13: Ethernet cable 7.5m (25ft.) with RJ45 and M12 connector

7.1.5. Ethernet cable, 80°C max., 25m (80ft.), (A-CB-LT-M12-W08-25)

Please see under 7.1.4, Ethernet cable, 80°C max., 7.5m (25ft.), (A-CB-LT-M12-W08-07).

Just the supplied cable length differs and is 25m (80ft.) instead of 7.5m (25ft.).

7.1.6. Ethernet cable, 80°C max., 50m (160ft.), (A-CB-LT-M12-W08-50)

Please see under 7.1.4, Ethernet cable, 80°C max., 7.5m (25ft.), (A-CB-LT-M12-W08-07).

Just the supplied cable length differs and is 50m (160ft.) instead of 7.5m (25ft.).

7.1.7. PoE Injector (Standard), 115/230VAC, (A-TV-POE1)

The A-TV-POE1 is a single port, high-power solution for remote powering of current and emerging high-power applications. The device generates up to 30W and enables remote power for a new range of applications. It complies with the IEEE 802.3at PoE+ standard and is backward compatible with IEEE802.3af. It can power both existing 10/100Base-T network devices and emerging wireless 1000Base-T devices such as wireless IEEE 802.11ac access points and IP Cameras.

Figure 14: Standard PoE Injektor to conform to office environments

Features:

- Single-port Gigabit PoE Midspan, 802.3at Compliant with 2-event classification
- Backwards compatible with IEEE802.3af
- 30W output power from -20ºC to +40ºC, 25W output at +55ºC
- 1000Base-T compatible
- Safe & reliable power over existing Ethernet infrastructure
- Automatic detection and protection of non-standard devices
- Plug-and-play installation
- Guaranteed up-time

7.1.8. PoE Injector (Industrial), 115/230VAC, (A-TV-POE2)

The A-TV-POE2 is a single port, industrial DIN-rail mounted IEEE 802.3af/at Gigabit PoE+ Injector with an extended temperature range between -40°C (-40°F) to 75°C (167°F). The PoE injector can power attached devices (e. g. IP-cameras) of up to 30W.

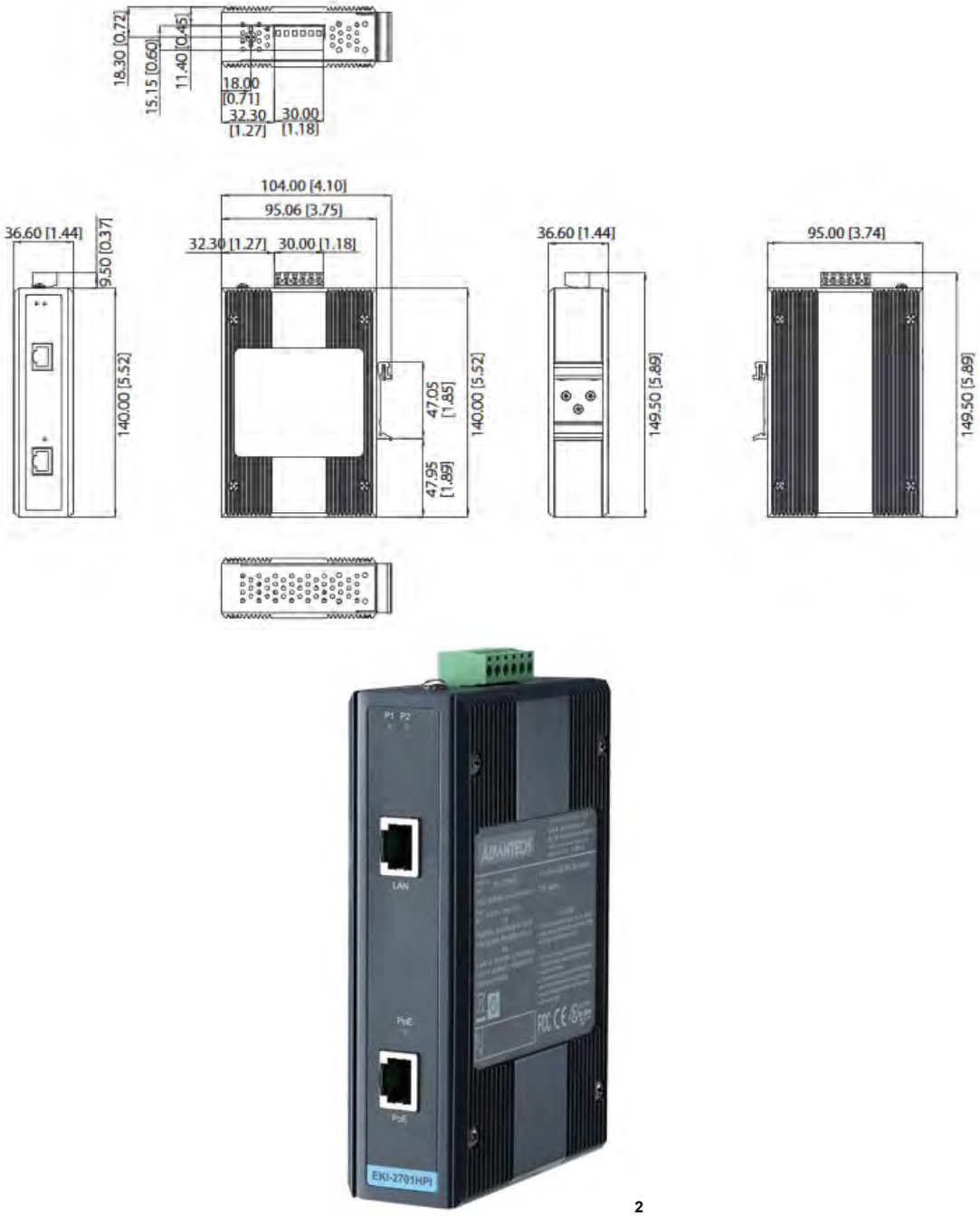


Figure 15: Industrial PoE Injektor to conform to extended temp. environments

Specifications:

Communications

- **Standard** IEEE 802.3, 802.3u, 802.3x, 802.3af/at, 802.3ab
- **LAN** 10/100/1000Base-T (X)
- **Transmission Distance** Up to 100 m
- **Transmission Speed** up to 1000 Mbps

Interface

- **Connectors** PoE OUT: RJ45
  DATA IN: RJ45
  6-pin removable screw terminal
- **LED Indicators** PWR1, PWR2, PoE status, Link/Activity

Power

- **Power Consumption** Max. 33.36 W @ 24 V_{DC} (Full load PoE)
- **Power Input** 24 ~ 48 V_{DC}, redundant dual power inputs
- **Power Output** 30 W @ 55 V_{DC}

Mechanism

- **Dimensions (W x H x D)** 37 x 140 x 95 mm (1.46" x 5.51" x 3.74")
- **Enclosure** IP30, Metal shell with solid mounting kits
- **Mounting** DIN-rail, Wall

Protection

- **Reverse** Present
- **Overload Current** Present

Environment

- **Operating Temperature** -40 ~ 75°C (-40 ~ 167°F)
- **Storage Temperature** -40 ~ 85°C (-40 ~ 185°F)
- **Operating Humidity** 5 ~ 95% (non-condensing)
- **Storage Humidity** 0 ~ 95% (non-condensing)
- **MTBF** 1,419,817 hours

Certification

- **Safety** UL508
- **EMI** FCC Part 15 Subpart B Class A, EN 55022 Class A
- **EMS** EN 61000-4-2
  EN 61000-4-3
  EN 61000-4-4
  EN 61000-4-5
  EN 61000-4-6
  EN 61000-4-8
- **Shock** IEC 60068-2-27
- **Freefall** IEC 60068-2-32
- **Vibration** IEC 60068-2-6
- **Patent** http://www.advantech.com/legal/patent

7.1.9. 24 VDC 1.3 A industrial power supply, DIN rail mount (A-PS-DIN-24V)

The DIN-rail mount industrial power supply delivers isolated dc power and provides short circuit and overload protection. The power supply can power a single camera, as well as Analog and Digital I/O Modules, and a media converter (if used).

To prevent electrical shocks, the power supply must be used in protected environments (cabinets)!

Technical data:

Protection class	prepared for class II equipment (IEC/EN 61140)
Environmental protection	IP20
Operating temperature range	-25°C to 55°C (-13°F to 131°F)
AC Input	100 – 240 VAC 44/66 Hz
DC Output	24 VDC / 1.3 A
Wire cross sections (input/output)	0.08 to 2.5 mm² (AWG 28 to 12)

3

Figure 16: 24 VDC, 1.3 A Industrial Power Supply (A-PS-DIN-24V)

7.1.10.Ethernet Cable 25 m (82 ft), two RJ45 connectors (A-CB-LT-RJ45-25)

Figure 17: Ethernet cable 25 m (82 ft) with RJ45 connectors on both ends

7.1.11. Fiber Optic to Ethernet Converter (A-CON-FO-RJ45)

The A-CON-FO-RJ45 is an industrial DIN-rail mounted unmanaged Ethernet switch with 6 RJ45 GBit Ethernet ports and 2 Multi Mode GBit Fiber Optic ports.

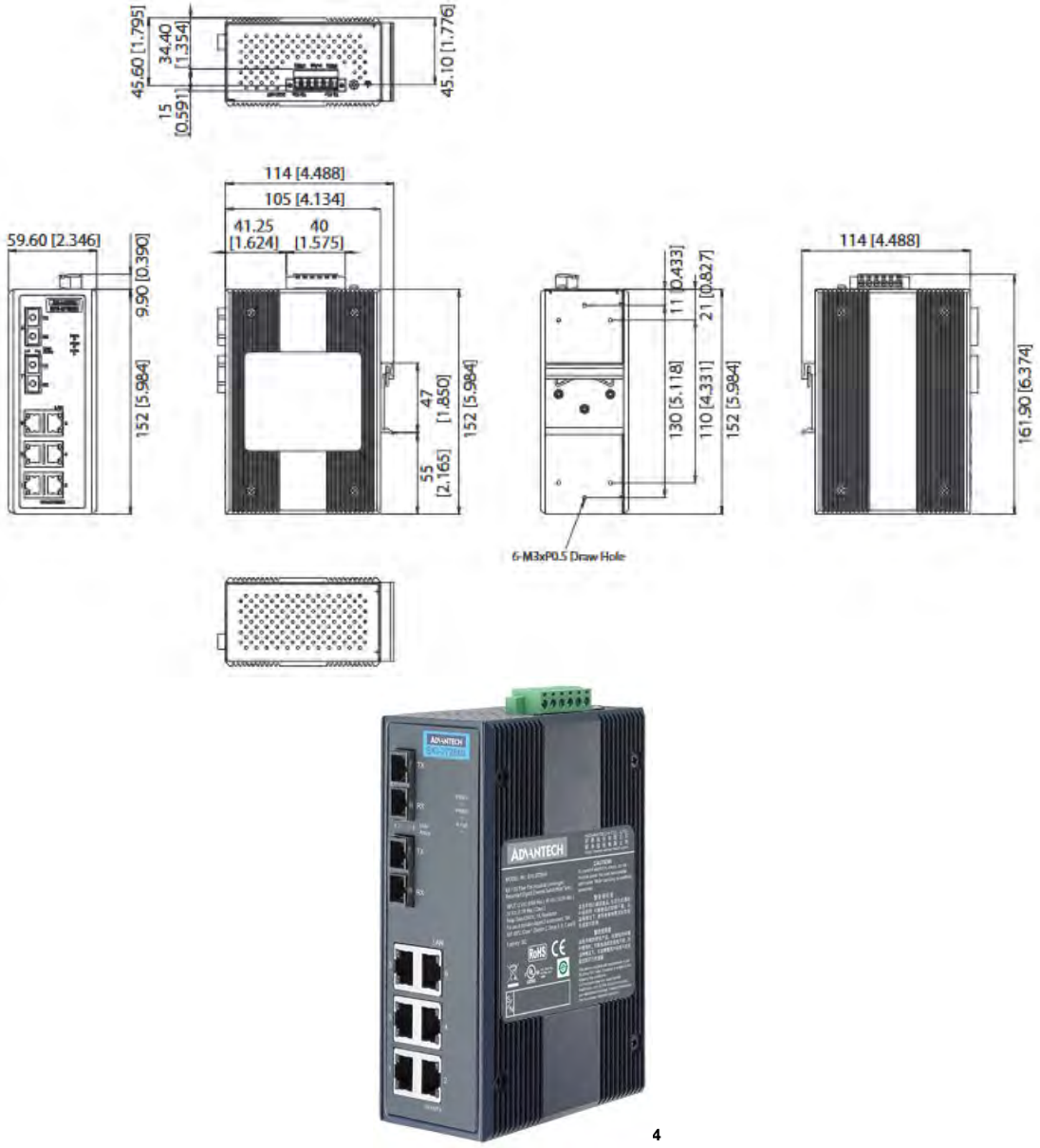


Figure 18: Fiber Optic to Ethernet Converter (6 RJ45 & 2 Multi Mode FO ports)

Specifications:

Communications

Standard	IEEE 802.3, 802.3u, 802.3ab, 802.3x, IEEE 802.3z
LAN	10/100/1000Base-T (X), 1000Base-SX or 1000Base-LX
Transmission Distance	Ethernet: Up to 100 m Fiber: Multi-mode: Up to 550 m (EKI-2728M/MI) Single-mode: Up to 10 km (EKI-2728S/SI)
Transmission Speed	Up to 1000 Mbps
Optical Fiber	
Multi-mode (EKI-2728M/MI)	Wavelength: 850 nm Tx Power: -4/-9.5 dBm Rx Sensitivity: -18 dBm Parameters: 50/125 um, 62.5/125 um
Single-mode (EKI-2728S/SI)	Wavelength: 1310 nm Tx Power: -3/-9.5 dBm Rx Sensitivity: -20 dBm Parameters: 9/125 um

Interface

Connectors	6 x RJ45 2 x SC type fiber connector 6-pin removable screw terminal (power & relay)
LED Indicators	P1, P2, P-Fail Fiber: LNK/ACT Ethernet: 1000M, LNK/ACT

Power

Power Consumption	7W
Power Input	12 ~ 48 V_{DC}, 24 V_{AC} (18 ~ 30 V_{AC}), redundant dual inputs

Mechanism

Dimensions (W x H x D)	59.6 x 152 x 105 mm (2.35" x 5.98" x 4.13")
Enclosure	IP30, Metal shell with solid mounting kits
Mounting	DIN-rail, Wall

Protection

Power Reverse	Present
Overload current	Present

Environment

Operating Temperature	-10 ~ 60°C (14 ~ 140°F)
Wide Temp Model	-40 ~ 75°C (-40 ~ 167°F) / (I model)
Storage Temperature	-40 ~ 85°C (-40 ~ 185°F)
Operating Humidity	10 ~ 95% (non-condensing)
Storage Humidity	10 ~ 95% (non-condensing)
MTBF	TBD

Certification

EMI	CE, FCC Class A
EMS	EN 61000-4-2 EN 61000-4-3 EN 61000-4-4 EN 61000-4-5 EN 61000-4-6 EN 61000-4-8
Shock	IEC 60068-2-27
Freefall	IEC 60068-2-32
Vibration	IEC 60068-2-6

7.1.12. Fiber Optic Cable 150 m (492 ft) (A-CB-FO-150)

Figure 19: Fiber Optic Cable Multi Mode 150 m (492 ft)

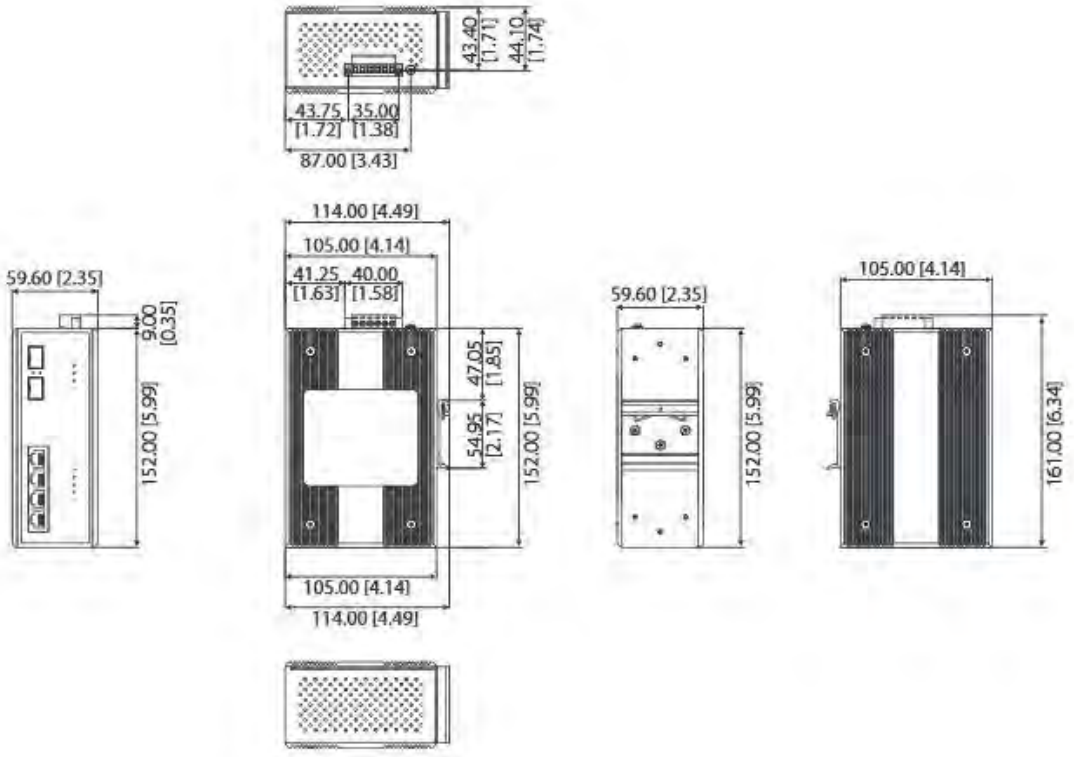
7.1.13. Fiber Optic Cable 300m (984ft) (A-CB-FO-300)

Please see under 7.1.12, Fiber Optic Cable 150 m (492 ft) (A-CB-FO-150).

Just the supplied cable length differs and is 300 m (984 ft.) instead of 150 m (492 ft.).

7.1.14. 4-Port Gigabit Ethernet Switch (A-CON-SW)

The A-CON-SW is a 4 port, industrial DIN-rail mounted IEEE 802.3af/at Gigabit PoE+ Injector switch with an extended temperature range between -40°C (-40°F) to 75°C (167°F). The PoE injector can power attached devices (e. g. IP-cameras) of up to 30W.



5

Figure 20: 4 Port Gigabit PoE Ethernet Switch and 2 SFP Fiber Ports

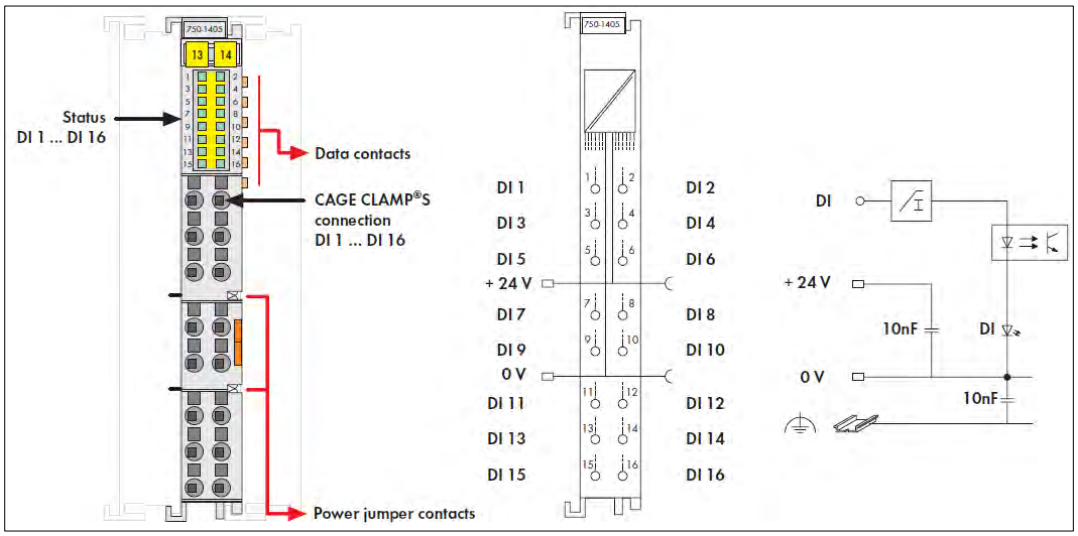
Features:

- All Gigabit Ethernet ports for 4 Copper and 2 SFP
- Back-plane (Switching Fabric): 12Gbps
- Embedded 4 ports PoE inject function
- Provide 30 W at 55 V power output
- Redundant Power Design
- IP30 Chassis Design
- Supports operating temperatures from -40 ~ 75°C

7.1.15. Ethernet cable (short) for Junction Box (A-CB-LT-RJ45-03)

Figure 21: Ethernet patch cable short ~ 0.3m (1ft)

7.1.16. Digital In, 16 each (A-CON-16DI)



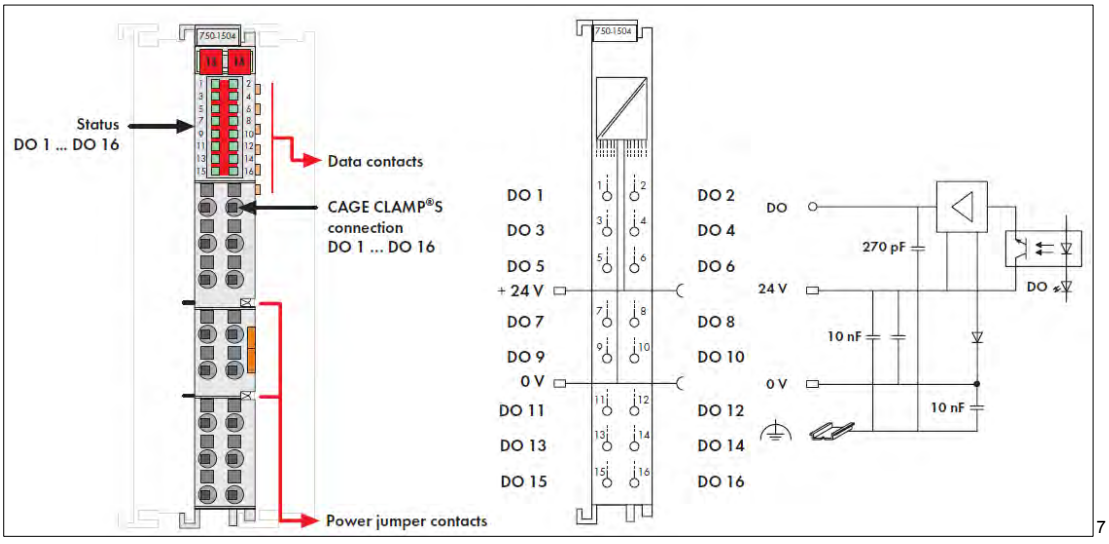
6

Figure 22: 16 Channel Digital-Input Module A-CON-16DI

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **750-1406**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

7.1.17. Digital Out, 16 each (A-CON-16DO)



7

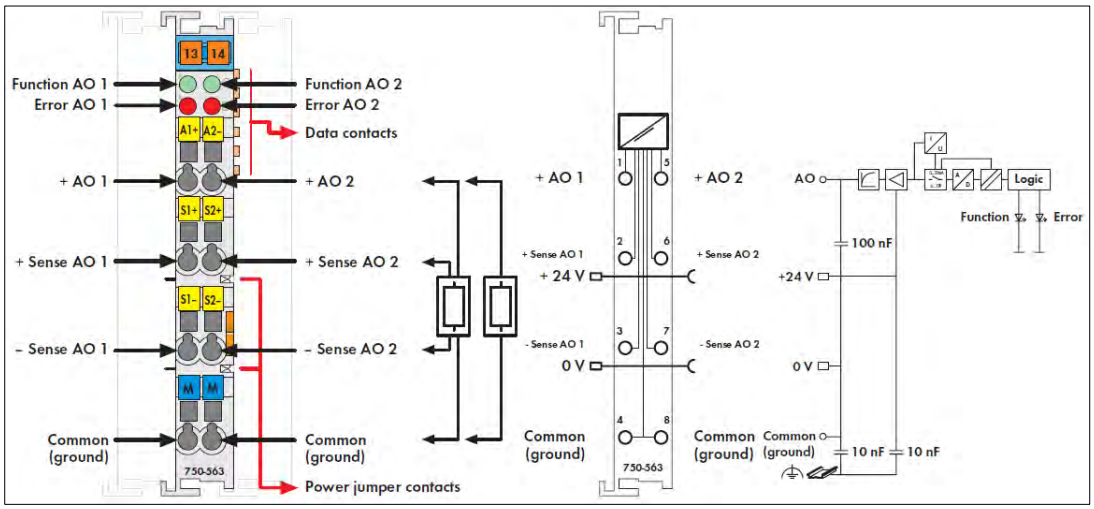
Figure 23: 16 Channel Digital-Output Module A-CON-16DO

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **750-1504**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

[6] Copyright Wago®

7.1.18.Analog Current Out, 2 loops, 0-20mA (A-CON-2AOC0)



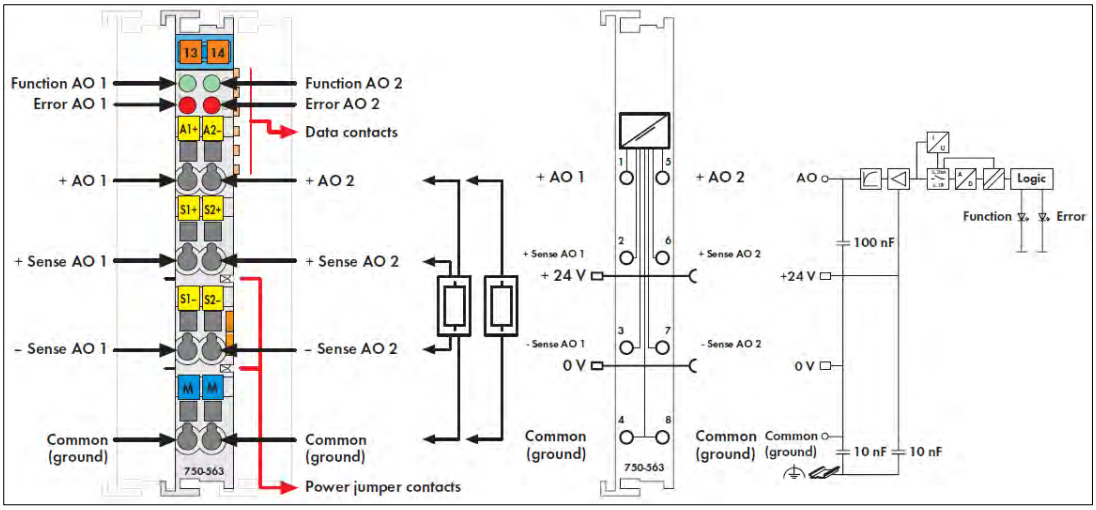
[8]

Figure 24: 2 Analog Current-Loop Output (0-20mA) A-CON-2AOC0

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **750-563**, which is preset to **0-20mA**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

7.1.19.Analog Current Out, 2 loops, 4-20mA (A-CON-2AOC4)



[9]

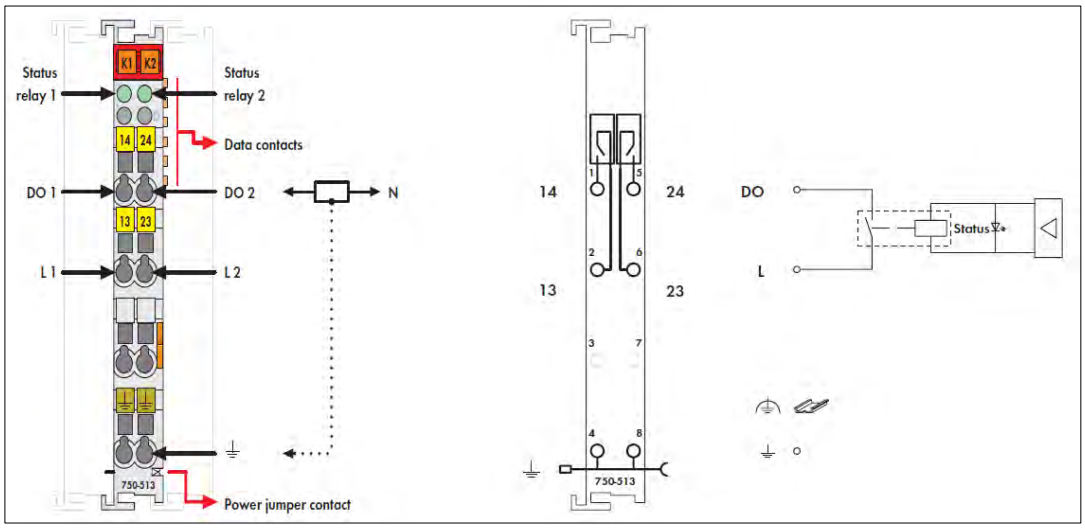
Figure 25: 2 Analog Current-Loop Output (4-20mA) A-CON-2AOC4

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **750-563**, which is preset to **4-20mA**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

[8] Copyright Wago®

7.1.20. Relay, 2 each (A-CON-2R)



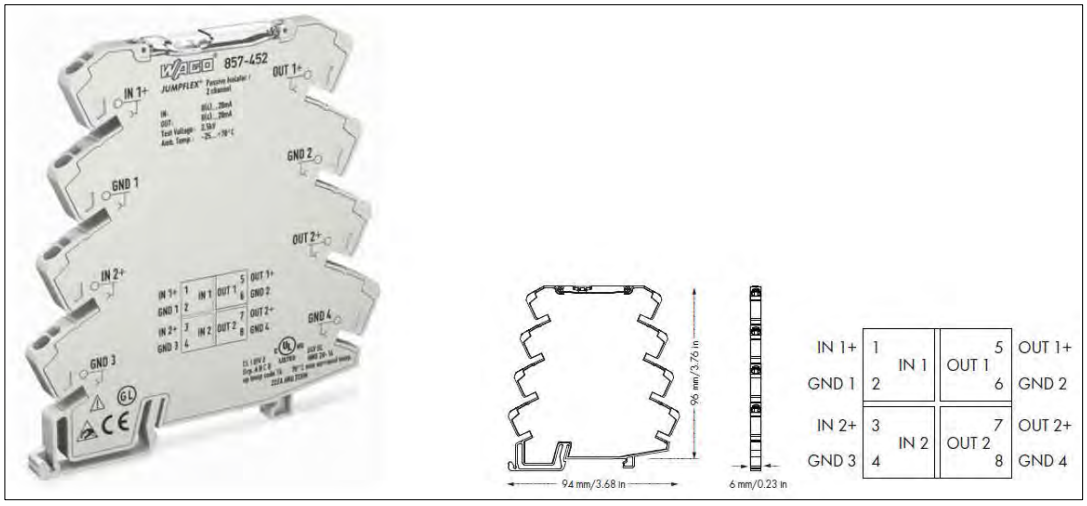
[10]

Figure 26: 2 Channel Relay Output Module A-CON-2R

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **750-513**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

7.1.21. Passive Current Isolator (A-CON-2A-ISO)



[11]

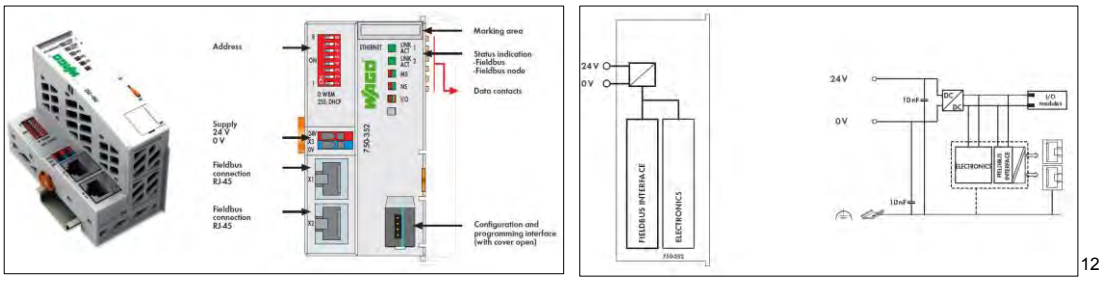
Figure 27: 2 Channel Passive Current Isolator Module A-CON-2A-ISO

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **847-452**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

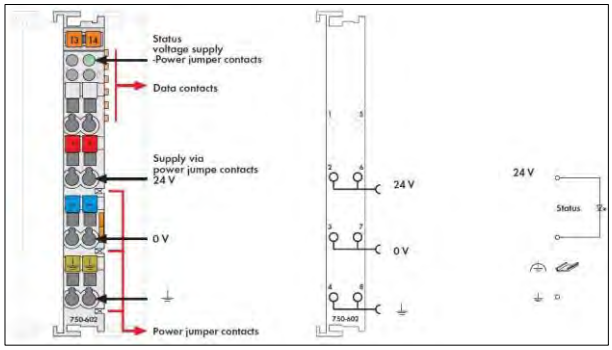
[10] Copyright Wago®

7.1.22. Basic Bus Coupler kit for several In-/Outputs (A-CON-BASICKIT)



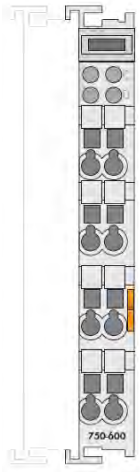
[12]

Figure 28: Fieldbus Coupler Module WAGO 750-352



[13]

Figure 29: Supply Module WAGO 750-602



[14]

Figure 30: End Module WAGO 750-600

Please refer to the Fluke Process Instruments document below, to get technical details and installation instructions for the WAGO module **750-352, 750-602, 750-600**:

Document title: I/O Module System for Infrared Linescanners and Thermal Imagers

Please note: Accessories need to be configured and installed by user. This accessory will need power supply A-PS-DIN-24V unless customer supplies power.

[12] Copyright Wago®
[13] Copyright Wago®

7.2. Available mechanical accessories for ThermoView® cameras

Code	Description
Mechanical Accessories	
A-TV-AP	Air purge collar
A-TV-AP-WC	Air purge collar including water cooling accessory
A-TV-WC	Protective enclosure (water cooled/air purged)
A-TV-ENC	Outdoor Enclosure
A-TV-MB	Mounting Base
A-TV-SB	Swivel Bracket
A-TV-CC	Carrying Case

7.2.1. Air purge collar (A-TV-AP)

Air flow rate: 30-60 l/min (7.925 – 15.85gpm)
Air pressure: < 5 bar (< 72.5psi)

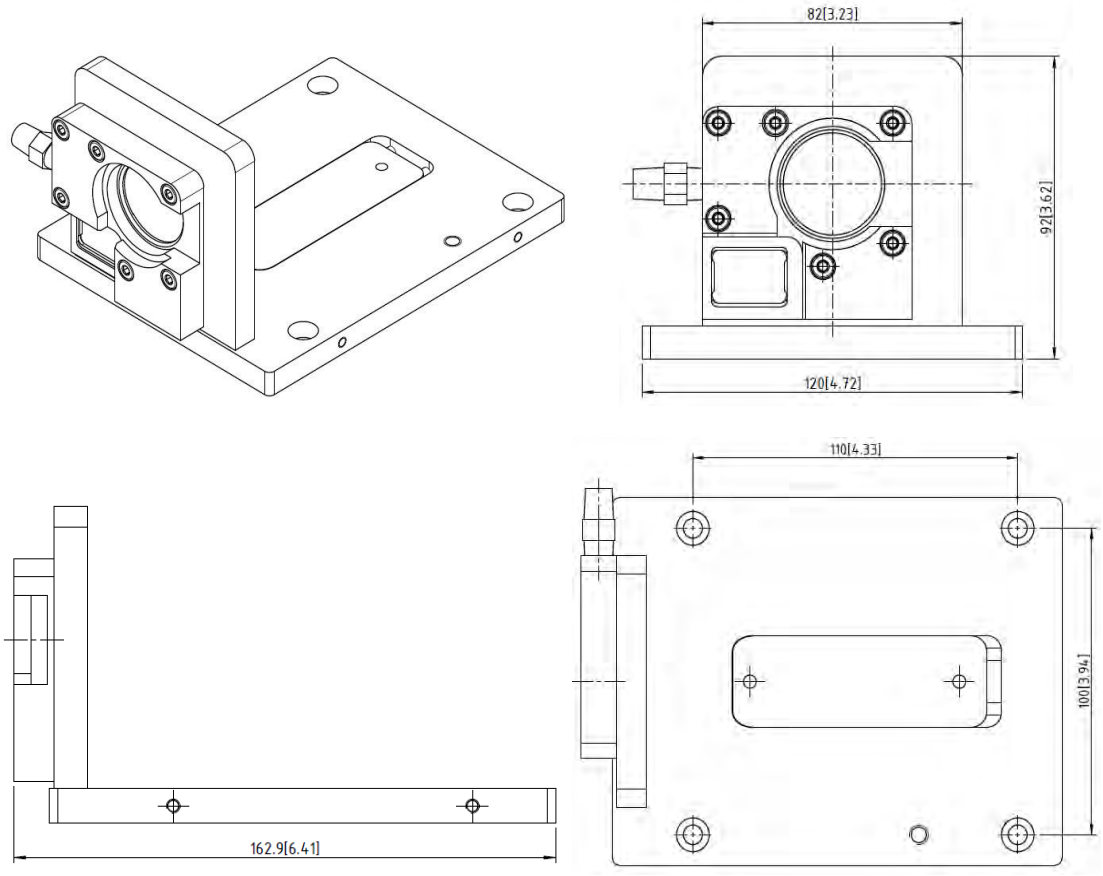


Figure 31: Air purge collar (A-TV-AP) without water cooling accessory

7.2.2. Air purge collar including water cooling accessory (A-TV-AP-WC)

Max. ambient temperature: 140°C (284°F)
Medium ambient temperatur: 20°C (68°F)
Recommended water flow rate: > 1.6 l/min (> 0.42 gpm)
Air flow rate: 30-60 l/min (7.925 – 15.85 gpm)
Air pressure: < 5 bar (< 72.5psi)

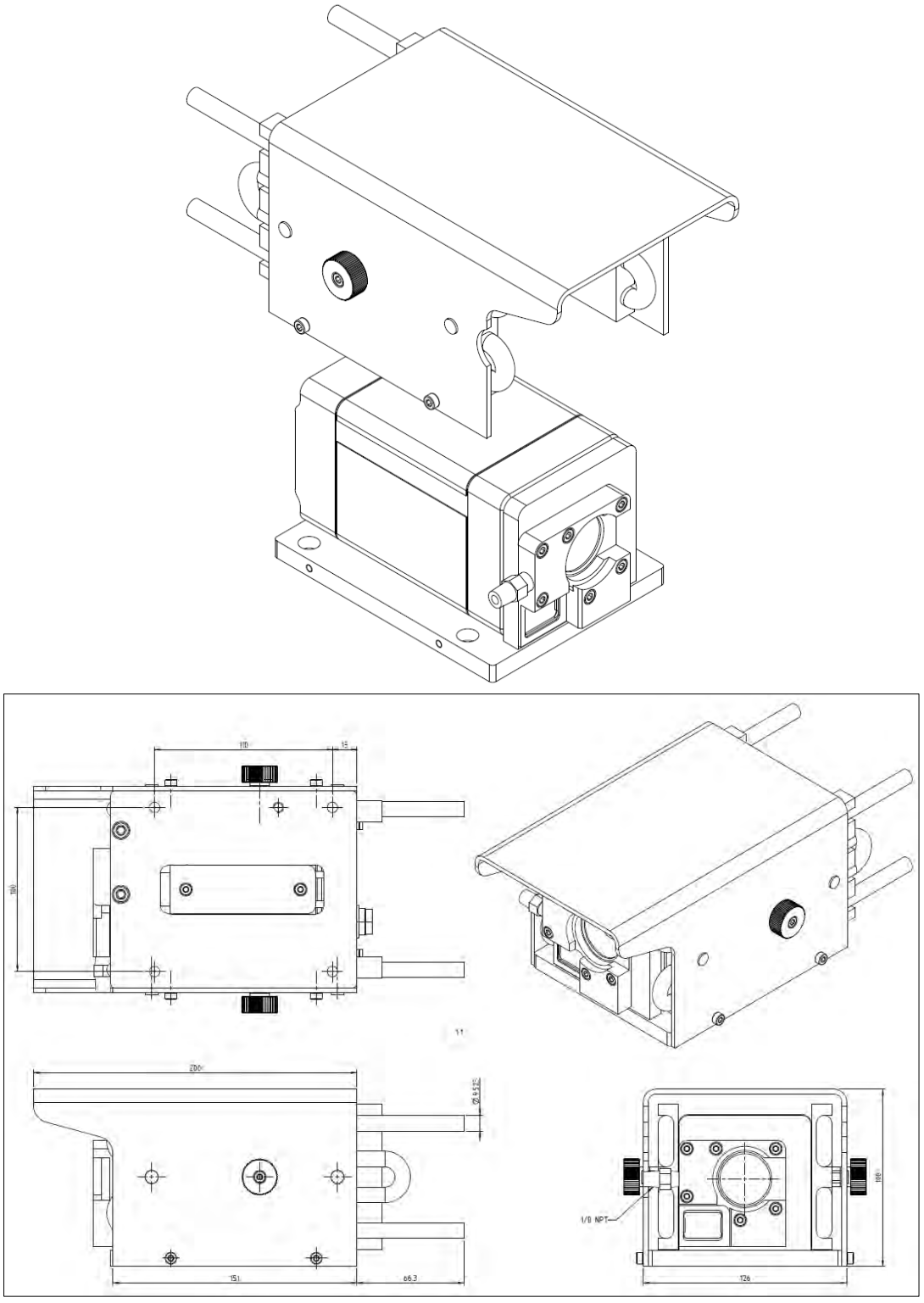


Figure 32: Air purge collar including water cooling accessory (A-TV-AP-WC)

7.2.3. Protective enclosure, water cooled/air purged (A-TV-WC)

If the ThermoView® imager needs to be installed in dirty and hot environments, a protective enclosure with water cooling and air purge fittings is needed to guarantee the protection.

Figure 33: Front & rear view of the Protective Enclosure (A-TV-WC)

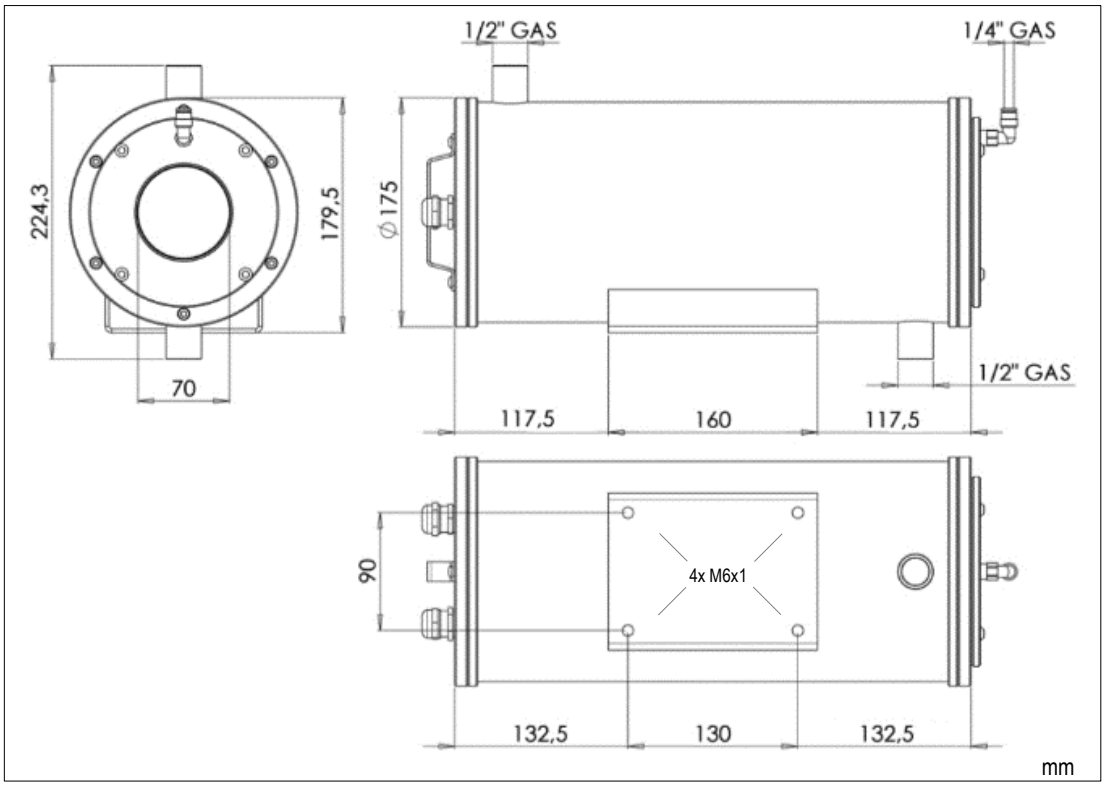


Figure 34: Dimensions of the Protective Enclosure (A-TV-WC)

Scope of delivery

- Enclosure with cooling jacket and Zinc Selenide window
- Air barrier flange
- 2x cable glands

Environment

Rating	IP67
Ambient temperature	200°C (392°F) with 6 l/min (1.5 gal/min) of water at 20°C (68°F) inlet temperature and 6 bar (87 PSI) for front air barrier
Air pressure	recommended: 4 to 6 bar (58 to 87 PSI)

Mechanical

Construction	stainless steel, AISI 316L, polished
Weight	13 kg (29 lb), without camera
Cable gland	M12x1.5, threaded holes on the rear flange

The Zinc Selenide window has a transmission factor of 0.96 meaning it transmits 96% of the radiation before it gets to the camera. For correct temperature readings, that transmission factor needs to be considered.

Cooling

By forcing water circulation, it is possible to maintain cooled internal housing temperatures. It helps to verify the flow capacity needed and cooling water temperature before proceeding with the installation. Before installation, it is also necessary to verify the environmental temperature and install the housing at the correct distance from the heating source.

Air Barrier

The flange for window cleaning uses ventilation to create an air barrier on the front of the housing in order to prevent any deposits of dust on the outer surface of the window. For proper use, it is always advisable to filter the compressed air with a dedicated filter that is equipped with a gauge pressure regulator. For proper installation, it is necessary to check the environmental temperature and place the air filter group at the correct distance from the heat source.

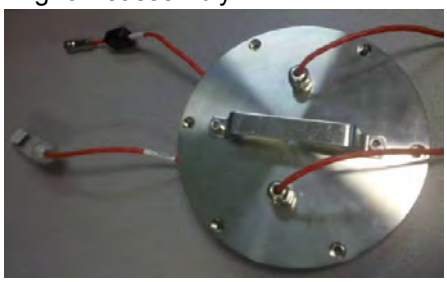
For optimal performance of air barrier, it is recommended positioning the enclosure in a horizontal position or decline angle. Positioning the enclosure with the air barrier vertically may affect its performance!

Noise level emissions produced by air barrier may exceed recommend safe exposure levels!

Installation

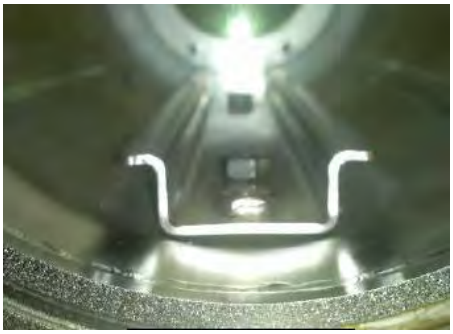
- Locate 2x M4 screws on camera
- Place conduction plate onto camera as shown, making sure to line up holes on camera with hole and slot on conduction plate.
- Install 2x M4 screws and secure conduction plate onto camera.
- Place the housing internal rail onto conduction plate as shown on first slot, making sure to place rail with correct orientation by having rail securing hole at rear.
- Secure rail to conduction plate by installing 2x screws (truss), 4x curved washers (2x per screw), and 2x flat washers. Insert the screws until each screw contacts with curved washer; curved washers will be compressed once camera is installed in enclosure.
- **Note**: For cameras with remote focus place rail as shown with one screw in each slot.
- Secure ground cable to camera as shown (color of cable/ring terminals used for display only).

- Disassemble Ethernet cable connector by loosening nut as shown.
- Remove cable from RJ45 jack by lifting tab, note wiring for reassembly.
- Pass Ethernet cable through cable gland on rear enclosure flange then reassemble connector.
- Pass power cable end with isolated cable ends through cable gland on rear enclosure flange.
- Using Ethernet and power cables that have been passed through cable glands on rear flange.
- Install cables onto camera as shown (turn camera on if needed).



- Place conduction plate onto inside surface of enclosure and slide rail onto internal rail. Now you can move the camera forward.

  Internal rail and cables are removed for clarity



- Secure ground to enclosure using 1x tooth washer, 1x flat washer, and rail screw from enclosure as shown.

- Install rear flange onto enclosure by screwing-in the 6x screws. Then tighten cable glands to create seal around cables.

7.2.4. Outdoor Enclosure (A-TV-ENC)

In case, the ThermoView® imager has to be mounted in outdoor environments, an outdoor enclosure ensures weatherproofed installations. It provides a high protection rate, a sunshield, and a temperature controlled heater for cooler environments.

Scope of delivery

- Enclosure with sunshield and Germanium window
- Double thermostat control heater
- Cable glands

Environment	
Rating	IP66/IP67 EN60529 with cable glands
Max. Temperature	-30 to 50°C (-22 to 122°F)
Electrical	
Double heater	115/230 VAC, 80 W
Mechanical	
Construction	Aluminum
Weight	4.1 kg (9 lb), without camera
Cable entry	M16x1.5

The Germanium window has a transmission factor of 0.87 meaning it transmits 86% of the radiation before it gets to the camera. For correct temperature readings, that transmission factor needs to be considered.

Figure 35: Outdoor Enclosure (A-TV-ENC)[15]

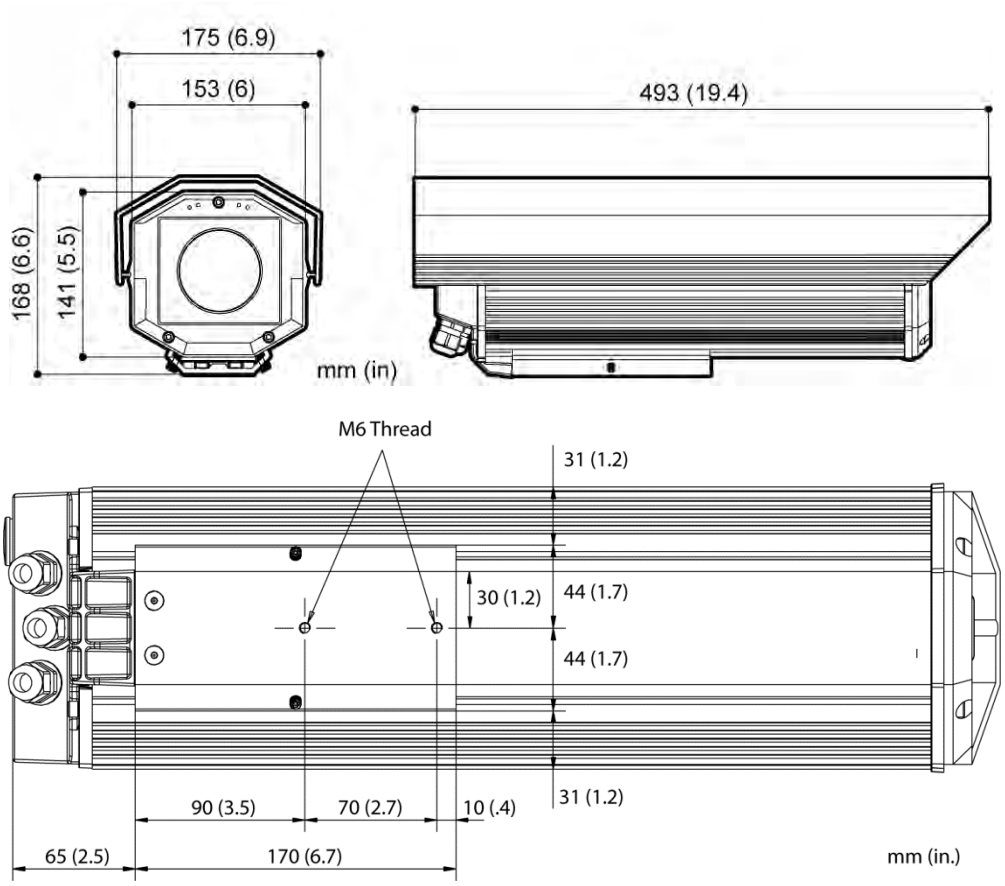


Figure 36: Dimensions and Footprint of Outdoor Enclosure (A-TV-ENC)

Installation

- Locate 2x M4 screws on camera
- Place conduction plate onto camera as shown, making sure to line up holes on camera with hole and slot on the conduction plate.
- Install 2x M4 screws and secure conduction plate onto camera.
- Place housing internal rail onto conduction plate as shown.

- Secure conduction plate to rail by installing 2x Screws (truss), 4x curved washers (2x per screw), and 2x flat washers. Insert each screw half a turn past after contacting curved washer and slide camera forward.

- Secure ground cable to camera as shown (color of cable/ring terminals used for display only), from camera to internal rail screw with tooth washer. Then install supplied ground cable onto heater board for connection to enclosure.
- Disassemble Ethernet cable connector by loosening nut as shown.
- Remove cable from RJ45 jack by lifting tab, note wiring for reassembly.
- Pass Ethernet cable through enclosure cable gland as shown and reassemble connector.
- Insert power cable with isolated cable ends through cable gland on enclosure.
- Using power and Ethernet cables that have been passed through cable glands on rear of enclosure, install cables onto camera (turn on camera if needed).

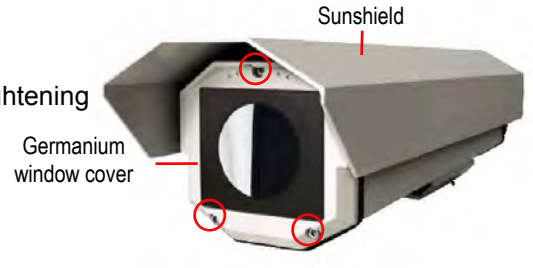
- Place camera conduction plate on inside surface
- of enclosure and slide the outer slide onto the
- housing as shown.

- Connect ground cable onto housing as
- shown before closing housing.

- Tighten rear cover 3x screws, then tighten
- 2x set screws on outer slide as shown.

Slide camera forward if needed and ensure that camera conduction plate contacts inside surface of enclosure in order to ensure adequate thermal conductivity.

- Install front Germanium window cover by tightening 3x screws then install sunshield as shown.



- Tighten rear cable glands to create
- seal around cables.

7.2.5. Mounting Base (A-TV-MB)

The mounting base is to adapt the ThermoView® imager in an easy way to any kind of fixture. It is mainly foreseen to fix the ThermoView® imager to swiveling brackets or tripods. For the fixture to tripods or swivel brackets, the mounting base has got 2 inner ¼" – 20 holes. Please see details in the lower drawing.

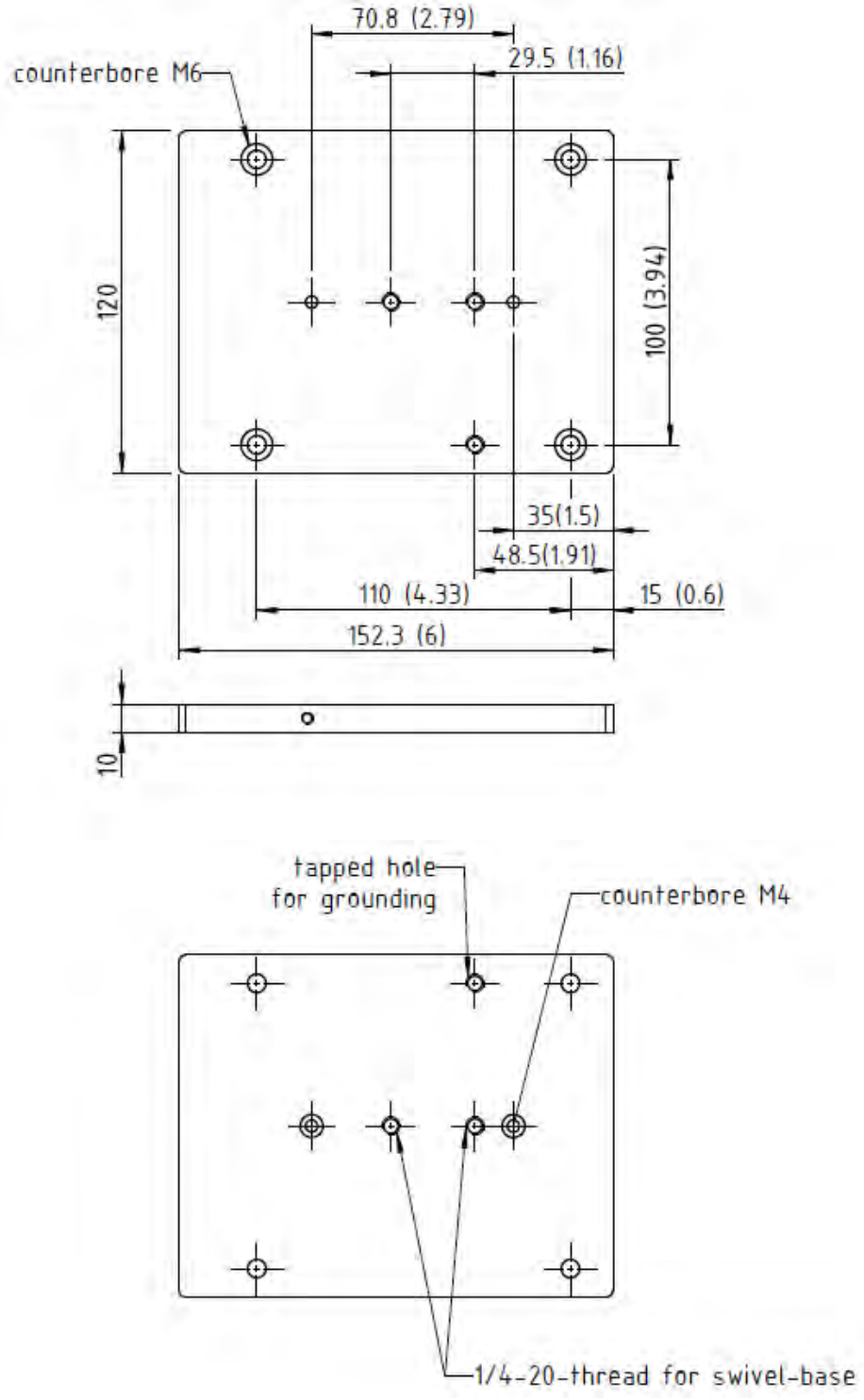


Figure 37: Dimensions for the Mounting Base

7.2.6. Swivel Bracket (A-BR-S)

The Swivel Bracket accessory is to mount the ThermoView® imager in a moveable position, to correct in an easy way the pitch and yaw orientation. For a correct imager orientation, you can pitch (0° – 90°) and swivel (0° - 360°) the imager-sighting axis. The base has a single control knob and a split-ball lock, to hold the specific head mount firmly in place.

Base features:

Circle diameter for three countersunk bolts:	109.5mm (4.3125")
Countersunk bolts:	6.3mm (1/4") flat-head screws (not included)
Height with head mount beam:	120mm (4.72")
Weight with head mount beam:	1.07kg (2.36 lbs.)

Figure 38: Swivel Bracket (A-BR-S)

8. Maintenance

8.1. Cleaning the Lens

Keep the lens clean at all times. Any foreign matter (dust, fingerprints…) on the lens or window surface will affect measurement accuracy. However, care should be taken when cleaning the lens.

To clean the window, do the following:

1. Lightly blow off loose particles with “canned” air (used for cleaning computer equipment) or a small squeeze bellows (used for cleaning camera lenses).
2. Gently brush off any remaining particles with a soft camel hairbrush or a soft lens tissue (available from camera supply stores).
3. Clean remaining “dirt” using a cotton swab or soft lens tissue dampened in distilled water. Do not scratch the surface.

For fingerprints or other grease, use any of the following:

- Denatured alcohol
- Ethanol

Apply one of the above to the lens. Wipe gently with a soft, clean cloth until you see colors on the surface, then allow to air dry. Do not wipe the surface dry, this may scratch the surface.

If silicones (used in hand creams) get on the window, gently wipe the surface with Hexane. Allow to air dry.

Do not use any ammonia or any cleaners containing ammonia to clean the lens. This may result in permanent damage to the lens’ surface!

9. Addendum

9.1. Typical Emissivity Values

The following table provides a brief reference guide for determining emissivity and can be used when one of the above methods is not practical. Emissivity values shown in the table are only approximate, since several parameters may affect the emissivity of a material. These include the following:

1. Temperature
2. Angle of measurement
3. Geometry (plane, concave, convex)
4. Thickness
5. Surface quality (polished, rough, oxidized, sandblasted)
6. Spectral range of measurement
7. Transmissivity (e.g. thin films plastics)

	NON-METALS
Material	**Emissivity**
	8 – 14 µm
Asbestos	0.95
Asphalt	0.95
Basalt	0.7
Carbon	
Unoxidized	0.8-0.9
Graphite	0.7-0.8
Carborundum	0.9
Ceramic	0.95
Clay	0.95
Concrete	0.95
Cloth	0.95
Glass	
Plate	0.85
"Gob"	
Gravel	0.95
Gypsum	0.8-0.95
Ice	0.98
Limestone	0.98
Paint (non-al.)	0.9-0.95
Paper (any color)	0.95
Plastic, opaque at 500 µm thickness (20 mils)	0.95
Rubber	0.95
Sand	0.9
Snow	0.9
Soil	0.9-0.98
Water	0.93
Wood, Natural	0.9-0.95

Table 3: Typical Emissivity Values (Non-Metals)

METALS

Material	**Emissivity** **8 – 14 µm**
Aluminum	
Unoxidized	0.02-0.1
Oxidized	0.2-0.4
Alloy A3003, Oxidized	0.3
Roughened	0.1-0.3
Polished	0.02-0.1
Brass	
Polished	0.01-0.05
Burnished	0.3
Oxidized	0.5
Chromium	0.02-0.2
Copper	
Polished	0.03
Roughened	0.05-0.1
Oxidized	0.4-0.8
Gold	0.01-0.1
Haynes	
Alloy	0.3-0.8
Inconel	
Oxidized	0.7-0.95
Sandblasted	0.3-0.6
Electropolished	0.15
Iron	
Oxidized	0.5-0.9
Unoxidized	0.05-0.2
Rusted	0.5-0.7
Molten	
Iron, Cast	
Oxidized	0.6-0.95
Unoxidized	0.2
Molten	0.2-0.3
Iron, Wrought	
Dull	0.9
Lead	
Polished	0.05-0.1
Rough	0.4
Oxidized	0.2-0.6
Magnesium	0.02-0.1
Mercury	0.05-0.15
Molybdenum	
Oxidized	0.2-0.6
Unoxidized	0.1
Monel (Ni-Cu)	0.1-0.14
Nickel	
Oxidized	0.2-0.5
Electrolytic	0.05-0.15
Platinum	
Black	0.9

	METALS
Material	**Emissivity**
	8 – 14 µm
Silver	0.02
Steel	
Cold-Rolled	0.7-0.9
Ground Sheet	0.4-0.6
Polished Sheet	0.1
Molten	
Oxidized	0.7-0.9
Stainless	0.1-0.8
Tin (Unoxidized)	0.05
Titanium	
Polished	0.05-0.2
Oxidized	0.5-0.6
Tungsten	0.03
Polished	0.03-0.1
Zinc	
Oxidized	0.1
Polished	0.02

Table 4: Typical Emissivity Values (Metals)

Mouser Electronics

Authorized Distributor

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Fluke:

A-CB-LT-RJ45-25 A-CON-16DI A-CON-16DO A-CON-2A-ISO A-CON-2AOC4 A-CON-2R A-CON-BASICKIT