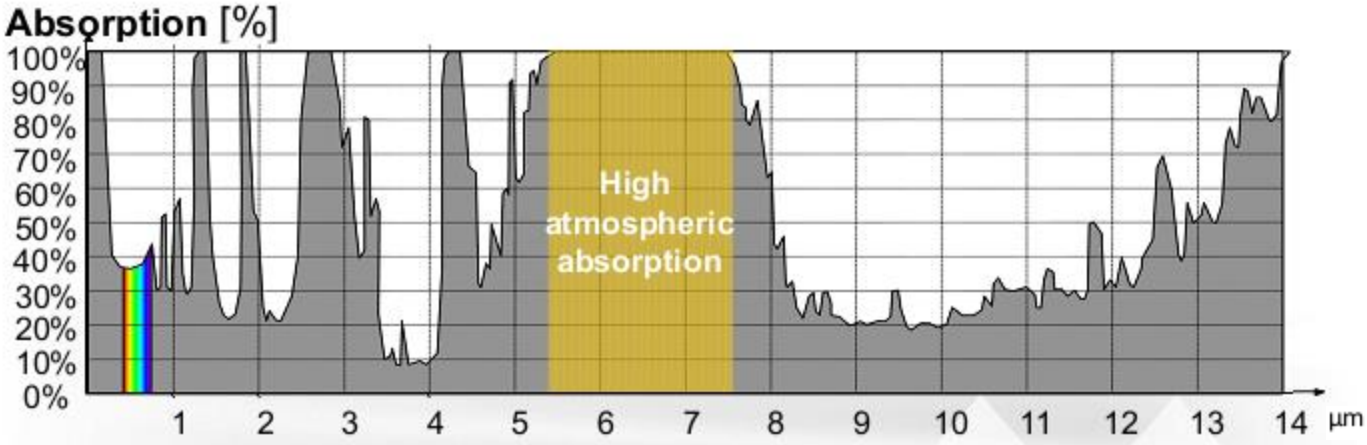
FLIR security cameras

Thermal Imaging

- Infrared radiation is a particular kind of “light”. It travels through space at the speed of light (186,000 miles per second).
- Infrared radiation is invisible for the human eye, but we can perceive it as heat.
- A thermal camera produces an image based on infrared radiation

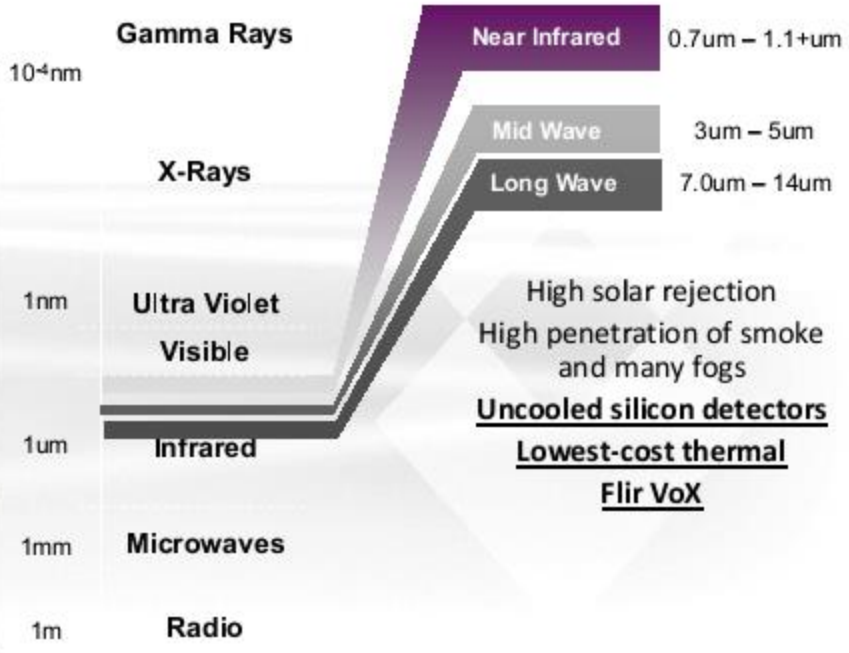
Thermal Imaging: Types of infrared



Visible	Near-IR	SWIR	MWIR	LWIR
.4-.75µ	. 75 – 1+µ	1-2.5µ	3-5.5µ	7-14µ

1000 nanometers = 1 micron = 1µm

Thermal Imaging: Long Wave Thermal



Considerations of Thermal cameras

- The Thermal image is not affected by the sun

Considerations of Thermal Cameras

- On WDR cameras backlighting does not affect the image

Considerations of Thermal Cameras

- Smoke does not affect thermal image

Considerations of Thermal Cameras

- Regarding identification
  - Disadvantages regarding identification
  - Advantages with respect to privacy
  - Details not recognizable with Infrared ilumination

INFRARED TRAINING CENTER

An Infrared Image

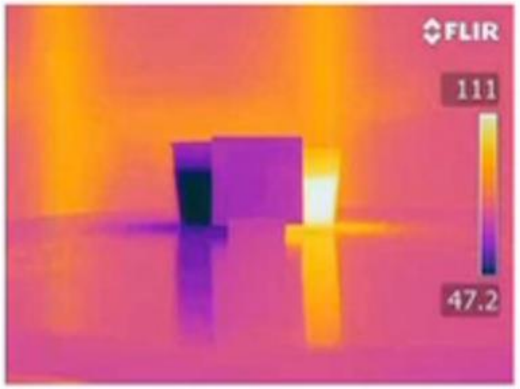
Darker means cooler, brighter means warmer.
What does this image tell us?

Visual vs. Night Vision vs. Thermal Imaging

- Visual
  - Color absorption and reflection
  - Requires some light
- Night vision
  - Amplifies small amounts of visible light
  - Requires some light i.e. moonlight or LED
- Thermal imaging
  - Detects heat energy emitted by objec[redacted]
  - Requires absolutely no light
  - Totally unaffected by light sources

Visible light image

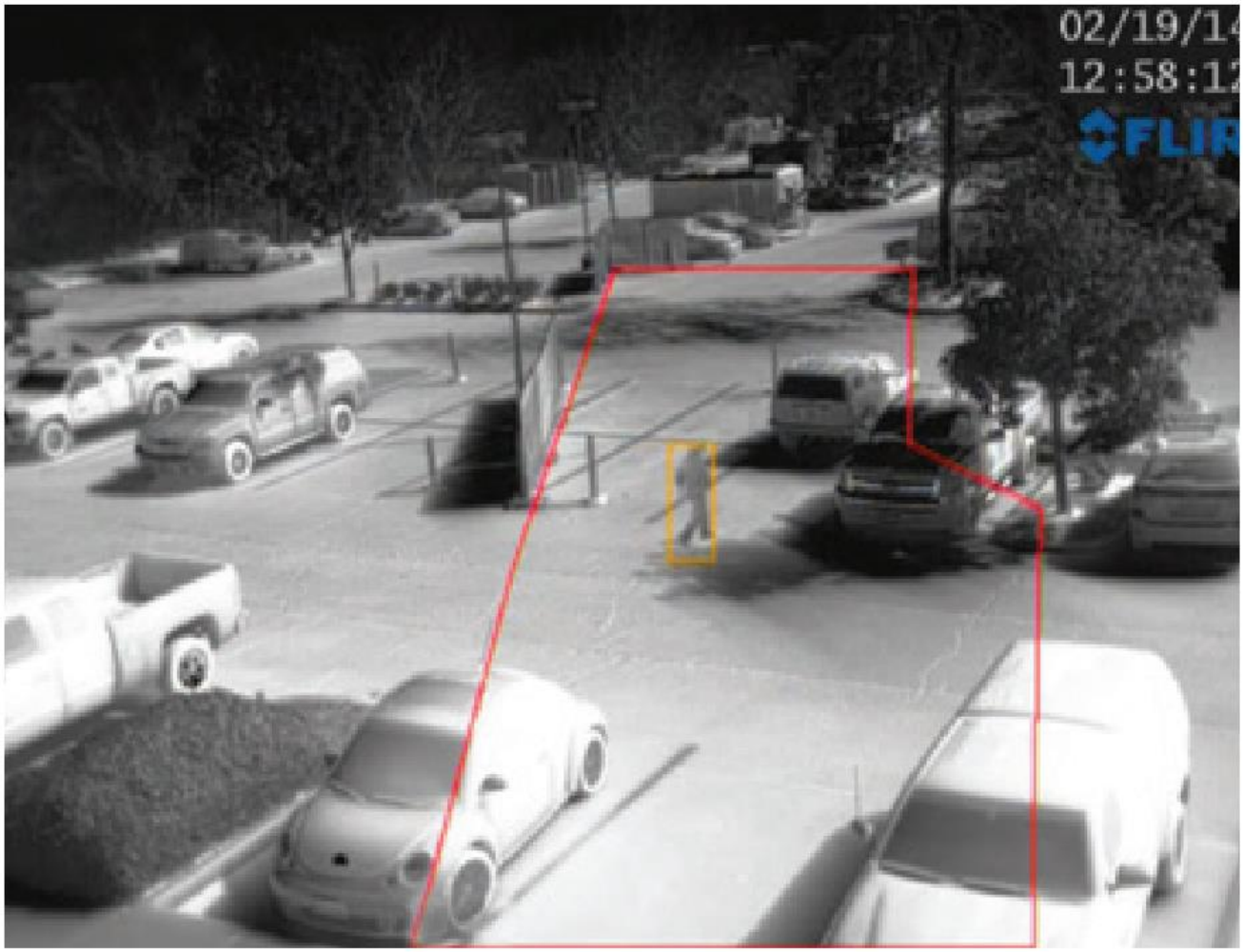
Near infrared "Night Vision" image



Thermal infrared image

A cool cup, a hot cup and a piece of glass

Sample Images:



F-Series

Fixed Thermal
Security Camera

PT-Series

Pan-Tilt Multi-Sensor

Shared Architecture

PT- & F- Key features

Multi-Sensor:
Thermal & visible cameras

Only thermal with H.264, MPEG-4, M-JPEG

Precision Motion:
- 0.1° to 70°/sec
- Continuous 360° pan

Only Network-Ready thermal with:
640x480
320x240
160x120

-40°C to 55°C operating Temperature

IP 66 enclosure

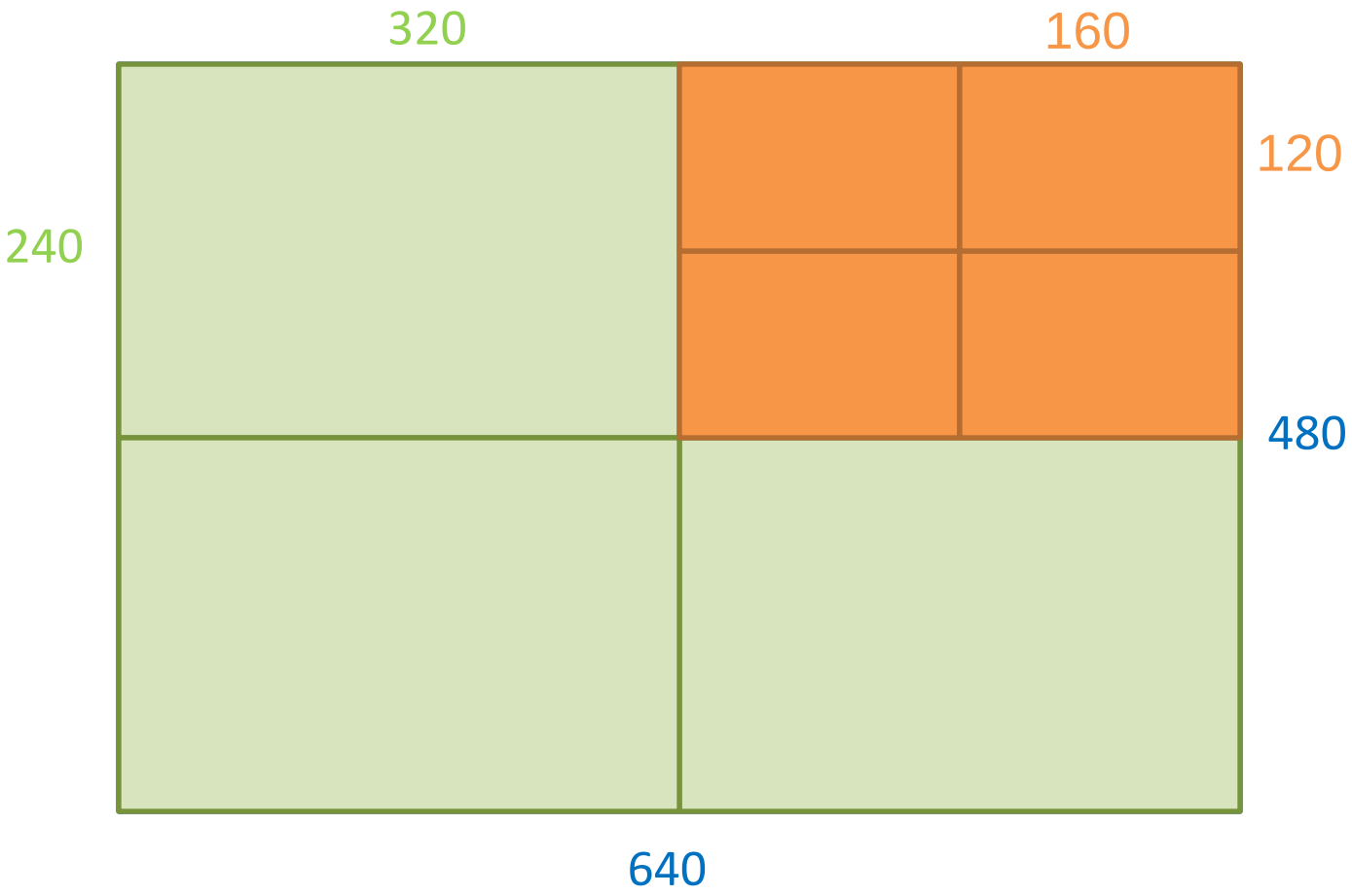
11 lens and resolution options

Easy to install & integrate – IP or analog

Nexus Enabled

Interchangeable sensor cassettes

Resolution = Pixel Count

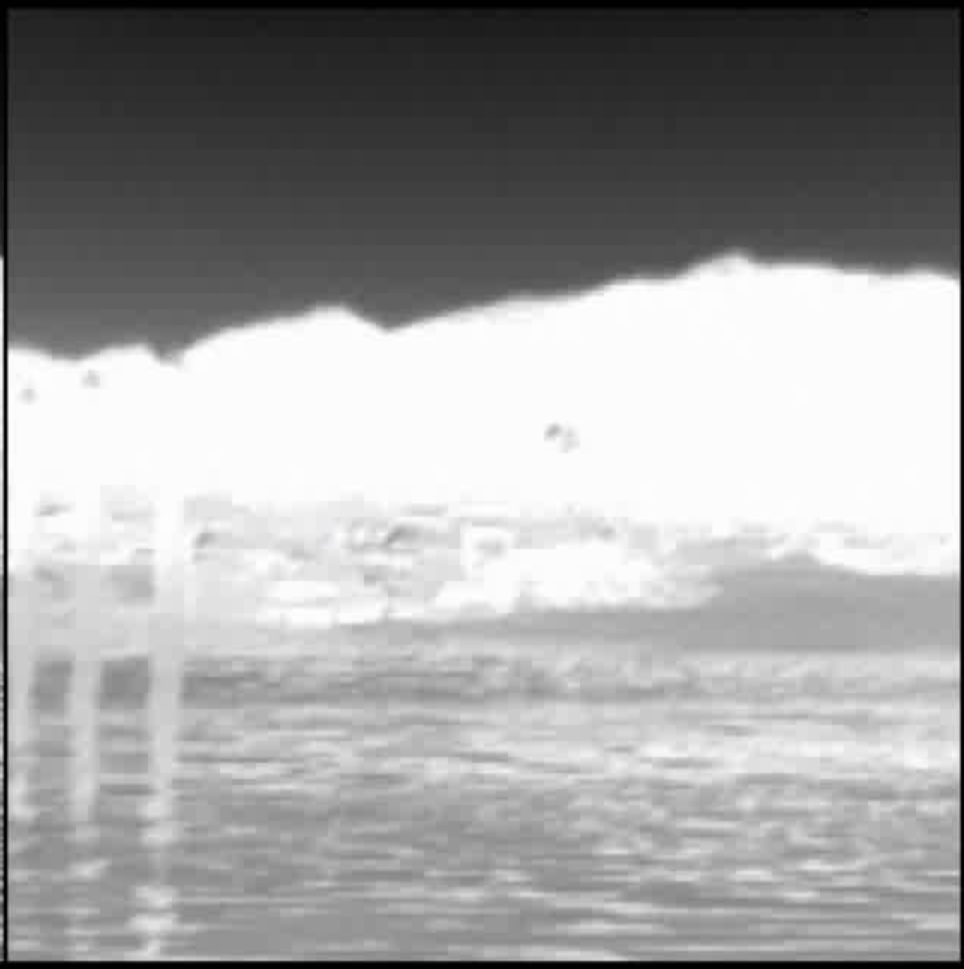


Resolution Comparison

320 x 240

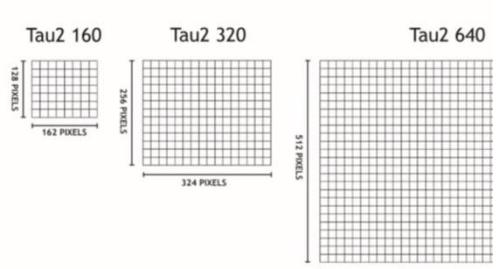
640 x 480

640x480



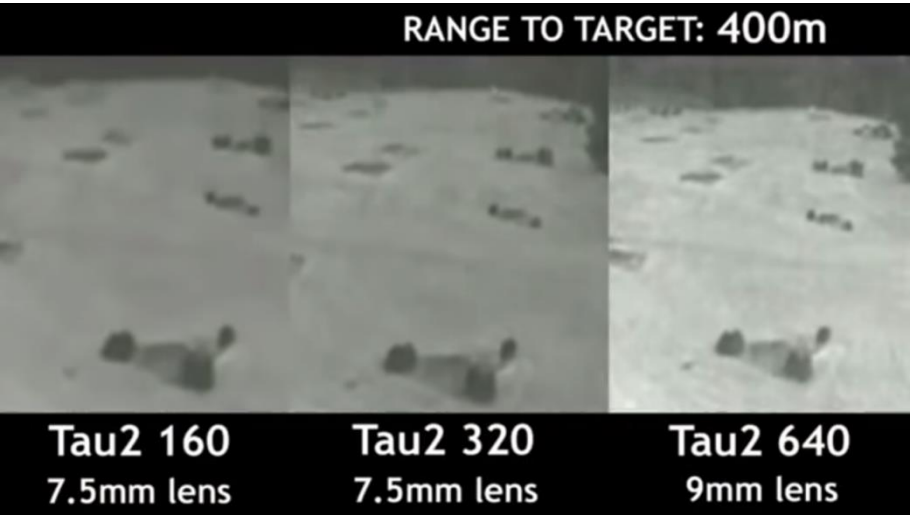
320x240

Resolution Comparison 160-320-640



Movie

Lens-res-distance



Rich Control & Viewing Options

FLIR Sensors Manager – FLIR's Preferred VMS

Dual Composite output on PT, Single on F

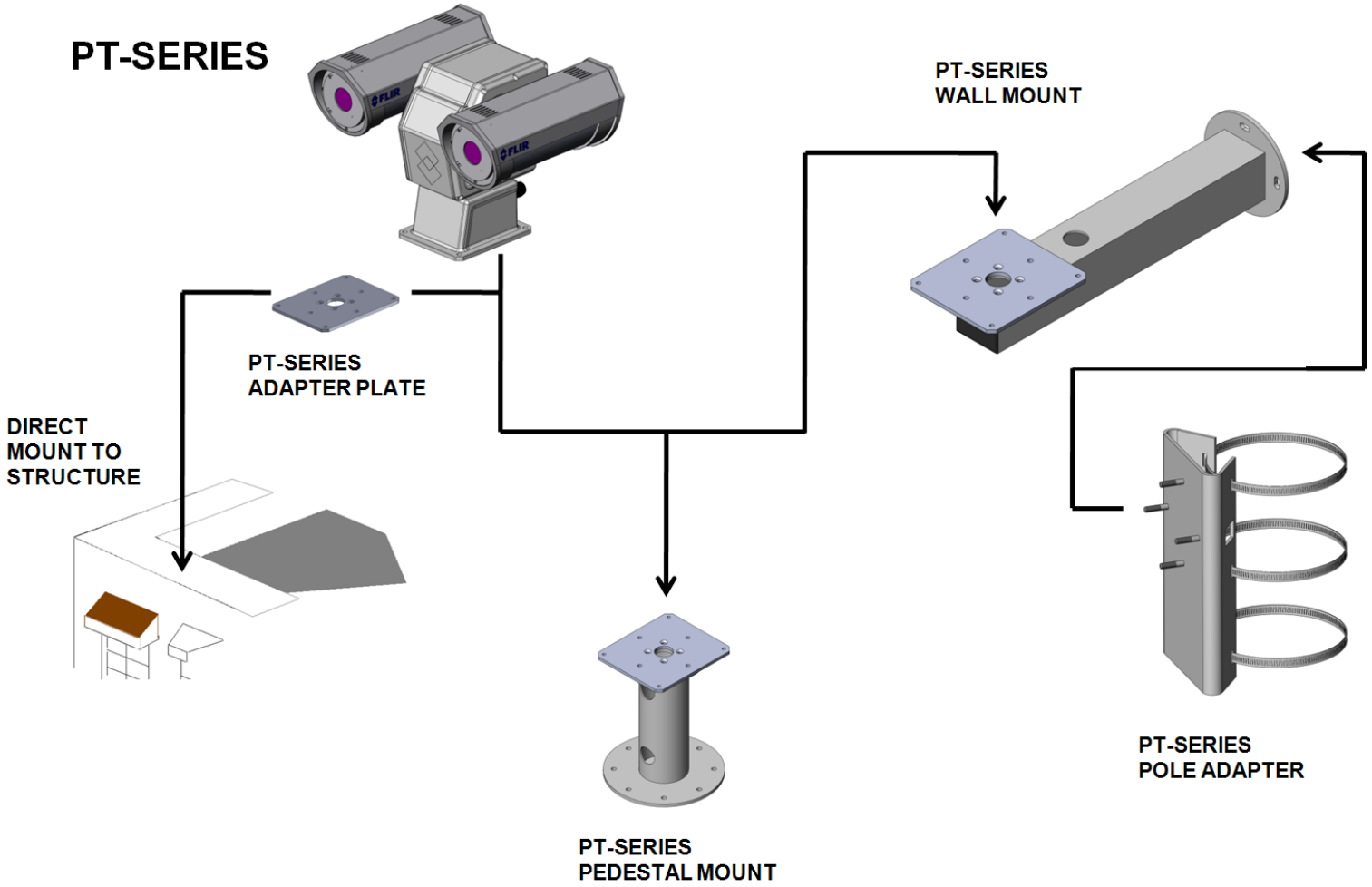
Third Party IP Video Management System

Serial control (Pelco, Bosch)

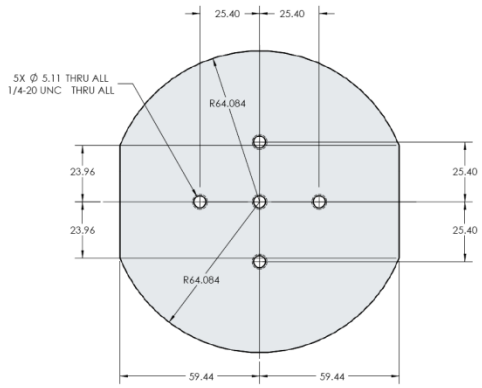
Sophisticated I/O Options

Function/Feature	F & PT Series
IP Control – FSM, Nexus, 3rd Party	Yes
Number of IP Video Channels	4 for PT-Series 2 for F-Series
Streaming Formats:	
H.264	Yes
MPEG-4	Yes
M-JPEG	Yes
Composite Video Outputs	2 for PT 1 for F
Serial Control	Yes
Simultaneous IP & Serial Control	Yes

PT-Series Mounting Options



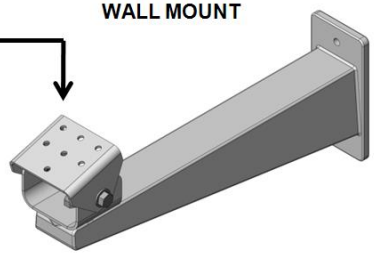
F-Series Mounting Options

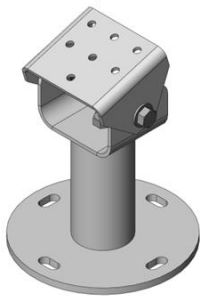


HOLE LAYOUT FOR FS BASE

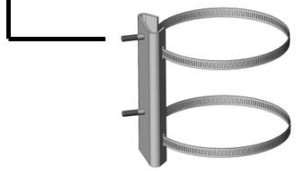
Common 1” mounting hole pattern compatible with large number of 3rd-party mounts

F-SERIES
WALL MOUNT





F-SERIES
PEDESTAL MOUNT



F-SERIES
POLE ADAPTER

F-Series & PT-Series Cameras

F-348 = 320x240 48° field of view

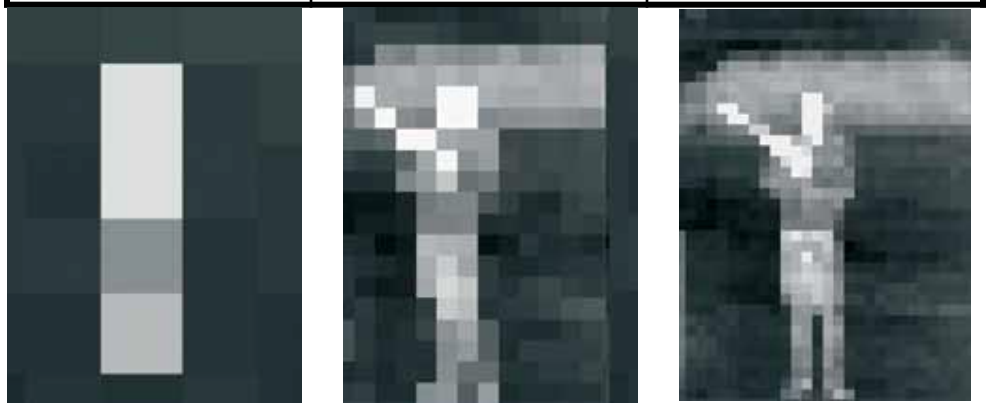
XX degree horizontal field of view

1=160x120, 3= 320 x 240, 6 = 640x480

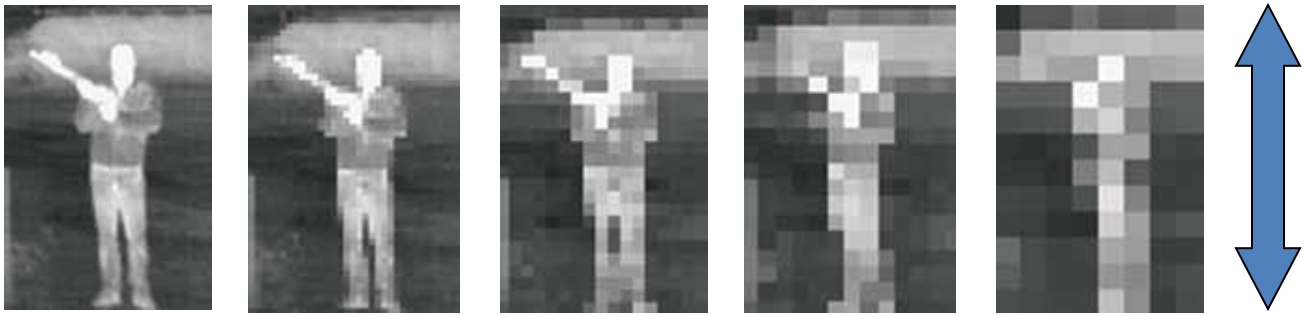
PT-124:	F-124: 9 mm lens – FOV: 24°(H) x 20°(V)
PT-117:	F-117: 13 mm lens – FOV: 17°(H) x 14°(V)
PT-112:	F-112: 19 mm lens – FOV: 12°(H) x 10°(V)
PT-348:	F-348: 9 mm lens – FOV: 48°(H) x 39°(V)
PT-334:	F-334: 13 mm lens – FOV: 34°(H) x 28°(V)
PT-324:	F-324: 19 mm lens – FOV: 24°(H) x 19°(V)
PT-313:	F-313: 35 mm lens – FOV: 13°(H) x 10°(V)
PT-307:	F-307: 65 mm lens – FOV: 7°(H) x 5°(V)
PT-304:	F-304: 100 mm lens – FOV: 4.6°(H) x 3.7°(V)
PT-645:	F-645: 13 mm lens – FOV: 45°(H) x 37° (V)
PT-625:	F-625: 25 mm lens – FOV: 25° (H) x 20°(V)
PT-618:	F-618: 35 mm lens – FOV: 18° (H) x 14°(V)
PT-612:	F-612: 50 mm lens – FOV: 12° (H) x 10°(V)
PT-610:	F-610: 65 mm lens - FOV: 10° (H) x 8°(V)
PT-606:	F-606: 100 mm lens – FOV: 6.2° (H) x 5°(V)

Human target DRI

Detection =	Recognition =	Identification =
3.6 pixels by 1 pixel	14.4 pixels by 4 pixels	28.8 pixels by 8 pixels



80px	60px	30px	20px	10px



Range performances for FC-S, SR-, F-, PT-, and D-Series with 320 x 240 pixels detector

Detection, Recognition, Identification of Human Target

9 mm lens	Detection approx. 230 m Recognition approx. 57 m Identification approx. 28 m
13 mm lens	Detection approx. 330 m Recognition approx. 82 m Identification approx. 41 m
19 mm lens	Detection approx. 490 m Recognition approx. 124 m Identification approx. 62 m
35 mm lens	Detection approx. 880 m Recognition approx. 225 m Identification approx. 112 m
35 mm lens with 17µm pixel pitch	Detection approx. 1,080 m Recognition approx. 320 m Identification approx. 160 m
50 mm lens	Detection approx. 1,280 m Recognition approx. 320 m Identification approx. 160 m
65 mm lens	Detection approx. 1,650 m Recognition approx. 410 m Identification approx. 205 m
100 mm lens	Detection approx. 2,400 m Recognition approx. 600 m Identification approx. 300 m

Detection, Recognition, Identification of Vehicle with 2.3 m critical dimension

9 mm lens	Detection approx. 700 m Recognition approx. 175 m Identification approx. 88 m
13 mm lens	Detection approx. 1,000 m Recognition approx. 250 m Identification approx. 125 m
19 mm lens	Detection approx. 1,500 m Recognition approx. 375 m Identification approx. 190 m
35 mm lens	Detection approx. 2,700 m Recognition approx. 680 m Identification approx. 340 m
35 mm lens with 17µm pixel pitch	Detection approx. 3,250 m Recognition approx. 950 m Identification approx. 495 m
50 mm lens	Detection approx. 3,800 m Recognition approx. 970 m Identification approx. 490 m
65 mm lens	Detection approx. 4,900 m Recognition approx. 1,250 m Identification approx. 630 m
100 mm lens	Detection approx. 7,100 m Recognition approx. 1,840 m Identification approx. 920 m

Range performances for FC-S, SR-, F-, PT- and D-Series with 640 x 480 pixels detector

Detection, Recognition, Identification of Human Target

13 mm lens	Detection approx. 440 m
	Recognition approx. 112 m
	Identification approx. 56 m
19 mm lens	Detection approx. 640 m
	Recognition approx. 160 m
	Identification approx. 80 m
25 mm lens	Detection approx. 930 m
	Recognition approx. 230 m
	Identification approx. 116 m
FC-Series S 35 mm lens	Detection approx. 1,080 m
	Recognition approx. 272 m
	Identification approx. 136 m
35 mm lens other models	Detection approx. 1,280 m
	Recognition approx. 320 m
	Identification approx. 160 m
50 mm lens	Detection approx. 1,700 m
	Recognition approx. 430 m
	Identification approx. 215 m
65 mm lens	Detection approx. 2,200 m
	Recognition approx. 550 m
	Identification approx. 275 m
100 mm lens	Detection approx. 2,950 m
	Recognition approx. 750 m
	Identification approx. 380 m

Detection, Recognition, Identification of Vehicle with 2.3 m critical dimension

13 mm lens	Detection approx. 1,340 m
	Recognition approx. 340 m
	Identification approx. 170 m
19 mm lens	Detection approx. 1,950 m
	Recognition approx. 500 m
	Identification approx. 250 m
25 mm lens	Detection approx. 2,800 m
	Recognition approx. 710 m
	Identification approx. 360 m
FC-Series S 35 mm lens	Detection approx. 3,250 m
	Recognition approx. 835 m
	Identification approx. 410 m
35 mm lens other models	Detection approx. 3,850 m
	Recognition approx. 950 m
	Identification approx. 495 m
50 mm lens	Detection approx. 5,100 m
	Recognition approx. 1,320 m
	Identification approx. 660 m
65 mm lens	Detection approx. 6,500 m
	Recognition approx. 1,650 m
	Identification approx. 840 m
100 mm lens	Detection approx. 8,800 m
	Recognition approx. 2,300 m
	Identification approx. 1,160 m

PT-602CZ

PT-series camera for long range applications

Daylight / Low light
zoom camera

Cooled, 640x512 px
Thermal camera

28º ~ 2º continuous
zoom AF lens

D-Series

24/7 Video Security Dome

D-Series Key features

- 24/7 Dome Replacement
  - 36X CCD + Thermal
- Aesthetically pleasing dome-style
- Network ready, **Plus** legacy serial & composite video
- Simple installation & integration
- Quad channel streaming IP video

Rich Control & Viewing Options

FLIR Sensors Manager – FLIR's Preferred VMS

Dual Composite output

Third Party IP Video Management System

Serial control (Pelco, Bosch)

IP Network control

D-Series Video & Control

Function/Feature	D-Series
IP Control – FSM, Nexus, 3rd Party	Yes
Number of IP Video Channels	2 per camera = 4
Streaming Formats:	
H.264	Yes
MPEG-4	Yes
M-JPEG	Yes
Composite Video Outputs	1 per camera = 2
Serial Control	Yes
Simultaneous IP & Serial Control	Yes

D-Series Lens Options

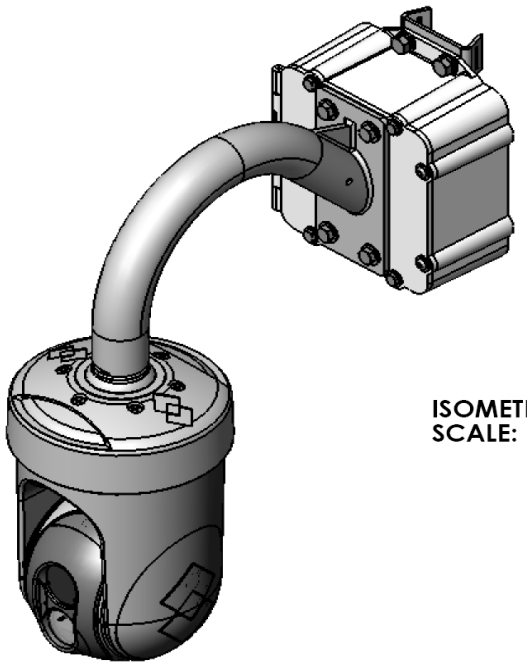
D-348

48 degree horizontal field of view

320 x 240 thermal imager

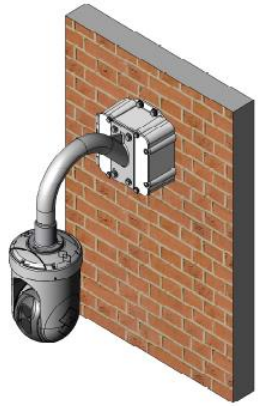
D-348: 9 mm lens – FOV: 48°(H) x 39°(V)
D-334: 13 mm lens – FOV: 34°(H) x 28°(V)
D-324: 19 mm lens – FOV: 24°(H) x 19°(V)
D-313: 35 mm lens – FOV: 13°(H) x 10°(V)
D-645: 13 mm lens – FOV: 45°(H) x 37°(V)
D-625: 25 mm lens – FOV: 25°(H) x 20°(V)
D-618: 35 mm lens – FOV: 18°(H) x 14°(V)

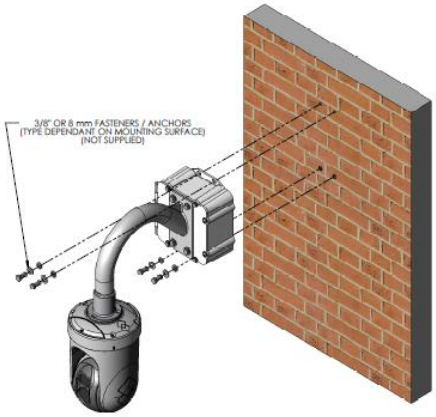
D-Series Kit Contents

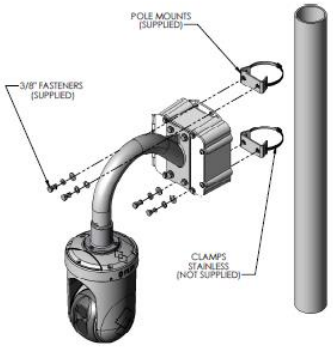


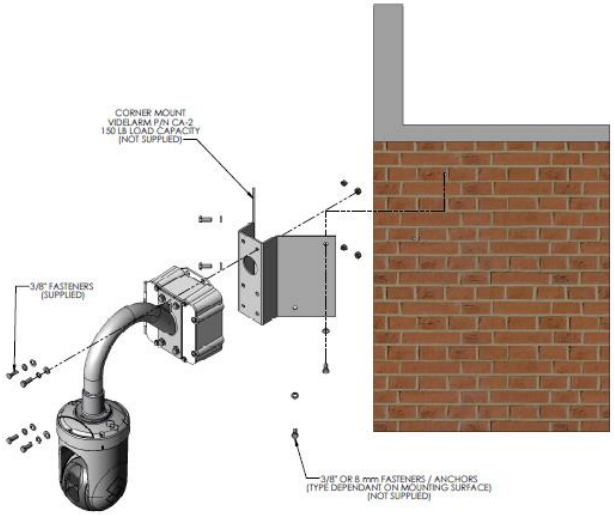
- Dome/turret
- Mounting Arm
- Back-box miniserver
- Pole mount hardware
- FLIR Sensors Manager single sensor license
- Installation guide

D-Series Mounting Options







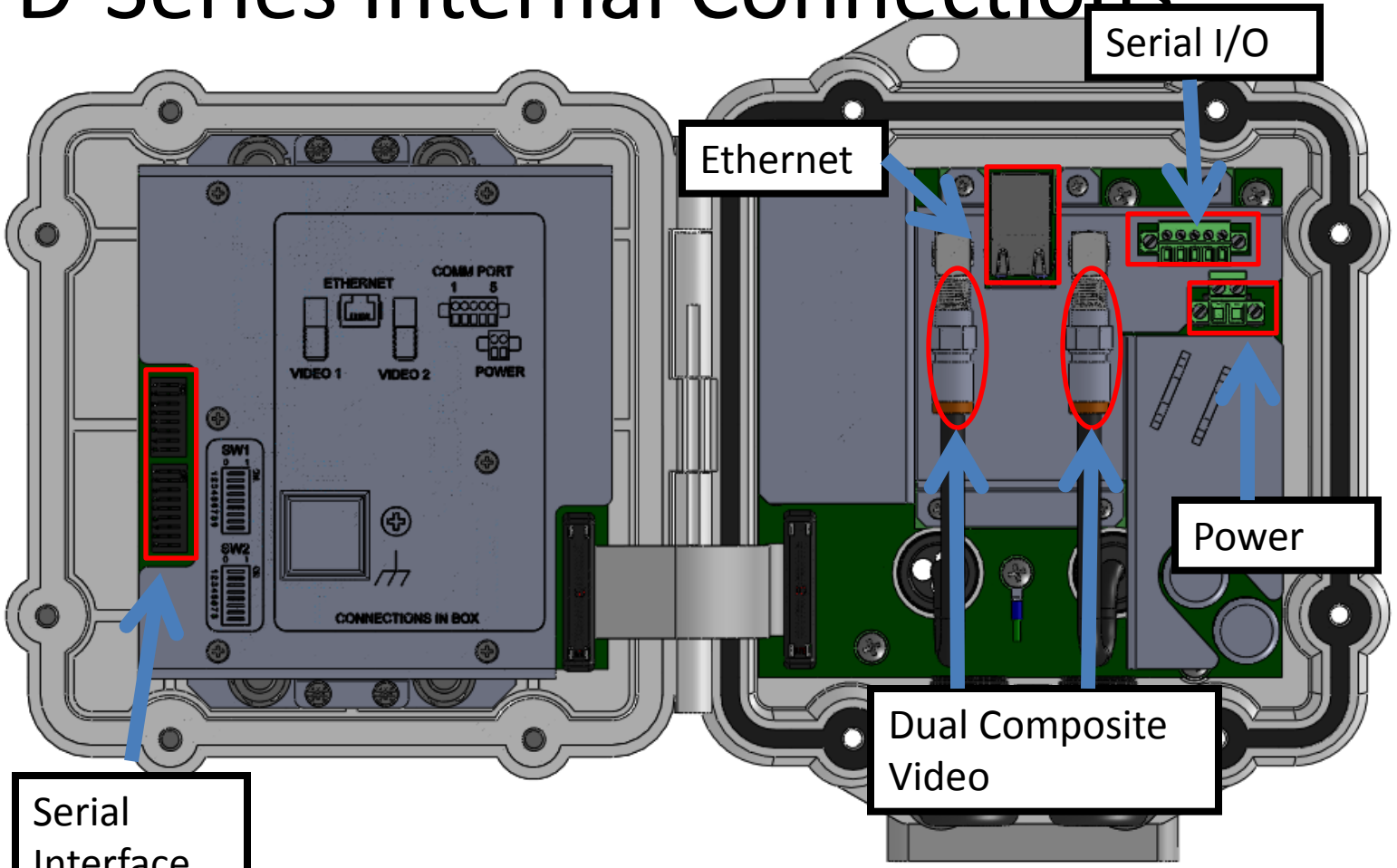


Cable Installation Examples

Shown with dual conduits on building surface

Concealed connections via rear panel

D-Series Internal Connections



FLIR FC-S

WDR THERMAL

- With / Without WDR Thermal

FC-Series

- PoE and Easy Installation

FLIR FC-S

Specifications

Camera Model	FC-Series	FC-Series
Thermal Camera		
Array Format (NTSC)	320 x 240	640 x 480
Detector Type	Long-Life, Uncooled VOx Microbolometer	
Effective Resolution	76,800	307,200
Pixel Pitch	25 µm	17 µm
Field of View	63° x 50° (FC-363; 7.5 mm) 48° x 39° (FC-348; 9 mm) 34° x 28° (FC-334; 13 mm) 24° x 19° (FC-324; 19 mm) 13° x 10° (FC-313; 35 mm) 9° x 7° (FC-309; 35 mm, 17 µm)	90° x 69° (FC-690; 7.5 mm) 69° x 56° (FC-669; 9 mm) 45° x 37° (FC-645; 13 mm) 32° x 26° (FC-632; 19 mm) 18° x 14° (FC-618; 35 mm)
Zoom	Continuous E-zoom, up to 4X	
Spectral Range	7.5 µm to 13.5 µm	
Focus Range	Athermalized, focus-free	
Outputs		
Composite Video NTSC or PAL	Yes; Hybrid system with IP & Analog video	
Video over Ethernet	Two independent channels of H.264, MPEG-4 & M-JPEG (see website for full details)	
Streaming Resolution	D1: 720x576, 4CIF: 704x576, Native: 640x512, Q-Native: 320x256, CIF: 352x288, QCIF: 176x144	
Control		
Ethernet	Yes	
External Analytics Compatible	Yes	

FLIR FC-S

Video	
Composite Video NTSC or PAL	Yes: Hybrid IP & Analog
Video Compression	Two independent channels of H.264, MPEG-4 & M-JPEG
Streaming Resolution	D1: 720 × 576 4CIF: 704 × 576 Native: 640 × 512 Q-Native: 320 × 256 CIF: 352 × 288 QCIF: 176 × 144
Thermal AGC Modes	Auto AGC, Manual AGC, Plateau Equalization AGC, Linear AGC, Auto Dynamic Detail Enhancement (DDE), Max Gain Setting
Thermal AGC Region of Interest (ROI)	Default, Presets and User definable to insure optimal image quality on subjects of interest
Image Uniformity Optimization	Automatic Flat Field Correction (FFC) - Thermal and Temporal Triggers

FLIR FC-S

System Integration	
Ethernet	Yes
Serial Control Interfaces	No
External Analytics Compatible	Yes
Network APIs	Nexus SDK for comprehensive system control and integration Nexus CGI for http command interfaces ONVIF 2.0 Profile S
Network	
Supported Protocols	IPV4, HTTP, Bonjour, UPnP, DNS, NTP, RTSP, RTCP, RTP, TCP, UDP, ICMP, IGMP, DHCP, ARP, SCP

FLIR FC-S

Power Consumption (Consult product manuals for details of power requirements)	PoE (IEEE 802.3af-2003) PoE+(IEEE 802.3at-2009 standard) 11-56 VDC 12-38 VAC
Enivronmental	
IP Rating (dust & water ingress)	IP66
Operating Temperature Range	-50°C to 70°C (continuous operation) -40°C to 70°C (cold start) 55°C high-temp op limit w/black paint
Storage Temperature Range	-55°C to 85°C
Humidity	0-95% relative
Shock	IEC 60068-2-27 10g shock pulse with a 11 ms half-sine profile
Vibe	MIL-STD-810F "Transportation"
Handling Shock	FedEx free-fall drop test
De-Icing / Anti-Icing	MIL-STD-810F, Method 521.1; 6 mm of ice

SR-Series

- SR-Series – world leader
- Plug & play – no control required.
- Composite Video & Serial

SR-Series – World's Most Popular Thermal

SR-348 = 320 x 240 48° field of view

XX degree horizontal field of view

1=160x120, 3= 320 x 240, 6 = 640x480

SR-124: 9 mm lens – FOV: 24°(H) x 20°(V)
SR-117: 13 mm lens – FOV: 17°(H) x 14°(V)
SR-112: 19 mm lens – FOV: 12°(H) x 10°(V)
SR-348: 9 mm lens – FOV: 48°(H) x 39°(V)
SR-334: 13 mm lens – FOV: 34°(H) x 28°(V)
SR-324: 19 mm lens – FOV: 24°(H) x 19°(V)
SR-313: 35 mm lens – FOV: 13°(H) x 10°(V)
SR-309: 50 mm lens – FOV: 9°(H) x 7°(V)
SR-304: 100 mm lens – FOV: 4.6°(H) x 3.7°(V)
SR-645: 13 mm lens – FOV: 45°(H) x 37°(V)
SR-625: 25 mm lens – FOV: 25°(H) x 20°(V)
SR-618: 35 mm lens – FOV: 18°(H) x 14°(V)
SR-612: 50 mm lens – FOV: 12°(H) x 10°(V)
SR-606: 100 mm lens – FOV: 6.2°(H) x 5°(V)

PTZ-35X140MS & SR-35x140MS

- Three sensors
  - 5° narrow thermal
  - 20° wide thermal
  - 26X Zoom day/night
- Virtual Zoom
- Robust, precision PTZ
- IP Video/Control + composite video & serial control

Indoor D-Series

- PT dome
- Ideal for:
  - Security
  - Safety – see through smoke
  - Green – no lighting
- Prisons, warehouses, public venues, casinos
- Lowest-cost pan-tilt thermal on the market

Model	Resolution	FOV
D-19	320x240	36˚ x 27˚
D-6	160x120	52˚ x 40˚

FLIR TCX – low cost thermal camera

- Detection with built-in VMD or third-party analytics
- Detection Range: 50° ~ 20m, 25° ~ 40m

Camera Model	TCX Thermal Mini Bullet
	Fixed IP/MPX/analog Thermal Camera
Image Sensor	Uncooled Sun-safe VOx Microbolometer
Resolution	80 x 45
Thermal FOV	25° or 50°
Video Outputs	IP, MPX & analog video outputs
IP Video	H.264 and MJPEG
ONVIF Conformance	Profile S
On-board Video Motion Detection	Yes, 4 independent VMD masks
Event notifications	Email (SMTP) , Recording, Snapshot
Alarm Event Scheduler	Yes
AGC Region of Interest	Yes
Privacy Masking	Yes
Video Overlay Options	Time, Picture, Channel Name, Custom
Human Detection Range	20m for 50°, 40m for 25°

Technology Common to All FLIR Security Cameras

Auto Digital Detail Enhancement (DDE)

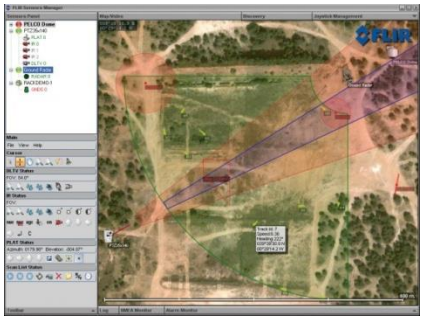
Traditional AGC	FLIR Proprietary Auto DDE
	
	

NEXUS & FLIR Sensors Manager

Each FLIR Network camera includes Nexus which provides <u>embedded</u> intelligence & connectivity.

FLIR Sensors Manager

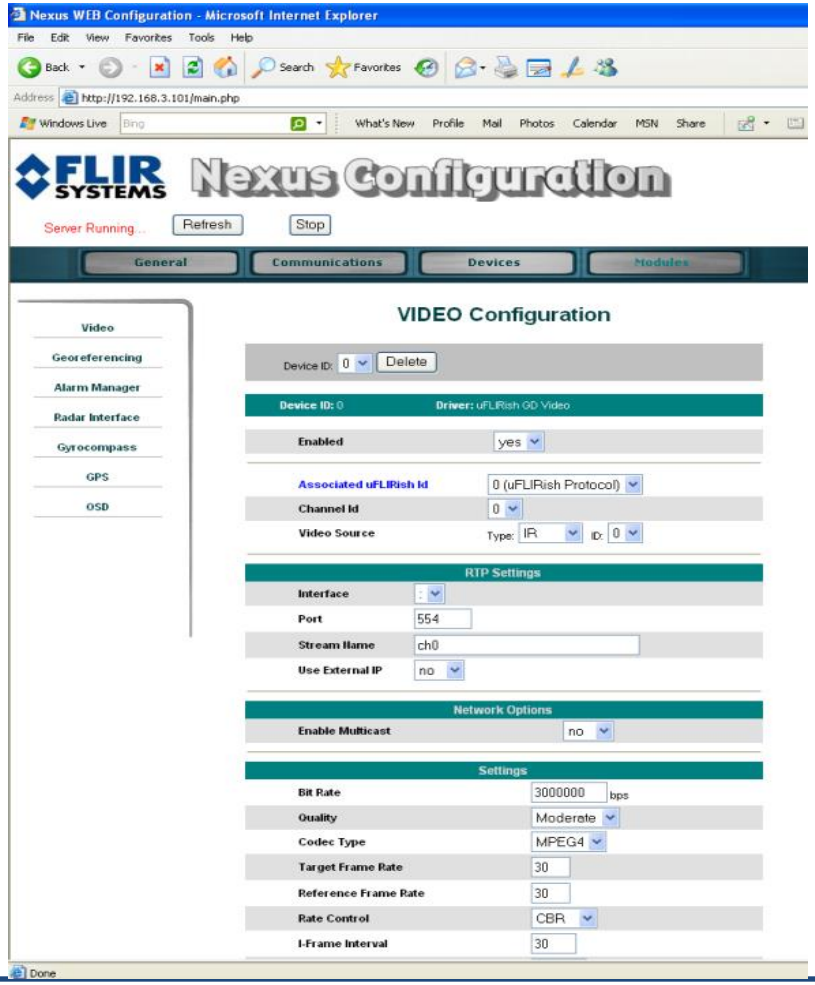
FLIR Nexus network cameras know what cameras, lenses and features they have, and know their GPS location.



Sensor Mapping & Slew to alarm

Sensor discovery & Video wall

IP Camera Configuration



Third-Party IP Compatibility

- FSM is the preferred Video Management System (VMS)
- FLIR IP video conforms to open standards
- FLIR has adopted ONVIF as the standard for 3rd party compatibility

Examples of Onvif members:

FLIR strengths

- FLIR offer a 10 year warranty on the uncooled detector. 3 years on the fixed camera and 2 years on the PTZ
- The Vox detector can look into the sun without damage, Axis use a silicon detector which is damaged. Bosch use a FLIR detector.
- DDE gives FLIR the best image in the market
- FLIR are the thermal experts, other usually sell many other products.
- The FLIR range is the most extensive in the market.
- The payloads are changeable on many products for service and repair.
- The surge protection from FLIR is the best in the market.
- VoX detectors offer a higher F-number and increased sensitivity.

SECURITY

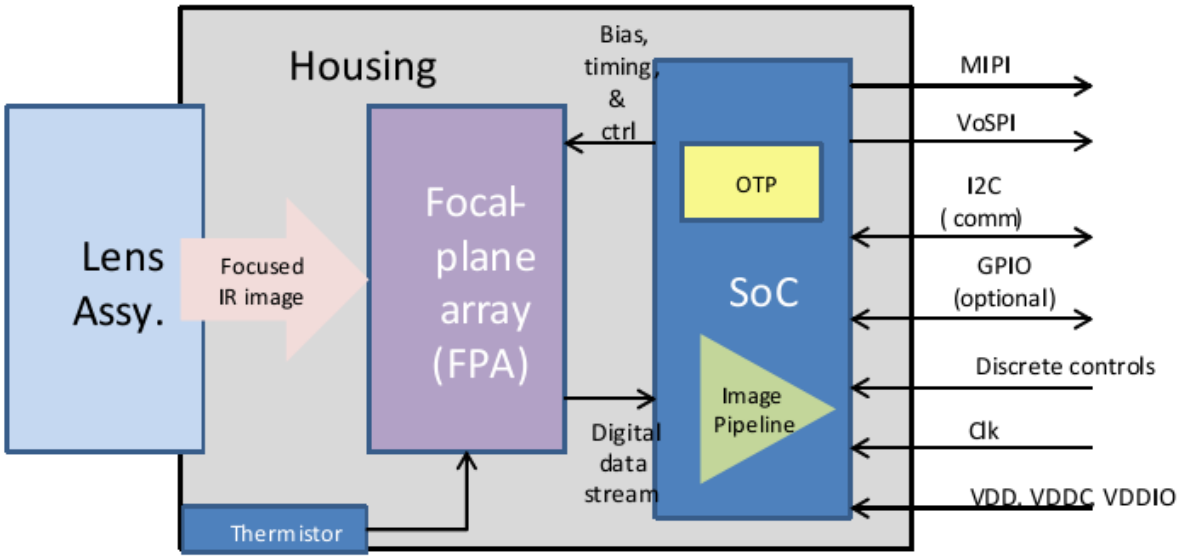
Solar Immunity

- Many security cameras are installed in locations where they view the sun for extended periods of time
- FLIR uses VOx detector technology which is immune to permanent damage from the sun
- Other systems based on amorphous silicon are known to be susceptible to permanent damage to the sensor

6.0 System Architecture

A simplified architectural diagram of the Lepton camera module is shown in ***Figure 4***.

Figure 4 Lepton Architecture



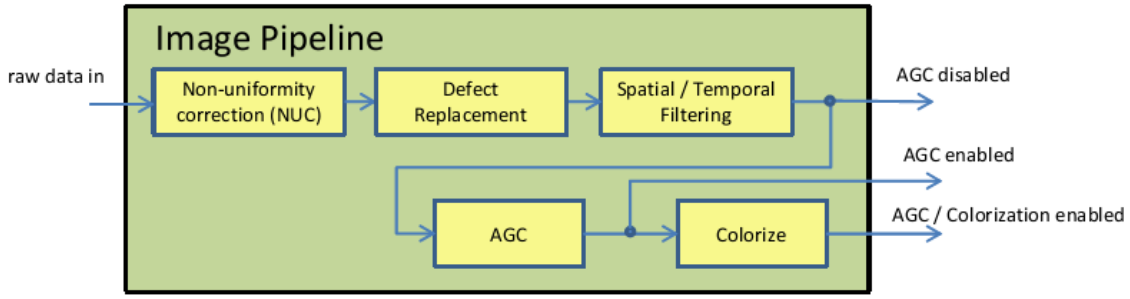
The lens assembly focuses infrared radiation from the scene onto an 80x60 array of thermal detectors with 17-micron pitch. Each detector element is a vanadium-oxide (VOx) microbolometer whose temperature fluctuates in response to incident flux. The change in temperature causes a proportional change in each microbolometer's resistance. VOx provides a high temperature coefficient of resistance (TCR) and low 1/f noise, resulting in excellent thermal sensitivity and stable uniformity. The microbolometer array is grown monolithically on top of a readout integrated circuit (ROIC) to comprise the complete focal plane array (FPA). Once per frame, the ROIC senses the resistance of each detector by applying a bias voltage and integrating the resulting current for a finite period of time called the integration period.

The serial stream from the FPA is received by a system on a chip (SoC) device, which provides signal processing and output formatting. The image pipeline is defined in ***Video Pipeline, page 12***.

7.0 Video Pipeline

A block diagram of the video pipeline is shown in *Figure 5*.

Figure 5 Lepton Video Pipeline Block Diagram



The video pipeline includes non-uniformity correction (NUC), defect replacement, spatial and temporal filtering, automatic gain correction (AGC), and colorization.

7.1 NUC

The non-uniformity correction (NUC) block applies correction terms to ensure that the camera produces a uniform output for each pixel when imaging a uniform thermal scene. Factory-calibrated terms are applied to compensate for temperature effects, pixel response variations, and lens-illumination roll-off. To compensate for temporal drift, the NUC block also applies an offset term that can be periodically updated at runtime via a process called flat-field correction (FFC). The FFC process is further described in *FFC States, page 17*.

7.2 Defect Replacement

The defect-replacement block substitutes for any pixels identified as defective during factory calibration or during runtime. The replacement algorithm assesses the values of neighboring pixels and calculates an optimum replacement value. The typical number of defective pixels is ≤1.

7.3 Spatial / Temporal Filtering

The image pipeline includes a number of sophisticated image filters designed to enhance signal-to-noise ratio (SNR) by eliminating temporal noise and residual non-uniformity. The filtering suite includes a scene-based non-uniformity correction (SBNUC) algorithm which relies on motion within the scene to isolate fixed pattern noise (FPN) from image content.

7.4 AGC

The AGC algorithm for converting the full-resolution (14-bit) thermal image into a contrast-enhanced image suitable for display is a histogram-based non-linear mapping function. See *AGC Modes, page 25*.